City of Kitchener

Official Plan Climate and Energy Technical Background Study

April 2025

Climate Mitigation & Adaptation Report

Image: The Old City Hall Clock Tower, Kitchener. Source: Adobe Stock under SSG's license.

Prepared for

City of Kitchener

Prepared by

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Glossary and Terms

Term	Definition
AMOC	Atlantic Meridional Overturning Circulation
ASHP	Air Source Heat Pump
BIPV	Building-Integrated Photovoltaics
BPS	Building Performance Standards
C40	Cities Climate Leadership Group
CCAP	Community Climate Adaptation Plan (Region of Waterloo)
CCCR	Canada's Changing Climate Report
CCHVA	Climate Change and Health Vulnerability Assessment
CDM	Conservation and Demand Management
CEIS	Community Energy Investment Strategy
CFE	Carbon-Free Energy
CO_2	Carbon Dioxide
COP	Conference of the Parties
CPI	Consumer Price Index
CRVA	Climate Risk and Vulnerability Assessment
CUSP	Canadian Urban Sustainability Practitioners
DER	Distributed Energy Resource
ECCC	Environmental and Climate Change Canada
EV	Electric Vehicle
FSR	Floor Site Ratio

Term	Definition
GCM	Global Climate Model
GHG	Greenhouse Gas Emissions
GRCA	Grand River Conservation Authority
GRT	Grand River Transit
$GtCO_2e$	Gigatonnes of Carbon Dioxide Equivalents
HPDS	High Performance Development Standards
IBC	Insurance Bureau of Canada
IESO	Independent Electricity System Operator
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
IPCC	Intergovernmental Panel on Climate Change
IPSASB	International Public Sector Accounting Standards Board
LEED	Leadership in Energy and Environmental Design
LIC	Local Improvement Charge
LRT	Light Rail Transit
MURB	Multi-Unit Residential Buildings
NDC	Nationally Determined Contribution
NIR	National Inventory Report
OEB	Ontario Energy Board
OP	Official Plan
PPS	Provincial Planning Statement
PSAB	Public Sector Accounting Board

Term	Definition
PV	Photovoltaic
RCP	Representative Concentration Pathway
RNG	Renewable Natural Gas
ROP	Regional Official Plan
S:V	Surface-to-Volume Ratio
SSP	Shared Socioeconomic Pathway
UNFCCC	The United Nations Framework Convention on Climate Change
VKT	Vehicle Kilometers Travelled
ZEV	Zero-Emission Vehicle

Executive Summary

Kitchener is projected to grow from an estimated population of 300,000 today to approximately 446,000 by 2051. To plan for this growth, the City is currently updating its Official Plan (OP), which was last updated in 2014. Over the past 10 years, the provincial framework for government planning in Ontario has been updated, including through amendments to the Planning Act and with the adoption of the Provincial Planning Statement (2024), which replaced the Provincial Policy Statement (2020) and the Province's Growth Plan for the Greater Golden Horseshoe (2019). In addition, the Region of Waterloo has updated its OP. As a result, the City of Kitchener's new OP will need to align with provincial and regional changes while focusing on the City's proposed key themes:

Key Themes

- Housing supply, choice, and affordability;
- Energy transition and climate change;
- Complete walkable communities;
- Sustazinable, safe, and equitable transportation;
- Parks, open spaces, and community infrastructure;
- Supported growth;
- Economic health; and
- An equity-based approach to, and useability of, the OP.[1]

The new OP offers the opportunity to bring about systemic change through designing how Kitchener will grow and evolve. The OP can leverage numerous opportunities to enable the city's transition to net-zero emissions. Municipalities generally prepare for climate change mitigation and adaptation through specialized plans, such as community energy plans, climate change action plans, or climate change adaptation plans. These plans are important standalone documents that outline a community's energy use and emissions, and vulnerabilities and risks associated with climate change, as well as mitigation and adaptation strategies and measures. However, a comprehensive approach to climate risks requires an integrated approach with existing regulatory frameworks, such as the OP, to ensure systematic and effective implementation.[2]

The OP provides policies and a decision-making framework on land-use planning, development, infrastructure, and transportation—all of which are intrinsically linked to greenhouse gas (GHG) emissions and climate change. An OP influences emissions by

1 City of Kitchener. "Building a Connected City Together: New Official Plan Launch," February 7, 2024. https://pub-kitchener.escribemeetings.com/filestream.ashx?DocumentId=16113.

2 C40 Cities Climate Leadership Group, Global Platform for Sustainable Cities (GPSC), "Integrating Climate Adaptation: A Toolkit for Urban Planners and Adaptation Practitioners," October 20, 2024. https://www.c40knowledgehub.org/s/article/Integrating-Climate-Adaptation-A-toolkit-for-urban-planners-and-adaptation-practitioners?language=en_US.

determining the land-use patterns and other characteristics of the built environment. The land-use planning, development, infrastructure, and transportation decisions made today will determine the climate impacts and development outcomes for several generations to come. These decisions can either lock in high energy intensity and emission pathways, or lead to building a climate-resilient, affordable, and sustainable future which benefits both people and the environment.

The declaration of climate emergencies by many municipalities, such as the City of Kitchener, produces a range of challenges and imperatives. The climate emergency is unique in that some of the challenges can be acted upon immediately and produce quick results, while many others can only be addressed on a longer time scale. Many aspects of an OP direct changes in the siting of development and urban form, which take years to influence how a community functions. Conversely, some actions adopted through OP policies, such as changes to by-laws governing development, can have near-term effects. Like all municipal planning, decisions related to climate change typically have multiple consequences and work best with a holistic and integrated approach.[3]

Most fundamentally, a climate-aligned OP must plan for more efficient use of energy and the phase-out of fossil fuels, along with their replacement with non-emitting energy sources. Together, these refer to: the energy transition. The OP must consider the economic, infrastructure, social, and equity implications of a near-term future in which natural gas is no longer used for heating, and gasoline and diesel are no longer used in vehicles. Replacement technologies are already economically viable, but the OP must anticipate how these technologies will change the functioning of the community, enable their rapid deployment, and continue to influence the development of the community while achieving multiple other objectives.

Similarly, the City can help safeguard the community from climate change risks and vulnerabilities by incorporating adaptation strategies into the OP through land-use and other policy decisions. This is crucial because many decisions made today can have long-lasting effects on a community's built-form and climate change resilience.[4]

3 Stechemesser, Annika, Nicolas Koch, Ebba Mark, Elina Dilger, Patrick Klösel, Laura Menicacci, Daniel Nachtigall, et al. "Climate Policies That Achieved Major Emission Reductions: Global Evidence From Two Decades." Science 385, no. 6711 (August 22, 2024): 884–92. https://doi.org/10.1126/science.adl6547.

4 Bai, Xuemei, Ryan Rj McAllister, R Matthew Beaty, and Bruce Taylor. "Urban Policy and Governance in a Global Environment: Complex Systems, Scale Mismatches and Public Participation." Current Opinion in Environmental Sustainability 2, no. 3 (June 14, 2010): 129–35. https://doi.org/10.1016/j.cosust.2010.05.008.

The Study

The purpose of the Official Plan Climate and Energy Technical Background Study ("the study") is to provide the City of Kitchener with strategic direction on how to create an OP that is climate-ready. The study offers a policy framework that can be used to support the achievement of the City's climate mitigation, adaptation, and energy goals and targets. In doing so, the study aims to investigate the following questions:

How does Kitchener need to change the way it grows to reduce GHG emissions by at least 80% by 2051?

What policies does the OP need to include to support, and be ready for, the clean energy transition?

How does the Kitchener of today need to change to reduce risks to the health of the community and its infrastructure, arising from climate change?

The first and second stages of research which informed this study focused on energy transition and climate mitigation, while the third and fourth looked at climate change adaptation strategies. The research, findings, and recommendations from these stages were used to inform this study.

The first stage of research provided an overview of the key factors that will likely influence the energy transition and climate mitigation strategies developed in the City's new OP. It aimed to evaluate and describe the trends and disruptors that influence energy and emissions in Kitchener, including those in technology, urban development patterns, transportation behaviour, and economic development. This research was the basis for understanding the state of Kitchener's policies related to energy and climate, as well as policies at other orders of government. The work presented in this document draws on the principles of community energy and emissions planning which is used to, first, quantify the relationship between GHG emissions and municipal decision-making, and second, identify strategies to reduce emissions and avoid lock-in to a high-emissions pathway.

The second stage of research considered how the City's new OP can reflect and direct action to mitigate the climate emergency by addressing GHG emissions. The outcome of this research was a proposed method to track the implementation and impact of the policies presented as part of the study. This included framing the City's response to the climate emergency by integrating "Big Moves" as overarching, transformative concepts, and using a target-setting approach and a set of principles as a framework to create OP policies.

The third stage of research provided a summary of the background and policy context of climate change adaptation in Kitchener, as well as findings from a gap analysis. It drew upon findings that a changing climate poses the highest risk to food and agriculture, infrastructure, the natural environment, people and communities, and business and the economy in Kitchener.

Lastly, the fourth stage of research identified policy directions and areas of influence that can be incorporated into the OP, building upon all previous research. It established guiding principles which can frame policy directions, development, and implementation approaches. This document includes recommended policies, organized by overarching policy areas and their purpose, with example statements under each category to inform language for the new OP.

Findings

Insights from the various research stages are listed below and shape the context described in the appendices. These findings directly informed the policy themes recommended via the Big Moves in this study.

Climate Impacts

1. Climate change has resulted in **widespread adverse impacts and related losses and damages** to nature and people.
2. Standardized frameworks are used to evaluate future climate impacts.
3. Climate hazards are **increasingly severe** and their impacts **increasingly disruptive**.
4. **Economic costs** of extreme weather are both direct (e.g., physical damage to infrastructure or buildings) and indirect (e.g., revenue loss for businesses, temporary unemployment, health impacts).
5. Like most places, Kitchener will become **warmer, wetter, and wilder**.
6. Physical and ecological infrastructure are **both vulnerable and sources of resilience**.

The Response

7. A radical reduction in GHG emissions is **urgent**.
8. The world now **invests almost twice as much in clean energy** as it does in fossil fuels.
9. Governments and private sector entities are being increasingly challenged and held accountable **through the legal system** for their limited or inadequate response to climate change.

The Role of Cities

10. Cities play increasingly recognized roles in global climate change responses as **change laboratories, spaces of opportunity, and administrative and economic hubs** that concentrate human and financial resources and needs. They host high climate mitigation potential and acute climate adaptation vulnerabilities.
11. Cities are seeking to **align their response with science** but are constrained by financial and policy limitations.
12. Cities have **agency to take climate action** which includes, but is not limited to, municipal administration, municipal policy-making, and municipally owned corporations.

Kitchener's Context

13. In 2019, the City of Kitchener joined 2,364 jurisdictions and municipalities around the world in **declaring a climate emergency**.
14. A dynamic and growing city, with **a history of leadership in climate and energy**, Kitchener is well-positioned for leadership in planning policy.
15. Future growth brings investments, which could lead to **locking in more GHG emissions and physical risks** from climate change.
16. Kitchener is closely linked geographically to its neighbouring municipalities, **requiring a coordinated regional approach** to address many urban issues.
17. A dispersed community, Kitchener is both **investing and focusing growth in its downtown and in neighbourhoods around major transit stations**. This presents an opportunity for district energy and zero emissions transportation through a more transit-oriented approach to development across the city.
18. Many **urban streets can be transformed** into places where motor vehicles place only a modest claim on the public realm; Kitchener has begun this journey.
19. Kitchener is one of a few municipalities in Ontario that **owns the local gas distribution utility**, and is a **shareholder in the electrical distribution utility**, enabling better coordination of energy and development planning.
20. **Transportation and heating** are the major sources of GHG emissions in Kitchener.

21. **Solar photovoltaic (PV)**, the cheapest and most flexible form of renewable electricity, is Kitchener's best option for renewable electricity, and it can be complemented by **geothermal and waste heat sources**.
22. At least **one-quarter of the population is highly vulnerable** to climate hazards in Kitchener, either because of socio-economic factors that limit their ability to adapt in the absence of necessary supports, or due to physical considerations such as being located within flood-prone areas.

The OP

23. An OP is a document which **guides future development** of an area in the best interests of the community as a whole.
24. The City of Kitchener's 2014 OP includes **many elements that support climate action**.
25. The new OP can include a **systematic approach** to climate planning.
26. The OP can combine credible policy strategies with a consistent mix of policy instruments designed to **create synergies and avoid conflicts**.
27. The OP offers opportunities to **design how the city will grow and change**, and leverage numerous opportunities including a skilled workforce, strong community, diversity, and new mobility technologies.
28. A **rigorous multi-stage process** was applied to identify possible policies for inclusion in the City's OP.

In Conclusion

29. Climate change **changes everything**, and as a future-focused document, the **OP must contemplate a fundamentally changed world**.

Kitchener's Big Moves

The research findings describe a City with an extensive track record on development and planning that prioritizes climate and energy, and has coordinated closely with its neighbouring jurisdictions in the region. This experience and knowledge is the foundation which can enable the City to lead with a comprehensive and systematic policy approach to climate change.

The urgency of the response to climate change grows every minute, day, and year. A plan that reaches into the future must contemplate a future that is very different from the present in every way, as current projections indicate that climate change and its impacts will disrupt everything. As this study demonstrates, it is not possible to overstate the existential nature of climate change.

Responding to climate change is also an opportunity to decrease costs, stimulate new businesses and jobs, improve health outcomes, and enhance the quality of living in Kitchener. This upside is recounted in many of the policy recommendations identified in this study. An extensive list of policies was drafted, drawing from reports, academic literature, the project team's experiences, and best practices from other contexts; in some cases, the policies were developed in response to specific aspects of climate risk or energy transition. These policies were sorted, refined, and revised to reflect Kitchener's specific context. They were then evaluated, refined again, scored, and classified into recommendations on the Big Moves (Table 1).

Table 1. Kitchener's Big Moves.

#	Big Moves	Policy Themes	
1	Municipal Leadership	1.	Targets
		2.	Guiding Principles
		3.	Innovation
		4.	Climate-Ready Infrastructure
		5.	Municipal Operations
		6.	Municipal Finance
		7.	Collaboration
2	Natural Infrastructure	8.	Precautionary Approach to Climate Hazards
		9.	Ecosystem-Based Services
		10.	Climate Adaptive Land-Use
		11.	Vulnerable Populations
		12.	Green Infrastructure

#	Big Moves	Policy Themes	
3	Energy Transition	13.	Clean Electricity
		14.	Clean Heat
4	Compact, Complete Communities	15.	Compactness
		16.	Reenvisioning Streets
		17.	Multi-Functional Hubs
		18.	From Roads to Accessibility Corridors
5	Climate-Ready Buildings	19.	Urban Form for the Future
		20.	Building Benchmarking
		21.	Zero-Emissions New Buildings
		22.	Zero-Emissions New Homes
		23.	Zero-Emissions Existing Buildings
		24.	Deep Home Retrofits
6	Sustainable Consumption	25.	Waste to Resources
		26.	Local Food Production
7	Resilience Hubs	27.	Resilience Hubs
8	Preparing for Emergencies	28.	Climate Emergency Preparedness
9	Learning While Doing	29.	Tracking Progress

Kitchener's Big Moves

1 Municipal Leadership

1. Targets
2. Guiding Principles
3. Innovation
4. Climate Ready Infrastructure
5. Municipal Operations
6. Municipal Finance
7. Collaboration

2 Natural Infrastructure

8. Precautionary Approach to Climate Hazards
9. Ecosystem-based Services
10. Climate Adaptive Land-use
11. Vulnerable Populations
12. Green Infrastructure

3 Energy Transition

13. Clean Electricity
14. Clean Heat

4 Compact, Complete Communities

15. Compactness
16. Reenvisioning Streets
17. Multi-functional Hubs
18. From Roads to Accessibility Corridors

5 Climate Ready Buildings

19. Urban Form for the Future
20. Building Benchmarking
21. Zero Emissions New Buildings
22. Zero Emissions New Homes
23. Zero Emissions Existing Buildings
24. Deep Home Retrofits

6 Sustainable Consumption

25. Waste to Resources
26. Local Food Production

7 Resilience Hubs

27. Resilience Hubs

8 Preparing for Emergencies

28. Climate Emergency Preparedness

9 Learning while Doing

29. Tracking Progress

Introduction

The Climate Emergency

The City of Kitchener declared a climate emergency in 2019,[5] joining 2,364 jurisdictions and municipalities around the world.

In August 2024, the remnants of Hurricane Debby set rainfall records and brought record-breaking floods to Quebec, inundating 55 communities. Just a month before, nearly 10 centimetres of rain fell in Toronto in three hours, causing nearly $1 billion in insured damages alone.[6] In July 2024, a wildfire devastated the iconic mountain village of Jasper. A single week of wildfire smoke in June 2023 was estimated to have cost Ontario over $1.2 billion in health impacts such as premature deaths, increased hospital visits, and health emergencies.[7] The cumulative economic toll of such climate disasters can never be fully tallied, but without action the costs of climate change to the economy and society are potentially catastrophic.[8]

Climate change is both a threat and a threat multiplier, jeopardizing peace and security locally, nationally and internationally, degrading infrastructure, undermining economies, compromising population health, and destabilizing the ecological systems that provide the physical necessities of life. The resulting social and economic disruptions are accelerating political instability, and leading to conflict, migration, and war.[9,10] Responses by states and municipalities are constrained by an inherent conservatism, economic lock-in, and incumbency. These are the application of linear,

5 "Corporate Climate Action Plan for the City of Kitchener." City of Kitchener Corporate Sustainability. City of Kitchener, 2024. https://www.kitchener.ca/en/water-and-environment/corporate-sustainability.aspx#:~:text=Our%20second%2Dgeneration%20Corporate%20Climate,for%20and%20supply%20of%20energy.

6 The Canadian Press. "July Flash Floods in Toronto, Southern Ontario Caused Over $940M in Insured Damage." Global News, August 20, 2024. https://globalnews.ca/news/10706438/flash-floods-weather-toronto-ontario-insurance/#:~:text=Initial%20estimates%20put%20the%20total,Station%2C%20a%20key%20transit%20hub.

7 Sawyer, Dave, Seton Stiebert, and Colin Welburn. "With the Forest Ablaze, the Health Costs Hit Home." Canadian Climate Institute, June 26, 2023. https://climateinstitute.ca/with-the-forest-ablaze-the-health-costs-hit-home/.

8 Canadian Climate Institute. "The Costs of Climate Change - Canadian Climate Institute," January 18, 2023. https://climateinstitute.ca/reports/the-costs-of-climate-change.

9 Cattaneo, Cristina, and Valentina Bosetti. "Climate-induced International Migration and Conflicts." CESifo Economic Studies 63, no. 4 (August 1, 2017): 500–528. https://doi.org/10.1093/cesifo/ifx010.

10 Alverio, Gabriela Nagle, Jeannie Sowers, and Erika Weinthal. "Climate Change, Conflict, and Urban Migration." Environment and Security, August 4, 2024. https://doi.org/10.1177/27538796241259242.

historically derived trends to nonlinear change,[11] and most fundamentally, limits of the human imagination,[12] which risk the safety and well-being of the community. A former US presidential scientific advisor said, "We will respond to climate change with a mix of mitigation, adaptation and suffering: all that remains to be determined is the mix."[13]

The Municipal Response

Municipalities are seeking to align their response with science, but they are constrained by financial and policy limitations.

As the government entity closest to the people and their activities, municipalities are directly responsive to the urgency of climate action. Municipalities implement a wide range of policies and programs designed to support the energy transition and reduce GHG emissions, with varying degrees of efficacy.

Cities are a concentration of energy consumption in the form of heating, cooling, transportation, financial capital, trade, and human ingenuity. They are able to stimulate, influence, and implement various aspects of the climate response through their roles in municipal administration, municipal policy-making, and municipally owned corporations, or their executive, regulative and economic powers.[14] The effectiveness of the response depends on the integration and coherence of the application of each of these aspects, including a coherent policy package that includes the triad of economic, regulatory, and informational instruments, also known as "carrots, sticks and sermons."

Canadian cities with more than 100,000 residents account for one-third of Canada's GHG emissions, and all Canadian municipalities have the ability to influence approximately 50% or more of Canada's emissions.[15] In 2018, the Canadian Institute of Planners (CIP) released a Climate Change Statement recognizing the relationship

11 Wise, R.M., I. Fazey, M. Stafford Smith, S.E. Park, H.C. Eakin, E.R.M. Archer Van Garderen, and B. Campbell. "Reconceptualising Adaptation to Climate Change as Part of Pathways of Change and Response." Global Environmental Change 28 (January 11, 2014): 325–36. https://doi.org/10.1016/j.gloenvcha.2013.12.002.

12 Abbas, Ansar, Dian Ekowati, Fendy Suhariadi, and Rakotoarisoa Maminirina Fenitra. "Health Implications, Leaders Societies, and Climate Change: A Global Review." Springer Climate, January 1, 2022, 653–75. https://doi.org/10.1007/978-3-031-15501-7_26.

13 Roberts, David, and David Roberts. "Preventing Climate Change and Adapting to It Are Not Morally Equivalent." Grist, April 1, 2021. https://grist.org/climate-energy/preventing-climate-change-and-adapting-to-it-are-not-morally-equivalent/.

14 Schmieder, Lisa, Dirk Scheer, Johannes Gaiser, Ines Jendritzki, and Benjamin Kraus. "Municipalities as change agents? Reconsidering roles and policies in local energy sector-coupling." Energy Research & Social Science 103 (2023): 103210

15 Elliot Cappell, Sadhu Johnston, and Jennifer Winter. "The Municipal Role in Climate Policy." Institute on Municipal Finance & Governance, 2022. https://imfg.org/report/climate-policy/.

between land use, energy use, and climate change and the importance of climate change planning, or climate change-informed planning, in these policy directives.[16] Local governments are responsible for decision-making or influencing decisions about their transportation systems, waste management systems, land-use and urban planning, green spaces, and in some cases, building and energy codes.

Cities in Canada and beyond have a long history of climate action. More than 11,500 cities, representing 20% of the world's population, have made commitments to take climate action.[17]

The first generation of climate action planning focused on building awareness, setting initial emissions and some resiliency targets, and developing resources; city policies were not aligned with the scope of the challenge.[18] In the second generation, climate action became more mainstream, as networks such as ICLEI, the Global Compact of Mayors, and others increased awareness of climate action planning and developed the practice. This included creating planning processes such as the five milestones: inventory, target, plan, implementation, and reporting. In this generation, climate action planning and implementation occupied a marginal niche within municipalities, with few staff and small budgets. GHG reductions, if any, often resulted from actions of other orders of government. In Ontario, for example, although municipalities were required to develop and implement energy conservation and demand management (CDM) plans, most municipal GHG reductions occurred when coal-fired electricity generation was phased out.

We are now in the third generation of climate planning, which is about whole city planning, transformation, equity, and implementation.[19] 'Whole city planning' is defined as integrating climate action across a municipality's functions, including its OP. In this generation, climate action has graduated to being a core service area for municipalities of all sizes, alongside more traditional functions but with an overarching mandate in their communities.

Most major cities in Canada have comprehensive and detailed climate action plans informed by technical modelling.[20] TransformWR fulfills this mandate for Kitchener, with the regional approach having both strengths and weaknesses. The variation in the

16 Clean Air Partnership and Clean Air Council. "Clean Air Council Bringing Climate Change into Official Plans Primer and Workshop Summary," n.d. https://council.cleanairpartnership.org/wp-content/uploads/2019/03/Bringing-Climate-Change-into-Official-Plans_V3.pdf.

17 Bäckstrand, Karin, and Jonathan W. Kuyper. "The Marrakech Partnership for Global Climate Action." In Cambridge University Press eBooks, 180–200, 2024. https://doi.org/10.1017/9781009383486.008.

18 Stephen M. Wheeler, "State and Municipal Climate Change Plans: The First Generation," Journal of the American Planning Association 74, no. 4 (October 21, 2008): 481–96, https://doi.org/10.1080/01944360802377973.

19 Joan Fitzgerald, "Transitioning From Urban Climate Action to Climate Equity," *Journal of the American Planning Association* 88, no. 4 (April 19, 2022): 508–23, https://doi.org/10.1080/01944363.2021.2013301.

20 Herbert, Yuill, Ann Dale, and Chris Stashok. "Canadian cities: climate change action and plans." Buildings & Cities 3, no. 1 (2022).

modelled decarbonization pathways among Canadian cities is illustrated in Figure 1, and are influenced by the ambition, timing, and GHG profile of each community. Despite their shared commitment to decarbonizing their economies, cities vary in the capacity and expertise they mobilize to address the challenge.

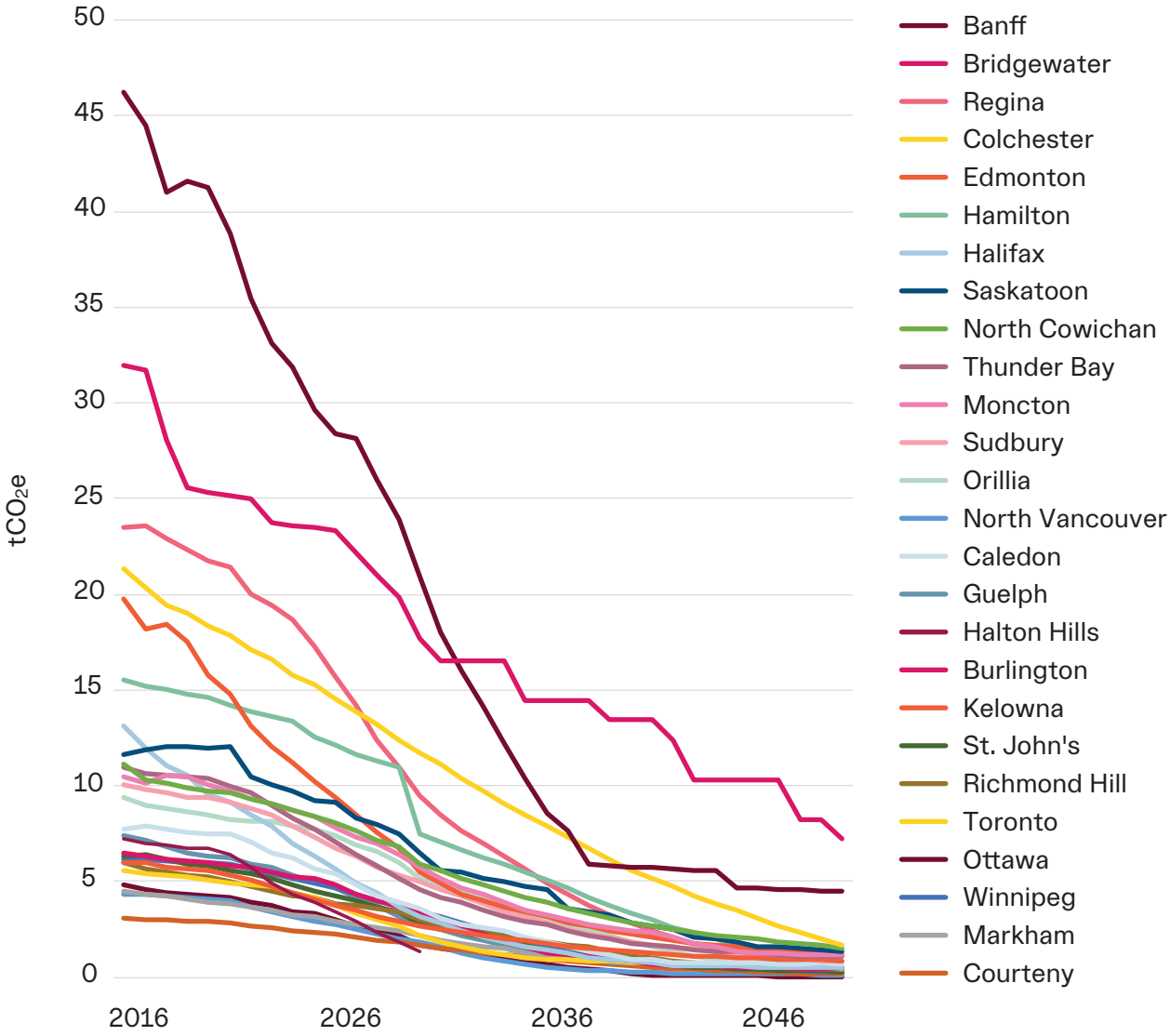


Figure 1. Decarbonization pathways for a selection of Canadian cities modeled by SSG.

In parallel, many municipalities are also developing climate adaptation plans, which identify the potential impacts of climate change on the community and infrastructure. The standard framework used is a climate risk and vulnerability assessment, which has evolved from a primarily qualitative to quantitative assessment with a growing focus on equity or vulnerability.[21] As is the case with mitigation, adaptation plans need to mature in their focus on implementation, measurement, and verification.[22] The benefits of adaptation are clear: one report indicates that for every $1 spent on adaptation measures today, $13–$15 will be returned in the years ahead in direct and indirect benefits.[23]

The transnational municipal ecosystem, while primarily aspirational, has given rise to the key ingredients of a systematic and comprehensive approach to climate action. Methodologies that align city targets with the latest science[24] standardize GHG inventory protocols, daylight leading municipalities (C40, ICLEI, Global Compact of Mayors, Race to Zero) and track progress (CDP and Global Compact of Mayors).

Globally, actions by municipalities have pushed the envelope on climate action, and shaped the response of other orders of government, examples of which are described in Table 2.

Table 2. Cities undertaking bold climate actions.

Action	Examples of Cities Undertaking These Actions
Natural gas (or fossil fuel) bans in new construction	Montreal, Vancouver, Nanaimo, 76 US municipalities in California and the US Northeast[25]
Limitations on fossil fuel advertising	Toronto, Montreal[26]

21 Susarla, Vasantha. "Assessing Canadian Municipal Climate Change Adaptation Plans: Investigating Equity Considerations in Adaptation Planning." PhD diss., Concordia University, 2023.

22 Donoghue, Sophie, and Ryan Katz-Rosene. "Evaluating the comprehensiveness of municipal climate change adaptation plans in Ontario, Canada." Regional Environmental Change 23, no. 1 (2023): 44.

23 Sawyer, Dave, Ryan Ness, Caroline Lee, and Sarah Miller. 2022. Damage Control: Reducing the costs of climate impacts in Canada. Canadian Climate Institute. https://climateinstitute.ca/reports/damage-control/

24 ARUP & C40, n.d., p. 40.

25 Robinson, Alex. 2024. "Despite Backlash, Bans on Gas Use in New Buildings Keep Spreading." Corporate Knights. July 5, 2024. https://www.corporateknights.com/buildings/gas-ban-us-backlash/.

26 Noakes, Taylor. 2024. "Toronto and Montreal Move Ahead With Fossil Fuel Ad Restrictions on Transit." DeSmog. October 17, 2024. https://www.desmog.com/2024/10/17/toronto-and-montreal-move-ahead-with-fossil-fuel-ad-restrictions-on-transit/.

Action	Examples of Cities Undertaking These Actions
Vehicle low-emissions zones	London, UK[27]
Car-restricted areas	Montreal,28 Barcelona[29]
Bans on fossil fuel equipment	Oxford (stoves, boilers)[30]
Building renovation standards	Vancouver[31]
Fines for poor-emissions performing buildings	New York City[32]
Emission standards for various service vehicles, e.g., taxis, ride-sharing.	Toronto[33]
Refunds to employees who don't drive to work	Washington D.C.[34]

27 Matters, Transport for London | Every Journey. n.d. "Low Emission Zone." Transport for London. https://tfl.gov.uk/modes/driving/low-emission-zone.

28 Drimonis, Toula. "Montreal Kicked Cars to the Curb and Thrived." The Walrus, September 5, 2024. https://thewalrus.ca/montreal-kicked-cars-to-the-curb-and-thrived/.

29 Castrezzati, Michele. 2023. "Barcelona's Superblocks: Putting People at the Centre – Literally." CityChangers.Org – Home Base for Urban Shapers. August 14, 2023. https://citychangers.org/barcelona-superblocks/.

30 Waple, By Katie. 2023. "Oxford City Council Plans to Ban Gas Hobs and Boilers in All New Homes." November 24, 2023. https://www.bbc.com/news/uk-england-oxfordshire-67497749.

31 Vancouver, City Of. n.d. "Energy Requirements for Home Renovations." City of Vancouver. https://vancouver.ca/home-property-development/energy-requirements-for-single-family-home-renovations.aspx.

32 "Press Release - Buildings." n.d. https://www.nyc.gov/site/buildings/dob/pr-getting-97-done.page.

33 Director, Executive, Executive Director, Municipal Licensing and Standards, Environment & Climate, and City Council. "Transitioning the Vehicle-for-Hire Industry to Net Zero Emissions by 2030." Report. City of Toronto, 2023. https://www.toronto.ca/legdocs/mmis/2023/ec/bgrd/backgroundfile-239119.pdf

34 Streetsblog USA. "D.C. 'Parking Cash Out' Law Makes Employers Refund Workers Who Don't Drive." June 16, 2023. https://usa.streetsblog.org/2022/01/07/d-c-parking-cash-out-law-makes-employers-refund-workers-who-dont-drive.

Whole City Planning

Cities have agency to take climate action, which includes, but is not limited to, municipal administration, municipal policy-making, and municipally owned corporations.

A whole city planning approach requires that a municipality mobilize all of its staff, assets, activities, and capacities to address climate change. Land-use policy is the primary regulatory mechanism available to municipalities to shape their response to climate impacts, determined through the OP, zoning by-law, urban design and green building guidelines, and other development and building maintenance-related guidance. Municipalities can restrict or limit development near areas vulnerable to current and future climate hazards; this requires developing sophisticated projections of the way current hazards will evolve in the future and an assessment of what the future hazards may be.

Municipalities can apply site plan controls to shape development patterns and implement infrastructure that increases resilience to future climate hazards. The design and implementation of adaptation strategies, such as green infrastructure or climate-ready servicing, can be incorporated into new developments. The More Homes Built Faster Act, 2022 limits the ability of municipalities to apply site plan controls to smaller residential developments (10 or fewer units).

Municipalities are major investors stimulating economic opportunities in the community. Applying a climate mitigation and/or adaptation lens to procurement decisions sends a signal to the market, stimulates new business opportunities, and shapes the direction of businesses. Municipalities design, own, and operate infrastructure such as roads, sidewalks, parks, green space, stormwater facilities, and water and wastewater facilities. Climate change poses significant risks to these assets. Extreme weather events, rising temperatures, and increasing freeze-thaw cycles can damage infrastructure, leading to costly repairs and maintenance. Ontario requires that municipalities consider "vulnerabilities that may be caused by climate change to the municipality's infrastructure assets" in their assessment management plans.[35] The City of Kitchener has not yet incorporated climate change considerations into all of its comprehensive asset management plans; risks to municipal infrastructure were considered within the Corporate Climate Action Plan.

Cities are also exploring innovative ways to fund emissions reductions or increased resilience of the existing built environment, leveraging their access to a relatively low cost of capital to provide financing programs for homes and businesses. For example, the City of Kitchener could directly operate a program or partner with a third party to

35 Ontario, Legislative Assembly, "O. Reg. 588/17: Asset Management Planning for Municipal Infrastructure," consolidated March 15, 2021, https://www.ontario.ca/laws/regulation/170588.

retrofit commercial or residential buildings to increase their resilience. Other financing mechanisms could include catastrophe bonds ("cat bonds")[36] and land value uplift agreements.[37]

As a trusted voice in the community, municipalities can convene partners formally on initiatives through, for example, roundtables, task forces, advisory committees, and neighbourhood associations. Municipalities can also lead educational programs for community members on climate adaptation and encourage or incentivize actions.

In the context of whole city climate action planning, the City of Kitchener's role can take multiple forms, including:

1. **A Regulator:** Through policies and regulations, the City can shape the built environment and public realm to improve resiliency and reduce carbon emissions.
2. **A Mobilizer:** The City can engage residents, other levels of government, and local organizations around a vision, goals, objectives, and targets.
3. **An Innovator:** The City can directly or indirectly support innovation by reducing risk through investments, partnerships, and/or policies that support low-carbon projects or enterprises.
4. **A Collaborator:** The City can collaborate with other orders of government, transit authorities, utility providers, the Region of Waterloo, businesses, non-profit organizations, post-secondary institutions, neighbourhoods, and local community members to develop joint projects or investments.
5. **An Investor:** The City can invest directly into building retrofits and renewable energy technologies, or enable investments in resilience or decarbonization projects. As a shareholder of the electrical utility, the City can accelerate technologies or infrastructure to support or enable the energy transition.
6. **An Implementer:** The City can support residents and local businesses through policies, infrastructure, operations, incentives, programs, and projects.
7. **An Incubator:** The City can cultivate the development of new technologies or applications by supporting, procuring, and attracting new and existing businesses and creating a hub or ecosystem in which businesses and organizations support each other.

36 A catastrophe bond is a form of insurance in which an organisation issues a bond, investors purchase that bond and receive interest. If no disaster occurs, investors receive the principal back but if a disaster occurs, the organisation can use the bond to cover losses.

37 For example: Minjee Kim, Financing Climate Resilient Infrastructure for Boston's Waterfront: Leveraging land value uplift to floodproof the Raymond L. Flynn Marine Industrial Park, 2024. https://go.lincolninst.edu/Kim_WP24MK2.pdf.

A Standard Planning Process

The OP can include a systematic approach to climate planning.

While Kitchener has many initiatives underway, the City has not articulated a systematic approach to climate planning on its own. Instead, it has participated in a regional effort, TransformWR, in which Ontario has defined a process that includes six key steps (Figure 2):[38]

1. **Preparation:** The plan objectives, partners, data sources, and process approach are identified.
2. **Inventory:** An inventory of sources and amounts are completed for a base year, providing the baseline for future scenario development, and creating a reference against which future inventories and policy and action effects can be measured.
3. **Target setting:** Energy and emissions reduction targets are established.
4. **Policy, action, and scenario development:** Potential actions and policies that reduce energy and emissions are identified and bundled into scenarios. A preferred scenario that achieves the target is selected and actions are prioritized within the scenario.
5. **Implementation:** The policies and actions developed are implemented by the municipality and its partners.
6. **Monitoring and evaluation:** Implementation of policies and actions are monitored for their effectiveness and feedback is applied to the next planning cycle.

38 Ministry of the Environment and Climate Change. "Guideline on Community Emissions Reduction Planning | Environmental Registry of Ontario," April 17, 2018. https://ero.ontario.ca/notice/013-2083.

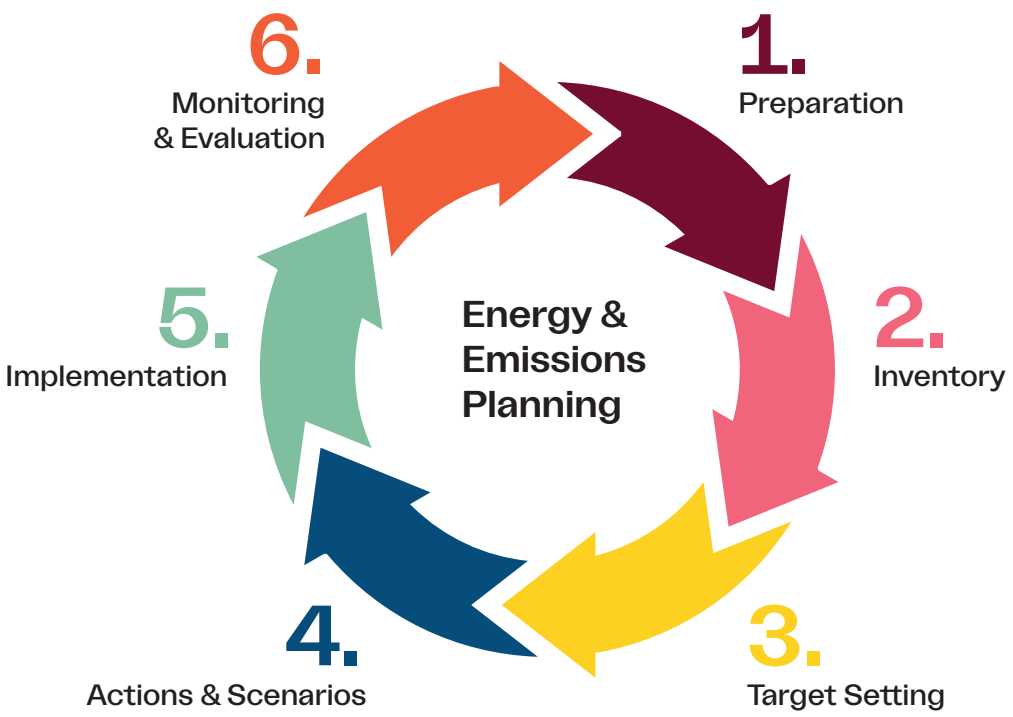


Figure 2. A cyclical climate planning process.

The Role of the Official Plan

The Official Plan can combine credible policy strategies with a consistent mix of policy instruments designed to create synergies and avoid conflicts.[39]

Every tonne of emissions counts in a climate emergency. The OP must respond to this challenge with clear mechanisms to decarbonize Kitchener as quickly as possible, while protecting people, facilitating the required investment, and concurrently achieving other community objectives.

Municipalities have taken many different approaches in terms of which policies to include in the OP. To provide the City of Kitchener with the most comprehensive set of options, SSG evaluated a broad range of policy options identified as contributing to reducing GHG emissions or enhancing adaptation to climate hazards (See Appendix 2).

39 European Commission, Joint Research Centre, Kivimaa, P. and Rogge, K., Pursuing sustainability transitions and open strategic autonomy. A policy mix perspective on synergies and trade offs, European Commission, Seville, 2024, JRC139504.

Ontario's Planning Act explicitly contemplates the need to reduce GHG emissions and to respond to the impact of climate change. Part 3, Section 16 of the Planning Act states:[40]

> *"(14) An official plan shall contain policies that identify goals, objectives and actions to mitigate greenhouse gas emissions and to provide for adaptation to a changing climate, including through increasing resiliency."*

The mechanisms by which a municipality undertakes these actions can be detailed in an OP, as indicated earlier in Part 3, Section 16:

> *"(2) An official plan may contain, (a) a description of the measures and procedures proposed to attain the objectives of the plan."*

Ontario's 2024 Provincial Planning Statement (PPS) is a policy document issued under the Planning Act that took effect on October 20, 2024.[41] As of this date, any local decisions related to planning matters must be consistent with the policies outlined in the new PPS. The new PPS notes the importance of addressing climate change through land-use planning. Section 2.9 states that:

> *"Planning authorities shall plan to reduce greenhouse gas emissions and prepare for the impacts of a changing climate through approaches that:*
>
> - support the achievement of compact, transit-supportive, and complete communities;
> - incorporate climate change considerations in planning for and the development of infrastructure, including stormwater management systems, and public service facilities;
> - support energy conservation and efficiency;
> - promote green infrastructure, low impact development, and active transportation, protect the environment and improve air quality; and
> - take into consideration any additional approaches that help reduce greenhouse gas emissions and build community resilience to the impacts of a changing climate."

40 Government of Ontario. Planning Act, R.S.O. 1990, c. P.13. 2024. https://www.ontario.ca/laws/statute/90p13.

41 Ministry of Municipal Affairs and Housing, "Provincial Planning Statement, 2024," 2024, https://www.ontario.ca/page/provincial-planning-statement-2024.

The PPS also includes other requirements related to land-use planning. Section 2.4.2 requires municipalities to delineate major transit station areas, and defines the minimum density targets required for these areas. Section 4.1 emphasizes the importance of protecting natural features, including significant woodlands and wildlife habitat, from development.

The PPS sets guidelines for managing development in areas vulnerable to natural hazards, which it notes may be exacerbated by climate change in the future. Chapter 5 of the PPS requires planning authorities to limit development on hazardous lands such as those prone to flooding, erosion, and wildland fires, with some exceptions noted.

In addition to the Planning Act, the Ontario Municipal Act confers power to municipalities. These powers often relate to the passing of by-laws which can be foundational to the implementation of an OP. Part 2 describes the powers of municipalities and states that:

> *"147 (1) Without limiting sections 9, 10 and 11, a municipality may provide for or participate in long-term energy planning in the municipality. 2017, c. 10, Sched. 1, s. 11."*

Here, long-term energy planning may include consideration of energy conservation, climate change, and green energy.

It is also important to note that creativity and foresight is required; historical patterns or policies are not a precedent for the unprecedented response required to respond to and reduce climate change risks.

Integrating climate change and energy considerations into the OP is a core policy element in systematic climate action planning.[42] Land-use policy can avoid locking in infrastructure systems and activities that are costly to retrofit or provide without generating GHG emissions. Land-use policy can enable cost-effective emissions reductions. For example, it is more affordable to provide zero-emissions transportation and energy to a compact, complete community than to a distributed population. Electric buses can provide a service to more people with shorter routes and lower energy consumption. When destinations are in close proximity, people can walk or cycle. Homes tend to be smaller and share walls, which reduces energy consumption. District energy is more viable when demand for heat is concentrated, reducing the length and cost of distribution pipes and the associated heat losses.

Land-use policy is also the most cost-effective action a City can take, as it can result in GHG emissions reductions without requiring the City or society to make a direct investment other than thoughtful planning, as demonstrated by the comparison of Atlanta and Barcelona in Figure 3.

42 Federation of Canadian Municipalities, "Integrating Climate Considerations: Community Planning | Green Municipal Fund." n.d. https://greenmunicipalfund.ca/resources/integrating-climate-considerations-community-planning.

Atlanta's population is comparable to Barcelona's, but Atlanta is ~25 times larger than Barcelona and its GHG emissions from transportation are ~10 times higher. Barcelona's compact form locks in low-carbon lifestyles, whereas Atlanta's investments in roads and buildings result in an energy and emissions trajectory that is costly and difficult to change. Barcelona can consider solutions such as district energy and enhanced transit to generate positive economic returns, which may not be possible in Atlanta. Land-use planning determines population density and connectivity to goods and services and is therefore critical in enabling future low-carbon opportunities.

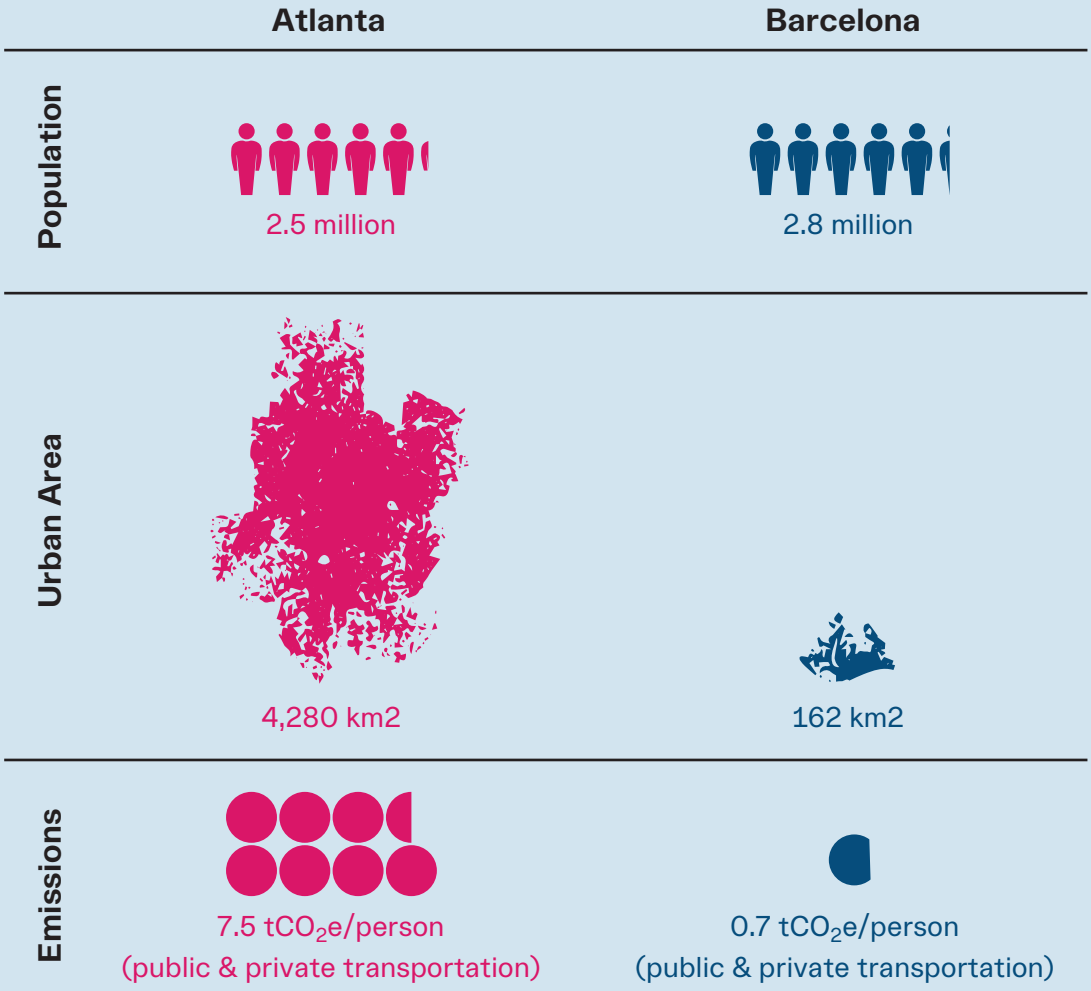


Figure 3. Lock-in and path dependence: Atlanta vs. Barcelona.

While focusing on compact development is critical, the spatial configuration of Kitchener is well-established and even rapid growth presents limited opportunities for transformation, necessitating careful consideration of other policy levers. Many of these levers have been evaluated in this study.

The OP and related land-use planning tools can help reduce climate risk in multiple ways, beyond reducing GHG emissions.[43] First, it can integrate energy considerations in land-use planning. Second, land-use planning can restrict or limit new developments in areas prone to climate hazards, such as flooding. Third, planning tools can ensure that development and infrastructure are designed to withstand and mitigate the environmental stresses projected to result from climate change, such as more intense storms. Fourth, land-use planning can expand and enhance open spaces and preserve natural areas. These areas can protect communities from climate risks by absorbing excess stormwater runoff during heavy rainfall and mitigating the urban heat island effect. Fifth, land-use plans can enable community resilience by strengthening the community fabric and social capital with places to gather, mingle, share, and interact. These places can include public squares, resilience hubs, and neighbourhood pocket parks that provide enabling and inclusive physical environments.

Advancing Equity

Climate change can impact groups and individuals rendered vulnerable due to inequality, driving greater inequality. It is therefore vital to break this cycle with concurrent or complimentary actions that mitigate emissions and reduce risks.

In terms of mitigation, correlations between carbon emissions and morbidity and mortality are estimated with findings where, on a global basis, each 1,000 tonnes of carbon combusted will result in one premature death by the end of the century.[44] While Kitchener and its residents may not experience some of the severe global causes of this mortality, such as civil conflict and human displacement, it is not free from impacts to vulnerable populations. Research has shown that lower-income areas are more greatly impacted during heat waves.[45] In BC, the report of the Chief Coroner's investigation into the 619 deaths caused by the 2021 heat dome found that: "More decedents lived in socially or materially deprived neighbourhoods than the general population;" and that "Most decedents were in homes without adequate cooling systems such as air conditioners or fans."[46]

43 Government of Canada, "Land use planning tools for local adaptation to climate change," 2012. https://publications.gc.ca/collections/collection_2013/rncan-nrcan/M4-106-2012-eng.pdf.

44 Renaud, Jeff. 2023. "Climate-changing Human Activity May Cause 1 Billion Deaths." Western News. August 30, 2023. https://news.westernu.ca/2023/08/climate-change-human-deaths/#:~:text=Pearce%20and%20Parncutt%20found%20the,of%20fossil%20carbon%20are%20burned.

45 UN Office for Disaster Risk Reduction. "Low-income Areas Experience Hotter Temperatures in LA County." 2023. May 1, 2023. https://www.preventionweb.net/news/low-income-areas-experience-hotter-temperatures-la-county.

46 Egilson, Michael, British Columbia Coroners Service, Kristy Anderson, Jatinder Baidwan, Alex Boston, Sam Bugis, Rowan Burdge, et al. 2022. "Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in B.C. in Summer 2021." Report to the Chief Coroner of British Columbia. https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/extreme_heat_death_review_panel_report.pdf.

The same trend is true of flooding in the US, which lower-income populations are more prone to and impacted by. A study led by the US federal reserve banks found that low- and moderate-income community members face financial barriers to moving to higher ground and that insurance is increasingly cost-prohibitive.[47]

While municipal governments cannot eliminate income disparities, joining the global effort to cut GHG emissions can reduce the extent they will occur. Currently, average climate impacts are projected to increase the Gini index[48] by 1.4, on average,[49] a notable increase in income inequality in an OECD country.

Municipalities can work to increase resilience by ensuring equity is a cross-cutting theme. Policies and programs that build resilience in communities identified to have higher rates of exposure and sensitivity to climate risks stand to have the greatest ability to improve community outcomes, as these communities are particularly challenged by climate-driven extreme weather events.

Kitchener's Track Record

Kitchener can leverage and build upon local community climate action plans that support climate action, including the 2014 Official Plan, TransformWR and the Region's Climate Adaptation Plan.

The City of Kitchener's OP is being developed for a community that has changed greatly since the last plan was approved in 2014. Kitchener is Canada's eighth fastest growing city, and as of January 2025, the City was processing over 190 active planning applications.[50] Kitchener's growth and pressure to provide housing, including affordable housing, will need to align with the City's efforts to develop an OP that helps address climate mitigation and adaptation.

47 Nair, Ambika, Theresa Dunne, Matt Klesta, and Dyvonne Body. 2024. "Lower-income Neighborhoods Face Greater Flood Risk, Tougher Recovery." *Fed Communities*, November 19, 2024. https://fedcommunities.org/lower-income-neighborhoods-face-greater-flood-risk-tougher-recovery/.

48 The Gini index is an internationally recognized scale of income equality. On a scale of 100, a score of one represents complete equality and a score of 100 represents complete inequality. Canada's 2022 score was 32.

49 Emmerling, Johannes, Pietro Andreoni, Ioannis Charalampidis, Shouro Dasgupta, Francis Dennig, Simon Feindt, Dimitris Fragkiadakis, et al. 2024. "A Multi-model Assessment of Inequality and Climate Change." *Nature Climate Change*, October. https://doi.org/10.1038/s41558-024-02151-7.

50 City of Kitchener, "Highlighted Applications, Current Applications. Kitchener Planning Applications," 2024. https://experience.arcgis.com/experience/bb2db3e61bd043209c1f16d16a3ced0c/page/Current-Applications/.

As a lower-tier municipality, the City of Kitchener works collaboratively with the Region of Waterloo (the Region) to take action on climate change. TransformWR, the region-wide climate action plan, identifies community-wide transformative changes that need to be achieved by 2050 and actions that need to be taken to get started, including actions by municipalities such as Kitchener. The regional collaborative also tracks GHG emissions in an annual inventory.

The Region and all area municipalities have endorsed TransformWR with a 2030 GHG reduction goal of 50%, and a 2050 reduction goal of 80%, with some discussion of achieving 100%. The plan strategy identified Waterloo Region as having 4.2 megatonnes of annual emissions and a carbon budget of 67 megatonnes.

To achieve the transformative changes and emissions reductions in TransformWR, other orders of government must take action including decarbonizing Ontario's electrical grid; implementing carbon pricing; enhancing land-use planning regulation; and increasing building codes for energy efficiency, embodied carbon, and climate resiliency. It also emphasizes land-use planning and community involvement, district energy, waste heat recovery, and renewable natural gas (RNG) and building retrofits.

WR Community Energy is an organization established to foster collaboration with the Region of Waterloo, its urban municipalities including Kitchener, and local utilities to steward the energy transition. WR Community Energy is currently working with all municipalities in Waterloo Region along with local utilities to develop high-performance development standards similar to the green development standards in place, or under development, in other Ontario municipalities,[51] as well as a retrofit program, RetrofitWR. It also led the development of the Community Energy Investment Strategy, and has undertaken studies of geo-exchange[52] and wastewater heat recovery[53] and a mapping of prospective renewable energy development locations.[54] Many of these initiatives can be reinforced by the City of Kitchener through policies in its OP.

The Regional Official Plan (ROP) also contains many relevant climate-related objectives including establishing an urban boundary, developing planned community structures with nodes, promoting transit-oriented development, creating more mixed and walkable neighbourhoods, and meeting or exceeding provincial density targets. With the transition of planning authority in January 2025, the ROP has become the City's responsibility and Kitchener 2051 will consider how to integrate ROP policies into one OP.

51 WR Community Energy, "High-Performance Development Standards," 2024, https://wrcommunityenergy.ca/high-performance-development-standards/

52 Region of Waterloo, "Opportunities for Open Loop Geo-Exchange in Waterloo Region," 2021, https://wrcommunityenergy.ca/wp-content/uploads/2021/11/Geothermal-Report-FINAL.pdf

53 Region of Waterloo, "Wastewater Heat Recovery in Waterloo Region," 2021, https://wrcommunityenergy.ca/wp-content/uploads/2021/11/Waste-Water-Heat-Recovery-Report-FINAL.pdf

54 Region of Waterloo, "Mapping Opportunities for Renewable Energy Development," 2020, https://storymaps.arcgis.com/stories/c77e2472e9aa4f2388580a9c832c3f02

Similar to many municipalities, several plans and master plans followed the development of the last OP, most importantly the City's three-year strategic plans. The current 2023–2026 strategic plan links all strategic goals to the United Nations Sustainable Development goals.[55] Mirroring the strategic plan, the Make it Kitchener 2.0 economic development plan has opened a sustainable development goals innovation centre. The Make it Kitchener plan has focused on a post-pandemic local economic revitalization by investing $110 million into the local economy.

Rounding out these major strategic plans, the City has developed a strategic plan for the environment and a Corporate Climate Action Plan. The City's climate action plan work to date includes the approval of Pivot: Net Zero, a plan to reduce corporate GHG emissions, and the in-progress development of a clean energy transition strategy for its community-facing energy businesses provided through its local utility, Kitchener Utilities. Kitchener Utilities concluded an engagement process in May 2024, which helped identify potential business activities that are now being investigated by staff.

The City has a Cycling and Trails Master Plan (2020) which was built on previous cycling, pathway, and trail plans. The plan is user centric and focuses on removing deterrents to cycling. Current key projects under the master plan include the downtown grid network and the trails capital plan.

The City's Transportation and Demand Management Plan was passed in 2011. It emphasized maintaining a balance between parking supply and pricing to discourage single-occupancy vehicles. It also discussed influencing modal choices initially to the downtown and later to other areas. An updated Transportation Master Plan (TMP) will be fully aligned with the new OP in aiming to implement TransformWR, prioritizing a multi-modal network including walking, cycling, micromobility, public transit, and other transportation demand management.

The City's framework for climate action is manifested in its existing OP which was adopted in 2014 as well as subsequent actions and resolutions. This OP mirrors the 2051 ROP in many ways while going into more detail in some aspects and setting some Kitchener-specific actions and targets. Like the ROP, the OP discusses active transportation, transit-oriented, and mixed development. The OP specifies resident and employment densities for specific areas. The OP builds on the Region's density targets, and pledges to collaborate on major transit station areas. Major office developments are directed to locate downtown or in a major transit station area, while new retail centers and institutional establishments are to be located at city nodes. Infill development and renewable energy are encouraged in the section on housing.

More broadly, the OP requires that sustainable development is reflected in programs, master plans, and development standards. The City supports renewable energy and district energy whenever feasible and also supports urban agriculture and recycling. Development applications are required to supply a sustainability report and checklist. City corporate buildings are to be Leadership in Energy and Environmental Design (LEED) certified and designed for southern exposure.

55 United Nations Department of Economic and Social Affairs, "Sustainable Development Goals," n.d., https://sdgs.un.org/goals

The OP addresses considerations including water conservation, rehabilitation of lands, integration of active transportation with transit, and land acquisition for the multi-use pathway system. The OP goes into detail on transit-oriented development, with a list of measures to encourage it, and makes reference to the cycling master plan and pedestrian safety.

A Pathway to the Future

The impacts of climate change and the energy transition can create uncertainty for some people and businesses and create opportunities for others, as investments in energy sources and technologies shift. The role of the OP in this context is to provide a pathway that limits uncertainty and insecurity; highlights and manifests opportunities; and provides security to enable households, businesses, and governments to make investments and ensure benefits are incurred to those who need them the most. In response to the context described above, the OP fulfills a number of roles:

1. **Setting the context:** Identifying the future trends to which the plan responds.
2. **Framing the response:** Articulating the principles and method the OP will apply.
3. **Defining land-use:** Defining the patterns of growth or change that will achieve the community's vision and objectives.
4. **Enabling policies:** Defining the parameters of subsidiary policies or tools, such as a zoning by-law, which will be refined elsewhere.
5. **Articulating community priorities:** Describing policies, actions, or investments and the mechanisms for realizing these priorities.
6. **Implementing the OP:** Including policies on how the community will manifest, monitor, measure, and report on progress as the plan is implemented, in order to enable reflection and adjustment.

An OP is, by definition, future-looking, and it must also be grounded in the current context. As the future is inherently uncertain, the OP must be dynamic in order to accommodate change and avoid obsolescence.

Climate change changes everything, and as a future-focused document, the OP must contemplate a fundamentally changed world.

A climate-ready OP for Kitchener must address a number of questions:

- Does it clearly identify the objectives and policies of decarbonization in alignment with the latest scientific and technological advancements, and protect communities from climate impacts?
- Does it ensure that policies do not lock in additional emissions?
- Does it contain policies for decarbonizing the existing built environment?
- Does it allow for and nurture innovation?
- Does it contain a comprehensive set of policies that encourage the energy transition and discourage fossil fuels?
- Does it contain provisions for evaluation, learning, and adaptation?
- Is it based on evidence?
- Does it incorporate different ways of knowing?
- Does it include a systematic planning process?
- Does it address equity?
- Does it seek to address any negative impacts of the energy transition?
- Does it identify solutions that address multiple challenges simultaneously?

An OP which can respond affirmatively to these questions is a climate plan that will help Kitchener progress in the face of climate change.

Big Move 1

Municipal Leadership

The City needs to build capacity and take leadership working with and for its residents, businesses, communities, and partners. A transformational approach includes taking collaborative, flexible, and distributed action. To be a leader, the City needs more than just a champion. It needs the support and know-how of its staff, who are on the frontlines of implementation, and defensible, information-driven technical resources to make climate-informed decisions.

Climate change affects everyone, and effectively reducing emissions and adapting to its impacts requires cooperation and collaboration throughout the community and beyond. The City needs to take a leadership role in working with and learning from its local partners and institutions; engaging with neighbouring municipalities and regions, and with other municipalities provincially and nationally; and participating in international networks.

Through the programs and regulations it establishes for the community and the policies, actions and budgets it sets for its own activities, the City has the ability to support climate adaptation and mitigation. This leadership can work to provide impetus for others to take action. Experience and the literature indicates that multiple, reinforcing policies have synergistic benefits.

Targets

The City's response to the climate emergency is best framed by a target or target-setting approach. The target signals where the City is aiming to go, while the principles signal the lens that will be applied in deciding how to get there. The City should regularly update its GHG targets to align with the latest science.

GHG Reduction Targets

Municipalities have generally adopted targets using one of three methods. The first option is to align with either provincial or federal targets. The second option is to develop a low carbon pathway in a model that reflects local circumstances, then derive the targets from the pathway. The third option is to apply a method that calculates a municipality's fair share of the remaining global carbon budget; this method is described as a science-based target (SBT).[56] A recent Court of Appeal decision shines a legal light on GHG targets in Canada for the first time:[57]

56 C40 Cities et al., "Science-Based Climate Targets: A Guide for Cities," Science Based Targets Network: Global Commons Alliance, November 2020. https://sciencebasedtargetsnetwork.org/wp-content/uploads/2021/04/SBTs-for-cities-guide.pdf.

57 Lois B Roberts, Steve A Coroza, and Sally A Gomery, "Mathur V. Ontario," *Decisions of the Court of Appeal* (2024 ONCA 762, October 17, 2024). https://climatecasechart.com/wp-content/uploads/non-us-case-documents/2024/20241017_CV-19-00631627_decision.pdf.

"It is appropriate in the context of this case to assess the Target in light of global targets that are based on scientific consensus/findings of the Intergovernmental Panel on Climate Change (IPCC)."

The decision clearly indicates a legal preference for targets to be grounded in the science of climate change. This project is an opportunity for the CIty to update its GHG targets with the latest science. As a result of its endorsement of TransformWR, the City's current targets are a 50% reduction by 2030, and 80% reduction by 2050, over 2010 levels.

Using the current guidance on SBTs, because Kitchener's per capita emissions are less than 5.1 tCO_2e/capita, the recommended SBT is –55% to –60% over 2015 by 2030 and net-zero emissions by 2050.[58]

The SBT guidance is informed by three principles: science-driven, equity, and completeness. The science-driven principles ensure the target is in line with the global warming target of 1.5oC. They also outline a defined carbon budget and an agreed overshoot, as well as a clear baseline and scenario the target will follow. The equity principles take into account national-level considerations for equity (such as the Human-Development Index), and the historical and intergenerational emissions. The completeness principle ensures the target is city-wide, includes the appropriate emissions scopes, and includes some or all of the GHGs (CO_2, N2O], HFCs, CH4, PFCs, and SF6).[59]

A Carbon Budgeting Target and Process

The carbon budgeting process is the current best practice for systematically and comprehensively managing GHG emissions both at the community scale and for municipal operations. The carbon budget is complementary to the 2030 and 2050 point-in-time targets.

GHG reductions targets for 2030 and 2050 are important milestones, but climate change is determined by cumulative GHG emissions, or the sum of GHG emissions over time. As illustrated in Figure 4, different pathways to the same target can result in different levels of cumulative GHG emissions.

58 C40 Cities et al., "Science-Based Climate Targets: A Guide for Cities."

59 C40 Cities et al., "Science-Based Climate Targets: A Guide for Cities."

Figure 4. Comparison of trajectories to reduce emissions from immediate action (far left) to delayed action (far right), where the area under the curve represents the cumulative GHG emissions.

A second challenge with the 2030 and 2050 targets is that they are difficult to operationalize for the following reasons:

- **Cause and effect:** Analysis of the impacts of GHG emissions-related policies, programs, and investments is limited, and when project-level impacts are available, there is no mechanism to assess or trade-off their impacts relative to all other activities in the organization.
- **Temporal disconnect:** The decision-making horizon of elected officials or City staff is typically annual or in five-year increments, whereas GHG reduction targets occur over several decades.
- **Organizational silos:** Climate action is usually the responsibility of the sustainability or climate team, which is typically a small team with limited visibility and influence on the policies, decisions, and investments that result in GHG emissions.

The City of Oslo pioneered the carbon budget as a way to systematically operationalize its GHG targets across the organization. Subsequently, Canadian municipalities (Edmonton, Calgary, Saskatoon, Regina, Montreal, Toronto, Whitby, Fredericton, Durham, Mississauga, Hamilton, and Saint John) have been evolving the approach, with some piloting the carbon budget for their operations, while others are applying it more comprehensively to their community GHG emissions.

A carbon budget compliments the point-in-time targets described above, by identifying a cumulative GHG emissions envelope for the community and municipal operations, downscaled from the global carbon budget, ensuring alignment with the latest science. This downscaled carbon budget provides the City with an annual GHG emissions "envelope" against which it can align its activities, policies, and expenditures, increasing transparency and accountability.

The carbon budget consists of the following components:

- A projection of GHG emissions for the community if no actions are taken;
- A projection of GHG emissions for the community that accounts for planned actions;
- An annual Carbon Budget (e.g., a GHG emissions limit), aligned with the global carbon budget;
- A Climate Lens to evaluate the impacts of planned investments, policies, and programs on GHG emissions; and
- Annual corporate and community GHG inventories.

Figure 5 illustrates the concepts addressed in a carbon budget on a sample timeline. Annual GHG inventories track GHG emissions from both the municipality and the community. The gap between the annual carbon budget and the inventory shows whether the City is in a budget surplus or deficit. Projecting forward, the City is able to determine the future carbon liability based on trajectories of no action, planned actions, and annual carbon budget limits.

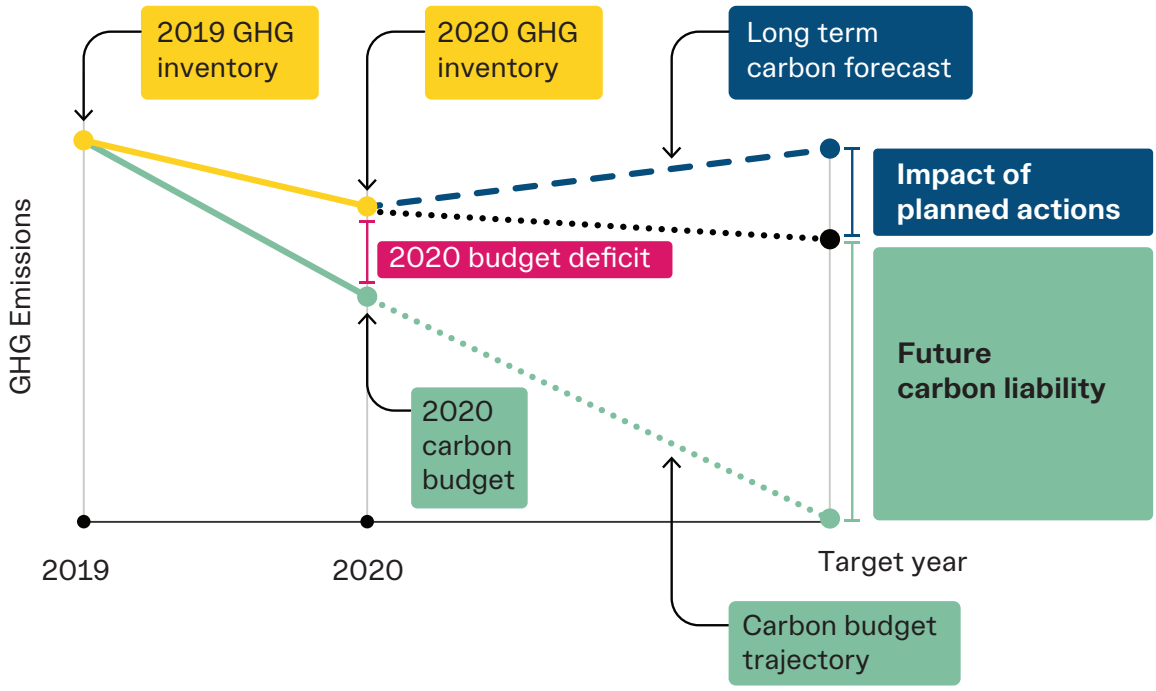


Figure 5. A sample carbon budget.

The carbon budget builds a link between emissions reduction targets, policies, and decision-making. By setting an emissions ceiling and devising strategies to adhere to this limit, carbon budgeting is analogous to financial planning while specifically addressing emissions management.

Adaptation Targets

Unlike climate mitigation, adaptation does not have overall targets, as there is no end-state of being "adapted."

A Climate Risk and Vulnerability Assessment (CRVA) is used to set priorities for adaptation based on local hazards, impacts, and risks. More specific targets reflecting these priorities could include, for example, minimum volume retention for stormwater or tree canopy coverage.

Understanding how to adapt to climate change requires assessing how climate change is expected to evolve hazards over time, what the potential impacts of those changes are, and how prepared Kitchener is to handle and recover from emergencies.

International Cooperation

The City can signal its commitment by joining international programs or efforts to limit climate change. For example, leading Canadian municipalities including Toronto, Vancouver, and Ottawa have signed on to the effort to develop a Fossil Fuel Non-Proliferation Treaty,[60] which aims to stop the expansion of fossil fuels and manage a global just transition.

Guiding Principles

Kitchener should indicate that its response to climate change is shaped by a series of overarching principles that can frame policy directions, policy development, and implementation approaches. Principles signal the lens that will be applied in deciding how the City of Kitchener will achieve its climate goals. The following principles represent key elements of a municipal approach to climate mitigation and adaptation.

Principle 1: Multi-Solving

Multi-solving was pioneered in 2015 by the organization Climate Interactive as a way to describe projects using **one investment of time, money, or effort to address multiple problems at the same time**.[61] Multi-solving has evolved to describe when representatives across sectors come together to address multiple problems with one policy or investment. A common example is how compact, complete communities reduce emissions from transportation, provide equitable access to transportation, improve people's health and well-being, and improve local economies. While these

60 Fossil Fuel Non-Proliferation Treaty Initiative, "The Fossil Fuel Non-Proliferation Treaty Initiative,", n.d. https://fossilfueltreaty.org/.

61 Janet Chikofsky, "What Is Multisolving?," Climate Interactive, 2022. https://support.climateinteractive.org/support/solutions/articles/47001159227-what-is-multisolving-.

are often co-benefits of climate action, multi-solving differs from co-benefits in that co-benefits are the effects that can result from successful multi-solving. Therefore, multi-solving is the process taken to achieve these co-benefits.[62]

Multi-solving allows decision-makers to solve multiple problems at once by aligning sectors for greater impact, solving short-term problems as a way to reduce longer-term crises, and including equity in all policies and programs. Multi-solving requires collaborators to take a whole system approach, avoid practicing in silos, and develop a comprehensive vision.[63] The Framework for Long-term, Whole-system, Equity-based, Reflection (FLOWER) provides a flexible framework to co-design policies or investments for co-benefits by mapping the application connections between the eight common co-benefits of health and well-being, jobs and livelihoods, resilience, built environment, food and water, climate protection, and biodiversity (Figure 6).[64]

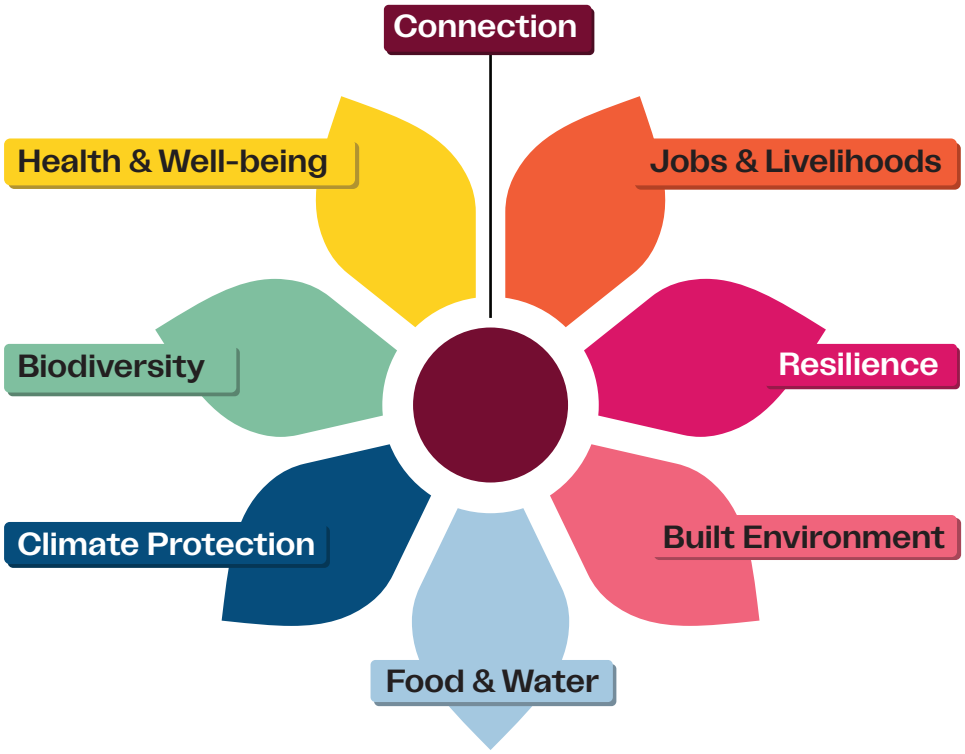


Figure 6. Multi-solving Institute's FLOWER tool for policy and investment planning.[65]

62 Janet Chikofsky, "What Is the Difference Between Multisolving and Co-benefits?," Climate Interactive, 2023. https://support.climateinteractive.org/support/solutions/articles/47001160474-what-is-the-difference-between-multisolving-and-co-benefits-.

63 Multisolving, "About Us - Multisolving Institute," Multisolving Institute, September 24, 2024. https://www.multisolving.org/about-us/.

64 Kelsi Bowens, "FLOWER - Multisolving Institute," Multisolving Institute, December 19, 2024. https://www.multisolving.org/flower/.

65 Bowens, "FLOWER - Multisolving Institute."

In Kitchener's context, multisolving could be further enhanced using a multi-hazard approach of identifying solutions that improve resource efficiency and avoid unintended consequences. A multi-hazard approach identifies and supports the implementation of solutions that address more than one hazard simultaneously. Through this approach, Kitchener can more efficiently use its resources to address the diverse array of climate hazards it faces.

Taking a multi-hazard approach also includes considering the interaction of hazards and solutions more holistically, rather than independently, to avoid unintended consequences. For example, if a system intended to address flooding is designed exclusively to move water into pipes and away as fast as possible, this could potentially impact the availability of groundwater during dry periods if infiltration and groundwater recharge are restricted. Or shading structures intended to alleviate the impacts of extreme heat during the summer may increase the demand for active heating during periods of extreme cold in the winter.

Principle 2: Implement a Transformational Approach

Climate change is a symptom of many other problems, ranging from the combustion of fossil fuels, to cultural norms, and the structure of the economy. Adapting to climate change requires consideration of many of these other problems, and this complexity places the challenge of climate change in a genre characterized as "wicked problems." The social dimensions of wicked problems mean that they cannot be solved by engineering or science alone.

Approaches to mitigating and adapting to climate change can be incremental or transformational. In general, governance processes, policies, and initiatives are developed by adjusting current practices informed by historical experience. This approach, which can be characterized as "one step at a time," is known as "incremental change." The broad scope of implications, combined with the exponential rate of change renders the one step at a time approach to both climate adaptation and the energy transition inadequate. A 'transformational approach' involves a broader and more systemic look at the root causes of Kitchener's vulnerability to the impacts of climate change, and assesses fundamentally different approaches to preparing for and responding to climate risks, including both mitigation and adaptation.

Transformational adaptation is characterized by transparency, integration, flexibility, monitoring, continual learning, different worldviews, and knowledge sharing. At the heart of this approach is cultivating and embracing uncertainty, enabling honest dialogue, and learning from doing.

Principle 3: Apply Adaptive Management

"Adaptive management" is an approach that enables Kitchener to manage the "wickedness"[66] of climate change. Characterized as "learning to manage by managing to learn," adaptive management relies on strategic planning, encouraging innovation, experimentation, and decision-making processes that join learning with action (Table 3).

Table 3. Aspects of adaptive management for policy design and implementation.

Aspects	Application
Integrated and forward-looking analysis	Identify key factors that affect policy performance; identify scenarios for how these factors might evolve in the future; develop policies that are robust to a range of anticipated conditions; develop indicators that trigger policy adjustments.
Multiple perspectives	Apply a collective and collaborative effort to examine an issue from different points of view; build common values and shared commitment; provide a comprehensive understanding of causal relationships.
Ongoing policy adjustment	Monitor key indicators to trigger policy adjustments.
Enable self-organization	Ensure that policies do not undermine existing social capital; create forums that enable social networking; facilitate the sharing of good practices and remove barriers to self-organization.
Decentralization of decision-making	Enable decision-making at the lowest effective and accountable unit of governance, whether existing or newly created, to increase the capacity of a community or neighbourhood to perform successfully when confronted with unforeseen events.
Promoting variation	Implement a diversity of policies to address the same issue to increase the likelihood of achieving desired outcomes. A diversity of responses is also a risk-management approach, facilitating the ability to perform efficiently in the face of unanticipated conditions.
Formal policy review and continuous learning	Review regularly and use well-designed pilots to test assumptions related to performance and to address emerging issues and trigger adjustments.

66 In public policy, problems are characterized as wicked when they are difficult to solve because of complex relationships, interactions with other problems, differing perspectives, and incomplete data.

Principle 4: Integrate Social Equity

Structural inequality in society results in climate change disproportionately impacting certain groups, communities, or populations due to their increased exposure and sensitivity to climate risks, or lack of adaptive capacity to deal with the impacts. With limited resources, it is important to prioritize action for the most vulnerable and affected members of communities, many of whom are already facing a range of challenges. These include those who live or work in hazard-prone areas, persons who experience homelessness or live in poor-quality housing or living conditions, the elderly and very young, and those with disabilities and pre-existing illnesses, among others.

It is also important to consider systemic barriers that some residents encounter. People living on low incomes, racialized groups, immigrants and refugees, non-English or French speakers, people with disabilities, and Indigenous peoples face physical, social, and structural barriers to accessing services and social supports, and frequently face discrimination. This directly influences their ability to seek and receive help, in addition to influencing their health and income.

Both historic and growing social and economic inequalities, and continued systemic and institutional inequity, exacerbate underlying drivers of vulnerability to climate change. For example, for racialized groups, structural and institutional racism negatively influence income, living conditions, and health, which in turn increases vulnerability to climate change. Similarly, racialized and low-income communities are frequently underfunded, which can result in inadequate green space or community assets, increasing and compounding exposure to climate risks.

Principle 5: Commit to Engaging Deeply and Collaboratively

As noted above, climate change is a "wicked" problem that cannot be addressed by one or even a few perspectives. It requires a diversity of worldviews and perspectives, including Indigenous knowledge systems, to develop novel approaches and diverse ways of thinking in order to address the urgency and complexity of the issue.

Broad, deep, and collaborative engagement is fundamental for the City of Kitchener to address climate change. Those affected by climate decisions should not only be directly engaged in shaping those decisions, but also in collaboratively identifying the solutions. Deciding **with**, not **for**, is at the foundation of this equitable and community-driven approach, which is particularly relevant for populations that are vulnerable to climate change.

An inclusive process involving a wide range of community members ensures that a broad range of perspectives are included. These perspectives then need to be incorporated into the design of new policies and programs to address climate change. This helps ensure the resulting policies and programs are inclusive and equitably distribute benefits.

Principle 6: Integrate Risk Reduction With Community Enhancement

Climate action planning often focuses on identifying and prioritizing actions that deliver the greatest risk reduction. However, climate risk can and will change based on changes in physical, human, and natural systems over time. For many practical reasons, risk cannot be completely eliminated. Successful adaptation does not mean negative impacts will not occur, only that they would be less severe than would be experienced had adaptive capacity not been enhanced. Additionally, a primary focus on risk reduction may result in missed opportunities, such as the exclusion of no-regret measures that consider wider social, environmental, and economic benefits.

No-regret measures

No-regret measures, sometimes referred to as "win-win" measures, are mitigation or adaptation actions that simultaneously deliver multiple benefits, with a net economic benefit. No-regret measures can be enacted now without being certain about all dimensions of future climate change, as they represent low-risk actions that do not possess hard trade-offs with other policy objectives. These measures improve the living conditions for both present and future generations.[67] No-regret measures can be identified in multiple sectors to address the same hazard. For example, in the case of reducing flood risk, the following no-regret measures can be implemented in the following sectors:

Built environment: Install door guards and locate electrical controls, cables, and appliances at a higher level;

Land-use planning: Avoid construction in high-risk areas and/or floodplains; and

Agriculture: Establish hold ditches for excess run-off.

The cumulative impact of seemingly small measures is also important to consider. For example, one green roof, or one tree, alone will not necessarily make a significant contribution in reducing flooding or heat impacts. However, the mass deployment of green roofs, or a significant increase in tree canopy cover, can have a significant impact specifically in areas more prone to flooding and the heat island effect.

67 Circles of Social Life, "No Regrets: Circles of Climate Change Adaptation," Principles and Practices for Responding to Climate Change, n.d. https://www.circlesofclimate.org/.

Principle 7: Align Financial Management and Investment

Climate change will continue to have a financial impact on Kitchener. As climate events become more extreme and occur more frequently, these events will disrupt and damage infrastructure, driving up repair costs and shortening asset lifetimes. Infrastructure may need to be replaced sooner than anticipated as already-aging infrastructure ages faster and reaches the end of its useful lifetime earlier than designed for.

Adaptation to climate change will require significant investment, but every dollar invested proactively can save as much as $13 to $15 in direct and indirect benefits.[68] Despite the compelling financial return, it is challenging for both organizations and individuals to prioritize paying predictable costs today for mitigation and adaptation, compared to delaying action and paying higher and unpredictable costs later.

Frameworks

Most community plans and climate action plans tend to take a scattershot approach to reducing GHG emissions, with long lists of policies or actions that lack structure or strategy. An underlying framework or paradigm ensures a systematic approach that makes effective use of resources, a form of triage in the face of the climate emergency. The City of Kitchener's approach to integrating climate change into the OP should be shaped by complementary frameworks.

Efficiency First

"Reduce, Improve, Switch" is a simple framework that provides guidance on an overall approach to community energy and emissions planning. It was adapted from similar approaches such as "Reduce-Reuse-Recycle" (from the waste sector) and "Avoid-Shift-Improve"[69] (from the transportation sector).

The framework's advantage is that by prioritizing a reduction in energy use, the need for retrofits and fuel switching is lessened. TransformWR has used this model to create its GHG reduction framework: conserve, fuel switch, and generate. Prioritizing efficiency measures decreases the need for energy, and as a result, the demand for renewable energy generation and related infrastructure. Conversely, if fuel switching is prioritized, the scale of renewable generation is larger and potentially excessive if efficiency measures are implemented later, leading to higher costs.

68 Sawyer, Dave, Ryan Ness, Caroline Lee, and Sarah Miller. Damage Control: Reducing the costs of climate impacts in Canada, 2022. Canadian Climate Institute. https://climateinstitute.ca/reports/damage-control/.

69 Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, "Sustainable Urban Transport: Avoid-Shift-Improve (A-S-I)," 2011. http://www.sutp.org/files/contents/documents/resources/E_Fact-Sheets-and-Policy-Briefs/SUTP_GIZ_FS_Avoid-Shift-Improve_EN.pdf.

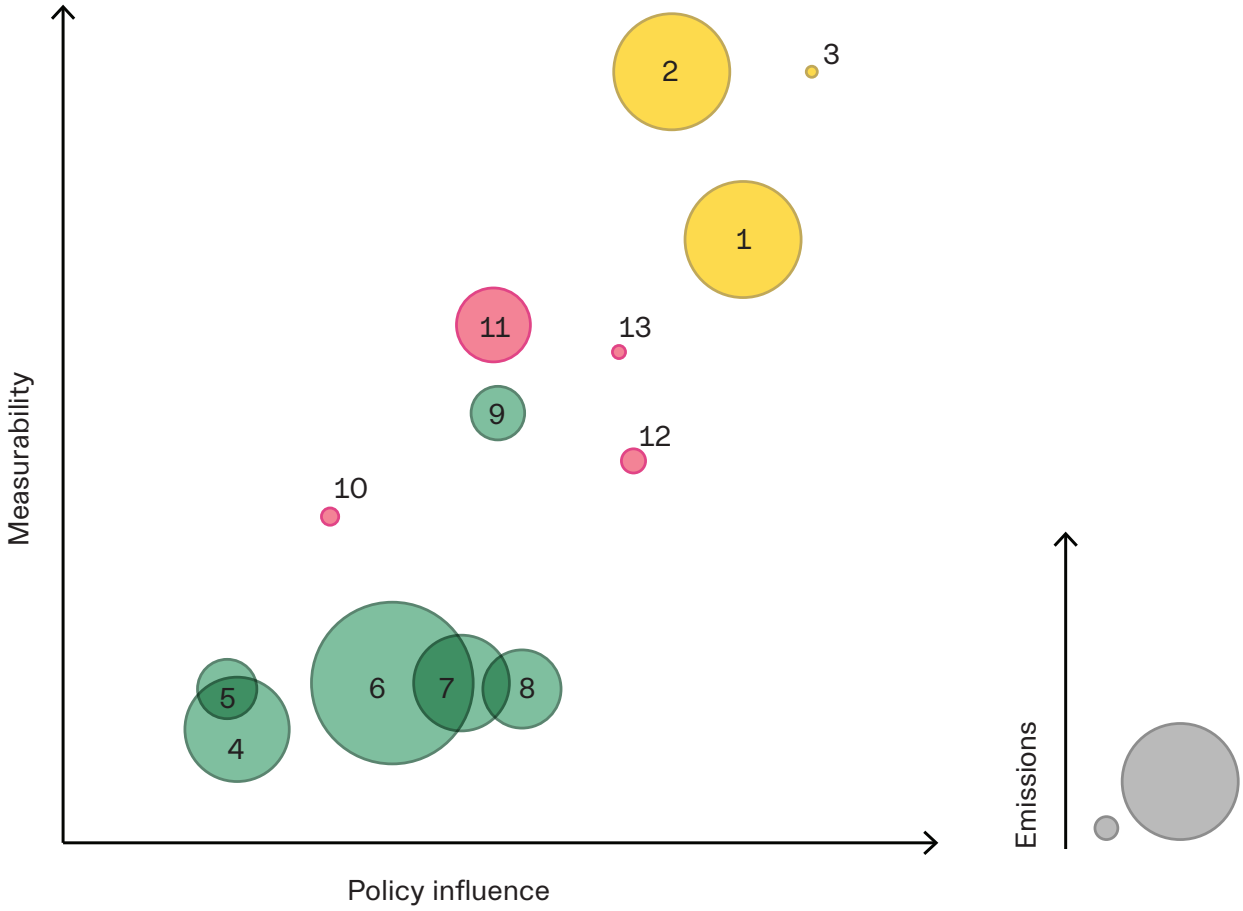
Table 4. Reduce, Improve, Shift framework for community energy and emissions planning with sample policies.

Framework	Buildings	Transportation
Reduce: Reduce energy consumption and optimize energy demand.	Ensure the shape and orientation of buildings is designed to minimize energy consumption.	Build compact, complete communities and transit-oriented development.
Improve: Increase energy efficiency.	Upgrade to energy-efficient lighting systems. Perform energy retrofits for existing buildings. Introduce energy storage and district energy.	Increase walking, cycling, and transit trips.
Switch: Shift to low-carbon energy sources.	Source energy from renewable sources (e.g., solar energy, wind).	Switch to zero-emission vehicles that use renewable energy.

Consumption-Based Emissions

There are two distinct but complementary approaches for completing a GHG inventory. Most municipalities have conducted a geographic analysis, which captures GHG emissions resulting from the energy consumed and waste produced within the geographic boundary of the municipality. A consumption-based GHG inventory expands the opportunity for GHG emissions reductions at the community scale by considering emissions that occur in other geographic locales as a result of the goods and services consumed by the members of the community (Figure 7).

Methods to assess consumption-based emissions are not as developed as geographic-based inventories, but the resulting policies can achieve objectives in public health, waste management, affordability, and community-building.



Geographic Sectors
1 Local vehicle travel
2 Local building energy
3 Waste

Production-based Sectors
10 In-area Agriculture
11 In-area Industry
12 Port, marine
13 Land clearing

Consumption-based Sectors
4 Services (consumed)
5 Long-distance freight
6 Goods (consumed)
7 Food (consumed)
8 Construction (embodied GHGs)
9 Air Travel

Figure 7. Geographic-based vs. consumption-based inventory.[70]

70 Adapted from: Peter Erickson and Michael Lazarus, "Revisiting Community-Scale Greenhouse Gas Inventories," Environmental Science & Technology 46, no. 9 (April 17, 2012): 4693–94. https://doi.org/10.1021/es301366b.

Planning for Adaptation

There are three leading frameworks for climate adaptation planning best practices:

1. Resilient Cities Network;[71]
2. International Institute for Environment and Development (IIED) Tracking Adaptation and Measuring Development Framework;[72] and
3. The Global Center on Adaptation's Principles for Locally Led Adaptation Action.[73]

A review of these frameworks found the following cross-cutting best practices that can be applied to the City's adaptation planning:

1. **Center climate adaptation and resilience** within the organization, and ensure the climate adaptation and resilience lens is applied to financial and policy decisions.
2. **Use local, Indigenous, and scientific knowledge** to understand climate risks and hazards, and build mechanisms to update programs and policies as climate knowledge evolves.
3. **Develop long-term, climate-focused funding mechanisms** that are simple and accessible, and ensure financial decision-makers understand climate change impacts and adaptation actions.
4. **Center equity and participation** in the planning, development, and implementation of adaptation plans, policies, and projects.
5. **Build institutional and community capacity for climate action** based on formal training about climate change, local climate risks and hazards, and cross-departmental climate adaptation action implementation.
6. **Provide transparent, clear, and accessible communication** on climate hazards, progress toward goals, planning and community priorities, and decision-making.
7. **Build cross-sectoral collaboration** within the City and across businesses, institutions, communities, and funders.

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71 Jo Da Silva, Arup International Development, and Nancy Kete, "City Resilience Framework," report by Rockefeller Foundation, *City Resilience Index*, March 2014. https://resilientcitiesnetwork.org/downloadable_resources/UR/City-Resilience-Framework.pdf.

72 Brooks Nick et al., "An Operational Framework for Tracking Adaptation and Measuring Development (TAMD)," International Institute for Environment and Development, 2013. https://www.iied.org/10038iied.

73 Global Commission on Adaptation, "Adapt Now Report," World Resources Institute, 2019. https://www.wri.org/initiatives/global-commission-adaptation/adapt-now-report.

Act Now

In addition to the above action needed to take action in responding to climate change, there is also an economic imperative. Delays can lock in inefficient approaches or technologies that are costly to retrofit later on, imposing a cost on households and society. The durability of the patterns of built environment and the associated infrastructure that is directed by land-use planning results in a phenomenon called lock-in or path dependence—the limits that are imposed on a municipality by the long-term consequences of decisions that have been made in the past.

Climate action considers lock-in effects by prioritizing interventions using a hierarchy of what lasts longest:[74]

1. Land-use planning and infrastructure (>100 year duration): Includes density, land-use patterns, energy supply infrastructure, and transportation infrastructure.
2. Industry, transportation modes, and buildings (>50 year duration): Includes industrial process, choice of transportation modes, and building and site design.
3. Energy-using equipment (>5 year duration): Includes transit vehicles, motors, appliances, and HVAC systems.

Yet, the urgency of climate action limits this idealized approach, as time is short. More climate mitigation and adaptation solutions are needed and emerging, but the urgency of climate action means that transformative actions taken today are better than potential new actions in the future.[75]

Information

As the City works to increase climate resilience, data collection, mapping, and monitoring play a critical role in ensuring that municipal decisions are informed by accurate, up-to-date information. Effective climate adaptation strategies rely on robust data and the ability to track changing conditions in real-time. The use of detailed and regularly updated climate risk mapping allows the municipality to identify vulnerable areas, prioritize interventions, and make informed land-use decisions.

Regular updates to the Regional Climate Risk and Vulnerability Assessment (CRVA), or the development of a Kitchener-specific CRVA, will ensure that the City continues to evolve its understanding of climate impacts and risks as the science and CRVA methods

74 Mark Jaccard, Lee Failing, and Trent Berry, "From Equipment to Infrastructure: Community Energy Management and Greenhouse Gas Emission Reduction," Energy Policy 25, no. 13 (November 1, 1997): 1065–74. https://doi.org/10.1016/s0301-4215(97)00091-8.

75 Project Drawdown. "Drawdown Climate Solutions Library," n.d. https://drawdown.org/solutions.

evolve. The CRVA analyzes the likelihood, consequences, frequency, and impacts of climate hazards on residents, assets, and key sectors within a municipality. The City should also integrate the findings of the CRVA into city plans, policies, investments, and operations.

Citizen science enables community members to support the monitoring of the ecosystem, human activity, and the climate, and for their findings to inform municipal policy and investments, while building their understanding of the changes that are underway. The citizen science process can also inform a community CRVA and regular updates, ensuring that the CRVA, which can often be quite theoretical, is grounded in the community`s experience.

Leading the Change

The ongoing implementation and updates to the Corporate Climate Action Plan is the primary way the City's operations can demonstrate leadership for broader community efforts and develop local capacity. Key elements of this effort include:

- Deep retrofits for municipal facilities;[76]
- Implementation of a zero emissions standard for new municipal buildings;
- Continuing to install solar PVs at its new and existing facilities, including evaluating third-party net metering[77] and other procurement mechanisms;[78]
- Procuring RNG and biodiesel in the interim phase prior to electrification;
- Continuing to decarbonize the fleet; and
- Ensure that new and replacement municipal infrastructure is resilient. Climate-resilient infrastructure is one which is planned, designed, built, and operated with the future climate impacts in mind, allowing infrastructure systems to withstand climate impacts and recover quickly after a disruption.[79]

76 City of Kitchener. "Corporate Climate Action Plan for the City of Kitchener." City of Kitchener Corporate Sustainability, 2019. https://www.kitchener.ca/en/water-and-environment/corporate-sustainability.aspx#:~:text=Our%20second%2Dgeneration%20Corporate%20Climate,for%20and%20supply%20of%20energy.

77 "Supporting Residential Roof-Top Solar and Other Renewable Resources by Clarifying Eligibility of Third-party Leasing and Financing Net Metering Arrangements | Environmental Registry of Ontario," April 26, 2022. https://ero.ontario.ca/notice/019-4554.

78 Government of Ontario, Ministry of Economic Development, Job Creation and Trade. "Ontario Regulation 429/04 Amendments Related to the Treatment of Corporate Power Purchase Agreements." © King's Printer for Ontario, 2022. https://www.ontariocanada.com/registry/view.do?postingId=45890&language=en.

79 Government of Canada, "National Adaptation Strategy for Canada."

Beyond the Corporate Climate Action Plan, the City can also implement programs that will stimulate innovative GHG reduction efforts. For example:

- An emissions credit system enables trading of emissions reductions between departments and community entities, creating flexibility within the carbon budget system and enabling more rapid reductions where there are opportunities to do so.
- An innovation pathway can accelerate the development and mainstreaming of innovation niches.[80] This pathway can advance pioneering projects such as evolv1, or geothermal district energy or net-zero neighbourhoods, that represent novel responses to climate action and can be scaled across the city or beyond; the City of Vancouver has a similar policy.[81] The innovation pathway could include financing, reduced or accelerated regulatory or permitting requirements, or technical support from the City or other experts.

The City can leverage its procurement activities to reduce GHG emissions. Municipalities procure a wide range of products and services that have a wide range of carbon footprints and opportunities for emissions reductions, which can both provide direction to suppliers and markets and improve the quality and durability of the goods the City procures. Many municipalities have reviewed their purchasing policies with a view to improving sustainability performance.[82,83]

The approach to procurement will depend on the good or service being procured. Concrete and concrete-based materials such as drainage pipe, steel, and asphalt are products which are heavily procured by municipalities and can have a high GHG intensity. The City can select lower-carbon decarbonizing the City's investment portfolios options or preferentially procure lower-carbon footprint options.[84,85,86]

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80 Coenen, Lars, Rob Raven, and Geert Verbong. "Local Niche Experimentation in Energy Transitions: A Theoretical and Empirical Exploration of Proximity Advantages and Disadvantages." Technology in Society 32, no. 4 (November 1, 2010): 295–302. https://doi.org/10.1016/j.techsoc.2010.10.006.

81 City of Vancouver Planning, Urban Design and Sustainability Department. "City of Vancouver Land Use and Development Policies and Guidelines," April 1, 2024. https://guidelines.vancouver.ca/policy-sustainability-zero-emissions-building-catalyst.pdf.

82 City of Mississauga. "Sustainable Procurement," September 13, 2022. https://www.mississauga.ca/services-and-programs/business/doing-business-with-the-city/bids-and-tenders/sustainable-procurement/.

83 City of Brampton. "Sustainable Procurement Strategy." 2020. https://www.brampton.ca/EN/City-Hall/policies-directives/Documents/Sustainable%20Procurement%20Strategy.pdf.

84 Neidl, Chris, and Caleb M. Woodall. "A Design Guide to State and Local Low-Carbon Concrete Procurement." Natural Resources Defense Council, 2022. https://www.nrdc.org/sites/default/files/low-carbon-concrete-procurement-guide.pdf.

85 Ministry of Transportation and Gelu Vasiliu. "Ontario's Transportation Technology Transfer Digest." Ministry of Transportation, season-03 2021. https://files.ontario.ca/mto-road-talk-newsletter-fall-2021-en-2022-03-01.pdf.

86 Canadian Ready Mixed Concrete Association. "A Guideline for Specifying Low Carbon Ready Mixed Concrete in Canada," 2024. https://cement.ca/wp-content/uploads/2024/06/Concrete-Carbon-June-2024-web.pdf.

Financial management strategies that support or enable the decarbonization of operations and policies include using the social cost of carbon to embed the externalized cost of climate change into financial analysis, ensuring that impacts on future generations are accounted for.[87] Lifecycle costing brings together the capital and operating cost impacts to ensure more cost-effective, energy-efficient, and low-carbon investments are made, avoiding the lock-in that can result from lower capital cost projects that involve more emissions and energy consumption over their lifetime.

Decarbonizing the City's investment portfolios is another important mechanism used by many cities and organizations, and an important symbol for youth in ensuring a consistent and principled approach to climate action.[88]

Funding climate action is crucial for ensuring that the City and community can implement necessary mitigation and adaptation measures. Funding includes increased incentives, fewer barriers, and coordination across multiple sectors[89] through, for example, collaborating on the on-bill financing program currently being developed for Waterloo Region (RetrofitWR). The OP can enable established and innovative funding mechanisms to support the investments made by the City, community, and its partners.[90] Novel approaches to funding climate adaptation, based on evidence of the cost-effectiveness of these investments, are also emerging.[91]

Recommended policy themes are outlined below.

#	Theme	Recommendations	Implementation Approach
1	Targets	State its GHG targets in the OP alongside a community carbon budget in order to provide increased transparency and accountability for municipal and community efforts to reduce emissions.	The GHG impact of policies, investments, and new developments can be assessed in the context of the overall carbon budget in order to ensure they don't limit the ability of the City to achieve its targets.

87 US EPA. "EPA's 'Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances' | US EPA," November 20, 2024. https://www.epa.gov/environmental-economics/scghg.

88 C40 Cities. "Mayors of 12 Major Cities Commit to Divest From Fossil Fuel Companies, Invest in Green and Just Recovery From COVID-19 Crisis - C40 Cities," December 17, 2021. https://www.c40.org/news/cities-commit-divest-invest/.

89 Lulham et al., "Canada in a Changing Climate: Synthesis Report."

90 Hamilton, Daniel, Paul Herman, Nick Gower, Lucia Pohlman, and Adam Mason. "Funding and Financing Climate Action Plans." USDN Innovation Fund Project, 2019. https://www.usdn.org/uploads/cms/documents/usdn_funding_financing_climate_action_final_report.pdf.

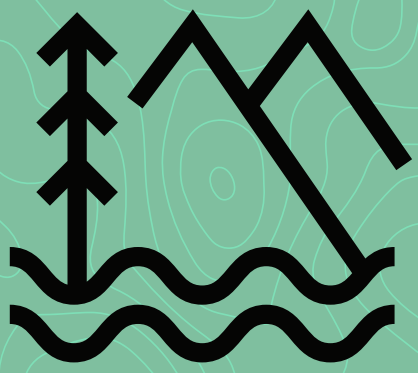
91 Ewart, Tom, Joyce Coffee, and Sarah Miller. "Mobilizing private capital for climate adaptation infrastructure." Canadian Climate Institute, 2023. https://climateinstitute.ca/wp-content/uploads/2023/05/mobilizing-private-capital-climate-adaptation-infrastructure.pdf

#	Theme	Recommendations	Implementation Approach
2	Guiding principles	Include a set of guiding principles that articulate the City's approach to climate action. Considerations for equity and Indigenous reconciliation should be incorporated into these principles.	These principles can be used to guide approaches to implementation and to shape subsidiary policies.
3	Innovation	Include an alternative planning and approval pathway to support innovations that address climate mitigation and adaptation.	The response to climate change requires novel approaches to development, land-use, building design, and infrastructure design that are different from our past experience. The City needs a process to support, review, approve, evaluate, and incorporate these innovations.
4	Climate-ready infrastructure	Include a policy to complete regular CRVAs and to incorporate updated climate change projections into projects, infrastructure, and subsidiary plans.	The projections should inform the location of potential infrastructure and the design of the infrastructure with implementation tools including a Climate Adaptation Plan, regularly updated climate change projections, CRVAs, iterative design standards, and capacity building for staff.
5	Municipal operations	Include a policy committing to leadership in both mitigation and adaptation in its own operations, including buildings, fleet, energy systems, investments, procurement, and corporate policies.	The implementation tools include the Corporate Climate Action Plan, land-use policies, procurement policies, levels of services for municipal operations, and asset management plans.

#	Theme	Recommendations	Implementation Approach
6	Municipal finance	Include a policy committing to using innovative financial methods to assess the impacts of projects and to finance, or enable financing, of low carbon and resilience.	This policy will empower the City to incorporate the social cost of carbon in financial cases and apply lifecycle cost analysis to development projects or in the evaluation of land-use policies. It will also enable the City to develop financing mechanisms such as revolving loan funds, green banks, Local Improvement Charge (LIC) programs for adaptation or mitigation projects and other strategies.
7	Collaboration	Include a policy that recognizes that climate change is a cross-border, cross-sector challenge that requires unique collaborations between governments, agencies, and other actors.	This policy enables the City to collaborate fully with higher education, conservation authorities, businesses, public health, non-profits, and other governments using strategies such as roundtables, citizen juries, or other mechanisms, which can increase the effectiveness and impact of the City's efforts. For example, the City could consider a partnership such as the City of Bristol's Leap,[92] which mobilizes massive investment and programming capacities.

92 City of Bristol. "Bristol City Leap." Bristol City Leap, July 24, 2024. https://www.bristolcityleap.co.uk/.

Big Move 2



Natural Infrastructure

Green spaces are an important urban feature that provide health and climate change mitigation and adaptation benefits.[93] Within the built environment, green spaces encompass green infrastructure, natural spaces, open spaces, and engineered green spaces. Studies show that access to green space reduces the occurrence of chronic diseases such as cancer, cardiovascular disease, diabetes, and respiratory disease, while also improving mental health, physical fitness, and cognitive and immune function.[94] This not only lowers premature deaths, but also reduces health care costs to treat chronic illnesses. The health benefits of green spaces have been particularly evident in lower-income and vulnerable communities.

The City can acknowledge the crucial role that natural heritage can play in climate change adaptation, particularly when identifying ecological restoration areas. The City defines these areas as "lands and waters that have the potential to be enhanced, improved, or restored to a natural state, contributing to the overall diversity and connectivity of the natural heritage system."[95] As previously noted, these areas can also absorb excess stormwater runoff and reduce the risk of flooding. As Kitchener is projected to experience more extreme precipitation events in the future due to climate change, more protected natural areas may be needed to prevent major flood events. These natural areas can also help cool the air and mitigate the urban heat island effect within the city.

Natural systems and biodiversity form the basis of many of the systems humans rely on to support their livelihoods, including food, water, economic growth, health and well-being, and regulating the climate. Natural systems, both land and ocean, are responsible for absorbing more than half of the world's carbon emissions as well as enabling life itself.[96] The degradation of land and natural systems have been the main drivers of biodiversity loss, and climate change has increasingly exacerbated the decline of biodiversity across the world.

The EU Biodiversity Strategy recognizes the interconnection between biodiversity loss and climate crises, and calls for coordinated action to address both.[97] This strategy focuses on nature-based solutions, as these allow decision-makers to enact actions that tackle the dual crises of biodiversity loss and climate change while producing co-benefits in the economy, communities, and nature.[98,99]

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93 Lulham et al., "Canada in a Changing Climate: Synthesis Report."

94 Public Health Agency of Canada. "Commentary: Climate Change, Health and Green Space Co-benefits." Government of Canada, 2021. https://www.canada.ca/en/public-health/services/reports-publications/health-promotion-chronic-disease-prevention-canada-research-policy-practice/vol-39-no-4-2019/climate-change-health-green-space-co-benefits.html.

95 City of Kitchener. "City of Kitchener: Natural Heritage System Technical Background Report." 2014. https://www.kitchener.ca/en/resourcesGeneral/Documents/DSD_PLAN_Natural_Heritage_Systems_Background_Report.pdf.

96 United Nations. "Biodiversity - Our Strongest Natural Defense Against Climate Change | United Nations," n.d. https://www.un.org/en/climatechange/science/climate-issues/biodiversity.

97 European Environment Agency. "Biodiversity." Climate ADAPT, n.d. https://climate-adapt.eea.europa.eu/en/eu-adaptation-policy/sector-policies/biodiversity.

98 UNESCO. "Biodiversity and Climate Change," 2023. https://www.unesco.org/en/climate-change/biodiversity.

99 European Environment Agency, "Biodiversity."

Evolving Categories of Hazards and Severity

The OP indicates that the City of Kitchener "will consider the potential impacts of climate change that may increase the risk associated with natural hazards when evaluating development applications and infrastructure projects." This suggests the City should examine whether climate change could exacerbate the dangers in areas already identified as hazardous. However, it does not necessarily indicate that the City has factored future climate risks into the delineation of hazardous areas in collaboration with the Grand River Conservation Authority (GRCA).

Moving forward, the City should incorporate climate change projections when identifying natural hazards and developing hazard maps. Many of the risks highlighted in the Region of Waterloo's Risk Assessment Report relate to extreme storms and rainfall events. These could heighten the risk of overland flooding and erosion in places that have not previously been associated with such hazards. As a result, areas currently considered non-hazardous may be vulnerable to future flooding, posing risks to future residents. The City can proactively address this by ensuring that climate change is a key consideration in the delineation of hazardous zones, in coordination with the GRCA. An increasing focus for a number of cities is to develop localized heat risk maps to inform and shape development and municipal investments, particularly for vulnerable populations.

Hazardous lands are areas susceptible to location-specific risks such as flooding, wildfires, and extreme weather events. Climate change is expected to increase the frequency and intensity of these hazards, making these areas even more dangerous. More intense storms and heavier rainfall are likely to increase the risk of flooding, while higher temperatures and droughts will likely increase the likelihood of wildfires, even in areas with limited tree cover.

The City's current OP includes a Natural Hazards section that focuses primarily on flooding and erosion. The OP notes that specific boundaries of hazardous lands are determined in consultation with the GRCA. Generally, developments and site alterations are prohibited on hazardous lands affected by flooding and erosion, except under specific circumstances outlined in Policy 6.C.2.5. Developments are also typically directed away from areas adjacent to these hazardous lands. Figure 8 illustrates a precautionary approach to protecting from hazardous areas that accounts for the hazard area, the impact of climate change on that hazard area, and a further buffer to address the uncertainty in projections on the impacts of climate change at a local scale.

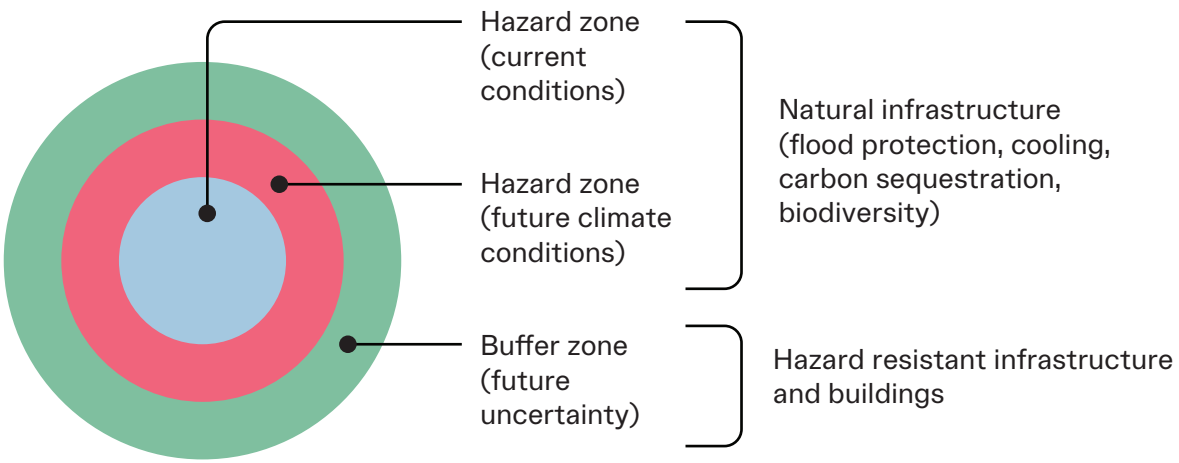

Figure 8. Conceptual representation of land-use policies to limit exposure to hazard zones.

The City should also evaluate whether to include additional hazards related to climate change —such as extreme weather events (wind), forest fires, and extreme heat—in the OP, as seen in other municipal OPs and zoning by-laws.[100] The City of Nanaimo's Zoning Bylaw includes Wildfire Hazard Guidelines, which set out specific requirements for all new developments in the hazardous area, such as using fire-resistant building materials.[101] The City of Cambridge, Massachusetts, identified extreme heat as a hazard in its zoning ordinance. While the ordinance does not prohibit new development in areas susceptible to the heat island effect, it does encourage the incorporation of features that provide a cooling effect on sites and buildings through a Cool Target."[102]

In the near future, Kitchener is expected to face more extreme weather events due to climate change. Areas that were previously not at risk of climate hazards, such as flooding or wildfires, may experience these events with greater frequency and severity. To mitigate these risks, the City or property owners may be able to protect existing infrastructure by altering the environment through hard infrastructure solutions, like riprap, or nature-based solutions, such as wetland restoration. Property owners may

100 Some municipalities in Ontario require Wildland Fire Assessments or strategies to mitigate wildland fire hazards as described in the Wildland Fire Risk Assessment and Mitigation Reference Manual (Ministry of Natural Resources and Forestry, 2014), which includes techniques and tools for implementing wildland fire policies in the Provincial Planning Statement, 2014.

101 City of Nanaimo. "Zoning Bylaw No. 4500." City of Nanaimo, July 29, 2024. https://www.nanaimo.ca/bylaws/ViewBylaw/4500.pdf.

102 "Sustainable Design and Development." Cambridge, Massachusetts, n.d. https://library.municode.com/ma/cambridge/codes/zoning_ordinance?nodeId=ZONING_ORDINANCE_ART22.000SUDEDE_22.90GRFAST.

also be able to adapt their buildings to accommodate future risks.[103] However, in some cases, it may not be feasible to protect or adapt existing infrastructure, and planned retreat may become necessary.

Planned retreat, also referred to as managed retreat, is defined as "the purposeful movement of people and/or infrastructure and land uses from areas at high risk of flooding, slope destabilization and other risks made worse by climate change to areas that are at lower risk and/or more resilient."[104] Ontario's Planning Act and PPS, as well as Kitchener's 2014 OP, do not reference planned retreat,[105] and there is no standardized framework for managing retreats at the provincial or federal level. In Canada, retreat planning tends to be reactive, typically only occurring after a disaster such as flooding. However, researchers and practitioners argue that proactive retreat is a more effective approach.[106] The Global Commission on Adaptation found that for every dollar invested proactively in climate resilience, $2 to $10 can be saved from future losses.[107]

Municipalities can implement or support planned retreats in several ways. Some communities have collaborated with higher orders of government to buy out properties,[108] while others have offered land swaps to property owners, exchanging municipally owned land elsewhere in the community for the land being retreated. In some instances, local governments have even started to reduce municipal services and restore natural functions in retreat areas.[109] Each of these options requires detailed planning and engagement with affected community members, businesses, and higher levels of government, and consideration of vulnerability.

103 DV8 Consulting, and H. Parnham. "[Managed] Retreat: The Elephant in the Adaptation Framework." Report, 2023. https://climatlantic.ca/wp/wp-content/uploads/2023/05/CLIMAtlantic-Managed-Retreat-Discussion-Paper-FINAL-March-15-2023.pdf.

104 Gevity Consulting Inc. "Planned Retreat Approaches to Support Resilience to Climate Change in Canada." Natural Resources Canada. Natural Resources Canada, 2021. https://ostrnrcan-dostrncan.canada.ca/entities/publication/86101251-6e5f-45e4-9414-76612a31f267.

105 The 2014 OP recognizes existing uses in natural hazardous lands and sites and allows a change in use and site alteration under specified conditions.

106 Gevity Consulting Inc. "Planned Retreat Approaches to Support Resilience to Climate Change in Canada."

107 Global Center on Adaptation and World Resources Institute. "Adapt Now: A Global Call for Leadership on Climate Resilience." Global Commission on Adaptation, n.d. https://openknowledge.worldbank.org/server/api/core/bitstreams/4d8d5979-ed31-5d22-977c-2c838b1732c5/content.

108 The 2014 OP enables land acquisition in order to reduce hazards to life and property caused by flooding (policy 6.C.2.17).

109 Gevity Consulting Inc. "Planned Retreat Approaches to Support Resilience to Climate Change in Canada."

Ecosystem-Based Adaptation

The City's current OP also includes a full chapter dedicated to Natural Heritage and Environmental Management. An ecosystem-based approach considers natural spaces as a system, including wetlands, valleys, woodlands, fish habitats, natural linkages and corridors, significant wildfire habitats, environmentally sensitive areas, and ecological restoration areas.

Ecosystems also help communities adapt to climate change. Wetlands, valleys, and other natural features can absorb excess water during heavy rainfall, reducing stormwater runoff and lowering the risk of flooding. These natural areas also mitigate the urban heat island effect by cooling the air and evapotranspiration.

Urban forests and the tree canopy provide critical services that improve resilience and reduce climate risks. As surface temperatures continue to rise, areas without adequate shading will experience a rise in the urban heat island effect. This increases reliance on air conditioning during peak temperatures, leading to stress on the electrical grid and energy systems. Urban forests and green spaces provide a critical service by cooling the air through shade and evapotranspiration, thereby offering "the most efficient air conditioner."[110,111] In the urban context, green spaces need to be complemented with other mechanical and passive cooling strategies to keep people safe against extreme heat.

Floodplains, wetlands, forests, and riparian zones are essential natural buffers against hazards including heating and flooding. They also absorb excess stormwater, and reduce the risk of downstream flood impacts. Connecting natural spaces and prioritizing forest and floodplain restoration, ecosystem protection, and riparian zone enhancement will safeguard water quality, enhance biodiversity, and reduce the risk of flooding and heat.

The specific features included in the City's natural heritage system were identified in the Kitchener Natural Heritage System Technical Background Report.[112] This analysis should be revised regularly to ensure that climate change is considered in the delineation of the natural heritage system.

While increasing urban forests and green spaces is a critical adaptation action, it is important to adapt these systems to the current and projected climate impacts. The Urban Forestry Climate Change Response Framework (Figure 9) was developed to

110 Martini, Mike. "Urban Forests: An Essential Tool for Climate-Resilient Communities | Sustainable Brands." Sustainable Brands, September 25, 2024. https://sustainablebrands.com/read/regeneration-resilience/urban-forests-climate-resilient-communities.

111 University of British Columbia. "Fighting Climate Change Through Our Urban Forests." Beyond, October 8, 2021. https://beyond.ubc.ca/fighting-climate-change-through-our-urban-forests/.

112 City of Kitchener. "City of Kitchener: Natural Heritage System Technical Background Report."

address the gap between the CRVA (or a similar assessment) and action.[113] First applied by the City of Chicago, this Framework combines quantitative and qualitative methods of a vulnerability assessment with a decision-making process for adaptation. Informed by the framework, the City can incorporate adaptation strategies into its urban forestry management practices.

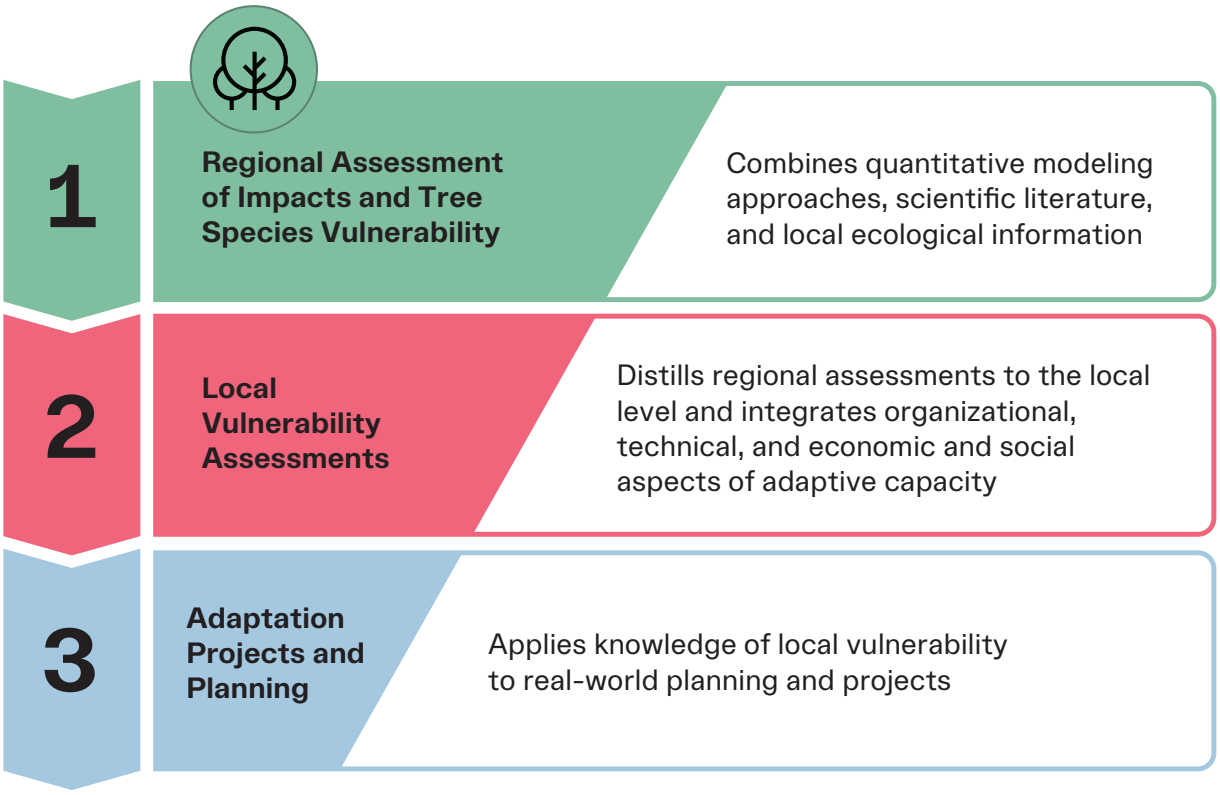

Figure 9. The Urban Forestry Climate Change Response Framework.

Climate change can accelerate the introduction and spread of invasive species. Native species are put under greater stress as the frequency and intensity of climatic change and extreme weather events increases opportune conditions for invasive species movement.[114] Invasive species are already a growing threat to Ontario's economy and environment.[115] The warming climate increases the number of growing degree days and reduces the number of frost days—these changes have extended the growing season

113 Brandt, Leslie, Abigail Derby Lewis, Robert Fahey, Lydia Scott, Lindsay Darling, and Chris Swanston. "A Framework for Adapting Urban Forests to Climate Change." Environmental Science & Policy 66 (June 25, 2016): 393–402. https://doi.org/10.1016/j.envsci.2016.06.005.

114 Brewington, Laura, LeRoy Rodgers, and Leigh Greenwood. "Recommendations for Incorporating Invasive Species Into U.S. Climate Change Adaptation Planning and Policy." Conservation Science and Practice 6, no. 9 (August 8, 2024). https://doi.org/10.1111/csp2.13210.

115 Government of Canada. "An Invasive Alien Species Strategy for Canada." 2004. https://publications.gc.ca/collections/collection_2014/ec/CW66-394-2004-eng.pdf.

and allowed invasive plant species to migrate northward. The reduction in the number of very cold days has led to warmer winters and the loss of a thick snowpack, allowing insects that carry diseases to survive the winter and thrive. Additionally, disturbances such as ice storms or prolonged droughts can open new habitat areas to colonization by fast-growing invasive species that outcompete the native flora.[116] Invasive species not only impact the environmental, economic, and human health of an impacted area, but they also hinder the development of climate change resilience.

Of particular concern are non-native species referred to as "sleeper species." Sleeper species are species that are already present in an ecosystem and have the potential to become invasive under certain conditions. Current conditions such as the climate and other species can limit the spread of sleeper species; however, climate change could create optimal conditions for them to spread.[117]

Natural spaces absorb and store carbon, but this value is not generally acknowledged in planning processes for building new infrastructure and upgrading existing infrastructure on private or public lands. Strategies that can increase the carbon sink include expanding green infrastructure, rewilding and restoring degraded lands, supporting citizen science and open data, and creating greenbelts and buffer zones. The City has a number of restoration initiatives underway through the Urban Forest Strategy and the Integrated Stormwater Management Master Plan, including rehabilitating and naturalizing concrete-lined creeks, a project which was recognized by the International Water Association.

Green Infrastructure Strategies

Green infrastructure is a system of measures used to reduce surface runoff during rainfall events, slow the speed of runoff, and increase the absorption of precipitation into the ground. These systems often feature natural elements, like plants and soil, but follow design guidelines like other stormwater management systems. Green infrastructure can include measures like bioswales and rain gardens, cisterns and rain barrels, and permeable paving and concrete. Adaptation is increasingly urgent for reducing climate risks to infrastructure, and many green infrastructure approaches are being developed and used to reduce such risks and improve the resilience of Canada's infrastructure.[118]

116 Brewington, Rodgers, and Greenwood, "Recommendations for Incorporating Invasive Species Into U.S. Climate Change Adaptation Planning and Policy."

117 Invasive Species Centre. "Climate Change – Invasive Species Centre," September 22, 2021. https://www.invasivespeciescentre.ca/invasive-species/what-is-at-risk/climate-change/.

118 Lulham et al., "Canada in a Changing Climate: Synthesis Report."

Green infrastructure is designed to supplement or even replace the existing grey infrastructure of pipes and culverts that are currently in place. Widespread use of green infrastructure can:

- Reduce the need to upgrade and expand grey infrastructure;
- Reduce the need for water treatment;
- Improve surface water quality;
- Increase groundwater recharge; and
- Enhance biodiversity in a region.

Some green infrastructure mechanisms can also work to reduce the urban heat island effect by providing shade and through evapotranspiration. Green infrastructure can be deployed on a local scale to improve the drainage and water management of a small area, or on a larger scale to impact water flow across a watershed.

Permeable surfaces play a critical role in enhancing climate resilience for urban areas. These are surfaces that allow water to pass through them, enabling rainwater to be absorbed into the ground rather than running off into storm drains. Examples of permeable surfaces include porous asphalt, permeable pavers, gravel, and turfgrass, as well as green infrastructure elements like rain gardens and green roofs. Permeable surfaces help mitigate the impacts of increasing challenges from climate change including heavier rainfall, flooding, and higher temperatures, by improving stormwater management and enhancing water absorption. The risk of increasing permeable surfaces is that surface water can contaminate groundwater.

The City is currently incorporating low-impact measures to mitigate stormwater when rebuilding streets. This effort should be expanded to increase permeability in city infrastructure, with consideration given to infrastructure sizing and other attributes to withstand climate-driven floods, as well as funding for pilot programs.[119]

Kitchener has a system of stormwater fees related to impermeable surface area.[120] The rules include a system of discounts for actions undertaken by property owners to encourage stormwater permeation. These discounts can go as high as 45%, and storage and permeation measures are periodically audited to ensure they are still operational. The stormwater program can be enhanced with outreach and education in the community, as well as up-front payments to residents who undertake projects to encourage permeation projects in priority areas.[121] For example, Rain Ready Ottawa

119 Managed Aquifer Recharge. "Managed Aquifer Recharge - Managed Aquifer Recharge," August 12, 2024. https://research.csiro.au/mar/#:~:text=Managed%20aquifer%20recharge%2C%20or%20MAR,term%20storage%20for%20drought%20supply.

120 Kitchener Utilities. "Stormwater Rates," n.d. https://www.kitchenerutilities.ca/en/rates/stormwater-rates.aspx#Stormwater-rates-table.

121 City of Ottawa. Strategic Initiatives Department. "Rain Ready Ottawa," n.d. https://ottawa.ca/en/living-ottawa/environment-conservation-and-climate/protecting-ottawas-waterways/rain-ready-ottawa#section-59b78051-98c5-4109-947e-9c3bb6d9df3d.

(RRO) offers home assessments and e-learning to help residents understand the importance and key details of stormwater management. In developing the program, the City of Ottawa partnered with Landscape Ontario to offer training and certification in stormwater management-focused landscaping called Fusion Landscape Design. The program focuses on the City's priority areas (changes to the delineation of these priority areas are pending).

Stormwater credits for retention and storage are being offered by many Ontario municipalities, and the City of Kitchener has the opportunity to take stormwater credit systems to the next level. For example, in the US, stormwater credit trading programs are used to allow locations with reduced scope to retain or permeate stormwater to trade with places that have more capacity.[122,123] This could involve developments with limited scope to store or permeate stormwater on their property to compensate others for doing so. In theory, the City, with its large stormwater retention opportunities could be a participant in this market. Development of this market could increase capacity in, and development of, stormwater management technology and practices.

Recommended policy themes are outlined below.

#	Theme	Recommendations	Implementation Approach
8	Precautionary approach to climate hazards	Include policies that specify consideration of climate change impacts in identifying natural hazards, and natural hazard areas, including consideration for future climatic changes and future uncertainty.	These policies are implemented through technical analysis with the GRCA to evaluate natural hazards under current and future conditions and incorporate buffer zones that address uncertainty around the areas identified on an ongoing basis. Based on this analysis, new hazard policy areas can be identified and the zoning by-law updated accordingly.

122 Odefey, Jeffrey, Janet Clements, Jim Henderson, Katie Rousseau, Shanyn Viars, and Rebecca Arvin-Colon. "Establishing a Stormwater Volume Credit Trading Program." EPA, 2019. https://www.epa.gov/sites/default/files/2020-10/documents/ar_stormwatervolumecredittrading_final_revised100919.pdf.

123 Dougherty, Sarah, Rebecca Hammer, Alisa Valderrama, NRDC, and Alisa Valderrama. "How to: Stormwater Credit Trading Programs." Report, 2016. https://www.nrdc.org/sites/default/files/stormwater-credit-trading-programs-ib.pdf.

#	Theme	Recommendations	Implementation Approach
9	Ecosystem-based services	Include policies that value, protect, and expand Kitchener's ecosystems and natural spaces (e.g., wetlands, valleys, woodlands, fish habitats, natural linkages and corridors, significant wildfire habitats, environmentally sensitive areas, and ecological restoration areas) in the face of climate change, recognizing the protection they provide against climate hazards.	These policies enable the enhancement of Kitchener's ecosystem through understanding this system's resilience to climate change and its role as a vital bulwark against climate hazards, in contrast or as a compliment to engineered protections. The policies are implemented through the Natural Heritage System, Ecosystem-based Adaptation Plan, and Invasive Species Strategy. Examples of opportunities include wetland restoration, and expansion of urban forests, natural cooling zones, buffer zones, green corridors and, tree canopies, among others.
10	Climate-adaptive land-use	Include policies that enable climate adaptation in land-use planning, including strategies such as build-back better, infrastructure retreat, and planned retreat.	These policies help reduce the risks from emerging climate hazards by making investments through the City's capital forecast, or developing plans to limit or reverse investments in public infrastructure.
11	Vulnerable populations	Include policies that enable the City to target adaptation strategies and investments to vulnerable populations.	These policies enable the City to make targeted infrastructure investments, or implement neighbourhood plans or policies, where the need is greatest.
12	Green infrastructure	Include policies that prioritize green infrastructure and set targets for impermeable surface area at the city-scale	The primary implementation tool is the Integrated Stormwater Management Master Plan.

Big Move 3

Energy Transition

Energy transition initiatives relate directly to many of the fundamental actions that lead to a zero-emissions community. These actions relate directly to energy systems, and while they contribute predominantly to climate mitigation, resiliency actions are required for overall success.

Secure, climate-resilient energy supplies are key to having a community that can withstand the impacts of climate change. Although many back-up systems are available for emergency services, hospitals, water distribution, wastewater collection, communications systems, and many businesses, none of these systems are fail safe. Increasing losses of primary energy systems opens the risk of back-up systems not performing adequately in times of disruption, particularly in longer disruptions.

Vulnerable populations are particularly susceptible to energy disruptions. They are more likely to lack preparedness and be less willing or able to evacuate,[124] to need power for medical devices, and to live in residences that lose heat quickly during a power loss. Food spoilage after a protracted power loss can cause a food crisis for those with modest incomes. Energy security is therefore an important social equity issue.

Clean Electricity

In September 2021, UN-Energy introduced the Energy Compacts, a voluntary commitment open to Member States and non-state actors such as companies, regional/local governments, NGOs, and others. **The 24/7 Carbon-Free Energy Compact** is an effort by a group of energy buyers, energy suppliers, governments, system operators, solutions providers, investors, and other organizations to transform global electricity grids to "absolute zero," or full decarbonization. 24/7 Carbon-free Energy (CFE) means that every kilowatt-hour of electricity consumption is met with carbon-free electricity sources, every hour of every day, everywhere.

In contrast to the objective of 100% clean electricity on an annual basis,[125] an hourly analysis requires a greater focus on integration between supply and demand and aligning strategies for energy efficiency, demand side management, and carbon-free energy generation.[126]

124 Dugan, Jesse, Dahlia Byles, and Salman Mohagheghi. "Social Vulnerability to Long-Duration Power Outages." International Journal of Disaster Risk Reduction 85, no. 1 (February 2023). https://doi.org/10.1016/j.ijdrr.2022.103501.

125 On an annual basis, total annual renewable electricity generated equals the total annual electricity consumed, even if, for example, 100% of the renewable generation occurs in the summer. On an hourly basis, every hour is matched, irrespective of the season.

126 FTI Consulting. "24/7 Carbon-Free Energy for Cities: Opportunities, Challenges, and Pathways for Urban Energy Systems." C40 Cities, 2022. https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q000000Zj5f/ryanWyYDaFyqG2dujbLvl0dhukj0lmPRSrEfwzqLHZ0.

While access to the electricity market is limited in Ontario, the City of Kitchener can explore strategies to achieve 24/7 CFE—including generation, procurement, storage, and arbitrage—in partnership with Enova Power, Grand River Energy, and others. This effort will position Kitchener as a leader in Canada, alongside London, UK, and New York, which are also implementing 24/7 CFE strategies, stimulating innovation and attracting organizations and businesses at the forefront of greening electricity systems, energy storage, virtual power plants, and energy efficiency.

Kitchener Utilities is a division of the City of Kitchener, making it one of two gas utilities in Ontario that is municipally owned. Given that it is a municipally owned utility, all profits go back into the community through services including water, natural gas, stormwater, sewer and rental water heaters.[127] Kitchener Utilities is currently developing a Clean Energy Transition Strategy.[128] The City can use its ownership of Kitchener Utilities, and its ownership stake in Enova Power Corp., to accelerate the development of clean electricity and clean heat.

Large renewable energy projects will be required to fully decarbonize the electricity grid. The Independent Electricity System Operator's (IESO) next three long-term procurements will be seeking energy using renewables and natural gas and capacity using natural gas and batteries. The OP could make provision for renewables while precluding fossil gas generation.[129] More broadly, the PPS and many OPs in Ontario make reference to "alternative energy."[130] Carefully defining this term to be close to zero emissions will play a role in ensuring that energy projects that are detrimental to emissions mitigation cannot be approved.

The City can also identify appropriate locations with compatible uses for large-scale solar projects, such as brownfield sites or agrivoltaics, and shape the design and strategy of these projects to maximize community benefit. For example, the City can include policies in the OP that support inclusive models such as renewable energy cooperatives, which provide greater economic participation for more community members or "prosumers," to advance equitable participation in the energy transition.[131]

127 City of Kitchener. "Kitchener Utilities: About Us," n.d. https://www.kitchenerutilities.ca/en/contact-us/about-us.aspx.

128 EngageWR. "Kitchener Utilities Clean Energy Transition Strategy," 2024. https://www.engagewr.ca/KUtransition.

129 It is notable that the Province's October 2024 long discussion of energy made reference to Carbon Capture and storage, an option Kitchener does not appear to have the geology to support. Government of Ontario. "Ontario's Affordable Energy Future: The Pressing Case for More Power." n.d. https://www.ontario.ca/page/ontarios-affordable-energy-future-pressing-case-more-power?utm_source=newsletter&utm_medium=email&utm_campaign=iesobulletin.

130 Lieutenant Governor in Council. "Provincial Policy Statement, 2020." Provincial Policy Statement, 2020. https://files.ontario.ca/mmah-provincial-policy-statement-2020-accessible-final-en-2020-02-14.pdf.

131 Campos, Inês, and Esther Marín-González. "People in Transitions: Energy Citizenship, Prosumerism and Social Movements in Europe." Energy Research & Social Science 69 (August 8, 2020): 101718. https://doi.org/10.1016/j.erss.2020.101718.

The City can collaborate with the Region, WR Community Energy and utilities to provide an open data map with renewable energy resources—including waste heat, geothermal, solar PV, and other sources—to enable public or private sector development of projects.

Solar PV is an affordable, accessible, decentralized, localized, and zero-emissions technology. The deployment of solar PV contributes to decarbonization and resilience of the grid. The City can expedite solar PV through simplified permitting or installation by right, developing a program with pre-approved contractors and incentives,[132] and establishing mandates.

PV systems can be installed on roofs and integrated into the building envelopes (building-integrated photovoltaics [BIPVs]), performing the double function of energy producer and building cladding. BIPVs turn surfaces into active energy generators but require consideration of inter-building solar reflections and overshadowing effects. Similar considerations apply to other solar technologies such as passive solar design and solar thermal walls.

To incentivize the decarbonization of heating and transportation, the City can provide incentives or financing programs to identify and address technical and financial barriers resulting from electrical upgrades.

Although the City has plans for asset reinforcements to address increasing electrical demand, there is no planning that would prioritize local generation and electrical energy storage as a resiliency measure to address the loss of electricity transmission into the region. To increase the resiliency of its electricity system, the City can encourage distributed energy resources (DERs).

DERs can exist in many forms and reflect local needs

Examples of DERs include solar panels, battery storage, electric vehicles that can feed power onto the grid, and even smart thermostats. DERs can exist on the inside of a customer's power meter or on the local distribution grid. They can have benefits for the customer, the electricity system, and society at large. For example, an 11 kWh battery can provide power to a household during a grid power failure, and also curtail demand from the grid when it is beneficial for grid operations. In either situation, it could help reduce GHG emissions. In some jurisdictions, DERs respond to market and customer opportunities. The US National Renewable Energy Laboratory recently analyzed battery storage, which was paired with solar generation, and found that benefits exist in three streams for customers, utilities, and society at large[133] In other places, DERs respond to urban forms.

132 City of Halifax. "About Solar City," 2024. https://www.halifax.ca/home-property/solar-projects/about-solar-city.

133 Manogaran, Indu, Amanda Farthing, Jeff Maguire, Kenny Gruchalla, and National Renewable Energy Laboratory. "Savings in Action: Lessons Learned From a Vermont Community With Solar Plus Storage." Technical Report. National Renewable Energy Laboratory, 2024. https://www.nrel.gov/docs/fy24osti/84660.pdf.

In Germany, extensive multi-residential living means that rooftop access for solar is greatly constrained. The response to this is balcony solar, where solar panels attached to balcony railings feed power into the adjoining apartments—this DER is now used in over 1.5 million German residences.

DERs by convention refer to electrical resources typically including renewable electricity generation, storage, and sometimes localized demand response which reduces or eliminates demand by customers during high grid demand periods or urgent power shortages.[134] Although they are not a part of integrated resiliency planning, the IESO does recognize the general ability of DERs to increase local electrical grid resiliency.[135] DERs can be deployed across an area comprising many feeder lines to provide a general background of local resources which can make an area less vulnerable. They can also be used at the specific feeder line level with the goal of enabling a specific feeder to continue to provide power during a supply interruption upstream in the system.

The City can require reporting on energy consumption of buildings over a certain size and report publicly on energy consumption and demand and GHG emissions to encourage higher performance and support the development of district energy or other targeted solutions.[136]

Clean Heat

The potential for improving energy efficiency and integrating renewable energy sources in existing buildings is significant, and is a fundamental component of decarbonizing society.[137] The decarbonization of heat is challenging, as it requires significant investments, changes in long-lived and expensive infrastructure and social habits, and new planning by different entities and expertise. In terms of opportunities, Kitchener has access to several sources of clean thermal energy which can be developed. Municipalities are the closest organizations to citizens and thermal energy systems, and they can support, coordinate, and develop projects and services.

134 IESO. "Ontario's Electricity Grid: Demand Response," n.d. https://www.ieso.ca/Learn/Ontario-Electricity-Grid/Demand-Response.

135 IESO. "Ontario's Electricity Grid: Distributed Energy Resources," n.d. https://www.ieso.ca/Learn/Ontario-Electricity-Grid/Distributed-Energy-Resources.

136 For example, see reporting from the City of Vancouver. "Vancouver GHG Limits By-law Reporting Map," 2024. https://energycarbonreport.vancouver.ca/map/, or City of Ottawa. "Energy benchmarking and auditing program," 2024. https://ottawa.ca/en/living-ottawa/environment-conservation-and-climate/loans-grants-and-programs/buildings-and-properties/home-energy-improvements/better-buildings-ottawa/energy-benchmarking-and-auditing-program.

137 Martínez, Sara Herreras, Robert Harmsen, Marijke Menkveld, André Faaij, and Gert Jan Kramer. "Municipalities as Key Actors in the Heat Transition to Decarbonise Buildings: Experiences From Local Planning and Implementation in a Learning Context." Energy Policy 169 (August 11, 2022): 113169. https://doi.org/10.1016/j.enpol.2022.113169.

Natural gas is a major source of GHG emissions in Kitchener, and any plan that meaningfully responds to the climate emergency must identify a strategy to systematically phase out fossil-based natural gas. Many jurisdictions are currently grappling with this challenge and developing policy frameworks to ensure the transition is affordable and equitable.[138]

Geographic scale	Purpose	Technologies	Implementation Approaches
City-wide	Accelerate the uptake of heat pumps for heating and cooling in the city.	Air source heat pumps (ASHPs)	The two primary mechanisms include the High Performance Development Standard for new buildings and the Building Condition Bylaw for existing buildings.[139]
Clean Heat Zone	Indicate an intention to phase out natural gas according to a specific time frame.	Renewable natural gas (transition), ASHPs, geothermal	Programs, policies, and incentives will support the decommissioning of natural gas in these zones in coordination with the gas utilities.

138 For example: Gridworks. "California's Gas System in Transition: Equitable, Affordable, Decarbonized, and Smaller," 2019. https://gridworks.org/wp-content/uploads/2019/09/GW_Calif-Gas-System-report-1.pdf; Walsh, Michael and Groundwork Data. "Leaping Forward: Local Energy Asset Planning (LEAP) an Energy Transition Planning Framework," October 14, 2022. https://static1.squarespace.com/static/62e94d16a77e1e191eafe4ae/t/656f520b633aa1226d805ff9/1701794316478/Local+Energy+Asset+Planning+-+v2022.10.14+%284%29.pdf.

139 For example, see: Toronto – Municipal Code Chapter 629 or Ottawa – Property Standards By-law No. 2013-416.

Geographic scale	Purpose	Technologies	Implementation Approaches
Zero-Emissions District Energy Zones	Indicate potential location for district energy. District energy systems should be spatially located where zero emissions heat sources are physically located and there is existing or future density of heat demand (e.g., urban nodes or intensification areas).	Geothermal, wastewater heat recovery	Implementation policies can include requirements for community energy plans for secondary plans, mandatory connections, requirements for district energy-ready buildings, alignment with the High Performance Development Standard, and local improvement changes for infrastructure financing.
Zero-Combustion Zones	Used primarily for new development areas to limit the installation of new combustion technologies, to avoid locking in new infrastructure.	ASHPs, geothermal	Secondary plans, site plans, the High Performance Development Standard, and infrastructure planning and investments.

City-Wide Strategies

The primary focus for reducing GHG emissions is fuel switching from natural gas to electricity using air source heat pumps (ASHPs), and the bulk procurement of renewable natural gas (RNG) as an interim measure.

ASHPs have the advantage of providing both heating and cooling, and therefore can be an important resilience strategy, particularly for populations vulnerable to heat exposure. Using a Building Condition Bylaw or a Heat Safety Bylaw, the municipality can require that ASHPs be installed when air conditioners are replaced. They can be the best practical replacement for rooftop heating and cooling units that can be hard to re-configure with district or geothermal energy.

Zero-emissions heating can also be required using the High Performance Development Standards (HPDS); to achieve this standard, buildings can use technologies including ASHPs, geothermal, RNG, or zero-emissions district energy.

Reducing or waiving the fee for permits required to switch to zero-emissions heating sources, if applicable, can help to incentivize their installation.

Municipalities are natural producers of the feedstock for RNG production. Organic materials from wastewater and municipal solid waste, which is managed by the Region, should be anaerobically digested to produce biogas, which can be purified to be injected into existing gas grids as RNG. Displacing natural gas results in more GHG reductions than using RNG for electricity production. The use of RNG as a transportation fuel is a lower priority due to the rapid electrification in that sector.

Studies have shown that RNG could displace up to 12% of fossil gas demand in Ontario,[140] although new technologies such as biomass methanation and chemico-thermal treatment of digester feedstock have the potential to increase this resource markedly.[141] The space, expertise, and utilities required to produce RNG need to be considered in ongoing development plans for wastewater treatment plants and solid waste handling facilities. Given this importance, the City's role in enabling RNG can focus on procurement by Kitchener Utilities and ensuring that organics are treated as a resource rather than a waste product.

The City of Kitchener, with its direct ownership of most of its gas infrastructure, is in a unique position to coordinate the planning for and implementation of heat decarbonization. A decarbonization program can be developed by generating and providing information on maintenance costs, capacity, utilization, and remaining asset life by areas of the system, building on Kitchener Utilities' Clean Energy Transition Strategy, which is currently in development. This would identify a systematic, spatially based decarbonization pathway for heating, by identifying clean heat zones, zero-emissions district energy zones,[142] or zero-combustion zones. Land-use policy can provide important signals on timing and approach, as well as ensuring that no additional investments are made in natural gas systems that may become a stranded investment later on. Figure 10 illustrates land use zones that can contribute to the decarbonization of heat.

140 Government of Ontario. "Archived - Fuels System 20-year Outlook | Fuels Technical Report," n.d. https://www.ontario.ca/document/fuels-technical-report/fuels-system-20-year-outlook.

141 Energir. "RNG Potential Study." Energir, February 27, 2023. https://energir.com/en/about/media/news/rng-potential-study. Note this is a Quebec-based study; higher gas usage in Ontario could potentially make the market penetration of RNG lower.

142 Department for Energy & Net Zero. Heat Network Zoning Pilot Supporting Methodology Statements (2025). https://assets.publishing.service.gov.uk/media/67aa009e5dea3871ea1ceae0/heat-network-zoning-pilot-methodology.pdf#page=4.08.

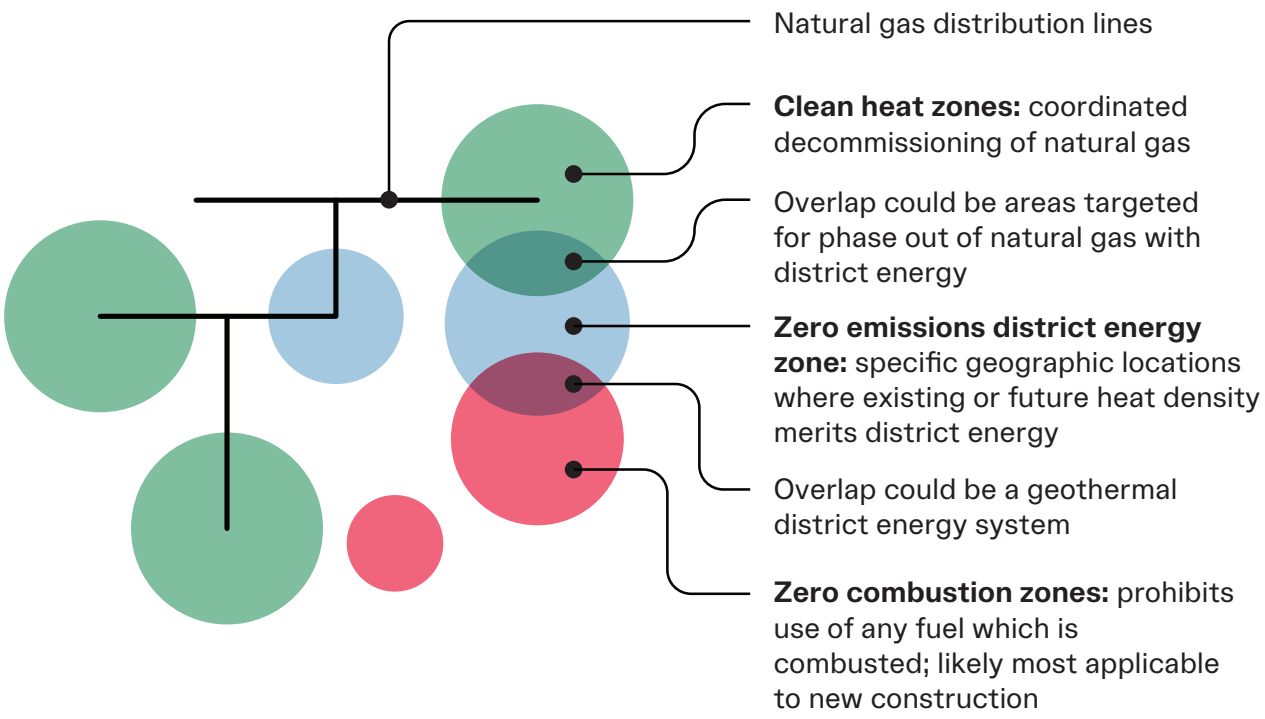

Figure 10. Illustration of land-use zones for decarbonization of heat.

Clean Heat Zones

A decarbonization program could see areas of Kitchener that have gas distribution assets with high costs, lower asset utilization, or end-of-life replacement as initial areas for decommissioning gas services and removing and salvaging gas assets. The City would also not add any new infrastructure and associated natural gas connections in clean heat or zero-combustion zones.

A timeline for decommissioning gas services by zone can be identified based on equity, costs, or other considerations, an approach called systems pruning,[143] which requires careful coordination between land-use planning and energy systems planning. With gas services phased down, the City can strengthen Kitchener Utilities by allowing it to focus on non-pipe solutions such as heat pumps, energy efficiency, renewable energy, and waste heat recovery.

143 Enbridge. System Pruning Pilot (2025).

Zero-Combustion Zones

A zero-combustion zone prohibits the use of any fuel that is combusted within the building envelope,[144] while a clean heat zone enables a broader range of energy sources such as RNG and biomass. There is a direct link between high-efficiency, zero-emissions buildings and reduced exposure to air pollution. The use of high-efficiency electric induction cooktops reduces indoor exposure: studies associate indoor gas stove use with childhood asthma;[145] and exposure to benzene, a carcinogen,[146] with more severe impacts on low-income households.[147] In 2022, the State of California announced that it will require zero-emissions space and water heaters for new construction or replacement by 2030 in order to reduce NOx emissions.[148]

Zero-Emissions District Energy Zones

Although new development is typically the trigger for the emergence of a new system,[149] existing building stock is a much higher source of emissions that must be abated between now and 2050. This older building stock might be a challenge to decarbonize through other measures such as deep retrofitting or fuel switching. The presence of older, high-emission buildings is arguably the strongest emissions-related rationale for developing or expanding district energy systems, provided that the targeted older buildings are feasible for hook-up. The City is already investigating district energy options in the downtown area.

Zero-emissions district energy systems use ambient temperature water, which can be derived from heat pumps, while low-emissions district energy systems use hot water and are reliant on combustion, which means they typically burn natural gas or

144 Biomass fuels are not strictly carbon neutral. For a detailed discussion, see: Ahamer, Gilbert. "Why biomass fuels are principally not carbon neutral." Energies 15, no. 24 (2022): 9619.

145 Gruenwald, Talor, Brady A. Seals, Luke D. Knibbs, and H. Dean Hosgood. “Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States.” International Journal of Environmental Research and Public Health 20, no. 1 (December 21, 2022): 75. https://doi.org/10.3390/ijerph20010075.

146 Kashtan, Yannai S., Metta Nicholson, Colin Finnegan, Zutao Ouyang, Eric D. Lebel, Drew R. Michanowicz, Seth BC Shonkoff, and Robert B. Jackson. "Gas and propane combustion from stoves emits benzene and increases indoor air pollution." Environmental Science & Technology 57, no. 26 (2023): 9653-9663.

147 Kashtan, Yannai, Metta Nicholson, Colin J. Finnegan, Zutao Ouyang, Anchal Garg, Eric D. Lebel, Sebastian T. Rowland et al. "Nitrogen dioxide exposure, health outcomes, and associated demographic disparities due to gas and propane combustion by US stoves." Science Advances 10, no. 18 (2024).

148 Hicks, Austin, Ariel Fideldy, and California Air Resources Board. “2022 State Strategy for the State Implementation Plan,” 2022. https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf.

149 Although new development is often the primary driver for establishing district energy systems, some district systems develop through the amalgamation of mechanical systems in large adjoining buildings. A good example is the amalgamation of hospital heating and cooling of hospitals on University Avenue in Toronto .

biomass. It is costly and complex to transition from a low-emissions system to a zero-emissions system, as hot water systems require different piping than ambient temperature systems. For this reason, low-emissions systems can risk becoming a stranded asset.

Kitchener has two potential sources of heat for a zero emissions district energy system, namely geothermal and waste heat, both of which have spatial implications.

Geothermal Heat

Geothermal energy relies on the relatively constant temperature of the earth at depths below two metres to enable heat pumps to operate efficiently, an efficiency and capacity advantage over ASHPs which must contend with air temperature extremes during the periods of highest heating or cooling demand. The disadvantage to ground source heat pumps is the economics of upfront cost. ASHPs, particularly in smaller capacity applications, can have upfront costs that are several times lower than that of geothermal systems, owing to the need for wells or burial of piping in geothermal systems. Recent improvements in the development of ASHPs, particularly the minimum outdoor temperature at which they can operate, mean they are gaining as a technology option over geothermal systems, particularly at a smaller scale.

This arguably leaves geothermal systems increasingly focused toward higher-capacity applications, for which the hydro-geological conditions in Kitchener present an opportunity. Broadly speaking, there are two types of geothermal energy systems: closed and open loop. Closed loop systems exchange heat with the earth surrounding a system of closed pipes which run through the earth. The heat transfer rate across the piping and immediately adjacent earth limits how much energy can be transferred. If arranged in vertical boreholes, each borehole can typically produce 12–16 kW of thermal energy.

In open loop systems, heat is exchanged with the ground by drawing water from it. Typically, the only physical limitation is the ability to pump water from the ground and manage it, by returning it to the same aquifer from which it was drawn after using it. Open loop geothermal systems in areas with productive wells typically have energy production capacities, with at least an order of magnitude higher than closed loop systems. This makes them ideal for serving areas with higher heating densities, including areas served by district energy systems. An additional benefit is that open loop systems can be 10–20% more energy efficient than closed loop systems,[150] which results in increased capacity with a similar-sized system.

150 US Department of Energy. “Geothermal Heat Pumps,” n.d. https://www.energy.gov/eere/geothermal/geothermal-heat-pumps.

Given these attributes, Kitchener's resourceful aquifers, and the improvement trends in ASHPs, which are more suited to smaller capacity service, it is reasonable for Kitchener to focus its consideration of geothermal to larger open loop systems. An open loop system would likely be anchored at a large facility, such as a hospital, with large net heating and cooling loads. Provisions could be made for such a system to evolve into a district energy system by allowing the sharing of this resource. To support geothermal development, the City can provide easements, identify aquifer locations, and enable projects in parks and rights of way.

Waste Heat

Sanitary sewer heat is a reliable but limited source of heat. The 2021 WR Community Energy report discusses sewer waste resources across the region and in Kitchener.[151] It identifies three specific locations that could provide approximately 2% of peak thermal demand in Kitchener. Because extraction at any one point impacts the availability of heat at downstream locations, sewer waste heat development needs to be coordinated across the region with consideration for how the resource will increase as the region grows and intensifies.

The City can encourage the use of sewer waste heat through a set of standard actions:

- Indicate that the municipality intends to use its sewer system as a waste heat resource;
- Share information about the sewage system, including locations of large lines and pumping stations, line sizes, and flows;
- Ensure the developer's rights to the thermal resource are clear once a project is undertaken;
- Develop a framework that covers the aspects of project development, including standards and possible fees for developing the resource; and
- Flag wastewater life cycle projects as opportunities to access sewer infrastructure at a lower cost than stand-alone waste heat projects.

Other water heat data sources include data centres and industrial processes. In most Ontario cities, waste heat recovery may be able to displace 1–2% of current thermal demand.[152] While not game-changing in quantity, this waste heat can complement other clean energy sources for district energy systems, alongside waste heat from other industries.

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151 Klas Bockasten, KEB Engineering, and Project Management for WR Community Energy. "Wastewater Heat Recovery in Waterloo Region: Prepared for WR Community Energy," 2021. https://wrcommunityenergy.ca/wp-content/uploads/2021/11/Waste-Water-Heat-Recovery-Report-FINAL.pdf.

152 World Economic Forum. "How Power-positive Data Centres Can Drive AI and Communities," September 23, 2024. https://www.weforum.org/agenda/2024/09/how-power-positive-data-centres-can-unlock-ai-s-potential-while-transforming-communities/#:~:text=Current%20figures%20estimate%20that%20electric,heading%20to%20a%20cliff%20edge.

District energy systems can and should be designed for full redundancy, and therefore should be the most reliable energy systems in the community. District energy can also incorporate DERs and enable real-time switching of primary energy sources between the electrical and gas energy networks. The City can also consider the resilience of heating and cooling infrastructure to ensure people are safe during power outages.

Recommended policy themes are outlined below.

#	Theme	Recommendations	Implementation Approaches
13	Clean electricity	Include policies that support renewable energy projects, including decentralized energy resources and storage, as well as associated infrastructure.	These policies enable the acceleration of renewable energy and batteries at the household scale as well as larger installations: ▪ Identify renewable energy targets ▪ Accelerate permitting for large scale-projects ▪ Require solar and batteries for large- scale developments ▪ Require solar systems in the HPDS ▪ Enable LICs for solar projects ▪ Incorporate solar gardens into secondary plans and site plans
14	Clean heat	Include policies that enable clean heat supply, provide an orderly transition for fossil fuels and require low carbon or zero emissions technologies.	These policies enable a systematic and equitable transition to emissions heating, minimizing financial losses and stranded assets: ▪ Designate areas that provide spatial context for decarbonizing heat with relevant requirements ▪ Require heat pump replacement in a Building Condition By-Law or Heat Protection By-Law ▪ Require neighbourhood energy plans for secondary plans and site plans

Big Move 4

Compact, Complete Communities

Land-use patterns can lend to GHG emissions from buildings and transportation, but they also enable or limit opportunities such as district energy, high-speed transit, and accessibility by walking or cycling to destinations. The City of Kitchener's 2014 OP is based on a development framework that cultivates compact, complete communities, identifying a growth centre; major transit station areas; and city, community, and neighbourhood nodes and corridors.

GHG emissions from transportation are a result of four key factors: 1) travel demand, 2) mode share, 3) vehicle efficiency, and 4) fuel carbon content. A municipality can influence all four (Table 5), but its ability to shape the configuration of the community has the most influence over travel demand and mode share.

Table 5. Factors determining GHG emissions from transportation and municipal influence.

GHG Emissions Factor	Municipal Influence
Travel demand	Compact land use, mixed-use development, active transportation infrastructure, road design
Mode share	Public transit expansion, complete streets, active transportation infrastructure, congestion pricing, parking pricing, personalized transportation planning, education programs
Vehicle efficiency	Zero-emissions zones, parking pricing, electric vehicle charging infrastructure, education programs, fleet procurement
Fuel carbon content	Fleet procurement

Compactness

The City of Kitchener's 2014 OP emphasizes compact development patterns. The OP can directly relate policies on compact urban form with energy efficiency and GHG emissions reductions. For example:

- **Transportation:** When travel destinations (e.g., homes, offices, hospitals) are closer together, the required trip length to reach them will be shorter and the associated vehicle energy use will be lower. If the trip lengths are short enough, denser development can foster increased cycling and walking. Moreover, higher population density and focused development nodes provide the prospective ridership base for cost-effective, high-quality public transit systems. As transportation continues to electrify, compact land-use patterns that enable walking or cycling avoid electricity demand and are therefore conservation demand management (CDM) strategies from the perspective of the electricity system.

- **Buildings:** Compact land development patterns support connected and multi-story buildings (e.g., row houses, apartment buildings, office towers) with fewer exposed walls and roofs and lower energy requirements for heating and cooling. Such buildings have a smaller footprint, allowing for greater public spaces (e.g., plazas, parks, sidewalks), and large roofs that can be used for plants, rainwater capture, and solar PV. Moreover, such buildings may comprise lower floor area per occupant, reducing overall energy use.
- **Infrastructure:** When buildings and neighbourhoods are closer together, the extent of connecting infrastructure (e.g., roads, wires, pipes) is shorter, requiring less construction material, a smaller environmental footprint, and lower operating costs. At the metropolitan or regional scale, more compact development patterns can allow greater populations to be served by the same infrastructure, whether they be utilities, road maintenance facilities, or schools.
- **Land:** A more compact built environment reduces the overall urban footprint and results in more space for critical functions such as agriculture, flood management, natural water treatment, heat mitigation, and biodiversity.

A compact built environment requires a set of complementary policies to avoid potential downsides or compromises, including diminished solar access critical for passive design and solar PV, exacerbated urban heat island effect, and increased stormwater due to a greater concentration of impervious surfaces.

Streets to Community Spaces

The City's focus on Vision Zero, plans for lower speed limits, street safety improvements, and the Complete Streets Guidelines are important steps in reenvisioning Kitchener's streetscape. In many cities, seasonal pedestrianization of streets has been popular and led to a vibrant social sphere,[153] as is the case in Gaukel Street and King Street (temporarily) in Kitchener. Other actions have included vehicular access restrictions of streets near schools during school hours[154] and weekend close-offs of streets to encourage cycling.[155]

The super-block concept is a strategy that can build on these concepts, to both reduce GHG emissions through building a culture of walking and cycling and to increase resilience by reducing impermeable spaces and increasing social connections. In the super-block concept, the streetscape is focused away from

153 "Pedestrian Streets Liven up the City This Summer." Ville De Montréal. https://montreal.ca/en/articles/pedestrian-streets-liven-city-summer-31971.

154 Green Communities Canada. "School Streets - Green Communities Canada," September 11, 2024. https://greencommunitiescanada.org/programs/school-streets/.

155 National Capital Commission. "NCC Weekend Bikedays," n.d. https://ncc-ccn.gc.ca/events/weekend-bikedays.

vehicles in favour of the community. While this shift of focus manifests in different forms in different geographies, in general, a street or group of streets is restricted to through traffic, and all vehicles (motorized and non-motorized) are limited to driving at 10 km/h in one direction.

With these changes, most rights-of-way can be turned back to local residents who can come together as a community in a design process to decide how the street space can be used. This highly localized community design process increases community cohesion and results in diverse and dynamic community spaces that serve multiple purposes and diverse age groups.

Although super-block streets would be a radical departure in how streets currently function, the idea of a safer, quieter, and more cohesive public space where people reside is expanding in Barcelona[156] and elsewhere.[157] Testing the concept in appropriate and engaged neighbourhoods in Kitchener should be accompanied by an ongoing evaluation process.

Nodes to Hubs

The City's OP is strongly centred around nodal development, transit-oriented development, and development in the downtown area. As such, some of the most promising opportunities to address vehicle kilometres travelled (VKT) involve regional collaboration to coordinate planning of land use, transportation, and housing along with infrastructure spending.

Kitchener's concept of nodes can be broadened to hubs, which emphasizes an increased focus on multidimensional connectivity including all modes of transportation, a greater diversity of destinations (associated with lower GHG emissions),[158] the development of energy centres, and resilience hubs (described below). Transportation hubs emphasize higher orders of transit, and can be convergence points for cycling infrastructure with electric bike chargers. The idea of energy hubs aligns with decentralized energy resources such as solar, geothermal, and waste heat, as well as district energy, microgrids, and battery storage. Integration between land use, transportation and energy can manifest in different forms. For example, a charging station for private vehicles can also transform into a battery system in a grid outage, if the batteries on electric city buses and school buses support two-way charging.

156 Pvandenbos. "How Barcelona's 'Superblocks' Are Transforming Urban Planning." Daily Passport, March 29, 2024. https://dailypassport.com/barcelona-superblocks-urban-planning/.

157 IAA Mobility. "Superblocks for Everyone!," January 2, 2023. https://www.iaa-mobility.com/en/newsroom/news/urban-mobility/superblocks-for-everyone.

158 Senbel et al., "The Relationship Between Urban Form and GHG Emissions."

Roads to Accessibility Corridors

As a provider and coordinator of infrastructure, the City can use the type and extent of infrastructure to shape the form of the city. The City can state that infrastructure for zero-emissions transportation is its foremost transportation priority in the OP, using a multi-solving approach, which considers affordability, health, and equity. An efficiency-first approach should be used for infrastructure, which considers the energy and financial cost of the mode of travel as an order of priority.

The City can continue to build on its current focus of Complete Streets and Vision Zero to prioritize walking and cycling networks as a system of accessibility based on equity (these modes are accessible to everyone), health outcomes, affordability, and reduced air pollution, in addition to GHG reductions and increased resilience.[159] Ensuring these routes are shaded "coolways" protects users from extreme heat while still facilitating accessibility. The use of pedsheds and cyclesheds can shape the configuration of the city's nodes and corridors.

Reducing personal VKT in some instances should draw on more direct policies that help make the urban environment more liveable and require vehicle users to shoulder more of the social cost of vehicle ownership and use. The City has eliminated many minimum parking restrictions and implemented some maximums. This helps reflect some of the cost of a less dense urban form that parking creates. Some cities have taken this further and are taxing private surface parking,[160,161] or are considering it.[162] Parking fees can also be redirected to local improvements that reduce private vehicle travel. This arguably fosters more social equity than municipalities raising revenue through property taxes. With respect to on-street parking, a Montreal borough now increases on-street parking fees for larger vehicles.[163]

Various forms of electric micromobility technologies can enable mode shifting out of vehicles, particularly for shorter trips. The Region of Waterloo and three urban municipalities' partnership with Neuron mobility provides e-scooters and e-bikes in Kitchener, Waterloo, and Cambridge. The safe and widespread deployment of electric micromobility requires dedicated lanes and corridors, low-speed zones for micromobility, integration with transit and parking, and charging infrastructure.

159 Kim, Eun Jung, Jiyeong Kim, and Hyunjung Kim. "Does Environmental Walkability Matter? The Role of Walkable Environment in Active Commuting." International Journal of Environmental Research and Public Health 17, no. 4 (February 15, 2020): 1261. https://doi.org/10.3390/ijerph17041261.

160 Toronto.ca. "Agenda Item History 2024.EX12.3," n.d. https://secure.toronto.ca/council/agenda-item.do?item=2024.EX12.3.

161 De Montréal, Ville. "Check Data Used to Calculate the Parking Lot Tax." Ville De Montréal, n.d. https://montreal.ca/en/how-to/check-data-used-to-calculate-parking-lot-tax.

162 CTV News. "Ottawa Studying Private Parking Levy to Help Fund OC Transpo," July 26, 2024. https://ottawa.ctvnews.ca/ottawa-studying-private-parking-levy-to-help-fund-oc-transpo-1.6979029.

163 Streetsblog USA. "Steal This Idea: The Larger the Car, the More You Pay to Park ," June 16, 2023. https://usa.streetsblog.org/2023/05/16/heres-a-big-idea-the-larger-the-car-the-more-you-pay-to-park-the-damn-thing.

Last mile delivery is a source of both GHG emissions and air pollution. The City can include policies that promote innovative last mile solutions including zero-emissions delivery zones, the identification of facilities where freight from multiple suppliers can be consolidated (urban consolidation centres), and programs to support e-cargo bikes.

The City can ensure that private and commercial drivers can access reliable charging stations on- and off-street. The charging stations need to be fairly priced and accessible for all. The OP should consider site selection for high-traffic areas, underserved neighbourhoods, transit hubs, equity, and where the built form is dominated by multi-unit residential buildings (MURBs). By-laws and right-of-way rules can be adjusted to enable electric vehicle (EV) charger installation in public spaces like curbside parking spots, avoiding conflicts with other municipal uses.

Climate change also impacts transportation infrastructure. Extreme events such as heavy rainfall, flooding, heatwaves, and freeze-thaw cycles can damage infrastructure and interrupt operations. For example, extreme temperatures can cause roads to crack, while increased rainfall and flooding can lead to road washouts and landslides. Rising temperatures can also affect the safety and comfort of passengers, particularly those in transit vehicles without air conditioning.

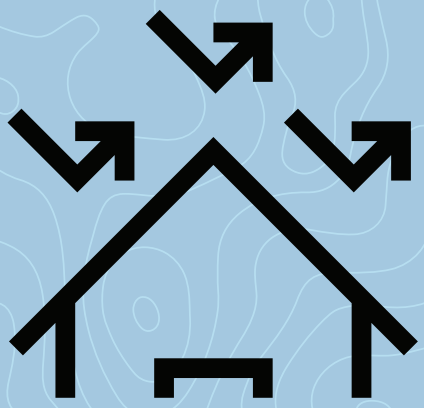
As climate change continues to impact cities, resilient transportation systems are essential for ensuring the safety, accessibility, and functionality of urban mobility. The City can integrate climate resiliency into its transportation network by evolving its use of materials. It can also create "cool corridors," including shaded active transportation pathways, to protect populations during heat waves.

Recommended policy themes are outlined below.

#	Theme	Recommendations	Implementation Approach
15	Compactness	Include policies that directly link compact, complete communities with GHG emissions reduction objectives.	These policies will ensure the compact communities objective aligns with GHG emissions reductions, while also addressing counteracting characteristics of compactness. Implementing mechanisms include: ▪ Cycling and Trails Master Plan ▪ Transportation Master Plan ▪ Sustainable Urban Forest Strategy ▪ Siting of operations facilities

#	Theme	Recommendations	Implementation Approach
16	Reenvisioning streets	Include policies that transition neighbourhood streets into community spaces, limiting vehicles and enabling a neighbourhood design process.	These policies will continue to shift people's relationship with streets in the community, particularly in residential neighbourhoods, using the following mechanisms: ▪ Kitchener Complete Streets ▪ Vision Zero ▪ Kitchener "super-block" strategy
17	Multi-functional hubs	Include policies that expand the nodes to hubs for destinations, accessibility, energy, and resilience.	These policies will expand the concept of nodes to the concept of hubs, signalling coordination across multiple programmatic and policy domains at a localized level. The hubs can be implemented through: ▪ Land-use categories ▪ Urban Design Manual ▪ Cycling and Trails Master Plan ▪ Transportation Master Plan ▪ Integrated Resource Plan (electricity utilities) ▪ Resilience Hubs Strategy (recommended)
18	From Roads to Accessibility Corridors	Include policies that prioritize and accelerate infrastructure for walking, cycling (including electric bikes), transit, and EVs, in that order, as well as increasing the resilience of the infrastructure.	These policies centre the importance of the most efficient and equitable modes of transportation, complemented by other policy mechanisms the CIty can use, including: ▪ Parking by-law ▪ Last Mile Strategy ▪ EV Charging Strategy

Big Move 5



Climate Ready Buildings

As durable investments, buildings lock in patterns of energy use and GHG emissions for decades. As new buildings are constructed, the stock of existing buildings grows. If those new buildings are net-zero emissions, the challenge of decarbonizing the building stock declines. However, if those buildings also require retrofits, the challenge grows exponentially, as there are more and more buildings to retrofit in an ever-declining period of time. The challenge is further compounded by the fact that it is more costly to retrofit a building than it is to build a new net-zero emissions building.

The primary focus of this paper is on net-zero emissions as opposed to net-zero energy, which has different but related design challenges. The term "**net**-zero emissions" implies that a project can secure additional emissions reductions to address any emissions associated with the building. The primary objective is to achieve zero emissions. If there are emissions, however, another policy the City may consider is to develop a local emissions trading mechanism, which can be used to net out the emissions from a particular project to ensure a credible approach.[164]

Urban Form for the Future

In designing for net-zero emissions, passive design strategies are essential in order to minimize costly mechanical systems and even more costly renewable energy technologies.[165] Figure 11 illustrates the hierarchy of the design approach.

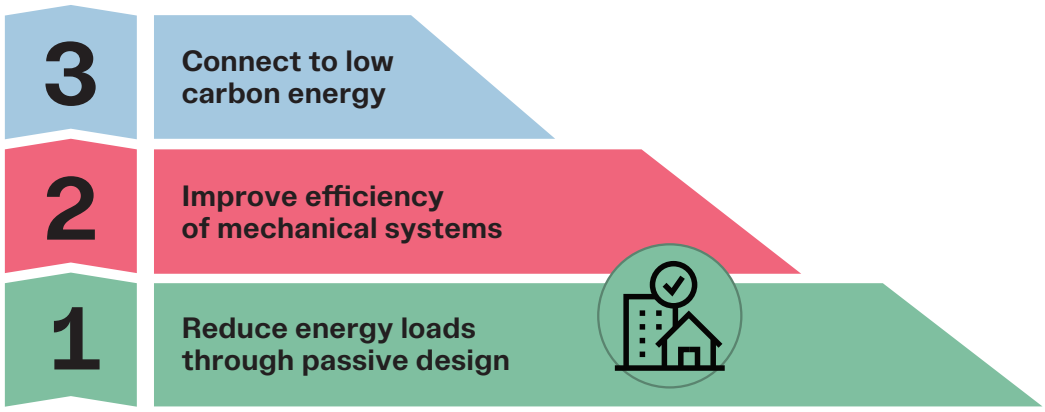


Figure 11. Hierarchy of building design principles.[166]

164 Probst, Benedict S., Malte Toetzke, Andreas Kontoleon, Laura Díaz Anadón, Jan C. Minx, Barbara K. Haya, Lambert Schneider et al. "Systematic assessment of the achieved emission reductions of carbon crediting projects." Nature communications 15, no. 1 (2024): 9562.

165 Lisa Coltart, Guido Wimmers, Light House Sustainable Building Centre, City of Vancouver, and Gregor Robertson. "Passive Design Toolkit for Homes." Report, 2009. https://www.passivehousecanada.com/downloads/Passive_Design_Toolkit_Homes.pdf.

166 King, Lisa, Bryan Purcell, Nickolas Lysenko, Geoff Gibson, Heather Black, Mark Gorgolewski, Steve Kemp, et al. "Zero Emissions Buildings Framework," 2017. https://www.toronto.ca/wp-content/uploads/2017/11/9875-Zero-Emissions-Buildings-Framework-Report.pdf.

Urban form influences building energy consumption in both building morphology and urban structure, and in two key ways: heat transfer and solar access.[167] At the individual building scale, building morphology refers to characteristics such as: size and shape of a building, surface-to-volume ratio (S:V), plan depth, building height, and façade design characteristics (glazing ratios and distribution, building orientation, and envelope performance). At the block or neighbourhood scale, urban structure refers to the arrangement and spacing of buildings, streets, and open space, which include measures such as density (as floor to space ratio), land coverage, and spacing between buildings. The neighbourhood scale also captures the cumulative impact of the relationships between multiple buildings (building massing, heights, arrangements and spacing), and their impact on energy consumption.

The built environment of Kitchener needs to be carefully designed to ensure that all current and future buildings have access to as much solar insolation as possible, including:

- Proposed neighbourhood developments should be modelled as a whole to allow for optimization of solar gain. Optimized mid- and high-rise neighbourhoods can achieve an ~8% increase in overall solar gain, and a ~5% increase in rooftop PV production with the same gross floor area.[168] Furthermore, optimized solar layouts create not only increased passive solar gain, but also significant potential increases in solar PV generation from BIPVs.
- Electricity generation from PVs on roofs and BIPVs on walls reduces the electricity demand from the grid and maximizes the provision of clean electricity.

Mechanisms to ensure solar access can include specifying heights within the OP designations, zoning by-law, and secondary plan in consideration of solar gain, and requiring a solar gain or solar harvesting analysis at the neighbourhood scale,[169] as part of a complete application for the draft plan of subdivision.

A solar access by-law protects the ability of each building to harvest solar energy both passively, through passive solar design, and actively through the integration of solar panels on roofs and facades. Without this security, investment in solar harvesting remains at risk from shading by future development. Two strategies can be used to protect solar rights:

- The solar envelope is a geometric method that enables urban planners and architects to design buildings while preserving solar access. The solar envelope was originally defined as “the volumetric limits of buildings that will not shadow surroundings” for a minimum number of hours.

167 Miller, Nicole. “Urban Form and Building Energy: Quantifying Relationships Using a Multi-scale Approach.” University of British Columbia, January 1, 2013. https://doi.org/10.14288/1.0074021.

168 SSG analysis for a municipal client.

169 An example of the analysis required by New York City: HPD Solar Feasibility Analysis. https://solar1.org/herecomessolar/hpd-solar-feasibility-analysis/

- An alternative approach developed by the City of Boulder is a solar fence,[170] a hypothetical fence along the property line. New structures are not allowed to shade adjacent lots to a greater extent than the hypothetical fence would in winter solstice. Boulder has grouped its zoning districts into three Solar Access Areas, protected by a 12-foot solar fence, a 25-foot solar fence, and by solar access permits, respectively.

Solar access by-laws must consider trade-offs with other objectives such as higher density and embodied emissions from different construction strategies.

Zero-Emissions New Buildings

A requirement for zero-emissions new buildings is to reduce emissions immediately, which is particularly important in areas experiencing rapid growth, such as Kitchener, in order to avoid the cost of future retrofits. Zero-emissions buildings both minimize energy consumption and generate electricity on-site using solar PVs or leverage other clean energy sources to bring GHG emissions as close to zero as possible.

Zero-emissions buildings also set targets for embodied emissions, or those emissions resulting from the materials used in the building. The City of Vancouver requires a completed embodied carbon design report and supporting documents for building permits for Part 3 (large buildings) with a limit of 800 $kgCO_2$/m2, declining to 360 $kgCO_2$/m2 by 2025. The City of Toronto has a tier 2 standard requirement for mid- to high-rise residential and non-residential projects to demonstrate an embodied emissions intensity of less than 350 $kgCO_2e$/m2.[171] Tier 2 is currently voluntary, but will become mandatory in the next version of the Toronto Green Standard.

Zero-emissions buildings benefit occupants through better living conditions, often resulting in positive health outcomes and better worker performance, due to more consistent and comfortable temperatures, better indoor air quality from improved ventilation, and quieter indoor spaces from enhanced insulation.

From a cost perspective, owners/occupants of zero-emissions buildings are shielded from energy price increases and fluctuations, as well as from increases in carbon prices. Owners also avoid disruptive and costly retrofits to meet net-zero standards down the road. Specific cost considerations include:

170 City of Boulder. "9-9-17 Solar Access," n.d. https://library.municode.com/co/boulder/codes/municipal_code?nodeId=TIT9LAUSCO_CH9DEST_9-9-17SOAC.

171 City of Toronto. Building Energy, Emissions & Resilience. 2025. https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/toronto-green-standard-version-4/mid-to-high-rise-residential-non-residential-version-4/buildings-energy-emissions-resilience/

- **Construction costs near parity:** The highest performing buildings (Passive House certified) can cost 0–10% more in construction costs, but recent analysis indicates costs are nearing parity.[172] Landmark Homes in Edmonton is one example, which recently constructed a net-zero single-family home for under $400,000. They designed the project to be "highly replicable, affordable and scalable,"[173] using innovative strategies such as panelization, or pre-assembly, of major building components.[174]
- **Minimal operating costs:** Building energy codes determine a building's long-term operational and environmental performance. Early thinking about how a building consumes energy, for example, during the initial design phase, helps lock in savings through efficient design and helps building owners avoid costly retrofits in the future that are meant to increase the building's performance. Affordable housing providers have used the Passive House standard to ensure exceptionally low operating costs for their occupants.[175]
- **Avoided future costs:** Buildings that are not designed at the outset to be high performance can expect to undergo more costly retrofits. These retrofits are likely to be disruptive, resulting in adverse economic impacts such as lost rent, or in the case of owner-operator buildings, displacement of staff.

Zero-emissions buildings should also include a comprehensive set of measures addressing climate adaptation, including strategies to mitigate or limit the heat island effect.[176] Some of these strategies both reduce GHG emissions and increase resilience. For example, improved building envelopes can better regulate temperature and therefore protect inhabitants in periods of extreme weather,[177] which the US Green Building

172 The Passive House Network. "Safe at Home: How All-Electric, Multi-Family Passive House Buildings Deliver Comfortable, Cost-Effective Climate Resilience." Passive House Network, 2023. https://passivehousenetwork.org/wp-content/uploads/2023/07/Passive-House-Network-Summer-2023-Report-Safe-at-Home.pdf.pdf.

173 Moore, Shannon, and Shannon Moore. "Landmark Homes Introduces $399,000 Net Zero Home in Edmonton." Building (blog), March 28, 2017. https://building.ca/landmark-edmonton-net-zero.

174 Nesseth, David. "Net-zero Energy Homes Capitalize on Computerized Construction - Canadian Manufacturing." Canadian Manufacturing Online, July 22, 2014. https://www.canadianmanufacturing.com/manufacturing/net-zero-energy-homes-capitalize-computerized-construction-139204/.

175 Chung, Emily, and Alice Hopton. "Many of Canada's Greenest Apartments Are Ultra-affordable. Here's Why." CBC, June 18, 2023. https://www.cbc.ca/news/science/green-affordable-housing-1.6876487.

176 Lauoadi, Abdelaziz, M Bartko, A Gaur, and M.A. Lacasse. "Climate Resilience Buildings: Guideline for Management of Overheating Risk in Residential Buildings." National Research Council Canada, 2022. https://publications-cnrc.canada.ca/eng/view/ft/?id=9c60dc19-ca18-4f4c-871f-2633f002b95c&dp=2&dsl=en.

177 Ribeiro, David, Eric Mackres, Brendon Baatz, Rachel Cluett, Michael Jarrett, Meegan Kelly, Shruti Vaidyanathan, and American Council for an Energy-Efficient Economy. "Enhancing Community Resilience Through Energy Efficiency," October 2015. https://unepccc.org/wp-content/uploads/sites/3/2016/03/u1508.pdf.

Council has defined as passive survivability or thermal safety.[178] Thermal safety is defined as maintaining thermally safe conditions during a power outage that lasts four days during peak summertime and wintertime conditions. A study of buildings in New York City found that homes with efficiency upgrades could maintain indoor temperatures of over 60°F during a week-long power outage, whereas the temperature in average-efficiency homes fell below 35°F within three days.[179]

The area municipalities in Waterloo Region, supported by the Region and in conjunction with local utilities and WR Community Energy, are each developing an HPDS, which will support GHG emissions reductions from new developments in Kitchener. Enabled by the Planning Act and addressing the PPS, the HPDS can address many factors that determine a development's energy performance and resiliency, such as shape, orientation, configuration, as well as landscape design, stormwater management, and mobility features (e.g., bicycle parking, shade, seating). The HPDS is proposed to apply to larger projects that go through the planning approvals including new neighbourhoods, multi-family developments (11+ units), and commercial, industrial, and institutional buildings.

Additional policies are required for the buildings to which the HPDS does not apply, such as single detached homes. In the absence of other policy mechanisms, the City can develop a certification program for these building types. The certification program can be complemented by incentives and financing using an LIC to address a barrier called the split incentive, where the developer or builder is not incentivized to invest the incremental capital required to achieve net-zero emissions, because the savings will accrue subsequently to the occupant. The LIC can be used to provide the incremental capital cost of achieving net-zero emissions to the developer or builder, and then the occupant can make the payments to the City using avoided energy costs.

Zero-Emissions Existing Buildings

Many Canadian municipalities have developed retrofit programs that incorporate incentives from various levels of government as well as loans. However, the pace of retrofits under this approach is slow, with one analysis concluding that it will take 140 years to retrofit the building stock at the current rate.[180]

178 US Green Building Council. "Passive Survivability and Back-up Power During Disruptions," n.d. https://www.usgbc.org/credits/passivesurvivability.

179 Leigh, Richard, Jamie Kleinberg, Cecil Scheib, Russell Unger, N. Kienzl, M. Esposito, E. Hagen, and M. Tillou. "Leaks and Lives: How Better Building Envelopes Make Blackouts Less Dangerous." 2014 ACEEE Summer Study on Energy Efficiency in Buildings (2014): 17–22.

180 Haley, Brendan, and Ralph Torrie. "Canada's climate retrofit mission." Efficiency Canada.(Ottawa: Carleton University, 2021) 6 (2021).

Building Performance Standards (BPS), which are being implemented by leading municipalities in Canada and the US to speed up the decarbonization of existing buildings, set legally enforceable GHG or energy performance limits.[181] These standards must be met by a specified date or triggering event, with the option to extend deadlines for social or affordable housing. Municipal governments can enforce these standards using their usual enforcement tools.

The BPS could also include resilience measures to reduce the vulnerability of buildings against key hazards. For example, the City could establish a fund that can be used to cost-share flood-proofing existing buildings in the floodplain according to equity-based criteria.

The BPS can be implemented through a property conditions by-law under the Ontario Building Code Act and the Municipal Act.[182] The Ontario Building Code Act enables the OP to include provisions related to property conditions that prescribe standards for the maintenance and occupancy of property to apply an associated by-law.

The BPS are contained within a broader framework that includes financial aid, programmatic assistance, and protections for vulnerable populations.

Benchmarking is used to establish a building's baseline energy performance, and to set targets for the BPS. Performance requirements can be triggered according to a specific timeline, as is the case for Vancouver, or at the point of a real estate transaction or planned construction work.

A financing program for commercial and multi-unit residential buildings can be developed using LICs.

The BPS generally does not apply to single detached homes or smaller buildings. RetrofitWR, a retrofit program currently under development, will focus on houses, offering on-bill financing with the electricity utilities, incentives, and contractor training. To accelerate retrofits in the residential sector, the City can consider a residential BPS with simplified requirements.

Recommended policy themes are outlined below.

181 Efficiency Canada, Carleton University, and LC3. "Regulating Energy and Emissions in Existing Buildings." Efficiency Canada, 2022. https://www.efficiencycanada.org/codes-report/.

182 Krystal-Anne Roussel, Canadian Environmental Law Association, and The Atmospheric Fund. "Recommendations for Municipalities: Mandatory Building Performance Standards." Report. Recommendations for Municipalities: Mandatory Building Performance Standards, 2023. https://cela.ca/wp-content/uploads/2023/10/FINAL-CELA-TAF-Report-on-Mandatory-Building-Performance-Standards-October-12-2023.pdf.

#	Theme	Recommendations	Implementation Approach
18	Urban form for the future	Include urban design policies that optimize shape and orientation for solar gain and protect the solar gain.	These policies enable requirements to consider shape and orientation at each step of the planning process, including: ▪ Site plan ▪ Neighbourhood plan ▪ Plan of subdivision The policies also enable a solar access by-law that protects the solar resource for existing buildings.
19	Building benchmarking	Include policies that enable a building energy and emissions benchmarking program.	These policies enable a Building Condition By-Law that includes benchmarking as a requirement.
20	Zero-emissions new development	Include policies that enable HPDS to address GHG mitigation, passive solar design energy efficiency, and resilience measures.	These policies enable comprehensive HPDS.
21	Zero-emissions new homes	Include policies that enable a labelling and incentive program for high-performance new homes.	These policies enable a certification program for new homes that recognizes their performance and LICs to finance incremental capital costs for high-performance homes.
22	Zero-emissions existing buildings	Include policies that enable a BPS for commercial and multi-unit residential buildings.	These policies enable a requirement for GHG emissions performance of existing commercial and multi-use buildings using a BPS. The policies enable the expansion of the existing building retrofit program (RetrofitWR) to commercial buildings, and enable an LIC, on-bill financing, and/or incentives for commercial and multi-use retrofits.

#	Theme	Recommendations	Implementation Approach
23	Deep home retrofits	Include policies that enable a retrofit program for owned and rented buildings, including energy, emissions, and resilience measures.	These policies enable RetrofitWR to undertake a more extensive and deeper retrofit program that includes incentives, financing, and recognition.

Big Move 6

Sustainable Consumption

Imported GHG emissions are increasingly addressed by leading municipalities, with the impacts captured from consumption-based GHG inventories. Historically, these emissions have been a blind spot due to accounting approaches being originally developed for national GHG inventories.

Urban centres represent concentrations of wealth and consumption, causing GHG emissions to be produced beyond city borders. One analysis found that 85% of emissions resulting from urban consumption are imported from other geographies, and for many cities, GHG emissions from consumption exceed those from local production, and these emissions are growing.[183] Ontario's Guideline on Community Emissions Reductions recommends that advanced municipalities in Ontario track and manage consumption-based emissions.[184]

The perspective of consumption-based emissions, as demonstrated in Figure 12, provides a new view on previous recommendations for policies and gives rise to new opportunities.

183 C40 Cities Climate Leadership Group, Arup, University of Leeds. The future of urban consumption in a 1.5°C world, 2019. https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/Vo000000TW1J/Q_k2C3XI4Qg5jEzYUd0vIvwPKP.p.y9J306Y17mZBKI.

184 Ministry of the Environment and Climate Change. Guideline on community emissions reduction planning, 2018. https://ero.ontario.ca/notice/013-2083.

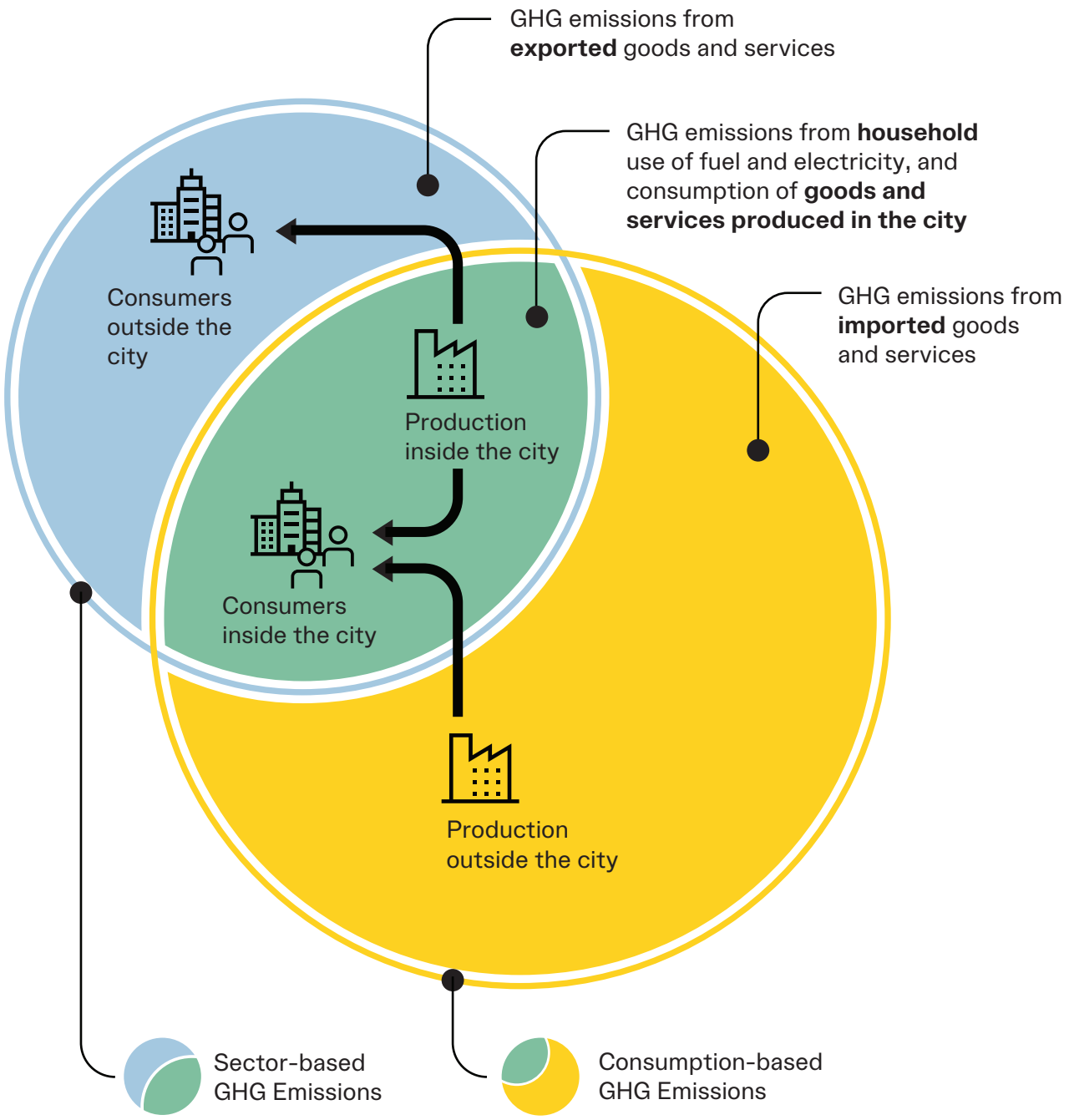


Figure 12. Illustration of the relationship between a sector-based (or geographic) GHG emissions inventory and consumption-based GHG inventory.[185]

185 C40 Cities. "New Research Shows How Urban Consumption Drives Global Emissions - C40 Cities," July 10, 2023. https://www.c40.org/news/new-research-shows-how-urban-consumption-drives-global-emissions/.

Table 6 provides examples of how the consumption-based lens can shape policy approaches to different sectors.

Table 6. Municipal influence on sources of GHG emissions from consumption.

Sector	Municipal Influence
Food	Policies that protect agricultural production and enable urban farming. Policies that reduce the consumption of meat through education and programming.
Construction	Policies that reduce building size, enable building reuse, use less building materials, use lower carbon building materials, and maximize occupancy.
Vehicles	Policies that reduce and/or eliminate the need for vehicle ownership by enabling walking, cycling, and transit use, while prioritizing accessibility and barrier-free design.
Aviation	Investments in alternatives like high-speed rail.
Electronics	Policies and programs that extend the life of consumer goods through repair and reuse, such as community workshops, tool libraries, and free stores.

Waste to Resources

Climate action plans have heightened the need to improve solid waste management by adding the emissions dimension to solid waste streams. The upstream emissions through the generation of waste, and those downstream through waste management streams, compound the resource and disposal issues of waste generation. While waste management is the responsibility of the Region of Waterloo, the City can advance industrial ecology and the circular economy[186] by including policies that support industrial symbiosis and material-reuse hubs.

The City can support the development of industrial ecology in industrial parks, where waste products from one enterprise become inputs for another enterprise.[187]

The City, possibly in coordination with the Region, can support "free stores" downtown or in hubs. Free stores provide a system for reusing goods prior to disposal, while also advancing affordability and building community.

186 FCM. A Guide to Catalyzing a Circular Economy in Your Community. A Guide to Catalyzing a Circular Economy in Your Community, 2022. https://media.fcm.ca/documents/programs/gmf/a-guide-to-catalyzing-a-circular-economy-in-your-community_vy24x4.pdf.

187 LeBlanc, Rachelle, Carole Tranchant, Yves Gagnon, and Raymond Côté. "Potential for eco-industrial park development in Moncton, New Brunswick (Canada): A comparative analysis." Sustainability 8, no. 5 (2016): 472.

Local Food Culture

Food production is both a major contributor to and highly vulnerable to climate change. Agriculture emissions constitute a significant portion of global GHG emissions, accounting for approximately 10–12% of total emissions, primarily from livestock, rice cultivation, and fertilizer use.[188] Food security is increasingly a risk as a result of climate change, jeopardizing food supply, access, and consumption;[189] driving up prices; and decreasing affordability. Municipalities collectively developed a framework, the Glasgow Food and Climate Declaration, to address GHG emissions from food production and the vulnerability of the food system to climate change.[190]

While Waterloo Region has extensive agricultural activity, Kitchener's land area available for large-scale agriculture is limited. The development and protection of urban agriculture and local and regional food systems is a critical climate adaptation strategy in the face of an increasingly fragile global food system.[191] Space for urban agriculture is contested due to competing demands, many of which provide greater economic returns.[192]

The allocation of space either for each household or community gardens for food production in new developments can be included as part of the HPDS or through development agreements. The allocation of space and programming for community gardens increases resilience by developing capacity and knowledge, increasing social capital and providing affordable access to food, even to those who live in dense, urban environments.

The City can actively protect equitable access to healthy, local food and encourage new food systems by mapping food deserts and developing strategies to encourage markets, growers, and retailers to open in these areas. Strategies can include financing, incentives, education, or coordination.

188 Nabuurs, Gert-Jan, and Richard Mrabet. "Agriculture, Forestry and Other Land Uses (AFOLU)." In Climate Change 2022: Mitigation of Climate Change Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, 748–832. Cambridge University Press, 2022. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter07.pdf.

189 Toromade, None Adekunle Stephen, None Deborah Aanuoluwa Soyombo, None Eseoghene Kupa, and None Tochukwu Ignatius Ijomah. "Reviewing the Impact of Climate Change on Global Food Security: Challenges and Solutions." International Journal of Applied Research in Social Sciences 6, no. 7 (July 16, 2024): 1403–16. https://doi.org/10.51594/ijarss.v6i7.1300.

190 International Panel of Experts on Sustainable Food. Glasgow Food and Climate Declaration, 2021. Retrieved from: https://www.glasgowdeclaration.org/the-glasgow-declaration

191 Dixon, Jane M., Kelly J. Donati, Lucy L. Pike, and Libby Hattersley. "Functional Foods and Urban Agriculture: Two Responses to Climate Change-related Food Insecurity." New South Wales Public Health Bulletin 20, no. 2 (January 1, 2009): 14. https://doi.org/10.1071/nb08044.

192 Jansma, Jan Eelco, and Sigrid Co Wertheim-Heck. "A City of Gardeners: What Happens When Policy, Planning, and Populace Co-create the Food Production of a Novel Peri-urban Area?" Environment and Planning B Urban Analytics and City Science 51, no. 3 (August 14, 2023): 705–20. https://doi.org/10.1177/23998083231193802.

The City can build on the success of its farmers market to support pop-ups or neighbourhood markets in nodes or hubs. Markets are a critical node in the local food system, as they enable relatively easy access to the food distribution system. Support can take the form of the provision of a location, development of infrastructure, funding, development of incentives such as food dollars, and educational programs.

The City can work with non-profits and regionally to build, support, and enhance networks of producers and processors, and of distribution systems, through programs such as community supported agriculture, food processing and storage facilities, city procurement, and food hubs in order to build farmer-to-customer relationships, improve the economic viability of farming, and increase the resilience of the local food system. Intervale Farm, an urban farm in Burlington, Vermont, includes farmer training, incubation, community gardens, institutional procurement, and many other services, stimulating a resilient and vibrant food system.[193]

Most studies have concluded that a diet that emphasizes plant-based foods with fewer animal-sourced foods results in both health and environmental benefits.[194] Plant-based diets decrease GHG emissions from cattle production, a major source of methane emissions. The City can encourage plant-based diets through policies that enable urban agriculture and community gardens, procurement, education, and operations.

The City can preserve land for food production by transferring public land to agricultural community land trusts or as part of development agreements, or by providing zoning protections or easements. Preservation of agricultural land can be compatible with renewable energy through systems such as agrivoltaics, which can increase the resilience of agricultural land by diversifying revenue streams.

Recommended policy themes are outlined below.

193 Intervale Community Farm. "The Intervale — Intervale Community Farm," n.d. https://www.intervalecommunityfarm.com/the-intervale.

194 Willet, Walter, Johan Rockström, Brent Loken, Marco Springmann, Tim Lang, and Sonja Vermeulen. "Food in the Anthropocene: The EAT–Lancet Commission on Healthy Diets From Sustainable Food Systems." The Lancet Commissions 393, no. 10170 (February 2, 2019). https://doi.org/10.1016/S0140-6736(18)31788-4.

#	Theme	Recommendations	Implementation Approach
24	Waste to resources	Include policies that advance industrial ecology and the circular economy.	These policies could be implemented by a Circular Economy Strategy for the city. Industrial ecology is advanced by planning strategies specific to industrial areas, including: ▪ Secondary plan determines the overall schema ▪ Zoning by-law identifies the mix of uses and other parameters
25	Local food production	Include policies that support local food sovereignty, including production and distribution in neighbourhoods and for equity-seeking populations; provide access to spaces for growing both privately and communally; and support partnership between the communities and growers, reducing GHG emissions and increasing resilience. For example, consider policies for the use of City-owned property as well as privately owned public spaces (POPS) to support urban agriculture.	These policies could be implemented by: ▪ Developing a Kitchener Food Charter and city-wide Food and Agriculture Strategy that advances food justice for marginalized communities, addresses food deserts, and creates food policy councils or other participatory governance mechanisms ▪ Integrating food systems planning into planning processes ▪ Protecting land for agriculture and urban agriculture using land banks, community land trusts, and covenants, as part of development agreements ▪ Enabling the use of public land for food production ▪ Providing infrastructure for neighbourhood farmers markets ▪ Developing a local food strategy

Big Move 7

Resilience Hubs

Infrastructure

Resilience hubs are neighbourhood-based facilities that can distribute resources, aid, and communication and offer overall support to residents before, during, and after climate events. Although a resilience hub is typically related to a building and its immediate surroundings, it should be seen as a community undertaking that employs and builds social cohesion whilst addressing climate change threats.

The City can develop or adopt a vulnerability index that fits the circumstances of Kitchener, informed by indicators on equity, age, income, inequality, ecosystem condition, built environment condition, and other factors. The vulnerability index[195] can be used to identify vulnerable neighbourhoods, information that will be used to prioritize investments and programming.

The City can also use the vulnerability index to identify locations for resilience hubs. Other geographic considerations should include risk from climate hazards; accessibility via walking, cycling, and transit; and location of microgrids or other energy services. Retrofits for existing facilities should both reduce GHG emissions and ensure the facilities are strengthened against extreme weather events.

To combat extreme heat, Kitchener has prioritized establishing cooling centres as safe centres during heatwaves and raising awareness about heat-related risks and precautions. Cooling spaces, which are one form of climate shelter, are buildings that are open to the public during business hours and intended to create temporary relief spaces for individuals to cool down during a heat wave. The Region of Waterloo's and City of Kitchener's cooling spaces include government buildings, libraries, community centres, and other recreational facilities.

Resiliency Hub in West Oakland, California

West Oakland is a historically marginalized but socially cohesive community. In 2020, the community started to work on a resiliency hub. This has involved seven City departments and the local councillor as well as two faith communities, a library group, seniors group, crime prevention group, and general community group. Collectively, they identified projects related to sanitation, energy, communications, shelter, clean air, transportation, medical care, and community activities.

When the City develops any new facilities, their role in providing a community safe space in the context of extreme weather events or other emergencies can be considered, as well as their location in serving vulnerable communities. Design considerations should include passive heating and cooling in the case of power outages during extreme weather events.

195 City of Edmonton, Neighbourhoods and Climate Change Vulnerability, 2021. https://storymaps.arcgis.com/stories/2676a0d561ea45b681ccaa596850e570.

One affordable strategy to ensure that youth and others have access to cooling during periods of extreme heat is to ensure that each neighbourhood has walking access to a splashpad. Splashpads provide high levels of cooling, and also act as gathering places for multiple generations, which can increase social capital.

Publicly Accessible Pools as Climate Shelters in Catalonia, Spain

In Catalonia, two elements of climate change are of concern for policymakers: freshwater is becoming increasingly scarce, and in summer, heat is regularly fatal. Like in France, in Catalonia it is forbidden to fill private pools with drinking water once a threshold heat crisis is reached. However, in April 2024, a policy caveat was added: once a drought emergency is declared, pools can be filled with drinking water if they are: a) open to the general public, and b) declared a climate shelter by the municipality. With this new legislation, private pools, e.g., in hotels or residential spaces, could be opened to the general public during a drought. If effectively implemented, this could provide an opportunity to find alternative heat shelters to overcrowded municipal pools during heatwaves, and redefines swimming pools as essential urban infrastructure in the face of escalating climate emergencies.[196]

Figure 13 summarises the characteristics of a climate-safe neighbourhood, where each home has walking access to a cooling space (splash pad) and a resilience hub, as well as shaded corridors to enable access.

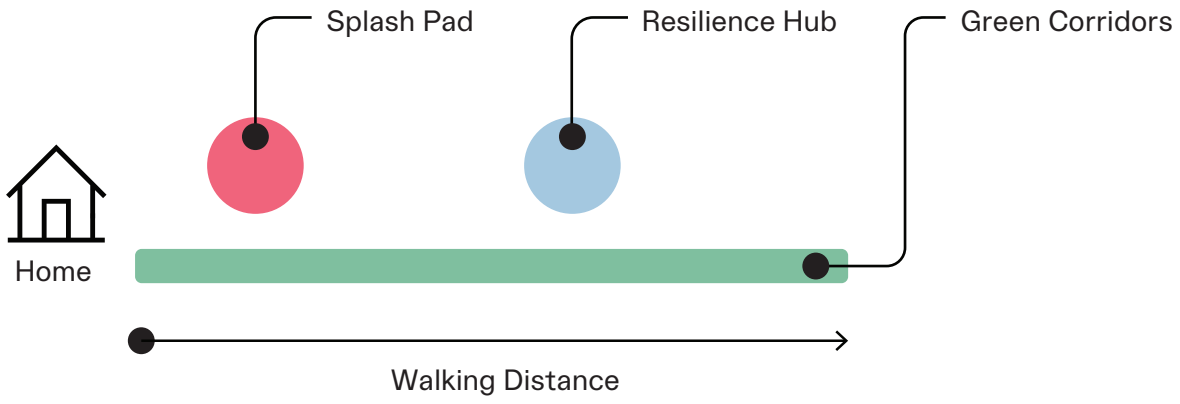


Figure 13. A conceptual representation of a climate-safe neighbourhood.

196 All Things Urban. "Are Pools a Public Good? How Catalonia Redefines Public Spaces in a Warming World," n.d. https://www.allthingsurban.net/blog/Are-Pools-A-Public-Good?utm_source=substack&utm_medium=email.

Programs

Climate change and climate hazards indirectly and directly affect human health and well-being. These effects include death and illness caused by extreme weather events, disruption of food systems, an increase in food-, water- and vector-borne diseases, and mental health issues (Figure 14). In addition, climate change impacts the social determinants of health including equity, housing, food security, and access to health care and support services.[197] Equity plays an important role in both mitigating and adapting the healthcare system to climate change. Equitable adaptation requires all levels of government to support community members who have limited access to health services, are at a higher risk of experiencing health impacts due to social determinants, and/or are at a higher risk of climate impacts.

197 World Health Organization: WHO. "Climate Change," October 12, 2023. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health .

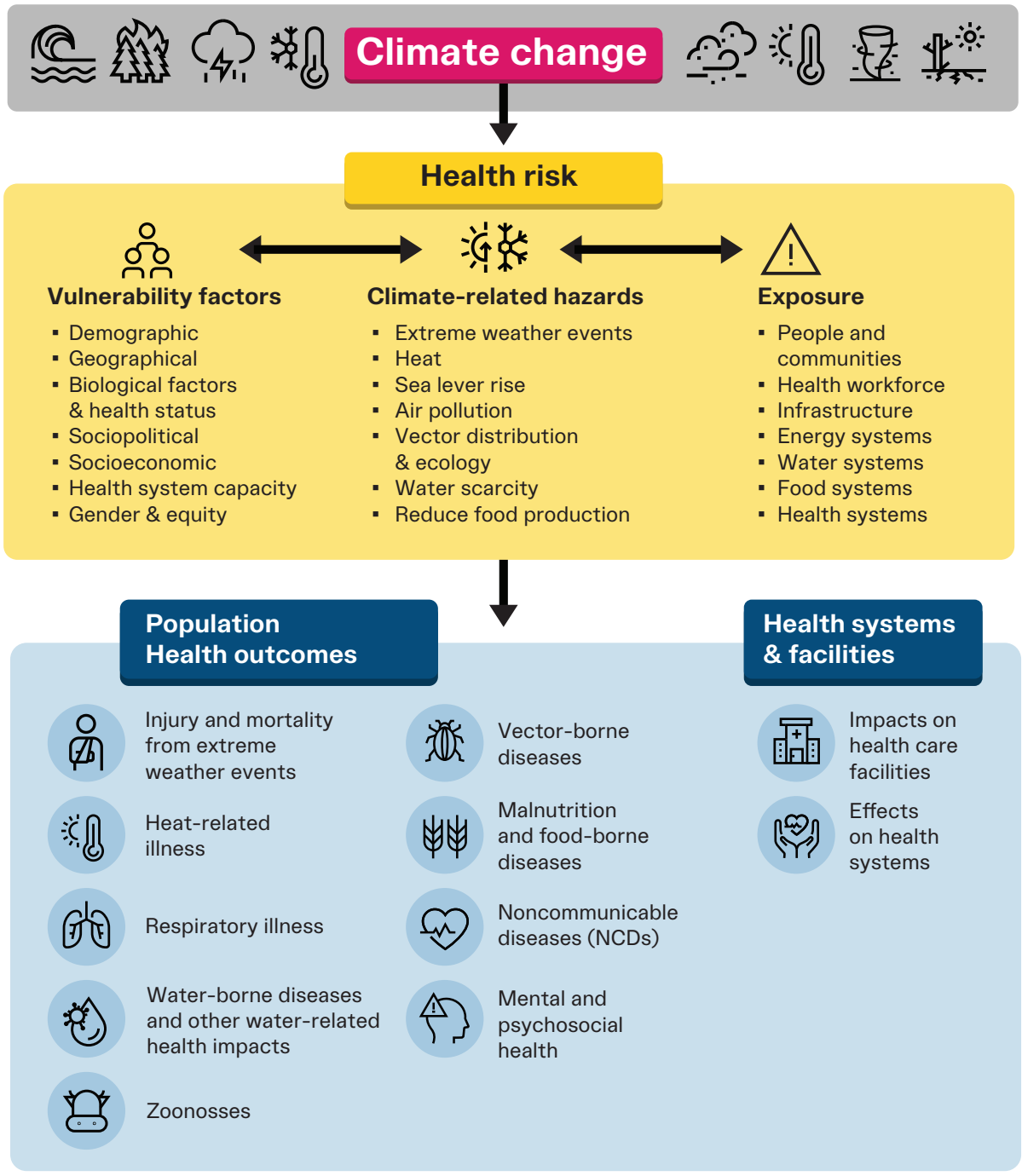


Figure 14. Overview of health risks, exposure pathways, and vulnerability factors.
Source: World Health Organization.[198]

198 World Health Organization: WHO, "Climate Change."

Resilience hubs can be a front-line and integrated response to the social and economic impacts of climate change, providing a range of programs, including disaster preparedness and recovery. These programs should be neighbourhood-based with strong community involvement that allows input into local challenges, needs, and opportunities. Resiliency hubs can address the event itself as well as the "long tail" of a recovery effort, which can include specific programming to "build back better" for vulnerable populations, including communication, coordination with public health and other services, provision of grants and materials, and other aspects. Beyond disaster preparedness and recovery, resilience hub programming can have a broad mandate including addressing physical and mental health impacts, stemming from extreme heat events, poor air quality, and vector-borne diseases. The programs can support GHG reductions, for example, coordinating community-based retrofits and climate literacy programs, with a focus on vulnerable populations who are precariously housed or are experiencing energy poverty. Programming at the resiliency hubs can be delivered in partnership with community partners.

The City can also run educational and communications programs on flood and heat risks and responses. Educational programs are critical to countering misinformation and maintaining widespread support for a collective response to climate action.

Resilience hub programs can also counter climate anxiety by providing information and facilitating constructive activities, such as:

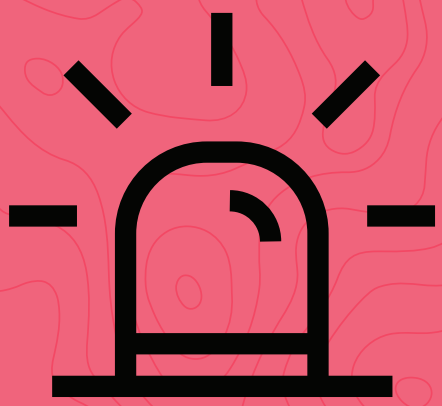
- Providing basic, foundational information on the climate crisis and what they can do about it. The information should be relatable and locally grounded and prioritize actions;
- Engaging community partners that support cycling, EVs, reducing food waste and increasing food security, promoting renewable energy, and repair cafes;
- Helping to address impediments to actions the community wants to undertake, from virtual net metering to waiving building permit charges for residential solar projects;
- Supporting neighbourhood-based climate committees or councils that coordinate hyper local activities; and
- Updating the community on City efforts to address climate change.

Much of this grassroots activity will touch on both mitigation and adaptation. This beneficial overlap reflects both citizens' typical interests and the inherent intersectionality of climate mitigation and adaptation.

A recommended policy theme is outlined below.

#	Theme	Recommendations	Implementation Approach
26	Resilience hubs	Include policies that enable multi-functional resilience hubs that build community capacity for GHG mitigation, climate adaptation and emergency response, and align these with community needs based on mapping inequities and considering the social and structural determinants of health.	The City can develop a Resilience Hubs Strategy as an overarching implementation approach to climate adaptation. This strategy should align with and be supported by nodes or hubs within the urban structure framework in the OP. The policies and programs can be implemented through a Climate Change Adaptation Plan, TransformWR, the Emergency Response Plan, and the Stormwater Master Plan. Investments in splash pads, development of parks, and other investments can also be aligned with or incorporated within the hubs.

Big Move 8



Preparing for Emergencies

As the frequency and severity of climate-related disasters increase, so do the costs to respond to and recover from those disasters. The Canadian Climate Institute calculated the financial cost of the Toronto flooding and Jasper wildfires, Canada's two largest extreme weather disasters, to be $1.8 billion.[199] This estimate only includes insured losses, meaning the total value is likely to surpass $1.8 billion; however, it provides a snapshot of the intensity of these costs on our economic, human, and ecological systems. The objective of improving disaster resilience is to reduce the number of people impacted by disasters while enhancing prevention, response, and recovery from these events for all Canadians.[200]

The UN's Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework) advocates for:

> *"The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries."*[201]

As a signatory of the Sendai Framework, Canada has committed to improving its resilience strategies, preparedness efforts, early warning systems, and cooperation to reduce disaster risks.[202] The Sendai Framework recognizes the need for a whole-system approach to promote action and collaboration across all levels of government and sectors in the following four priority areas:[203]

1. **Understanding disaster risk:** The Sendai Framework recognizes that disaster risk management should be based on the five dimensions of disaster risk: vulnerability, capacity, exposure of persons and assets, hazard characteristics, and the environment.
2. **Strengthening disaster risk governance to manage disaster risk:** The prevention, mitigation, preparedness, response, recovery, and rehabilitation to climate change requires collaboration and partnerships across all levels of government.

199 Institut climatique du Canada. "This Summer's Climate-fuelled Disasters Have Cost Canadians Billions." Canadian Climate Institute, December 20, 2024. https://climateinstitute.ca/news/climate-fuelled-disasters-cost-canadians-billions/.

200 Government of Canada, "National Adaptation Strategy for Canada."

201 United Nations Office for Disaster Risk Reduction. "What Is the Sendai Framework for Disaster Risk Reduction?," n.d. https://www.undrr.org/implementing-sendai-framework/what-sendai-framework.

202 United Nations Office for Disaster Risk Reduction. "What Is the Sendai Framework for Disaster Risk Reduction?"

203 United Nations Office for Disaster Risk Reduction. "What Is the Sendai Framework for Disaster Risk Reduction?"

3. **Investing in disaster risk reduction for resilience:** Investments in both structural and non-structural measures are required in order to enhance the economic, social, health, and cultural resilience of communities, assets, environment, and countries.
4. **Enhancing disaster preparedness for effective response and to build back better in recovery, rehabilitation, and reconstruction:** The Sendai Framework recognizes the interconnection between disaster preparedness and recovery. Enhancing preparedness includes improving response, taking action in anticipation of events, and ensuring systems are in place for effective response and recovery. The recovery, rehabilitation, and reconstruction after a disaster is an opportunity to integrate disaster risk reduction into redevelopment efforts.

The City has developed emergency response plans in order to prepare for more severe weather events, and can focus on a risk assessment, consideration of both acute and chronic impacts, identification of vulnerable populations, and implementation of proactive measures. The City can work with the resiliency hubs to coordinate an education program specifically on emergency response to prepare and empower neighbourhoods. They can also coordinate on the development and deployment of real-time warnings that are accessible in a range of formats.

Emergency response will consider transportation options for those who lack access to private vehicles or those with disabilities, and upgrades to new municipal transportation infrastructure can consider accessibility during emergencies.

Areas identified as vulnerable to flooding when climate projections are incorporated must identify safe evacuation routes.

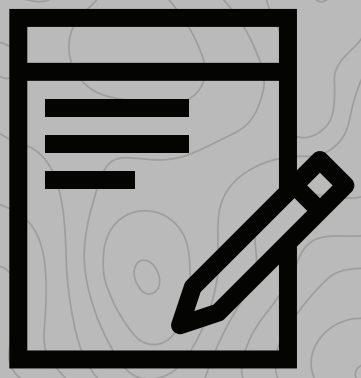
The City can coordinate with partners to ensure an emergency response for transportation infrastructure that supports all modes, including municipal vehicles, private vehicles, transit, walking, and cycling.

Social housing and senior housing should be equipped with redundant zero-emissions energy systems in order to maintain critical function during a disaster or extreme weather event.

A recommended policy theme is outlined below.

#	Theme	Recommendations	Implementation Approach
27	Climate emergency preparedness	Include policies that incorporate emergency management considerations into planning processes and infrastructure design with consideration for equity and disadvantaged populations.	These policies can be implemented by incorporating consideration of climate hazards and emergency management or response into the Transportation Master Plan, Kitchener's Emergency Response Plan, and resilience hub programming.

Big Move 9



Learning while Doing

Addressing climate change requires careful attention to cause and effect and organizational agility. An ongoing process of dialogue among different perspectives will facilitate a better understanding of the impacts.

Limitations in information about the future of climate change can be classified in terms of a series of uncertainties:

- Uncertainty in the description of the current climate;
- Uncertainty in future GHG emissions and their concentrations in the atmosphere;
- Uncertainty in the course of future climate change;
- Uncertainty in the impacts arising from that change; and
- Uncertainty in the actions required to manage those impacts.

Monitoring and evaluation activities can be used to examine and continuously adapt, to revise and improve climate policies, and to ensure transparency and accountability.

Two aspects are involved in monitoring and evaluation: (1) collecting data on indicators (monitoring), and (2) interpreting the results of those indicators (evaluation). Over time, the City can also evaluate its effectiveness in embedding the knowledge and wisdom gained through this process into the organization's processes and employees.

Tracking the effectiveness of the policies in the OP helps manage the risk and uncertainty associated with these efforts, as well as with external forces such as evolving senior government policy and new technologies that can disrupt the energy system. Key motivations for monitoring and evaluation include:

- Identifying unanticipated outcomes;
- Adjusting policies and policy approaches based on their effectiveness;
- Managing and adapting to the uncertainty of climate change; and
- Managing and adapting to emerging technologies.

Leading indicators are those which signal or lead to future events. For example, an increase in the installation of heat pumps can lead to a decrease in GHG emissions related to building heating. In this example, it is notable that GHG emissions reductions follow from the installation of heat pumps. Many Canadian municipalities undertake an annual inventory of GHG emissions; while this is necessary information, it is a lagging indicator as to the effectiveness of climate mitigation activity.

The concept of "Plan, Do, Check, Act" was formalized in management system processes and can be effectively employed in climate action. In this concept "Act" refers to taking course-correcting or implementing new policies or actions as evaluations are completed and reviewed.

From the perspective of climate change adaptation, data is collected for multiple purposes. The first purpose is to evaluate the effectiveness of the policies, the second is to evaluate the adaptive capacity of the community, the third is to evaluate the impact of the changing climate on the community, and the fourth is to evaluate the uptake of the lessons from the evaluation.

To that end, the City can conduct a standardized review process following extreme weather events that exceed a to-be-determined threshold in order to assess the City's response, evaluate the impact on the community, particularly vulnerable people, and to identify opportunities to reduce exposure.

The City can complete an annual indicators report that tracks trends in the community response to mitigation and adaptation against a standard set of indicators. The indicators report can help identify emerging trends or risks, and assess the effectiveness of the City's policy approach, enabling adjustments or revisions as needed.

The City can survey community members, particularly vulnerable people or neighbourhoods, to assess the impact of mitigation and adaptation measures on their lives and resilience. In the same effort, the City can evaluate levels of climate literacy in the community.

The City can also report annually in a risks report as required by the International Public Sector Accounting Standards Board's (IPSASB) Sustainability Standards.[204] IPSASB will be implemented in Canada by the Public Sector Accounting Board (PSAB) and require annual GHG inventories, an assessment of climate-related risks and opportunities, details on governance, disclosures about policies and their outcomes, the financial implications of climate change, and a description of targets, among other information. This report can complement or support the City's ongoing reporting to the Carbon Disclosure Project (CDP),[205] as part of its commitment to the Global Covenant of Mayors.

A recommended policy theme is outlined below.

204 IPSASB. "IPSASB SRS Exposure Draft 1, Climate-related Disclosures," October 31, 2024. https://www.ipsasb.org/publications/ipsasb-srs-exposure-draft-1-climate-related-disclosures.

205 CDP is the primary global reporting platform on municipal climate action. For more information, see: https://cdp.net/en.

#	Theme	Recommendations	Implementation Approach
28	Tracking progress	Include policies that require evaluation and reporting on the impact of the policies on reducing community and corporate GHG emissions and decreasing the risk that climate change poses to the community. Include equity-focused indicators to consider the disproportionate impact of climate change on marginalized populations.	The implementation can include mechanisms to track progress and course correct, including: ▪ Annual indicators report ▪ Annual climate change report on risks and opportunities ▪ Annual report to CDP ▪ Annual corporate and community GHG inventories ▪ Standardised review on the impacts of any severe climate events

Conclusion

The City's 2014 OP enabled the City and the community to advance sustainability and climate initiatives, including enabling policies on transportation, land-use, energy, and climate. This OP positions the City for national leadership in terms of integrating climate action into community planning, an elevation supported by the intention behind this report.

To meet this challenge, Kitchener 2051 must address fundamentally different conditions. The urgency of climate change is palpable. The need for leadership at all levels and in all contexts is acute, as are symbols of hope from which we can all draw inspiration. At the same time, the broader population is grappling with numerous issues, dominated by increasing costs and decreasing affordability. For this reason, the City's response to climate change, which should be commensurate with the urgency and magnitude of the challenge, must also solve or address multiple other challenges faced by the community, particularly those most vulnerable.

This study describes policies that substantively and systematically enable the City to advance its efforts to reduce GHG emissions and the risk of climate change for Kitchener. This list of policies is comprehensive and was informed and guided by the scientific literature and best practices from other jurisdictions in Ontario and beyond.

The list of policies represents our best understanding of what must be done by the City of Kitchener at this time. While the direction required to reduce emissions and risk is clear, the policies that will best deliver results are uncertain. The City must therefore be willing to test policies, and revise individual policies and the policy approach, according to insights from a process of monitoring and evaluation.

Appendixes

Appendix 1.
Description of Methodology

An Official Plan is a document that guides future development of an area in the best interests of the community as a whole.[1]

The Process

A rigorous multi-stage process was applied to identify possible policies for inclusion in the City of Kitchener's OP.

Four stages of research were completed:

1. **State of Play:** A review of trends and disruptors that will influence energy and emissions in Kitchener.
2. **Measuring Success (GHG mitigation):** Options to mitigate the climate emergency.
3. **Landscape of Climate Risk:** A summary of the background and policy context of adaptation in Kitchener.
4. **Adaptation Policy Options:** Options to reduce climate change risks and vulnerabilities.

Each stage was informed by a literature review and an assessment of best practices in Ontario, Canada and globally. Literature was compiled in Zotero, a reference management software.

The documents summarizing research findings were reviewed by a working group of City staff and agencies that provided feedback at each stage.

1 Government of Ontario. "The Planning Act | Citizen's Guide to Land Use Planning." 2024. https://www.ontario.ca/document/citizens-guide-land-use-planning/planning-act#section-1.

Step 1: Database

Policy options were distilled into a database (Airtable) and tagged or categorized against fields including: theme, detailed theme, big move, co-benefit, GHG inventory category, impact, and climate hazard (Figure A1.1). Appendix 2 lists the full scope of 180 policies that were analyzed.

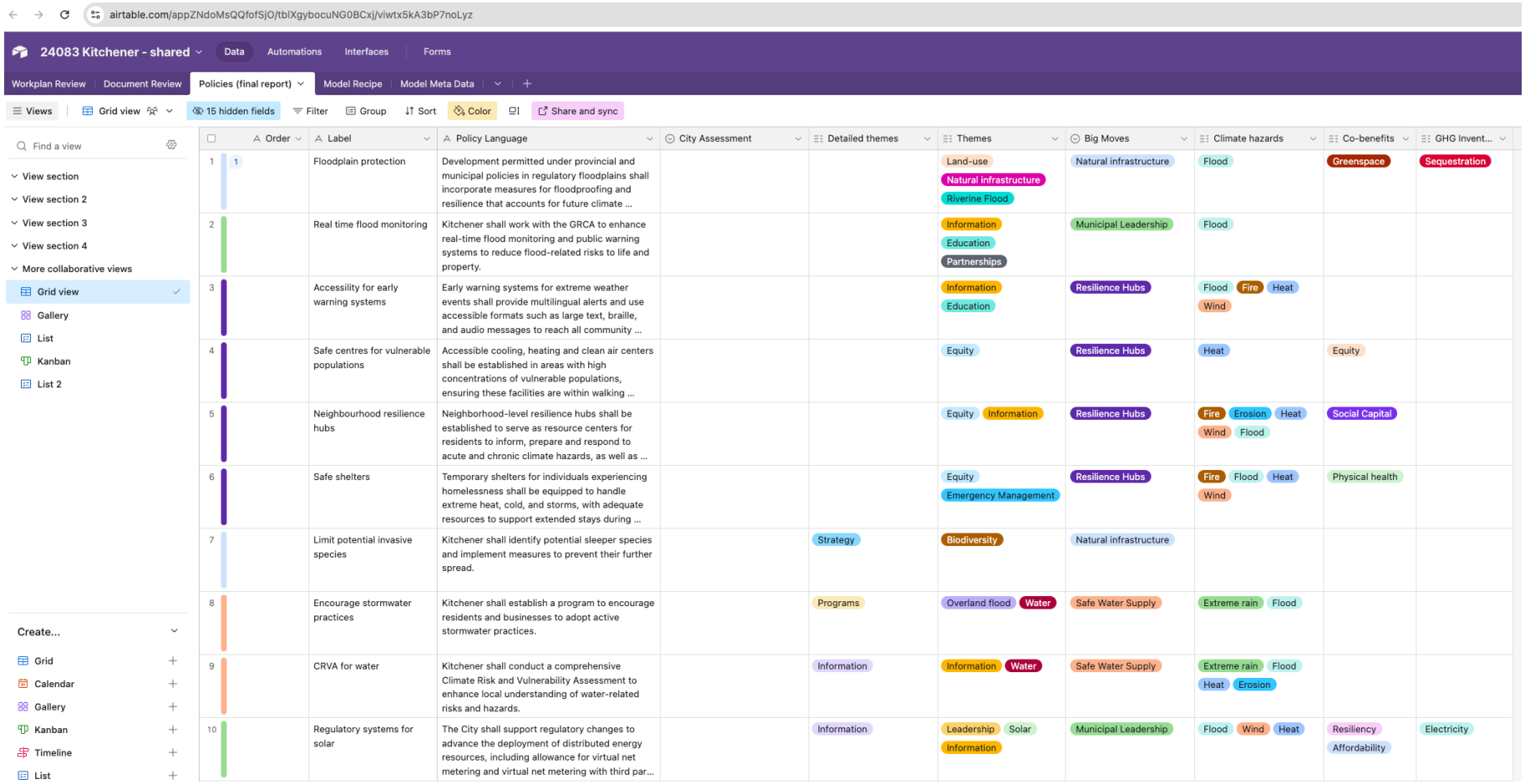


Figure A1.1. View of the database of policies.

Step 2: Policy Mapping

Policies were visualized in an interactive map in Kumu. This platform enabled the identification of key themes, which became the Big Moves (Figure A1.2).

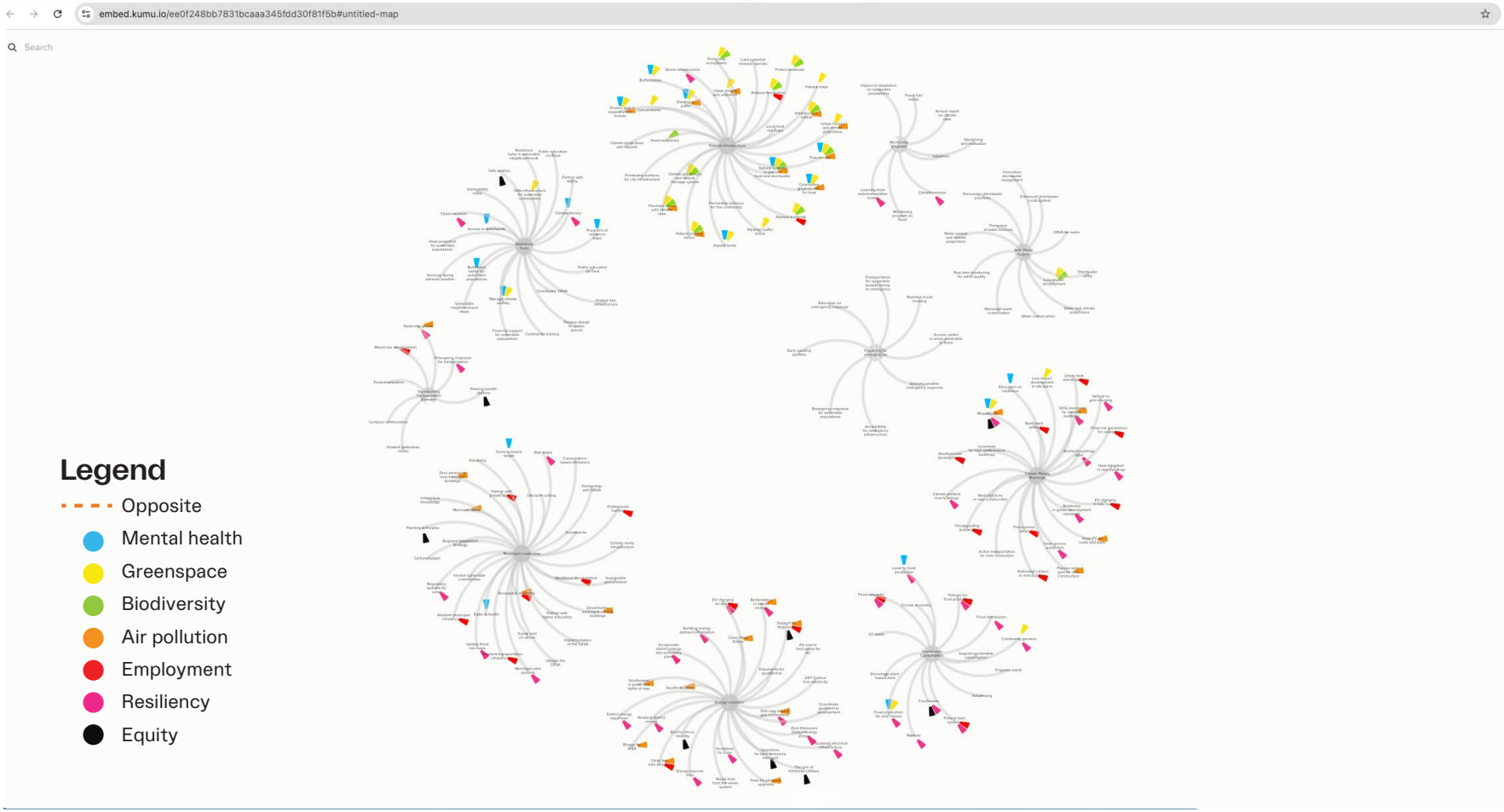


Figure A1.2. Kumu map of policies, categorized by Big Move.[2]

2 See interactive map here: https://embed.kumu.io/6b62b184abc877f03c72c77ebeaebcc9#untitled-map.

Step 3: Impact Assessment

Evaluating the relative impact of each of the policies results in dilemmas that can only be solved subjectively. For example, do policies that result in GHG emissions reductions have a greater impact than policies that help the community adapt to emerging climate hazards?

The list of policies was entered into a pairwise comparison tool called All Our Ideas to systematically and qualitatively assess the relative impact of each policy option. All Our Ideas randomly generates pairs of policies, and the user can choose the policy that has a greater impact, skip, or suggest an alternative (Figure A1.3). Each policy was assessed against another policy at least 10 times, for a total of more than 1,000 votes. In selecting the higher-impact policy, the team applied our collective knowledge of developing and analyzing hundreds of climate actions and policies, considering whether the policy directly reduced emissions or enabled emissions reductions, or directly or indirectly protected people, for example.

This method of assessment derives a score for each policy relative to the other policies. Based on the scores, the policies were categorized as very high impact, high impact, medium impact, or low impact. Note that this categorization does not indicate the effectiveness or absolute impact of the policy on GHG reductions or community resilience; it indicates the relative effectiveness compared to other policy options. The lowest-scoring policy may, for example, be critically important for Kitchener but not as critically important as a higher-scoring policy, according to the SSG team's assessment. The assessment of policies using this method gave rise to complex ethical considerations, for example, comparing adaptation and mitigation considerations (Figure A1.3.), which are meaningful dilemmas confronting policy-makers.

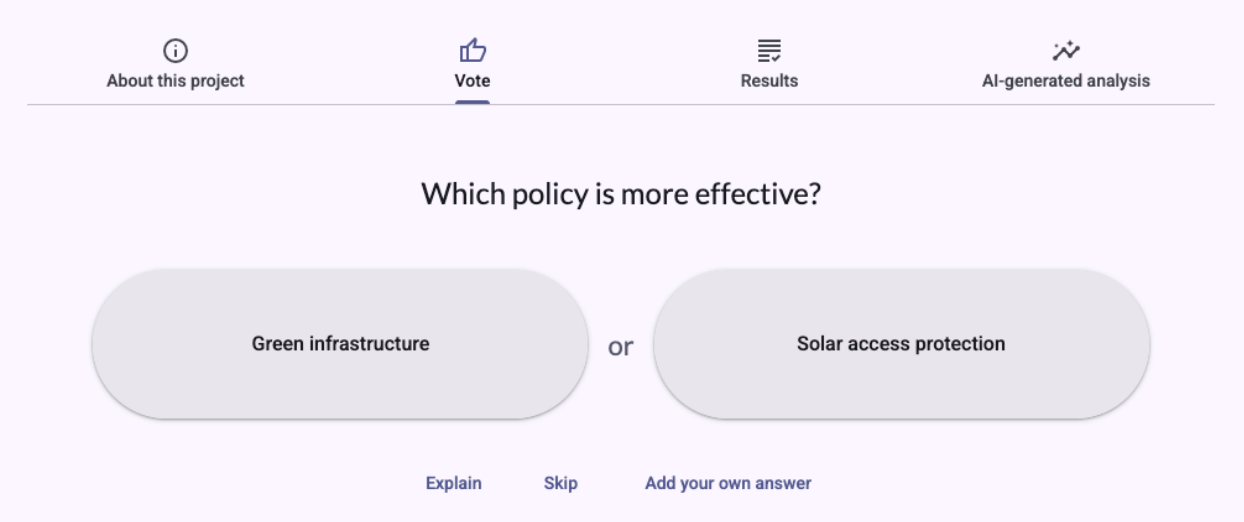


Figure A1.3. Comparing policies in All Our Ideas.

A subsequent review of the policies was undertaken with the City, and based on this review, additional research policy recommendations were developed.

Appendix 2.
Database of Policies

(External Document)

Appendix 3.
Climate Change and Its Impacts

State of the Science

Climate change has resulted in widespread adverse impacts and related losses and damages to nature and people.

Current Conditions

Climate change is driven by the release of GHG emissions from the combustion of fossil fuels and other sources into the atmosphere.[3] Between 1850 and 2019, the cumulative global emissions were 2,400 gigatonnes of carbon dioxide equivalent ($GtCO_2e$), with more than 40% of the emissions resulting from activities between 1990 and 2019.[4] In 2022, global atmospheric concentrations of the three main GHG emissions reached record levels, with carbon dioxide at 417.9 ± 0.2 parts per million (ppm) (Figure A3.1), methane at 1,924 ± 0.2 parts per billion (ppb), and nitrous oxide at 335.8 ± 0.1 ppb. These concentrations represent an increase of 150%, 264%, and 124%, respectively, above pre-industrial levels.[5]

3 World Meteorological Organization. "State of Climate," March 4, 2024. https://wmo.int/site/frontline-of-climate-action/state-of-climate#:~:text=2023%20was%20the%20hottest%20year,Ni%C3%B1o%2C%20a%20naturally%20occurring%20phenomenon.

4 World Meteorological Organization. "State of Climate."

5 World Meteorological Organization. "State of Climate."

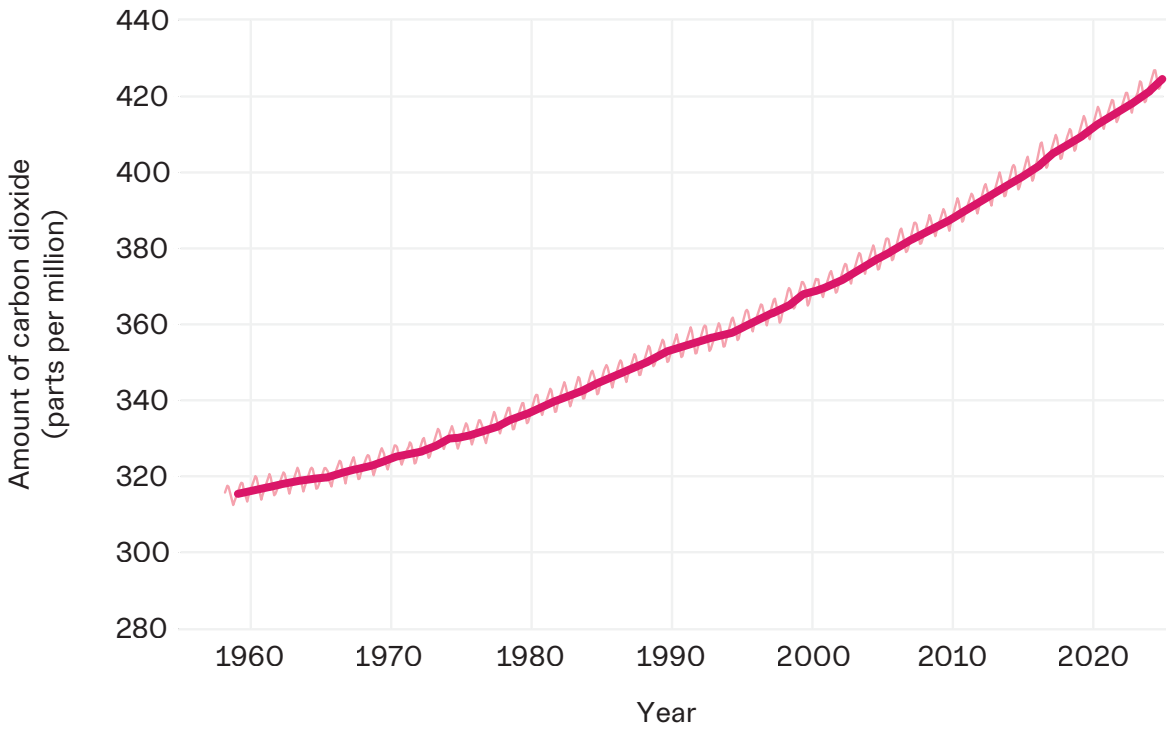


Figure A3.1. Carbon dioxide in the atmosphere.[6]

One hundred and ninety-five countries have signed the Paris Agreement, an international climate treaty that calls on signatories to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels.[7] The 1.5°C marker was chosen as a "defense line"—going beyond this limit dramatically increases the risk of extreme weather events, more frequent wildfires with higher intensity, sea level rise, and changes in flood and drought patterns that would have adverse, irreversible impacts for people and ecosystems.

November 2024 marked the first time global temperatures averaged 1.5°C above pre-industrial levels for a 12-month period (Figure A3.2). This is an alarm bell, amplified by the climate disruptions experienced worldwide that have resulted in billions of dollars in damages; the exacerbation of poverty, refugee flows, political disruption,

6 National Oceanic and Atmospheric Administration. Global Climate Dashboard, 2024. https://www.climate.gov/.

7 United Nations, "Paris Agreement," 2015. https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf.

and health impacts; and the claiming of lives and livelihoods worldwide.[8] In 2023, more than 16.5 million hectares of forest burned in Canada,[9] an area five times larger than the decadal average.[10] Temperatures in Lytton, British Columbia reached 49.6°C—the highest temperature ever recorded in Canada.[11] Previously uncommon terms such as "atmospheric river," "heat dome," "derecho," and "fire bomb" convey the magnitude of destruction and disruption to people's lives and the economy.

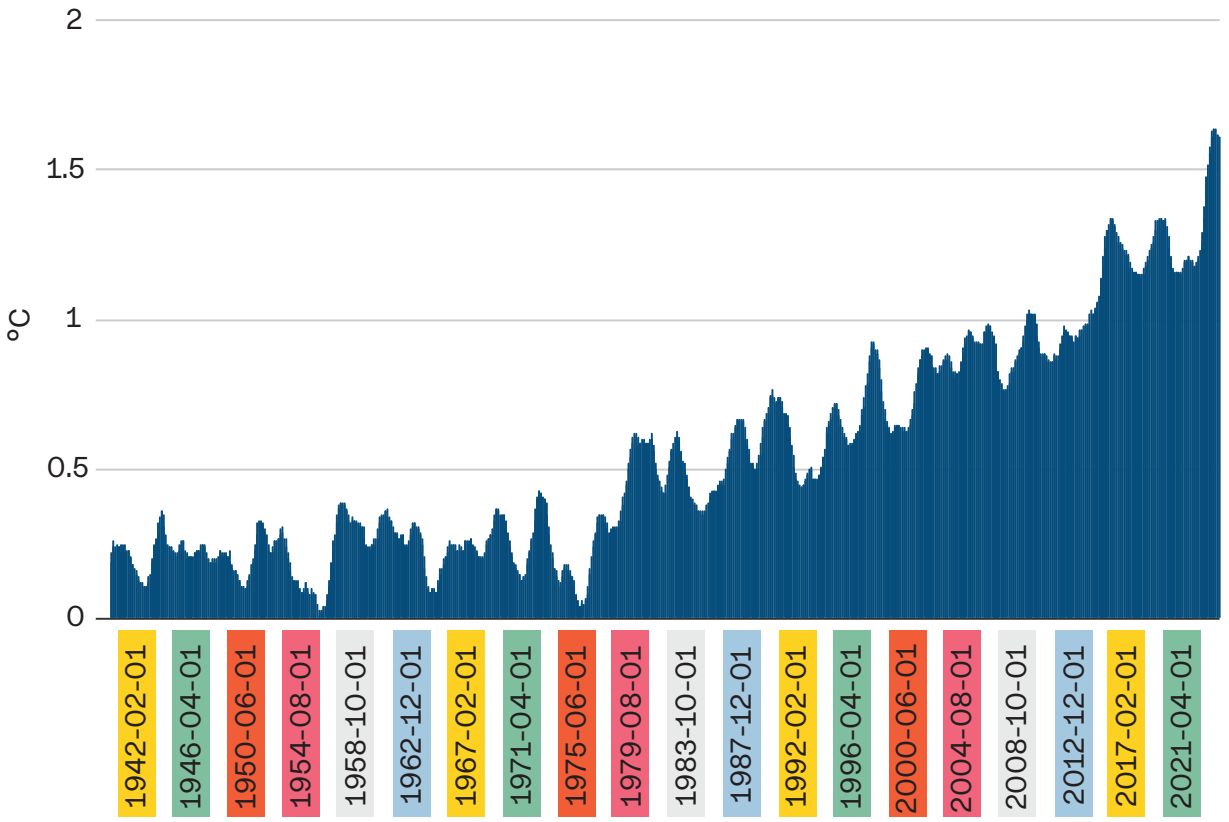


Figure A3.2. Change in global monthly average surface temperatures.[12]

8 Romanello, Marina, Maria Walawender, Shih-Che Hsu, Annalyse Moskeland, Yasna Palmeiro-Silva, and Daniel Scamman. "The 2024 Report of the Lancet Countdown on Health and Climate Change: Facing Record-breaking Threats From Delayed Action." The Lancet 404, no. 10465 (November 9, 2024): 1847–96. https://doi.org/10.1016/S0140-6736(24)01822-1.

9 Natural Resources Canada. "Canada's Record-breaking Wildfires in 2023: A Fiery Wake-up Call," August 19, 2024. https://natural-resources.canada.ca/simply-science/canadas-record-breaking-wildfires-2023-fiery-wake-call/25303.

10 Natural Resources Canada, "Canadian Wildland Fire Information System | Canadian National Fire Database (CNFDB)," 2024. https://cwfis.cfs.nrcan.gc.ca/ha/nfdb.

11 Dunne, Daisy. "Explainer: Why Is Climate Change Causing 'Record-shattering' Extreme Heat?" Carbon Brief, August 27, 2024. https://www.carbonbrief.org/explainer-why-is-climate-change-causing-record-shattering-extreme-heat/.

12 Copernicus. "Surface Air Temperature for November 2024," 2024. https://climate.copernicus.eu/surface-air-temperature-november-2024.

Projections

Climate Change

Future climate change is uncertain because GHG emissions will evolve as human activity and the future use of fossil fuels continue to evolve. The Intergovernmental Panel on Climate Change (IPCC) uses two main frameworks to ask "what if?" questions to assess possible future climatic conditions and the resulting hazards and impacts, in order to inform policies and investments. Representative Concentration Pathways (RCPs) assess the physical implications of climate change while Shared Socioeconomic Pathways (SSPs) consider the socio-economic pathways and implications. Both frameworks, which are complimentary, are analyzed using sophisticated global climate models (GCMs) to explore variations in population growth, economic activity, energy intensity, socio-economic development, land-use change and climate policy, the resulting GHG emissions, and the climate response.[13]

Both RCPs and SSPs have broad implications for the City's response to climate change, as illustrated by the very low to very high future projections in Figure A3.3. The RCPs define the extent of risk from climate change, which can guide land-use planning and infrastructure design (Tables A3.1. and A3.2.). The SSPs provide an evidence base that will inform the City's approach to reducing GHG emissions.

Table A3.1. Definitions of RCPs.

RCP	Definition
RCP 8.5 (highest risk)	The high-emissions scenario, where emissions continue to rise throughout the 21st century. This is based on continued, ongoing high levels of emissions, which could be driven by population growth, ongoing global use of coal, economic growth, or other fossil fuel use.
RCP 6.0 and 4.5	Intermediate emissions pathways, where emissions peak by 2040 and 2080, respectively. These pathways also include carbon capture and sequestration, but result in more serious climate consequences.
RCP 2.6 (lowest risk)	The most ambitious mitigation pathway, in which emissions peak immediately and then decline to near zero by the end of the century. The scenario is aimed at limiting warming to approximately 1.5–2°C.

13 Van Vuuren, Detlef P., Jae Edmonds, Mikiko Kainuma, Keywan Riahi, Allison Thomson, Kathy Hibbard, George C. Hurtt, et al. "The Representative Concentration Pathways: An Overview." Climatic Change 109, no. 1–2 (August 4, 2011): 5–31. https://doi.org/10.1007/s10584-011-0148-z.

Table A3.2. Definitions of SSPs.[14]

SSP	Definition
SSP1	Sustainability - Taking the Green Road: A world that prioritizes sustainability and global cooperation. Societies shift toward inclusive development, with investments in education, health, green technologies, and renewable energy. Population growth is low. Consumption is more resource-efficient.
SSP2	Middle of the Road: The world follows historical trends, with moderate development. Economic growth, technological progress, and environmental policies occur unevenly, leading to some regions making progress in reducing emissions, while others struggle to implement changes. Population growth is moderate.
SSP3	Regional Rivalry - A Rocky Road: This scenario envisions a world with increasing regional conflicts and nationalism. International cooperation breaks down, leading to slow economic growth and inefficiency in managing global challenges. Countries focus on their own interests, with weak global governance. Population growth is high in some regions.
SSP4	Inequality - A Road Divided: A world with growing inequality both within and between countries. A small, wealthy global elite drives technological development and reaps most of the economic benefits, while the majority of the population struggles with low development and weak social supports. This leads to high vulnerability for poorer populations, while wealthier nations and individuals have a higher capacity to adapt to climate impacts.
SSP5	Fossil-Fuelled Development - Taking the Highway: A world driven by rapid economic growth, fuelled by fossil energy and high consumption patterns. There is a focus on technological development and market-driven solutions, with an emphasis on exploiting natural resources. Population growth is low in high-income countries but moderate globally. Economic progress is prioritized over environmental sustainability, leading to high GHG emissions.

14 Allan, Richard P., Paola A. Arias, Sophie Berger, Josep G. Canadell, Christophe Cassou, Deliang Chen, Annalisa Cherchi, et al. "Summary for Policymakers." Report. In Climate Change 2021: The Physical Science Basis, edited by V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, et al., 3–32. Cambridge University Press, 2021. https://doi.org/10.1017/9781009157896.001.

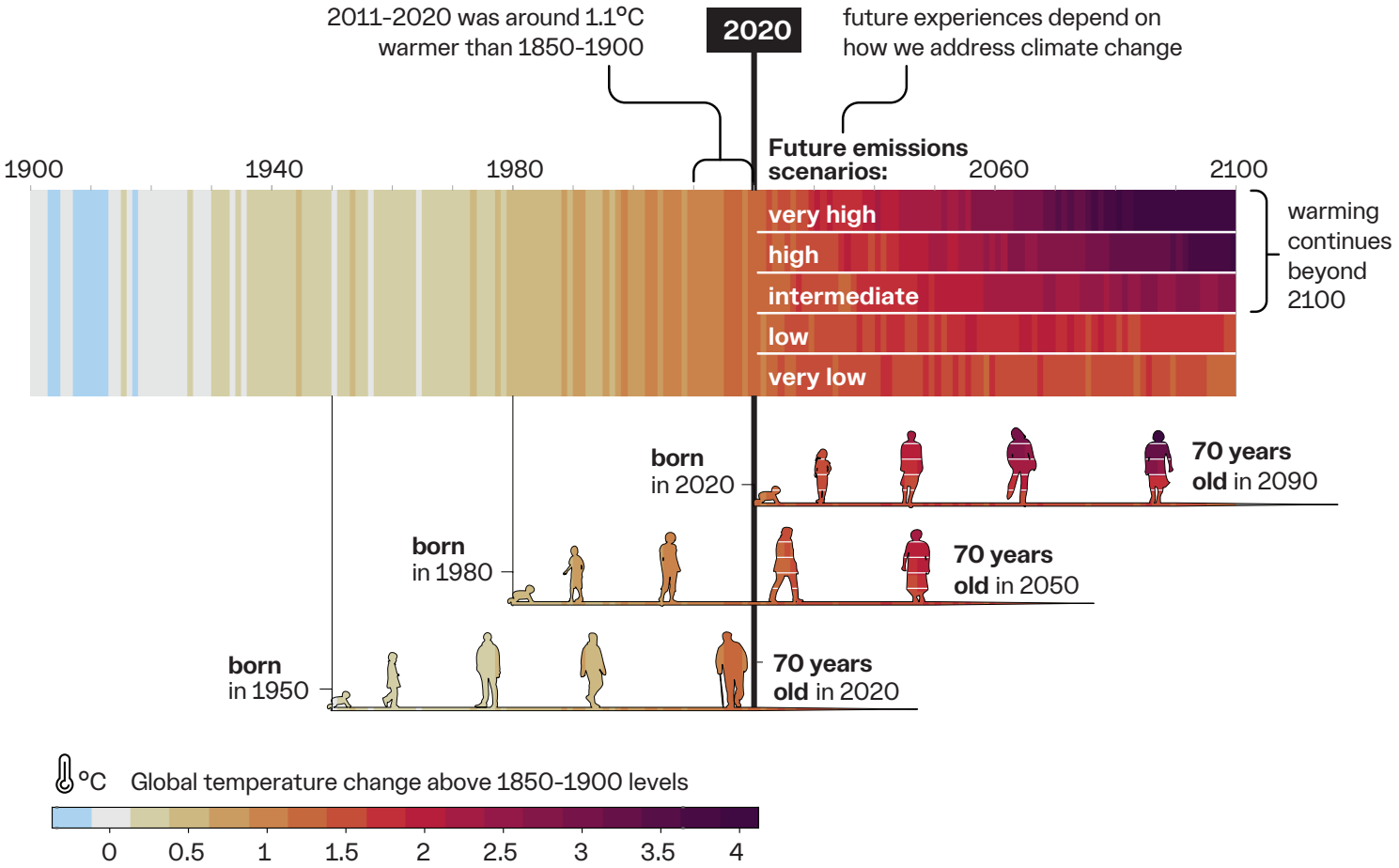


Figure A3.3. The extent to which current and future generations will experience a hotter and different world depends on choices now and in the near-term.[15]

15 Calvin, Katherine, Dipak Dasgupta, Gerhard Krinner, Aditi Mukherji, Peter W. Thorne, Christopher Trisos, José Romero, et al. "IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (Eds.)]. IPCC, Geneva, Switzerland.," July 21, 2023. https://doi.org/10.59327/ipcc/ar6-9789291691647.

The Impacts

"5.4 billion people – more than half of the world's projected population – will live in the 59 countries experiencing high or extreme water stress... These conditions will lead to worsening food insecurity and competition over resources, increasing civil unrest and mass displacement, exposing developed countries to increased influxes of refugees"[16]

The global consequences of climate change directly relate to the degree of warming, with risks intensifying for every increment of warming. Hazards and associated risks expected in the near term include:

- A rise in heat-related human mortality and morbidity;
- An increase in food-borne, water-borne, and vector-borne diseases;
- An increase in mental health challenges;
- Flooding in coastal and other low-lying cities and regions;
- Biodiversity loss in land, freshwater, and ocean ecosystems; and
- A decrease in food production in some regions.

These risks will become increasingly complex and difficult to manage. Climate-driven food insecurity and supply instability, for example, are projected to increase with increasing global warming, interacting with non-climatic risk drivers such as competition for land between urban expansion and food production, pandemics and conflict.[17]

16 Institute for Economics & Peace. 2020. "Ecological Threat Register 2020: Understanding Ecological Threats, Resilience and Peace." https://www.visionofhumanity.org/wp-content/uploads/2020/10/ETR_2020_web-1.pdf.

17 Calvin et al., "IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (Eds.)]. IPCC, Geneva, Switzerland."

If global average temperatures continue to exceed 1.5 °C, the risk of irreversible tipping points[18] with planetary-scale impacts increases, such as:

- Species extinction or irreversible loss of biodiversity in ecosystems including forests, coral reefs, and in Arctic regions;
- The collapse of the Greenland Ice Sheet and the West Antarctic Ice Sheet;
- The collapse of large-scale oceanic and atmospheric circulation patterns such as the Atlantic Meridional Overturning Circulation (AMOC); and
- The collapse of biosphere subsystems like the Amazon Rainforest.[19]

At sustained warming levels between 2°C and 3°C, the Greenland and West Antarctic ice sheets will be lost almost completely and irreversibly over multiple millennia, causing several metres of sea level rise.[20] The social and economic implications are catastrophic at both regional and global scales, as illustrated in Figure A3.4.[21]

The severity of climate change on specific geographies, and the inability of states to manage those impacts, is causing human migration. Future climate change will exacerbate these impacts as locations become inhospitable or uninhabitable due to changing climatic conditions, related economic or political conditions, or sea level rise. "Climate refugees" refers to people who have been "forced to leave their traditional habitat, temporarily or permanently, because of marked environmental disruption."[22] One study found that over one billion people will be at threat of being displaced by 2050,[23] with the Sub-Saharan Africa, South Asia, the Middle East, and North Africa regions facing the largest number of ecological threats. 5.4 billion people—more than half of the world's projected population—will live in the 59 countries experiencing high or extreme water stress, including India and China, and twice as many people as today (3.5 billion) could suffer from food insecurity by 2050.[24] These conditions will lead to worsening food insecurity and competition over resources, increasing civil unrest and mass displacement, exposing developed countries to increased influxes of refugees.

18 A tipping point is a critical threshold beyond which the system reorganizes, often abruptly and/or irreversibly.

19 Möller, Tessa, Annika Ernest Högner, Carl-Friedrich Schleussner, Samuel Bien, Niklas H. Kitzmann, Robin D. Lamboll, Joeri Rogelj, Jonathan F. Donges, Johan Rockström, and Nico Wunderling. "Achieving Net Zero Greenhouse Gas Emissions Critical to Limit Climate Tipping Risks." Nature Communications 15, no. 1 (August 1, 2024). https://doi.org/10.1038/s41467-024-49863-0.

20 Möller et al., "Achieving Net Zero Greenhouse Gas Emissions Critical to Limit Climate Tipping Risks."

21 OECD. "Climate Tipping Points: Insights for Effective Policy Action." OECD, December 2, 2022. https://doi.org/10.1787/abc5a69e-en.

22 Hinnawi, Essam E. and UNEP. "Environmental Refugees." United Nations Digital Library System, 1985. https://digitallibrary.un.org/record/121267?ln=en&v=pdf.

23 Institute for Economics & Peace. Ecological Threat Report 2024: Analysing ecological threats, resilience & peace, Sydney, October 2024. Available here: http://visionofhumanity.org/resources.

24 Institute for Economics & Peace. Ecological Threat Report 2024: Analysing ecological threats, resilience & peace, Ibid.

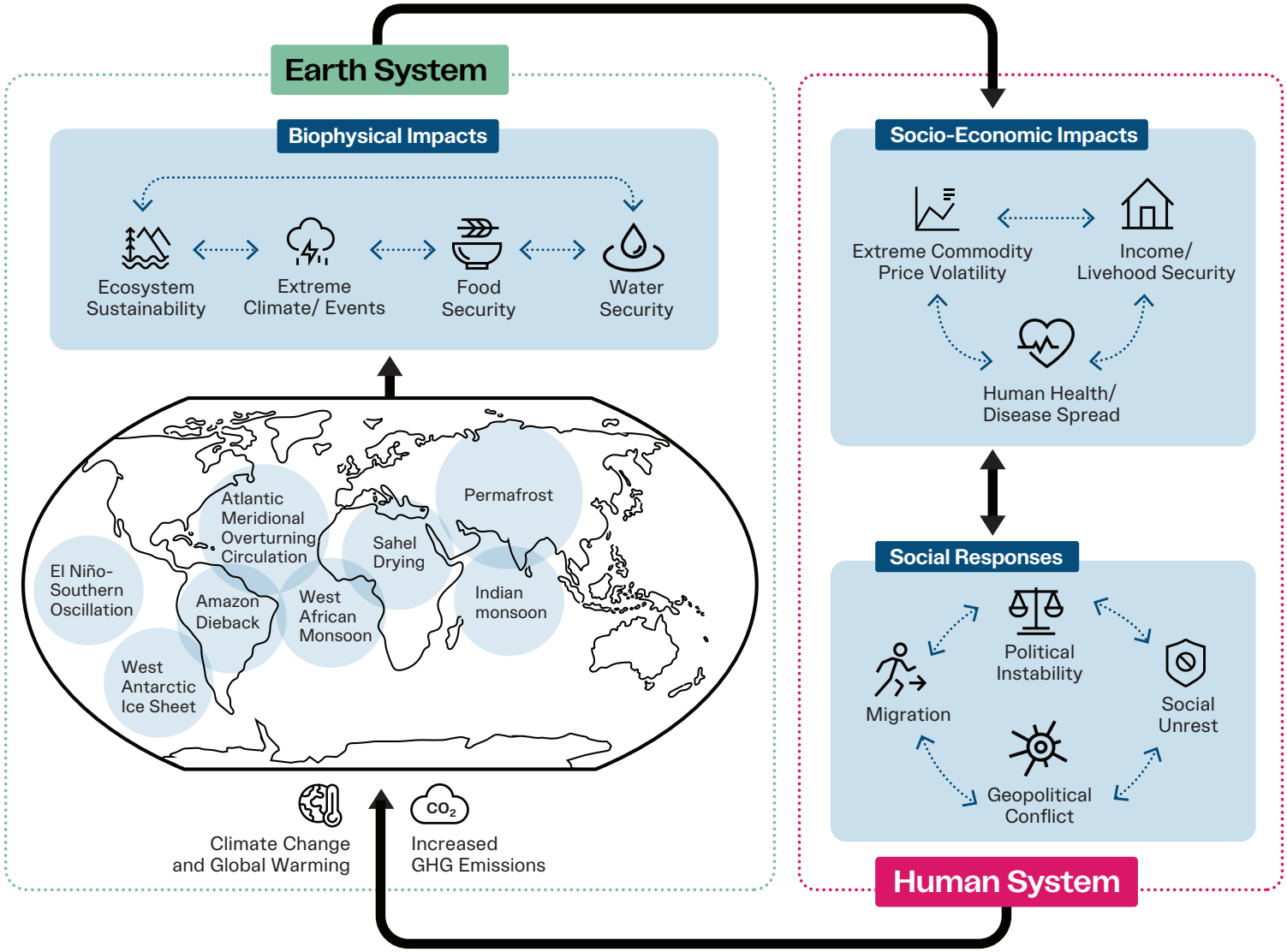


Figure A3.4. Schematic of possible interactions and cascading impacts between tipping points and Earth and Human systems.[25]

25 OECD, "Climate Tipping Points: Insights for Effective Policy Action."

The severity of climate change on specific geographies, and the inability of states to manage those impacts, is causing human migration. Future climate change will exacerbate these impacts as locations become inhospitable or uninhabitable due to changing climatic conditions, related economic or political conditions, or sea level rise. "Climate refugees" refers to people who have been "forced to leave their traditional habitat, temporarily or permanently, because of marked environmental disruption."[26]
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Mitigation Pathways

Reducing GHG emissions is urgent. The current extent of action will not keep global temperature increases below 2°C.

Limiting warming to 1.5°C requires rapid and deep emissions reductions.[29] As of 2020, the remaining global carbon budget to keep global warming within the IPCC's recommended 1.5°C is 500 $GtCO_2e$ (50% likelihood).[30] Based on recent trends in annual global emissions, the 1.5°C global carbon budget would be used up by 2030.[31]

Countries report on their policies and plans to reduce emissions to the United Nations in reports called Nationally Determined Contributions (NDCs). Various organizations evaluate the impact of the NDCs on global emissions trajectories to evaluate the gap

26 Hinnawi, Essam E. and UNEP. "Environmental Refugees." United Nations Digital Library System, 1985. https://digitallibrary.un.org/record/121267?ln=en&v=pdf.

27 Institute for Economics & Peace. Ecological Threat Report 2024: Analysing ecological threats, resilience & peace, Sydney, October 2024. Available here: http://visionofhumanity.org/resources.

28 Institute for Economics & Peace. Ecological Threat Report 2024: Analysing ecological threats, resilience & peace, Ibid.

29 IPCC, "Technical Summary. In: Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty," 2018. https://www.ipcc.ch/sr15/technical-summary.

30 Calvin et al., "IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (Eds.)]. IPCC, Geneva, Switzerland."

31 United Nations Environment Programme, "Annual Report 2023." January 24, 2024. https://www.unep.org/resources/annual-report-2023.

between current plans and policies and the emissions reductions required to limit warming to 1.5°C or 2°C. One recent assessment found that if current trends in policy and technology development continue, there is a less than 7% chance of keeping global temperature increases below 2°C.[32]

From Global to Local

Global Climate Models (GCMs) are downscaled to provide more localized and detailed projections that help inform decision-making at regional and community levels, using the same scenario framework described above. Downscaling involves refining GCMs to capture smaller-scale features of climate changes, such as local temperature, precipitation, and extreme weather patterns, which would be difficult to model on a global scale. Municipalities and other sectors such as agriculture, infrastructure, water management, and disaster preparedness rely on downscaled projections for planning for and adapting to climate change.

Two main types of downscaling are used for Canadian climate projections: dynamical and statistical. "Dynamical downscaling" uses regional climate models to simulate climate projections at a finer spatial resolution, typically ranking from 10–50 kilometres. The Canadian Regional Climate Model, developed by Environmental and Climate Change Canada (ECCC) is one such model, providing localized climate simulations that consider geography, coastlines, and other key geographic features.[33] "Statistical downscaling" uses historical climate data and statistical relationships to downscale global climate models to the local areas. This method provides climate projections for specific regions by analyzing how large-scale atmospheric conditions affect local climate variables, and applying those trends to the conditions predicted by the global models. Climatedata.ca is an online portal based on statistical downscaling that allows users to explore climate variables under different scenarios and time projections.[34]

Historically, RCP4.5 and RCP8.5 have been used for downscaled climate modelling in Canada. As new data becomes available, however, modelling is shifting to combined SSP-RCP scenarios, such as SSP2-4.5 and SSP5-8.5.

Like most places, Kitchener will become warmer and wetter, with more extreme weather events.

32 Kate Larsen, Mahmoud Mobir, Shweta Movalia, Hannah Pitt, Alfredo Rivera, Emma Rutkowski, and Marie Tamba. Rhodium Climate Outlook 2024: Probabilistic Global Emissions and Energy Projections. Rhodium Group, 2024. https://climateoutlook.rhg.com/.

33 Environment Canada and Climate Change. "Canadian Regional Climate Model Datasets," September 25, 2024. https://climate-scenarios.canada.ca/?page=rcm-intro.

34 ClimateData.ca. "About — ClimateData.ca," May 4, 2023. https://climatedata.ca/about/.

The climate for Kitchener is expected to become warmer and wetter, with more extreme weather events. This means higher average temperatures, more frequent and more severe heat waves, and seasonal shifts in warm temperatures. Precipitation will become less predictable, with increased likelihood of severe storms that cause flooding. While changes in heat may increase the probability of droughts, precipitation through fall, winter, and spring is expected to increase. Table A3.3 provides a summary of some of the key climate indicators that drive the expected changes in climate hazards.

Table A3.3. Climate change indicators for Kitchener for historic, near-term, and long-term climate change impacts for RCP 4.5 and RCP 8.5.[35]

Climate indicator	Historic	2021–2050 (RCP 4.5)	2050– 2080 (RCP 4.5)	2021–2050 (RCP 8.5)	2050–2080 (RCP 8.5)	Trend
Annual precipitation (mm)	900	944	969	955	981	Increasing
Summer precipitation (mm)	238	242	241	239	237	Stable
Winter precipitation (mm)	203	220	228	233	238	Increasing
Average annual temperature (°C)	7.1	9.1	10.1	9.2	11.4	Increasing
# days above 30°C	10	28	37	28	54	Increasing
# nights above 20°C	3	9	15	11	27	Increasing
# frost-free days	155	177	185	180	202	Increasing

35 Climate Atlas of Canada. "Municipality Kitchener," n.d. https://climateatlas.ca/data/city/447/plus30_2030_85/line.

The Impacts of Climate Change

Standardized frameworks are used to evaluate future climate impacts.

Understanding how to adapt to climate change requires assessing how climate change is expected to affect environmental hazards over time, what the potential impacts of those changes are, and how prepared a community is to handle and recover from emergencies.

Climate parameters like overall trends in temperature and precipitation, and changes to the number of very hot and very cold days, can be linked with climate hazards like flooding, wildfires, and heat waves. Translating these hazards into risk requires an assessment of the threat likelihood, the vulnerability of a community to the hazard, and the potential consequences of that hazard (Figure A3.5.).

Figure A3.5. Conceptual formula of risk.

Once the priority climate hazards are identified, an assessment of data availability and the geographic and temporal variability of the hazard is used to develop a qualitative assessment or a quantitative model.

Identifying sources of damages, injury, illness, death, and other vulnerabilities leads to the development of a suite of adaptation actions that work together to protect the community from climate change, and to prepare for emergency events and the changing environment.

Risk Assessments

Climate hazards are increasingly severe and their impacts increasingly disruptive, with both direct and indirect impacts.

Climate risk and vulnerability assessments have been completed for different levels of geographies: national (2023), provincial (2023), and regional (2019). These assessments are outlined below:

- The **2023 Canada's Changing Climate Report** (CCCR) assesses Canada's climate impacts, based on the findings of the IPCC's Sixth Assessment Report.[36] The CCCR documents how Canada is warming at twice the global rate, with the strongest impacts felt in the northern regions of the country.

The CCCR explores how climate impacts are already being felt across Canada, and how they will intensify in the future. Precipitation is projected to increase on average, but summer rainfall may decrease in some places, leading to instability in freshwater systems and resources. A warmer climate will intensify some weather extremes, with extreme hot weather becoming more frequent and more intense. Flooding from extreme precipitation will increase, felt most strongly in urban areas.

- **Ontario's Provincial Climate Change Impact Assessment** (PCCIA) assessed risks across five major themes:[37]

    1. **Food and Agriculture:** Rising temperatures, extreme weather, and droughts threaten crop productivity and livestock health. Southern Ontario is particularly vulnerable to high climate risks, with negative impacts likely to outweigh potential benefits of an extended and warmer growing season.
    2. **Infrastructure:** Aging infrastructure faces increased risks from extreme weather, floods, and heat. The PCCIA warns that no infrastructure asset currently faces less than a "medium" risk profile, with future risks likely to rise significantly by mid-century.
    3. **Natural Environment:** Species, habitats, and ecosystems across the province face escalating risks. By the end of the century, one-quarter of natural systems and species will likely experience "very high" risk.

36 Bush, Elizabeth, Barrie Bonsal, Chris Derksen, Greg Flato, John Fyfe, Nathan Gillett, Fisheries and Oceans Canada, et al. "Canada's Changing Climate Report in Light of the Latest Global Science Assessment." Government of Canada, 2022. https://changingclimate.ca/site/assets/uploads/sites/2/2022/03/CCCR-2022-Supplement-Final.pdf.

37 Climate Risk Institute, Dillon Consulting Limited, ESSA Technologies Ltd., Kennedy Consulting, and VIRIDI Global. "Ontario Provincial Climate Change Impact Assessment: Technical Report." Ontario Ministry of Environment, January 2023. https://www.ontario.ca/files/2023-11/mecp-ontario-provincial-climate-change-impact-assessment-en-2023-11-21.pdf.

4. **People and Communities:** Vulnerable populations, including Indigenous communities, face disproportionately high risks. Climate change will deepen existing inequities, particularly in northern regions.
5. **Business and Economy:** Economic sectors like forestry, agriculture, and resource-dependent industries will be affected by climate change. Risks will vary by region, with higher impacts expected in areas that are already facing infrastructure deficits.

- The **Region of Waterloo's Community Climate Adaptation Plan** (CCAP) was developed using the ICLEI Building Adaptive & Resilient Communities (BARC) method for climate adaptation planning.[38] This method uses a combination of interviews with interested and affected parties and subject-matter experts, and available quantitative data, to develop an understanding of the most pressing climate risks for the Waterloo Region.

The CCAP was developed using downscaled climate projections for Waterloo Region from the University of Waterloo. This climate scenario was represented by a series of impact statements provided by community partners that describe how climate projections for the region might affect the community. These impact statements covered social, physical, economic, and ecological impacts, and formed the foundation of the vulnerability and risk assessments for the region. They are used to describe the perceived vulnerability of community members. Final vulnerability assessments were developed using vulnerability assessment workshops that local organizations ran with staff, students, and other key groups.

Calculation of risk for different climate hazards was completed in a similar manner to the CCCR, with risk calculated as a product of likelihood and consequence, ranging from very low to extreme.

- Kitchener's **Corporate Climate Action Plan** includes a risk and vulnerability assessment of corporate assets.[39] The City of Kitchener collaborated with the Region of Waterloo to develop the Community climate Action Plan. This report, as well as the Integrated Stormwater Management Master Plan and Corporate Asset Management Program, is summarized in a subsequent section. The regional plan may fill this role, but a detailed assessment of the particular climate indicators and hazards that will affect Kitchener, as well as more specific assessments of adaptive capacity, vulnerability, and sensitivity of the community, are needed to confirm if more detailed work is required to plan for an adapted community in Kitchener.

38 Region of Waterloo Planning, Development and Legislative Services. "Community Climate Adaptation Plan for Waterloo Region." Region of Waterloo, 2019. https://www.regionofwaterloo.ca/en/living-here/resources/Environment/Community-Climate-Adaptation-Plan---Full-ACCESS.pdf.

39 Berry, Wendell and Claire Bennett. "Corporate Climate Action Plan for the City of Kitchener." Report. City of Kitchener, 2019. https://www.kitchener.ca/en/resourcesGeneral/Documents/DSD_Kitcheners_Corporate_Climate_Action_Plan.pdf.

Legal Findings

Governments and private sector entities are being increasingly challenged and held to account for a limited or inadequate response to climate change through the legal system.

In addition to scientific evidence, an important legal decision in Ontario found that: "Based on the evidence before [her], it is indisputable that, as a result of climate change, the [appellants] and Ontarians in general are experiencing an increased risk of death and an increased risk to the security of the person."[40]

This conclusion was based on expert evidence that was accepted by the Court, the basis of which is reproduced in part below:

The decision also found evidence of a disproportionate impact on young people and Indigenous peoples, including:

- Children are more sensitive to heat and respiratory and communicable diseases;
- Young people are especially at risk from the impacts of wildfire smoke, flooding, extreme heat, vector-borne diseases, and toxic contamination;
- Young people are more vulnerable to the impacts of climate change given increased reliance on caregivers for protection and adaptation;
- Climate change may differentially impact the mental health of children and youth;
- Indigenous youth face particular mental health challenges due to their strong ties to the land.
- Indigenous peoples in Ontario have already observed significant harmful effects from climate change, impacting food and water security and traditional and subsistence practices such as fishing, hunting, and plant harvesting;
- The loss of traditional foods and cultural practices is impacting Indigenous peoples' mental and physical well-being; and
- Indigenous peoples are particularly vulnerable to mental health impacts of climate change, which include anxiety, depression, grief, family stress, loss of identity, increased likelihood of substance usage, and suicidal ideation.

40 "Mathur V. His Majesty the King in Right of Ontario, 2023 ONSC 2316 (CanLII)." CanLII, April 14, 2023. https://www.canlii.org/en/on/onsc/doc/2023/2023onsc2316/2023onsc2316.html.

The Energy Transition

The world now invests almost twice as much in clean energy as it does in fossil fuels.[41]

A large-scale socio-economic transition refers to a fundamental change in how societal needs are met, with implications across sectors, the introduction of new technologies and new ways of applying those technologies, changes in markets, cultural discourses, and governance at all levels.[42]

The global energy system is transitioning due to rapid technological change and the evolution of sub-national, national, and international policies responding to the threat of climate change.[43] The transition is also a result of regional resilience and independence. Indicators of this change include the growth of clean electricity[44] and the adoption of EVs[45] and heat pumps.[46]

41 IEA. "World Energy Investment 2024 – Analysis - IEA," June 1, 2024. https://www.iea.org/reports/world-energy-investment-2024.

42 Coenen, Lars, Rob Raven, and Geert Verbong. "Local niche experimentation in energy transitions: A theoretical and empirical exploration of proximity advantages and disadvantages." Technology in Society 32, no. 4 (2010): 295-302.

43 Hirt, Léon F., Guillaume Schell, Marlyne Sahakian, and Evelina Trutnevyte. "A review of linking models and socio-technical transitions theories for energy and climate solutions." Environmental Innovation and Societal Transitions 35 (2020): 162-179.

44 International Renewable Energy Agency, "Record Growth in Renewables Achieved Despite Energy Crisis," March 21, 2023. https://www.irena.org/News/pressreleases/2023/Mar/Record-9-point-6-Percentage-Growth-in-Renewables-Achieved-Despite-Energy-Crisis.

45 Tom Randall, "US Crosses the Electric-Car Tipping Point for Mass Adoption," *Bloomberg*, July 9, 2022. https://www.bloomberg.com/news/articles/2022-07-09/us-electric-car-sales-reach-key-milestone.

46 Yannick Monschauer, Chiara Delmastro, and Rafael Martinez-Gordon, "Global Heat Pump Sales Continue Double-Digit Growth," *International Energy Agency*, March 31, 2023. https://www.iea.org/commentaries/global-heat-pump-sales-continue-double-digit-growth.

The Transformation of the Energy System[47]

"The energy world is in the early phase of a new industrial age—the age of clean energy technology manufacturing. Industries that were in their infancy in the early 2000s, such as solar photovoltaic and wind, and the 2010s, such as EVs and batteries, have mushroomed into vast manufacturing operations today. The scale and significance of these and other key clean energy industries are set for further rapid growth. Countries around the world are stepping up efforts to expand clean energy technology manufacturing with the overlapping aims of advancing net zero transitions, strengthening energy security and competing in the new global energy economy. The current global energy crisis is a pivotal moment for clean energy transitions worldwide, driving a wave of investment that is set to flow into a range of industries over the coming years. In this context, developing secure, resilient and sustainable supply chains for clean energy is vital."

IEA (2023). Energy Technology Perspectives 2023, P. 4

Foundationally, the energy transition involves a transition away from fossil fuels, which are responsible for most of the world's GHG emissions. Fossil fuels currently provide 81.5% of the world's primary energy.[48] The transition is displacing and disrupting the economic, policy, and cultural ecosystem that supplies this energy, while harvesting efficiency gains through high-efficiency technologies such as heat pumps and EVs. These technologies use three to four times less energy than the fossil-fuel powered systems they are typically replacing.

The transition is being driven predominantly by increases in wind and solar generation, which have contributed to reducing the carbon intensity of electricity systems in all regions of the world since the turn of the century.[49] In the past few years, owing to government policy and the falling cost of the technology,[50] solar generation has increased exponentially—to the point where more than a gigawatt of solar is being installed globally every day. Overall, the trajectory of renewable electricity generation is now over 80% of the way toward realizing the Conference of the Parties (COP) 28 objective of tripling renewable energy generation by 2028.[51]

47 International Energy Agency, "Energy Technology Perspectives 2023," January 2023. https://www.iea.org/reports/energy-technology-perspectives-2023.

48 Energy Institute, "Statistical Review of World Energy," 2023. https://www.energyinst.org/statistical-review.

49 Ian Tiseo, "CO_2 Intensity of Electricity Generation Worldwide 2000-2050, by Region," *Statista*, June 20, 2023. https://www.statista.com/statistics/1257765/global-emission-intensity-electricity-generation-region/.

50 Lazard, "Levelized Cost of Energy," 2024. https://www.lazard.com/media/xemfey0k/lazards-lcoeplus-june-2024-_vf.pdf.

51 International Energy Agency, "Massive Expansion of Renewable Power Opens Door to Achieving Global Tripling Goal Set at COP28," January 11, 2024. https://www.iea.org/news/massive-expansion-of-renewable-power-opens-door-to-achieving-global-tripling-goal-set-at-cop28.

A notable offshoot of the trend to wind and solar generation is the regionalization of energy markets, which was previously viewed as being global. This regionalization, and even localization, gives communities enhanced energy security by avoiding long supply lines that can be imperiled by geopolitical events and natural disasters across the globe.

Localization of energy supply, typically in the form of electricity, has become so pervasive as to merit its own terminology. Distributed energy resources (DERs) are typically sub-megawatt-scale electrical generation, and demand curtailment and/or storage located either on a distribution feeder or on the customer side of the utility payment meter. Customer side generation is typically referred to as net metering and, as of 2019, is allowed to varying degrees in 66 countries including the US, India, Australia, Chile, and many western European countries.[52]

Demand curtailment involves customers actively managing their electrical consumption away from grid-wide demand peaks. Together with storage, it can take many forms, including the use of EVs as storage. These resources can be dispatched by grid operators, and in the case of curtailment-based grid support, by customers, who are often referred to collectively as virtual power plants.[53]

Other developments in renewable energy include biofuels, deep geothermal energy, and renewable hydrogen. While these new energy resources are notable, their lower rates of growth and limited global extensiveness precludes them from qualifying as mega trends.

While renewable generation is arguably the most readily identified aspect of the energy transition, the way energy is both conserved and efficiently used is an equally important aspect of this megatrend. The COP28 conference committed countries to raise the annual rate of energy efficiency improvements from 2% to 4%.[54] This commitment represents the extrapolation of an existing trend, as in 2022, the energy efficiency improvement rate doubled its previous five-year rate to hit 2.2%.[55]

The final aspect of the energy transition involves electrification. This is happening extensively in both transportation and building heating. Globally, EV sales are growing at 25% annually and just reached 17 million in sales.[56] In the building heating sector, heat pumps are the avenue to electrification. Although market growth of heat pumps is not as

52 Waqas Ur Rehman et al., "The Penetration of Renewable and Sustainable Energy in Asia: A State-of-the-Art Review on Net-Metering," *IEEE Access* 8 (January 1, 2020): 170364–88. https://doi.org/10.1109/access.2020.3022738.

53 Yusuf Latief, "IESO Announces Largest Canadian Residential Virtual Power Plant," *Smart Energy International*, February 6, 2024. https://www.smart-energy.com/industry-sectors/energy-grid-management/ieso-announces-largest-canadian-residential-virtual-power-plant/.

54 United Nations Climate Change, "Global Renewables and Energy Efficiency Pledge," 2024. https://www.cop28.com/en/global-renewables-and-energy-efficiency-pledge.

55 International Energy Agency, "Decade for Action Highlights," 2023. https://www.iea.org/reports/energy-efficiency-the-decade-for-action/decade-for-action-highlights.

56 International Energy Agency, "Growth in Electric Car Sales Remains Robust as Major Markets Progress and Emerging Economies Ramp Up," 2024. https://www.iea.org/reports/global-ev-outlook-2024/executive-summary.

strong as that of EVs, 2022 marked the first year in which US heat pump sales exceeded the sales of gas furnaces.[57] In Canada, a market survey has forecasted a compound annual growth rate of 8.8% for heat pumps[58] between 2023 and 2030.

With regards to technological trends, all technologies have experienced curves which define the amount a given technology's cost is reduced in percentage terms each time its use or deployment is doubled. The experience curve for percentages for heat pumps, renewable generation, and battery storage varies between 10% and 21%, versus 2.2% for combustion-based technology which is no longer growing significantly. This trend suggests the energy transition will continue with benefits to the climate and energy consumers alike.[59]

Municipal Impacts

Cities play increasingly recognized roles in global climate change responses: as change laboratories, spaces of opportunity, and as administrative and economic hubs that concentrate human and financial resources and needs. They host high climate mitigation potential and acute climate adaptation vulnerabilities.[60]

The energy transition impacts municipalities in multiple ways, by changing the structure of the economy and requiring investments in infrastructure and transportation, coordination across multiple sectors, and careful planning and program delivery to achieve community objectives. Local electricity utilities are upgrading the electricity grid with new infrastructure to accommodate renewable energy sources, energy storage and distributed generation, charging for EVs, and smart technologies.

The shift from fossil fuels to renewable and decentralized energy requires new approaches to storage and energy balancing to ensure reliability and affordability. Local energy generation and storage will result in changes in building design and construction, with implications for planning and permitting, and electricity utilities. New infrastructure requirements, such as charging for EVs, can be undertaken by municipalities, utilities, or the private sector.

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57 State of New York., "U.S. Heat Pump Sales Surpass Gas Furnaces," 2023. https://www.nyserda.ny.gov/Featured-Stories/US-Heat-Pump-Sales.

58 Grand View Research, Inc. "Canada Heat Pump Market Size &Amp; Outlook, 2030." 2024. October 16, 2024. https://www.grandviewresearch.com/horizon/outlook/heat-pump-market/canada.

59 Atse Louwen, Martin Junginger, and Anand Krishnan, "Technological Learning in Energy Modelling: Experience Curves," *Utrecht University*, 2018. https://reflex-project.eu/wp-content/uploads/2018/12/REFLEX_policy_brief_Experience_curves_12_2018.pdf.

60 Sareen, Siddharth, and Katinka Lund Waagsaether. "New Municipalism and the Governance of Urban Transitions to Sustainability." Urban Studies 60, no. 11 (September 5, 2022): 2271–89. https://doi.org/10.1177/00420980221114968.

The decommissioning of fossil fuel infrastructure requires careful planning and strategy to avoid stranding investors and customers and driving up energy costs for customers, particularly vulnerable communities. New and emerging technologies will support and enable the implementation of the municipal climate action plans. The transition will stimulate new businesses, create opportunities for existing businesses, and create new employment opportunities. Careful planning can result in opportunities to reduce household energy costs, particularly for households experiencing energy poverty.

Key barriers to the energy transition are that it is more capital intensive, which can strain limited household, business, or municipal budgets, and it also requires new models of investment and financing. Additionally, resistance to change based on misinformation or localized visual or physical impacts can limit the ability of the community to undertake new renewable energy or storage projects.

Appendix 4.
Kitchener's Context

A dynamic and growing city, with a history of leadership in climate and energy, Kitchener is well-positioned for leadership in climate planning policy.

The City of Kitchener's response to climate change must be grounded in the history, geography, and economy of the city, building on opportunities and overcoming challenges that are unique to the place. Energy consumption and emissions in particular are a function of population change, technology adoption, and activity levels. The City's approach to energy transition and equity is also shaped by demographics and levels of inequality.

History

Indigenous Peoples

Local Indigenous peoples include, in part, the Anishinaabe, Chonnonton, and Haudenosaunee Peoples. During the 18th century, the Anishinaabe lost significant portions of their land due to European settlement. There was also a large movement of the Haudenosaunee into southwestern Ontario, and migration to the west and south, where they were absorbed by various Haudenosaunee communities.[61]

In 1784, the Haldimand Proclamation was signed. It allocated 950,000 acres of land to Six Nations Territory and the Mississaugas of the Credit for their loyalty to the British Crown, as well as for their substantial losses and sacrifices during the American Revolution. Today, only 46,000 acres remain for the Haundenosaunee and 6,100 for the Mississaugas of the Credit, with the remaining land spread between various cities and towns, including Kitchener.[62]

In June 2015, the Truth and Reconciliation Commission released its findings as well as 94 Calls to Action to redress the dark legacy of residential schools and pave a path forward in Canada's reconciliation process. Local Indigenous communities should be consulted to support the development of climate policies that reflect their knowledge and priorities.

61 Region of Waterloo, "Understanding and Celebrating Indigenous History in Waterloo Region," June 28, 2023. https://aroundtheregion.ca/understanding-and-celebrating-our-indigenous-history-in-waterloo-region/.

62 Region of Waterloo, "Understanding and Celebrating Indigenous History in Waterloo Region."

Excerpt from Indigenous Climate Action (Indigenous Strategic Discussions on City of Toronto Climate Strategies)[63]

Indigenous peoples will determine our own future—not merely as vulnerable people, but people with knowledge, who have ways to solve our own problems and contribute to broader strategies for addressing what is coming. Indigenous forms of knowledge need to be engaged meaningfully in addressing climate change. The knowledge is misunderstood and incomplete if non-Indigenous researchers merely "extract the knowledge." "We don't need to change our knowledge and laws, even when the data changes" (for example, signs of when to harvest certain things may change, but the underlying knowledge structures and processes remain). Indigenous people need to deconstruct external, colonial forces and replace these with Indigenous presence from within. Our own prophecies and natural phenomena are informing us of changes, and we already know how to adapt. If the city does not account for and address colonization in its policies it will keep repeating the same problematic behaviours. So Toronto's Biodiversity strategy, for example, needs "decolonizing." We need to look at indicators for biodiversity differently - not just counting things, but rather asking, in a much wider way, questions that have a much more comprehensive focus: "Are we good ancestors?" "What do women's economies look like that are not consumptive?" Our culturally rooted principles are fundamental truths or guideposts for right behaviour, and are legitimate unto themselves. Western Eurocentric values are not everybody's values. For example, we need not centre individualism; we can centre collective wellbeing. We can and must consider how our children and the generations hundreds of years ahead can have a viable and safe future. In all these ways and more, the gifts of Indigenous peoples are vital to all people of all backgrounds.

European Settlers

Known as "Berlin" until 1916, Kitchener was referred to as the German Capital of Canada.[64] German-speaking Mennonites immigrated to Kitchener as early as 1800 and their heritage continues to be recognized today.[65] Kitchener is characterized by a combination of traditional and modern urban forms and settlement patterns that have largely been influenced by modern European settlers in the region. Modern land-use patterns were automobile focused and extended beyond the central neighbourhoods, including the construction of the Conestoga Parkway expressway network in the 1960s and 1970s. More recent land-use patterns have been influenced by the construction of the region's light rail transit line, which opened in 2019.

63 Indigenous Climate Action, "Indigenous Climate Action Summary Report," 2018. https://www.toronto.ca/wp-content/uploads/2019/05/8eb4-2019-03-25_Indigenous-Climate-Report_final.pdf.

64 City of Kitchener, "Urban Design," n.d., https://www.kitchener.ca/en/development-and-construction/urban-design.aspx.

65 Parks Canada, Government of Canada, "Waterloo Pioneers Memorial Tower", November 19, 2022. https://parks.canada.ca/lhn-nhs/on/woodside/culture/waterloo/culture.

Demographics

Future growth brings investments, which risk locking in more GHG emissions and physical risk from climate change.

Population

Per Statistics Canada's 2021 census data, Kitchener is the ninth largest city in Ontario, in terms of population count, and is the eighth most rapidly growing city. Between 2016 and 2021, the population increased by 10.1%, whereas the national and provincial averages for the same period were 5.2% and 5.8%, respectively. In 2021, 1.7% (9,315 people) of Waterloo Region residents identified as Indigenous.

In 2023, the population of Kitchener surpassed the 300,000 mark; it had the biggest demographic increase, as a percentage, of all Ontario cities that year.

Immigration

In Kitchener, 75,445 persons (nearly 30% of the total population) are immigrants, meaning they are born outside Canada, while 169,400 persons (nearly 67%) are Canadian-born. In 2021, the largest racialized group was South Asian, with about 25,170 persons (just under 10%). Among recent immigrants living in Kitchener, the most common countries of origin were India, Eritrea, and Syria. Non-permanent residents comprise 9,300 persons (nearly 4%).

Age Structure

The population structure in terms of broad groups has remained consistent in Kitchener in recent years. In 2021, children (0–14 years old) accounted for 17.5% of the city population, the working age population (15–64) was just under 68%, and seniors (65 and over) were nearly 15%. By comparison, for Canada as a whole, the proportion of children was just over 16%, the working age population was just under 65%, and seniors were 19%. This means Kitchener contains a slightly higher percentage of children and working age population, and a lower percentage of seniors, than the Canadian average.

The result of Kitchener's rapid population growth and slightly higher percentage of children and working age adults may give the city an advantage in its energy transition efforts. A larger percentage of youth and working adults is often associated with increased workforce availability, and greater adaptability in terms of adopting sustainable practices and technology.

Geography

Kitchener is closely linked geographically to its neighbouring municipalities, requiring a coordinated regional approach to many urban issues. The City of Kitchener, together with the Cities of Waterloo and Cambridge and the Townships of Wilmot, Woolwich, Wellesley, and North Dumfries, are part of a two-tier municipal system in the Waterloo Region.[66]

Urban Form

A dispersed community, Kitchener is also reinvesting in its downtown, which presents an opportunity for district energy and zero-emissions transportation.

Kitchener's early growth was often attributed to its location as a railway hub,[67] but today it is characterized by a dispersed population[68] with a historical centre and levels of population and employment density comparable to parts of the Greater Golden Horseshoe.[69]

Kitchener's downtown has significantly changed, both socially and physically, in recent decades. Originally an industrial hub, the importance of the urban core was reduced by the end of the 20th century due to suburban migration and deindustrialization.[70] As an example, in 1981, nearly 60% of department and retail stores were located downtown; by 1991, that number had fallen to less than 12%.[71]

The downtown's revitalization in more recent years has been shaped by the new light trail transit (LRT) system and a thriving tech and development sector, shaped by urban intensification policies and a large, dedicated fund the City created to attract

66 McCarthy, Kelly. "Smart Growth and Parking: An Analysis of Downtown Revitalization in Mid-Sized Cities." *Uwspace.Uwaterloo.Ca*, 2019. https://dspacemainprd01.lib.uwaterloo.ca/server/api/core/bitstreams/e187693f-5ad6-424c-9dbd-3a30bd03b76c/content.

67 Chun-Fen Lee, "Twin Cities of Waterloo and Kitchener," Economic Geography 22, no. 2 (1946): 142–47. https://doi.org/10.2307/141702https://www.jstor.org/stable/141702.

68 Trudi E. Bunting and Pierre Filion, "Dispersed City Form in Canada: A Kitchener CMA Case Example," Canadian Geographies / Géographies Canadiennes 43, no. 3 (September 1, 1999): 268–87. https://doi.org/10.1111/j.1541-0064.1999.tb01385.x.

69 Paul Hess, André Sorensen, and Kate Parizeau, "Urban Density in the Greater Golden Horseshoe," Centre for Urban and Community Studies, University of Torono, May 1, 2007. https://tspace.library.utoronto.ca/handle/1807/94437.

70 Lee Barich, "Old Bones: A Recent History of Urban Placemaking in Kitchener, Ontario Through Media Analysis," 2020, University of Waterloo. https://dspacemainprd01.lib.uwaterloo.ca/server/api/core/bitstreams/1f440a62-6235-495a-9dc6-6f26deac2ac8/content.

71 Filion, Pierre, and Karen Hammond. "When Planning Fails: Downtown Malls in Mid-Size Cities." Canadian Journal of Urban Research 17, no. 2 (season-04 2008): 1–27. https://www.jstor.org/stable/26193214.

development downtown. Street networks in Kitchener are of a large variety—the result of multiple historical eras and adaptation to various natural boundaries. Former industrial heritage sites like the Tannery, Kaufman Lofts, and the Breithaupt Block and their adaptive reuse by developers, technology companies, and young adults have come to define the urban form of downtown.[72]

The varied urban fabric means that, compared to cities with a stricter grid system, Kitchener contains more developments which appear to have varying visual impacts or visual terminus. Particularly within its Downtown, Central Neighbourhoods, and Major Transit Station Areas, the city's eclectic mix of styles, typologies, and forms gives it a diversity that moves beyond a singularly defined "Kitchener Style."[73] Given the acceleration of development, conserving Kitchener's identity by encouraging creative building forms and styles, while retaining history, has become the City's approach to urban design.

Green Spaces

As an urbanized environment, Kitchener already has pockets of low canopy cover, contributing to the urban heat island effect. Development pressures will exacerbate this challenge.

In 2022, City Council approved a Tree Canopy Target, which aims to increase the total percentage of tree canopy coverage across Kitchener through active maintenance of public trees and intentional tree planting efforts. The City's target is to achieve 30% tree cover in each Ward of Kitchener by 2050, and 33% across the city by 2070. The first progress report is set to be reviewed by Council in 2025, which will determine whether the target should be increased.[74] The Sustainable Urban Forest Strategy (2019) identifies current tree cover at 27%, comparable to other municipalities such as Waterloo, Hamilton, and Guelph (Figure A4.1.).[75]

72 Filion and Hammond, "When Planning Fails: Downtown Malls in Mid-Size Cities."

73 City of Kitchener, "Urban Design Manual," n.d. https://www.kitchener.ca/en/resourcesGeneral/Documents/DSD_PLAN_Urban_Design_Manual.pdf.

74 City of Kitchener, "Engage Kitchener: Consultation on Tree Canopy Target", 2022. https://www.engagewr.ca/treecanopytarget.

75 Google Environmental Insights Explorer, "City of Kitchener – Tree Canopy," n.d. https://insights.sustainability.google/places/ChIJBVHuA4z0K4gRS1Rf3-b4JZU/trees?hl=en-US.

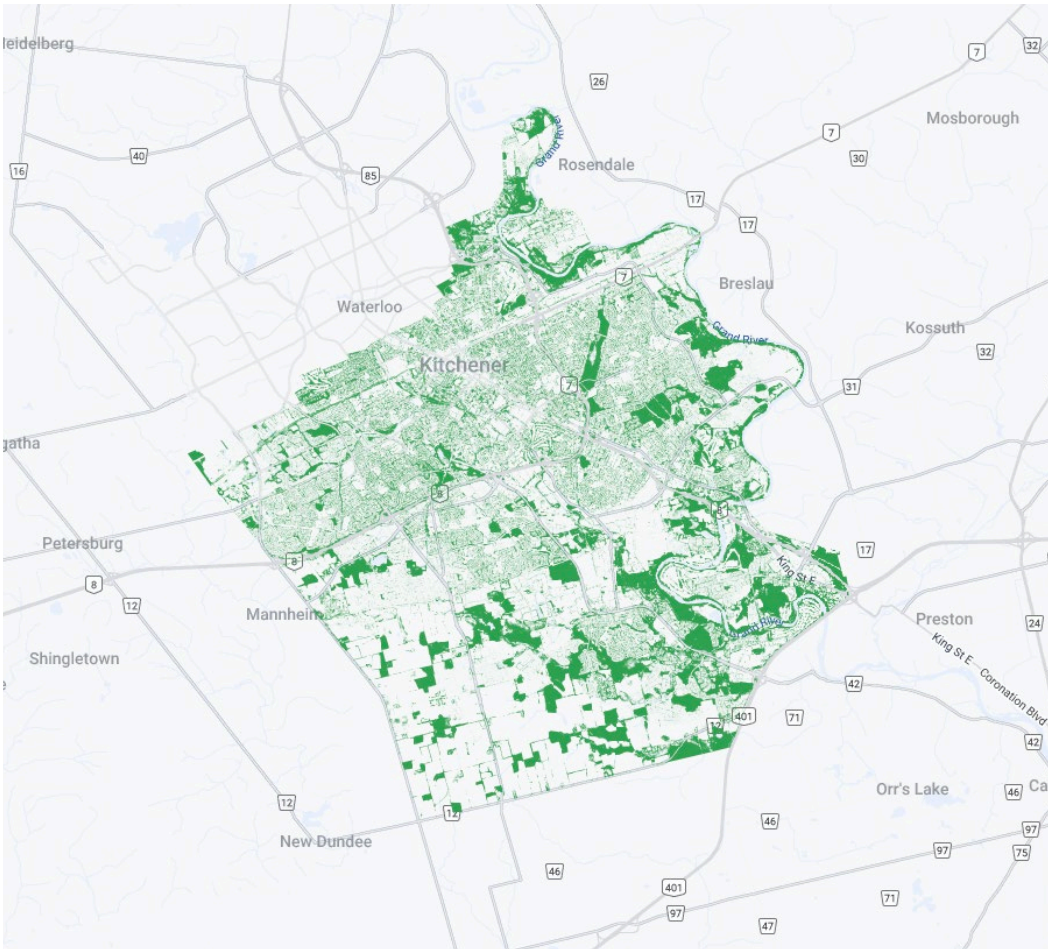

Figure A4.1. Tree Canopy in Kitchener.[76]

Similarly, the Region's Climate Change Policy Direction Paper (2021) references Big Moves which focus on the "integration of green infrastructure into infrastructure planning, asset management, and site development, to both accompany and replace engineered infrastructure," as well as identifying, protecting, and maintaining "a robust network of greenspaces within urban and rural areas."[77] These directions are intended to encourage infrastructure that provides shade, carbon sequestration, and expanded natural habitats, as well as equitable access to nature and flood prevention.[78]

76 Google Environmental Insights Explorer, "City of Kitchener – Tree Canopy."

77 Regional Municipality of Waterloo, "Policy Direction Paper on Climate Change – Regional Official Plan Review," January 2021, https://s3.ca-central-1.amazonaws.com/ehq-production-canada/abc66323e09fe4329fb1f3a9bfa78a86f0c1d707/original/1612804331/Climate_Change_Policy_Direction_Paper_%28PDL-CPL-21-01_Appendix_A%29.pdf_63d6d157efcaf614f3c411d4a7705598?1612804331.

78 Regional Municipality of Waterloo, "Policy Direction Paper on Climate Change – Regional Official Plan Review."

Energy

The emissions profile of electricity, critical to decarbonization pathways, is shaped by provincial policies and decisions.

The Province controls electricity generation procurement through the Independent Electricity System Operator (IESO). With the exception of behind-the-meter generation, all electrical generation in Ontario requires a power purchase agreement from the IESO. The IESO, as directed by the provincial Minister of Energy and Electrification, has the latitude to determine the type of electricity generation and storage, GHG-emitting or GHG-non-emitting, the Province will procure. All utility-scale electricity generation and storage projects, other than expansions and re-contracting of existing resources, require a municipal support confirmation, effectively giving municipalities a veto over most projects proposed in their jurisdictions.

In response to projected future electricity demand, the IESO has completed a set of capacity procurements,[79] is re-contracting some existing generation,[80] and is planning a series of cadenced electrical energy and capacity procurements between now and 2032.[81] The Province also announced plans to refurbish four of the six nuclear reactors at the Pickering nuclear power station, and has plans to develop three modular reactors.

A mix of planning and operational activities round out the balance of the IESO's work. With respect to planning, the IESO is responsible for bulk grid planning and recently produced the Pathways to Decarbonization report, which forecasts impacts of the energy transition on the electrical system.[82] Also, the IESO continuously runs regional electricity planning in the province in conjunction with local electricity distribution companies, municipalities, and other key stakeholders; the Kitchener/Waterloo/Cambridge/Guelph region's planning is presently underway.

In terms of operational activities, the IESO operates the electricity market in Ontario, which must be balanced between supply and demand on a real-time second-to-second basis. This includes the running of the hourly market, the capacity market, and the Industrial Conservation Initiative which sets global adjustment charges for Ontario's largest electricity customers. The IESO also manages output-based carbon pricing on fossil fuel-based generators, and manages import and export activities with the jurisdictions with which Ontario is interconnected.

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79 Independent Electricity System Operator (IESO), "Long-Term 1 RFP and Expedited Process," n.d. https://www.ieso.ca/Sector-Participants/Resource-Acquisition-and-Contracts/Long-Term-RFP-and-Expedited-Process.

80 Independent Electricity System Operator (IESO), "2023-2024 Medium-Term RFP," n.d. https://www.ieso.ca/en/Sector-Participants/Resource-Acquisition-and-Contracts/Medium-Term-RFP.

81 Independent Electricity System Operator (IESO), "2023-2024 Medium-Term RFP."

82 Independent Electricity System Operator (IESO), "Pathways to Decarbonization," December 15, 2022. https://www.ieso.ca/en/Learn/The-Evolving-Grid/Pathways-to-Decarbonization.

Utilities

Kitchener owns the local gas distribution utility and is a part owner of the electrical distribution utility, enabling better coordination of energy and development planning.

The IESO manages the electricity market and grid management through delivering information on the demand of power, the supply, and the price. Although it is not a direct utility company, the IESO plays a key role in energy supply and pricing in Kitchener by managing the broader Ontario electricity market.[83] The IESO is currently developing a regional electricity plan for Kitchener, Waterloo, Cambridge, and Guelph.[84]

Enova Power Corp. is jointly owned by the City of Kitchener, the City of Waterloo, and other local municipalities. This electricity distribution company serves more than 160,000 residents and businesses in the cities of Kitchener and Waterloo, and the Townships of Wellesley, Wilmot, and Woolwich.[85]

Kitchener Utilities is a division of the City of Kitchener, making it one of two utilities distributing gas in Ontario that is municipally owned. Given that it is a community-owned utility, all profits go back into the community through services including water, natural gas, stormwater, sewer, and rental water heaters.[86] Kitchener Utilities is currently developing a Clean Energy Transition Strategy.[87]

Whereas Enova Power Corp. handles local electricity transmission and distribution, Hydro One operates Ontario's high-voltage transmission grid, which in turn allows for power to be delivered to local utilities from generation facilities. The company also acts as a distributor in rural areas where it serves nearly 1.5 million customers.

83 Independent Electricity System Operator, n.d. https://www.ieso.ca/.

84 Independent Electricity System Operator, "Regional Electricity Planning – Kitchener Waterloo Cambridge Guelph 2024: Forecasting and Planning," n.d. https://ieso.ca/Sector-Participants/Engagement-Initiatives/Engagements/Regional-Electricity-Planning-Kitchener-Waterloo-Cambridge-Guelph-2024.

85 Enova Power Corp., "About Us - Enova Power," n.d. https://enovapower.com/corporate-information/about-us/.

86 Kitchener Utilities, "About Us," n.d. https://www.kitchenerutilities.ca/en/contact-us/about-us.aspx.

87 Kitchener Utilities, "Engage Kitchener - Kitchener Utilities Clean Energy Transition Strategy," 2024. https://www.engagewr.ca/KUtransition.

Regulation and Markets

With the exception of transmission pipelines that cross provincial boundaries, energy regulation in Ontario is the purview of the Ontario Energy Board (OEB).[88] The OEB is responsible for:

1. Distribution rate applications which determine compensation to utility companies and how rates are structured.
2. Leave to construct applications which approve or reject authorization to construct capital projects.
3. The design and implementation of conservation programs. The OEB determines the provider of conservation programs, measures what the programs will offer, and program budgets and incentives and compensation for the program providers.
4. Franchise agreements which allow energy distribution companies to operate in Ontario communities and establish conditions for the operation.
5. Determination of the boundaries between the regulated and non-regulated arms of utilities.
6. Enforcement of Energy Board rules through the OEB compliance and enforcement process.

Additionally, the OEB runs energy innovation programs such as the OEB innovation sandbox[89] and assists with policy analysis.[90] The OEB is influenced by cabinet directives and is directly governed by the Energy Board Act.[91] Although virtually all segments of the energy market are regulated by the OEB, which sets rates and ensures reliability, there are exceptions. The energy services affiliates of regulated utilities[92] are unregulated and district energy is an unregulated utility in Ontario, which means prices are market-driven and customers can opt in or out.

Finally, the market context for RNG is significant for municipalities. Ontario does not mandate an RNG blend for its pipeline gas, but its pipeline network is interconnected with the North American gas pipeline system, which means RNG may be bought and sold across the continent. This can have implications for RNG developments in, and by, Ontario municipalities.

88 Ontario Energy Board, "About the OEB," n.d. https://www.oeb.ca/about-oeb.

89 Ontario Energy Board, "OEB Innovation Sandbox," n.d. https://www.oeb.ca/_html/sandbox/index.php.

90 Ontario Energy Board, "Charting the Course for Regulatory Clarity and Consumer Value in Ontario's Energy Transition," January 30, 2023. https://www.oeb.ca/newsroom/2023/charting-course-regulatory-clarity-and-consumer-value-ontarios-energy-transition.

91 Legislative Assembly of Ontario, "Ontario Energy Board Act, 1998, S.O. 1998, C. 15, Sched. B", July 1, 2024. https://www.ontario.ca/laws/statute/98o15.

92 Examples of unregulated arms of regulated utilities include Enbridge's Sustain and Enova Energy Services, an alleviate of Enova Power Corp.

Ministerial Directives, Policy, Legislation, and Reports

The direct influence on energy in Ontario can come from the Ministry of Energy and Electrification and its Minister. Several times a year, the Minister issues letters of direction or orders in Cabinet to provincial agencies and Ministry staff. Recent examples of this include:

1. The November 2023 letter to the chair of the OEB[93] which discussed progress in the Powering Ontario's Growth report and the establishment of both the Green Button initiative and ultra-low overnight electricity rates. The letter requested that the OEB undertake initiatives in many areas including: innovation, DERs, electricity and gas conservation, EVs, intervenor processes, and distribution systems performance.
2. The IESO is the subject of much more frequent letters of direction. In 2024, the IESO had received 10 letters of direction to date,[94] covering generation and storage developments, contracting of resources, project siting, and energy efficiency.
3. Owing to the long timeline required for approval, legislation is used much less frequently. Recent legislative changes have included the repeal of the Green Energy Act and Bill 165. Bill 165 was a direct response to overturn an OEB ruling that would have seen developers pay the upfront costs of residential natural gas hook-ups.[95]

In addition to the prescriptive changes above, the Province has taken a consultative approach on some aspects of the energy transition through public panels. This recently occurred through the Electrification and Energy Transition Panel,[96] a panel convened to advise the government and public on opportunities for the energy sector to help Ontario's economy prepare for electrification and the energy transition. The panel's 2023 report discussed the following key themes:

- The need to engage with municipalities to ensure they are aligned and supported in the energy transition (Recommendation #3)
- Provide clarification on the role of natural gas in Ontario's energy future (Recommendation #6)

93 Ontario Minister of Energy, "Ministerial Letter MC-994-2023-864", November 29, 2023. https://www.oeb.ca/sites/default/files/letter-of-direction-from-the-Minister-of-Energy-20231129.pdf.

94 Independent Electricity System Operator, "Ministerial Directives", n.d. https://www.ieso.ca/en/Corporate-IESO/Ministerial-Directives.

95 Legislative Assembly of Ontario, "Bill 165, Keeping Energy Costs Down Act, 2024", 2024. https://www.ola.org/en/legislative-business/bills/parliament-43/session-1/bill-165.

96 Electrification and Energy Transition Panel, "Ontario's Clean Energy Opportunity: Report of the Electrification and Energy Transition Panel," December 2023. https://www.ontario.ca/files/2024-02/energy-eetp-ontarios-clean-energy-opportunity-en-2024-02-02.pdf.

- Develop a framework for local energy planning (Recommendation #7)
- Identify how the energy transition will be funded (Recommendation #25)
- Explore options to encourage the broad adoption of fuel switching and decarbonization (Recommendation #27)

This report is widely referenced and continues to be discussed with implications for municipal energy and emissions planning going forward.

Renewable Energy Opportunities

Solar PV, the cheapest and most flexible form of renewable electricity, is Kitchener's best option for renewable electricity, and can be complemented by geothermal and waste heat sources.

Waterloo Region is implementing a Community Energy Investment Strategy (CEIS) as a way to improve and sustain Waterloo Region's economic competitiveness and quality of life through coordinated energy investments.[97] This Strategy highlights the opportunities to improve energy resilience, optimize the use of energy resources, and integrate land-use planning to improve energy efficiency and decarbonize the energy systems of the region.

The goals of the CEIS are to:

1. Significantly improve energy performance of buildings;
2. Enhance local energy generation and security;
3. Transition to a low-carbon local transportation network; and
4. Cultivate a supportive and innovative environment for energy investments.

The CEIS was developed in partnership with the City of Kitchener, Kitchener Utilities, and Enova Power Corp., among other entities in Waterloo and Cambridge. WR Community Energy is a collaborative entity that was developed with the Region, the local municipalities, and the local utilities to lead the implementation of the CEIS. Work to date has focused on development, HPDS, community energy-efficiency financing programs, renewable energy generation, energy systems mapping, District Energy, and public communication and education.[98]

97 Waterloo Region, "Community Energy Investment Strategy," 2018. https://www.regionofwaterloo.ca/en/resources/Community-Energy-Investment-Strategy---For-Web---access.pdf.

98 WR Community Energy, "2022 Progress Report: Energy Transition Pillars," 2022. https://wrcommunityenergy.ca/wp-content/uploads/2022/11/WRCE-2022-Report.pdf.

In 2020, the Region of Waterloo partnered with QUEST to complete a high-level assessment of renewable energy development opportunities across the region,[99] mapping the theoretical and technical potential for the development of industrial-scale renewable energy resources, and using community engagement to assess interest and public opinions on potential developments. Key findings for specific energy sources are described below, with supplemental analysis.

Wind Energy

The combination of a low wind regime and limited open space indicates that wind would not likely be used as a technology in Kitchener.

Biomass Energy

The energy mapping project included an analysis of the total availability of stover (residues left over after corn harvest) and straw (residues left over after harvesting wheat or barley) within a 150 km radius of the region. These biomass resources could be converted directly into heat or electricity, or into an intermediate fuel such as ethanol or pellets.

The region is in a favorable location in terms of access to agricultural residues. The quantity is sufficient to support large-scale heating (e.g., as part of a district energy system). Feedstock costs are currently prohibitive without some combination of government grants, escalating carbon prices, escalating natural gas prices, and/or low-carbon regulations.

Solar Energy

Solar can be installed in multiple configurations and scales, for example, on bare land, as canopies over parking, on roofs, and integrated into building components.

Currently, prime agricultural land is restricted for the installation of solar PV developments, and solar farms may not directly interfere with the productive capability of the land.[100,101] If all agricultural lands are included, the region would have almost 30,000 hectares of land that could support PV farms, representing about 7,500 MW of installed capacity. Even if restrictions on prime agricultural land are applied, there are still areas of land available for PV development in the region. Large-scale ground-mount PV systems are the most likely near-term opportunity identified in the study.

99 Team, Aire. "Mapping Opportunities for Renewable Energy Development." ArcGIS StoryMaps, January 8, 2021. https://storymaps.arcgis.com/stories/c77e2472e9aa4f2388580a9c832c3f02.

100 Team. "Mapping Opportunities for Renewable Energy Development."

101 It may be possible to zone prime agricultural land as agrivoltaic; this would involve co-mingled solar and active agricultural production. Farmers are employing this in many parts of the world, although no one has tested current Ontario regulations with the agrivoltaic production.

Rooftop solar PV in Kitchener (Figure A4.2) has the potential to provide approximately 1,550 GWh of electricity,[102] enough to meet over 60% of Kitchener's electricity needs, with an estimated 63,900 roofs available for solar PV installation. Installing this much solar capacity could reduce emissions from electricity by 104 $ktCO_2e$ per year based on recent Ontario electricity emissions factors.[103]

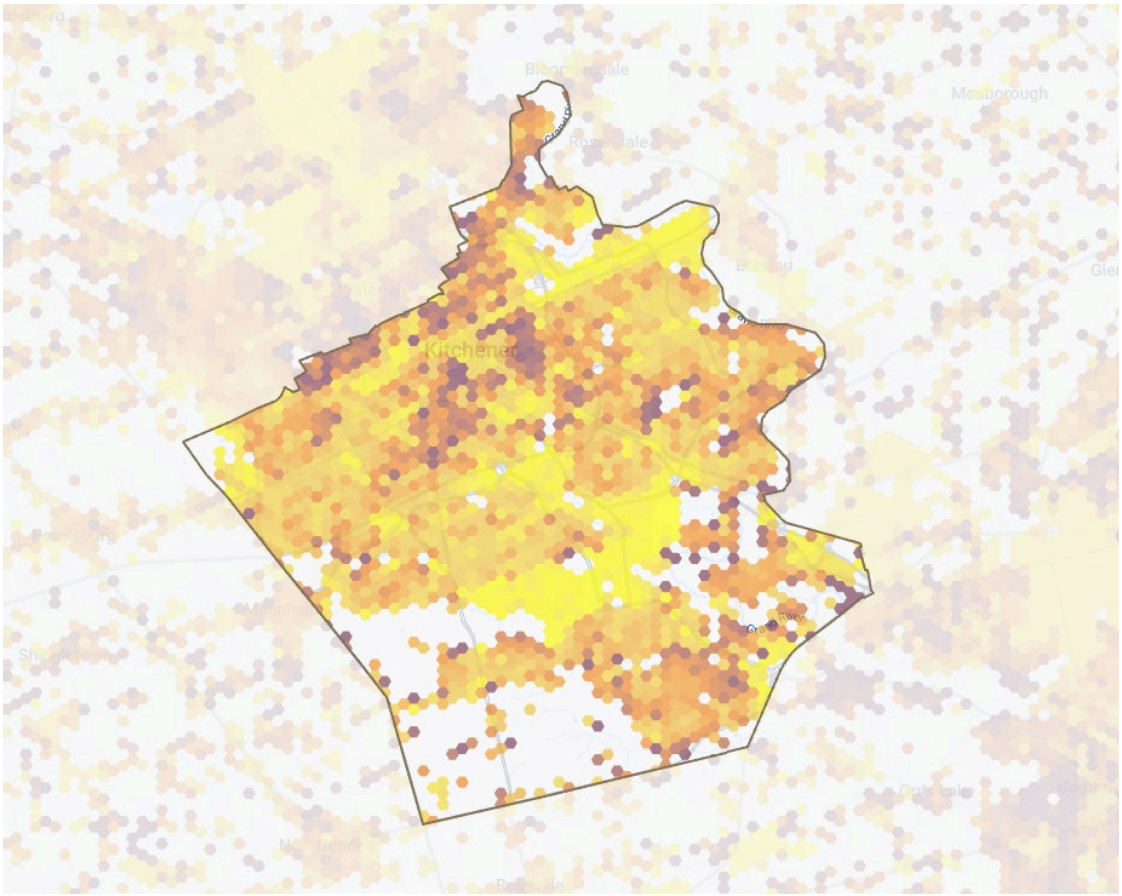

Figure A4.2. Rooftop solar potential in Kitchener.[104]

102 Google Environmental Insights Explorer. "City of Kitchener - Rooftop Solar Potential." Accessed January 1, 2025. https://insights.sustainability.google/places/ChIJBVHuA4z0K4gRS1Rf3-b4JZU/solar?hl=en-US.

103 The Atmospheric Fund, and Maryam Shekarrizfard. 2024. "Ontario Electricity Emissions Factors and Guidelines." Report. *The Atmospheric Fund*. June 2024 Edition. https://taf.ca/custom/uploads/2024/06/TAF-Ontario-Emissions-Factors-2024.pdf.

104 Google Environmental Insights Explorer. "City of Kitchener - Rooftop Solar Potential."

Wastewater Heat Recovery

Kitchener has a promising mix of thermal resources compatible with net zero.

A 2021 regional study[105] on the potential for heat recovery opportunities in specific trunk sewers across the region indicates that the region could save 1,600 tCO_2e during the annual heating season (five months of the year) through reducing natural gas use by using this waste heat (Figure A4.3). Over a third (37%) of these GHG reductions could come from applying this technology to the largest wastewater treatment plant in Kitchener, and four other trunk sewer sites in Kitchener were identified for further research.

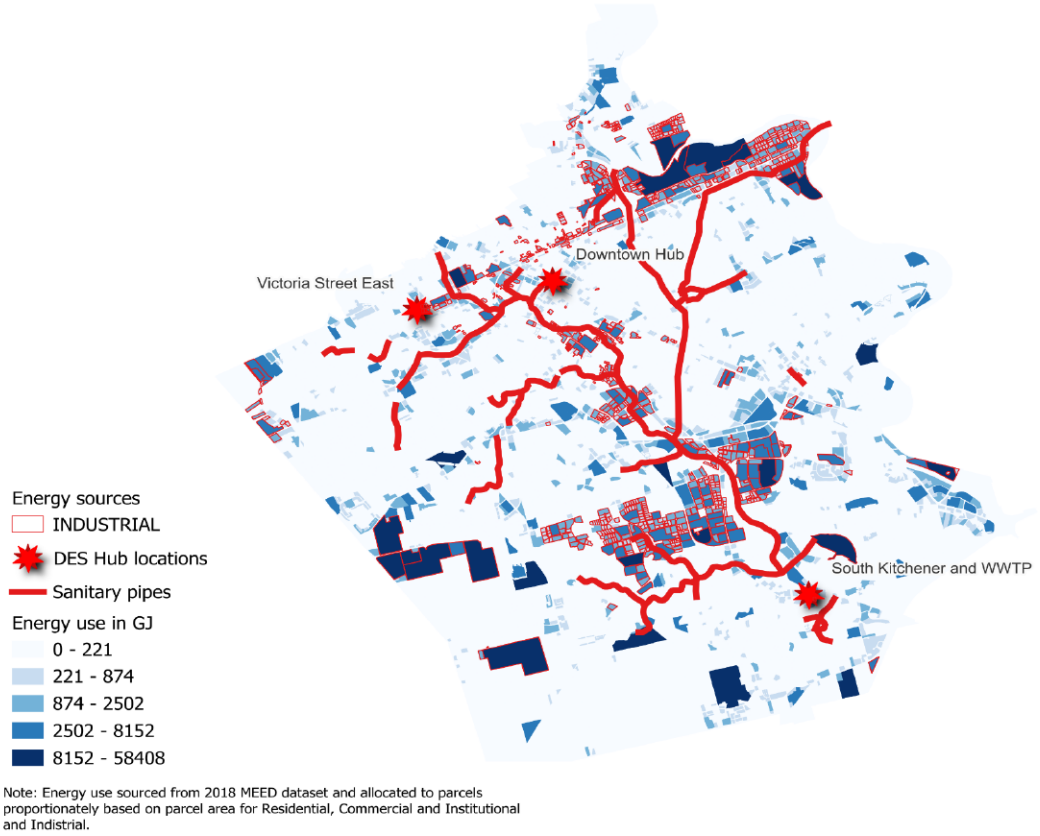

Figure A4.3. Energy density, sanitary pipes, and potential district energy hubs.

105 KEB Engineering & Project Management. "Wastewater Heat Recovery in the Waterloo Region: Prepared for WR Community Energy," Report, June 2021. https://wrcommunityenergy.ca/wp-content/uploads/2021/11/Waste-Water-Heat-Recovery-Report-FINAL.pdf.

Geothermal Energy

In the context of Kitchener, geothermal energy is geo-exchange energy that takes advantage of relatively constant temperatures at least two metres below the earth's surface. By employing heat pumps, heat is extracted from the ground and/or groundwater in the winter and deposited into it in the summer.

WR Community Energy has surveyed the geothermal resource across the region, including Kitchener.[106] The results are promising, as Kitchener has a plentiful and generally accessible open loop geothermal resource. Open loop geothermal systems draw water from aquifers for heat exchange and generally have higher capacities and efficiencies than the closed loop alternative. This resource is of sufficient magnitude to potentially replace natural gas use for large building heating across the community where feasible.

District Energy

An analysis of potential thermal energy projects for Kitchener identified the following:

- Waste heat recovery from treated effluent at the Kitchener Wastewater Treatment Plant (WWTP) could supply the Region's control centre and lab building on the site of the WWTP, and potentially also serve the Conestoga College Kitchener-Doon campus.
- Downtown Kitchener, with multiple buildings in a high-density area, could be a potential location for a district energy system (further evaluation is currently underway).
- Victoria St. North has multiple industrial sources with potential for densification and development of a district energy system.

106 WR Community Energy, "OPPORTUNITIES FOR OPEN LOOP GEOEXCHANGE WATERLOO REGION," 2021. https://wrcommunityenergy.ca/wp-content/uploads/2021/11/Geothermal-Report-FINAL.pdf.

Land Use

The City of Kitchener is a lower-tier municipality. Although many aspects of Ontario's Planning Act and the 2024 PPS will more heavily impact Waterloo Region, provincial direction will need to be reflected in the City's OP. Relevant expectations for the City include the following:

1. The City will reduce GHG emissions through compact, transit-supportive and complete communities; support energy conservation and efficiency; promote green infrastructure, low-impact development, and active transport; and any other additional approaches to help reduce GHG emissions.
2. The City will employ energy efficiency in the provision of its water and sewer services.
3. The City will provide opportunities for energy supply, including energy storage systems, district energy, and renewable energy systems.
4. The City will make provision for active transportation using open space provisions.
5. Municipal planning authorities are encouraged to go beyond their minimum density, and intensification targets should be re-visited in subsequent OPs.

The 2024 PPS requires that municipalities plan for the Region to lead several aspects of planning. In consultation with the City of Kitchener, this includes identifying areas for growth and development, setting minimum density targets, and coordinating on the provision of policy direction on issues that cross municipal boundaries.

The Province produced the Community Emissions Reduction Planning: A Guide for Municipalities.[107] This guide was specifically developed to support land-use planning related to energy and emissions plans. It provides guidance on municipal planning opportunities to reduce GHG emissions as well as methods and techniques to realize these reductions.

In addition to the Planning Act and PPS, some issues arise outside governance review cycles, which may enable Ontario cities to advance climate action. Although the Province has not issued a mandate for the construction of fourplexes, the City of Kitchener, along with other Ontario municipalities,[108] allows them as a right.

107 Government of Ontario, "Guideline on Community Emissions Reduction Planning," April 17, 2018. https://ero.ontario.ca/index.php/notice/013-2083.

108 Barrie, Mississauga, and St. Catherines allow fourplexes. Toronto has essentially ended exclusionary zoning by allowing multiplexes across many residential zones.

Buildings

The current mix of policies and programs will likely be insufficient to get existing buildings to be net zero in the timeline anticipated by most climate action plans in Ontario.

According to the 2021 census, nearly half of Kitchener's population lives in single-detached houses, the most common number of people in a home is two persons, there are more homeowners than renters, most homes were built between 1961 and 1980, and most private dwellings require only minor repairs and regular maintenance as opposed to major repairs. As a result, these buildings will not reach a point where major retrofits could drive a 40–50% decrease in their energy demand for at least the next two decades. Google EIE identified 72,180 residential buildings covering 12.9 million m2 and 4,999 commercial buildings covering 4.8 million m2.[109]

Transportation

Many urban streets can be transformed into places where motor vehicles place only a modest claim on the public realm. Kitchener has begun this journey.

In 2023, 218 million trips were taken within and across the city boundary; 80% of these trips were by personal vehicle, accounting for 1.6 billion VKT, with an average trip length of just over 9 kilometres.[110] Statistics Canada reports an even higher share of vehicle use for commuting trips, at 88% of total trips.

The City has been proactive in expanding its EV charging infrastructure with the installation of EV charging infrastructure, and EV adoption rates continue to accelerate. While EVs are critical to GHG emissions reductions, the City's strategy focuses more broadly on mode-shifting and livability.

The City is emphasizing Kitchener's active transportation networks. A "Complete Streets" approach is used with every roadway project to improve design and functionality for all users, whether that be pedestrians, cyclists, transit riders,

109 Google Environmental Insights Explorer, "City of Kitchener – Building Emissions," n.d. https://insights.sustainability.google/places/ChIJBVHuA4z0K4gRS1Rf3-b4JZU/buildings?hl=en-US.

110 Google Environmental Insights Explorer, "City of Kitchener – Transportation Emissions," n.d. https://insights.sustainability.google/places/ChIJBVHuA4z0K4gRS1Rf3-b4JZU/transportation?hl=en-US.

or motorists.[111] The network of pedestrian and cycling facilities has continued to expand from 265 kilometres of off-street trails and 80 kilometres of on-street cycling routes when the Cycling and Trails Master Plan was published.[112] Constraints on the system include discontinuous cycling facilities, unsafe intersections and crossings, and inaccessible hills. The City is planning 211 new kilometres of bicycle facilities, of which 140 kilometres are on-street and 71 kilometres are off-street. The City is implementing city-wide active transportation routes that connect neighbourhoods through holistic trail and bike route enhancements and easy-to-use wayfinding standards.

Current bike infrastructure in Kitchener has been critiqued for having a heavier focus on off-road bike trails compared to separated bike lanes within public rights-of-way, and a lack of designated cycling traffic lights and protected intersections. Additionally, most LRT stations do not connect to bike lanes.[113] The investments made to Kitchener's downtown cycling grid are an excellent example of the benefits of building infrastructure for all ages and abilities, and have shown a 218% increase in cycling and e-scooter use after construction. Continuing to expand the network will bring funding challenges, with limited provincial and federal grants, and inflationary costs leading to several years' delay in its 10-year construction schedule.

Waterloo Region selected Neuron Mobility to operate an e-scooter and e-bike share program across Kitchener, Cambridge, and Waterloo. In Kitchener, the program contains over 50 parking stations, with plans to expand across the city. In 2024, 173,700 rides were taken, totalling over 288,000 kilometers.[114] Short- and long-term, indoor, and weather-protected, bicycle storage are provided at various locations throughout Kitchener. As of last year, there were 164 parking spaces at five locations, with 450 pre-registered users.[115]

111 Google Environmental Insights Explorer, "City of Kitchener – Transportation Emissions,"

112 City of Kitchener, "Cycling and Trails Master Plan," n.d. https://www.kitchener.ca/en/strategic-plans-and-projects/cycling-and-trails-master-plan.aspx.

113 City of Kitchener, "Cycling and Trails Master Plan."

114 Region of Waterloo, "Update on Shared Micromobility Program 2024 Riding Season," 2025. https://pub-regionofwaterloo.escribemeetings.com/filestream.ashx?DocumentId=11227.

115 City of Kitchener, "Active Transportation & Trails in Kitchener 2023: A Progress Report."

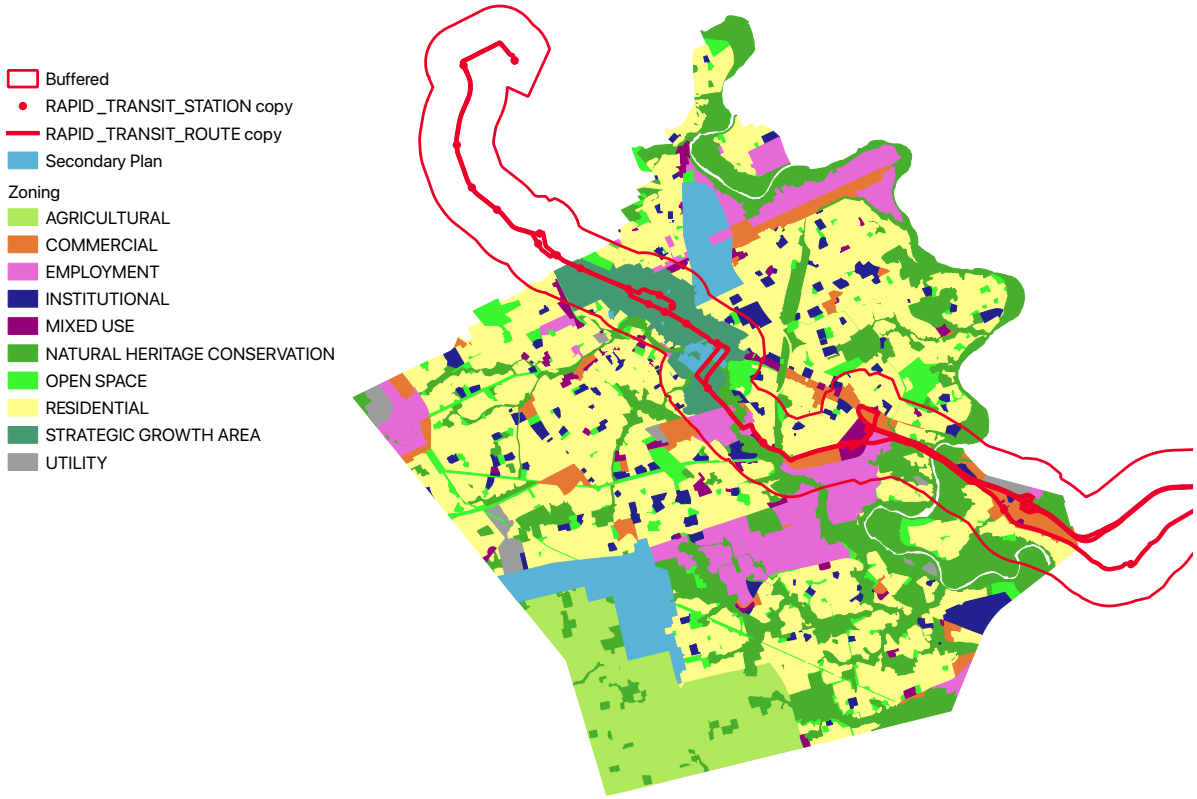

Figure A4.4. Rapid transit and land-use classifications in Kitchener.[116]

Grand River Transit (GRT) is the public transport operator for the Region of Waterloo, operating 250 conventional buses, ION light rail trains, an express bus network, community and flexible transit routes, and 35 specialized MobilityPLUS vehicles. GRT has more than 50 routes with 2,500 stops and covers over 16 million kilometres every year (Figure A4.4).

The ION LRT is a fully electric, zero-emissions component of GRT. In its early months, in 2019, GRT ridership exceeded initial projections and its target of 25,000 daily riders. Ridership dropped during the pandemic, but by 2022, daily use usage rates had largely recovered.

The investment in light rail stimulated activity in the core of Kitchener, including an estimated $1.2 billion in development projects[117] and the renovation of heritage buildings.

Via Rail provides daily train service to Toronto, while GO Transit provides train service every four hours as well as rush hour train groupings.

116 This visualization was created by SSG using open source data.

117 Lee Barich, "Old Bones: A Recent History of Urban Placemaking in Kitchener, Ontario Through Media Analysis," 2020, University of Waterloo. https://dspacemainprd01.lib.uwaterloo.ca/server/api/core/bitstreams/1f440a62-6235-495a-9dc6-6f26deac2ac8/content.

Province-Led Initiatives

The Province influences the development of Kitchener's transportation network through projects, policies, and legislation. Significant projects are underway in both road and rail transportation. The planned re-routing of Highway 7 has the potential to induce more traffic. Complete Streets projects include active transportation components and could align with the development of other active transportation infrastructure and advance Vision Zero principles.

In terms of rail infrastructure, the advancement of two-way, all-day GO train service continues, which will strengthen Kitchener's nodal approach to transit. It appears this service will only run to the East, as the pilot of GO train service extending to London ended in 2023 with no indication that service will be reinstated.

Although the Province has been extensively providing capital dollars for transit expansion, no direct support is available to help defray the operating costs of transit systems in Ontario. The current provincial one-fare program, which allows free transfers between GO Transit and municipal transit systems, is restricted to Toronto and its immediately adjoining municipalities.

In terms of policy and legislation, the influence of the Province is mixed. Although the Province has a Vision Zero Strategy,[118] other actions, such as not returning gas taxes to pre-pandemic levels and the waiving of vehicle registration fees, are likely to increase vehicle use and ownership. The increase in 400 highway speed limits from 100 to 110 km/h could increase speeds on residential streets.[119] Bill 212 accelerates highway construction, provides provincial oversight on bicycle lane construction, and limits environmental assessment requirements.[120]

118 Legislative Assembly of Ontario, "Bill 185, Vision Zero Strategy Act, 2020", 2020. https://www.ola.org/en/legislative-business/bills/parliament-42/session-1/bill-185.

119 Andrew Gross, "Fast on the Freeway Can Lead to Fury on the Side Streets," *American Automobile Association*, April 25, 2024. https://newsroom.aaa.com/2024/04/fast-on-the-freeway-can-lead-to-fury-on-the-side-streets-speed-limit/.

120 Government of Ontario. Bill 212, Reducing Gridlock, Saving You Time Act, 2024. https://www.ola.org/en/legislative-business/bills/parliament-43/session-1/bill-212.

GHG Emissions

Transportation and heating are the major sources of GHG emissions in Kitchener.

Through TransformWR, the Region's community climate action plan has a community GHG target of an 80% reduction below 2010 levels by 2050, with an interim target of a 50% reduction by 2030. Kitchener Council adopted this GHG target in 2018, and declared a climate emergency in 2019.[121]

GHG emissions are reported in a regional inventory through the ClimateAction WR initiative; Table A4.1 shows a breakdown by fuel type for Kitchener in 2022.

Table A4.1. Kitchener's GHG emissions by source (ClimateActionWR GHG inventory, 2022).

Source	Units	Consumption	Emissions (tCO_2e)
Gasoline	L	261,235,229	610,936
Diesel	L	63,964,831	175,108
Electricity	kWh	1,637,065,666	49,112
Fuel oil	L	8,102,388	22,340
Propane	m3	12,913,190	19,985
Natural gas	m3	268,790,057	519,117
Agriculture		N/A	N/A
Community waste		N/A	25,972
Total			**1,422,570**

GHG emissions are declining at the regional level. In 2022, regional GHG emissions were assessed to be at 12% below the 2010 levels.[122]

121 City of Kitchener, "Corporate Sustainability," 2024. https://www.kitchener.ca/en/water-and-environment/corporate-sustainability.aspx.

122 ClimateActionWR. "2022 Waterloo Region Community Greenhouse Gas Inventory Report."

A national source found 2018 GHG emissions for Kitchener to be 1.855 $MtCO_2e$, considerably higher than the 1.422 $MtCO_2e$ reported in 2022, although there are some methodological differences.[123] Google EIE's results provide an additional point of reference for the 2018 GHG emissions for buildings and transportation, excluding non-residential transportation (Table A4.2). GHG emissions from buildings appear to have declined from >700 $ktCO_2e$ in 2018 to ~590 $ktCO_2e$ in 2022 (sum of the emissions from natural gas, propane, and electricity).

Table A4.2. Comparison of GHG emissions from different sources (tCO_2e).

	MEED, 2018	Google EIE, 2018
Stationary energy	785,935	732,000
Transportation	956,776	468,000
Waste	112,419	N/A
Total	**1,855,130**	**1,200,000**

Emissions from fossil fuels, including natural gas, gasoline, and diesel account for most of Kitchener's GHG emissions.[124] Compared to other provinces, Ontario's grid emissions are relatively low (67 gCO_2e/kWh), as electricity is generated using nuclear power, hydroelectric systems, and minor combustion of fossil fuels.

Average per capita energy consumption is 154 GJ, while total energy consumption in the city is 35.9 PJ.[125]

Policies

International

The United Nations Framework Convention on Climate Change (UNFCCC) is the foundational international climate agreement and has been ratified by 198 countries, including Canada.[126] The UNFCCC convenes annual COP conventions; the 2015 COP gave rise to the Paris Agreement, which set a target of keeping global heating below 2°C with ambitions to keep heating below 1.5°C.

123 Sustainability Solutions Group, "Municipal Energy and Emissions Database: Kitchener, ON Energy & Emissions Data Profile", n.d. https://meed.info/en/ca/.

124 ClimateActionWR. "2022 Waterloo Region Community Greenhouse Gas Inventory Report," 2022. https://climateactionwr.ca/wp-content/uploads/2024/05/2022-Waterloo-Region-Community-Greenhouse-Gas-Inventory-Report-Published-June-2024.pdf.

125 ClimateActionWR. "2022 Waterloo Region Community Greenhouse Gas Inventory Report."

126 United Nations Climate Change, "UN Climate Change," n.d. https://unfccc.int/.

In addition to formal high-level agreements and protocols, governments have formed coalitions to accelerate climate action. Prominent examples include: the Powering Past Coal Alliance,[127] which seeks to end the use of coal as a fuel; and the Global Methane Initiative,[128] which aims to see methane, a powerful GHG, be captured and put to productive use. There is an increasing focus on cities—described as sub-national governments—in international negotiations with initiatives such as the Fossil Fuel Non-Proliferation Treaty.[129]

National

As one of the signatories of the Paris Agreement, Canada prepared its first Nationally Determined Contribution (NDC) in 2017. In the 2017 NDC, the Government of Canada committed to reducing GHG emissions by 30% by 2030, relative to the 2005 baseline levels. The NDC outlined actions to complete carbon pollution pricing and mitigation measures that would reduce emissions across all sectors.[130] In 2021, with the release of the Canadian Net-Zero Emissions Accountability Act and the updated NDC, Canada updated its commitments from a 40% to 45% reduction in GHG emissions by 2030, relative to the 2005 baseline levels.

In March 2022, building on previous climate plans, the Government of Canada released its 2030 Emissions Reduction Plan. The Plan establishes a plan for reducing emissions by 2030 and a pathway to 2050 for the following sectors: buildings, electricity, heavy industry, transportation, nature-based solutions, waste, and agriculture (Figure A4.5.). The Plan underscores the importance of continued ambition and enhanced collaboration between provinces and territories, Indigenous partners, municipalities, businesses, the scientific community, civil society, and community members.[131]

127 Powering Past Coal Alliance, "Powering Past Coal Alliance G2- Position Paper: The End of Coal Is in Sight," September 10, 2024. https://poweringpastcoal.org/insights/powering-past-coal-alliance-g20-position-paper-the-end-of-coal-is-in-sight/.

128 Global Methane Initiative (GMI), "Leading Methane Action Since 2004", n.d. https://www.globalmethane.org/.

129 Earth Island, "Fossil Fuel Non-Proliferation Treaty Initiative", n.d. https://fossilfueltreaty.org/.

130 Government of Canada, "Canada's 2017 Nationally Determined Contribution Submission to the United Nations Framework Convention on Climate Change, " 2017. https://unfccc.int/sites/default/files/NDC/2022-06/Canada%20First%20NDC-Revised%20submission%202017-05-11.pdf.

131 Government of Canada, "2030 Emissions Reduction Plan: Canada's Next Steps to Clean Air and a Strong Economy," June 2, 2022. https://publications.gc.ca/site/eng/9.909338/publication.html.

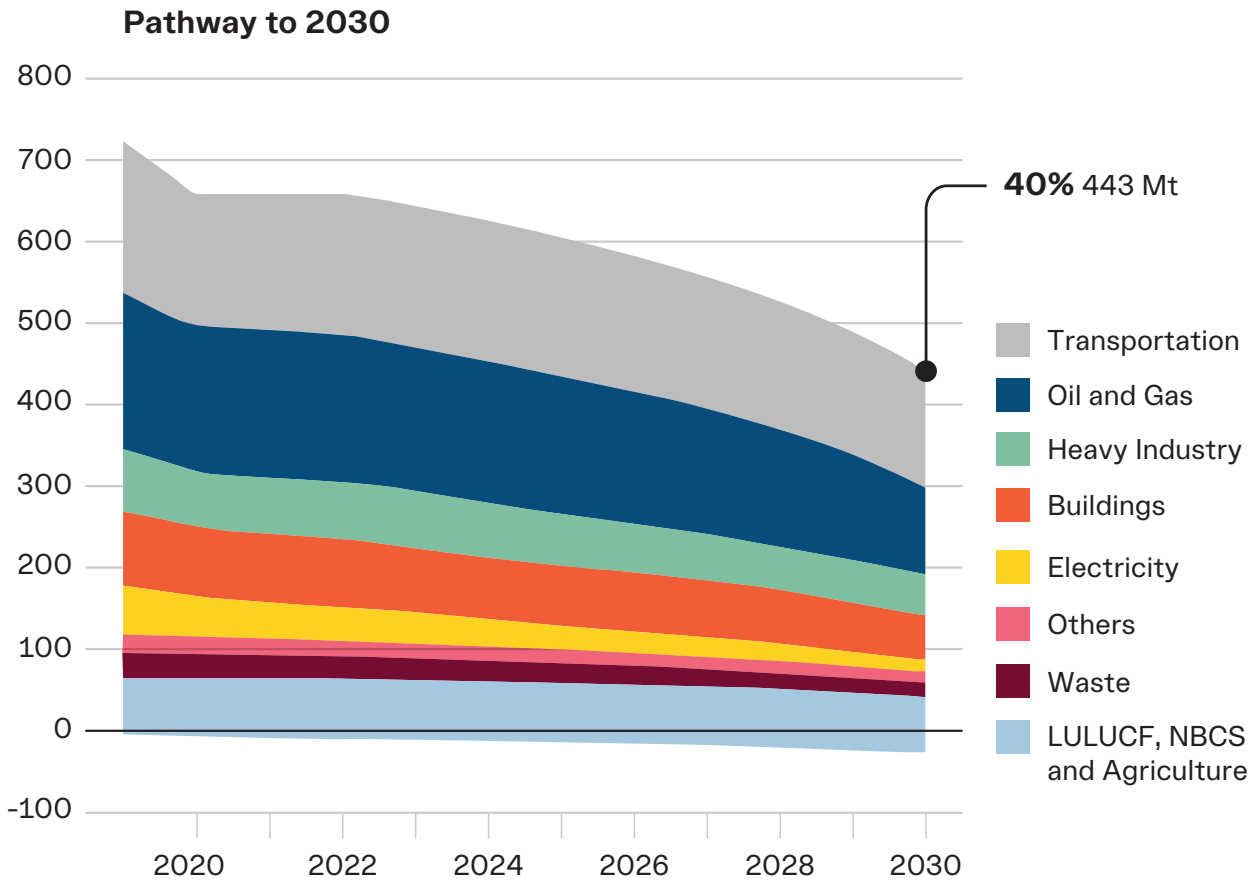

Figure A4.5. Canada's projected 2030 emissions by sector.[132]

The federal government has a suite of policies that aim to see Canada reach a-net zero target by 2050. While Canada is making progress toward its 2030 target, more reductions are needed, including in the sectors directly influenced by municipalities such as buildings and transportation.[133]

The Pan Canadian Framework on Clean Growth and Climate Change (the Framework) is Canada's comprehensive plan to address climate change and includes carbon pricing and sector-specific actions.[134] Provinces have the option to either set up their own systems based on carbon emissions trading or come under the control of the federal emissions pricing scheme, known as the federal fall back. Ontario currently employs the federal fall back for its commercial and consumer sectors.

132 Government of Canada, "2030 Emissions Reduction Plan: Canada's Next Steps to Clean Air and a Strong Economy."

133 Anna Kanduth and Dave Sawyer, "Is Canada on track to its 2030 target?" December 14, 2023. https://440megatonnes.ca/insight/is-canada-on-track-to-its-2030-target/.

134 Government of Canada, "Pan-Canadian Framework on Clean Growth and Climate Change," 2016. https://publications.gc.ca/site/eng/9.828774/publication.html.

A core element of the Framework is carbon pricing, which is shown to be effective at mitigating emissions regardless of local income or other climate initiatives being undertaken.[135] Exact arrangements vary by province; in Ontario, the carbon pricing regime includes output-based pricing in the industrial sector, which includes electricity generation, and rebated carbon pricing in the consumer and commercial sectors. The commercial and consumer sector carbon is split into two pools. The larger pool, comprising 90% of the carbon levies collected, is directly rebated to households through quarterly payments. The remainder is returned to the sectors they were collected from, through a set of programs. A recent example is the Green and Inclusive Community Buildings Program, which subsidizes high-performance new municipal buildings and deep retrofits of existing municipal buildings.

Several regulations and standards complement carbon pricing. The Clean Electricity Regulations will require Canadian electricity to achieve net-zero emissions by 2050, thereby forcing Ontario to clean its electricity grid. The Clean Fuel Standard is designed to limit carbon intensity of liquid and typically fossil-based fuels. The methods to reduce the carbon intensity of fuels governed by this Standard includes a system of offset which may create opportunities for the municipal sector.[136] The Electric Vehicle Availability Standard requires that 20% of new light-duty vehicles offered for sale in that year be zero-emission vehicles (ZEVs), increasing to 60% by 2030 and 100% by 2035.[137]

The federal government also has programs that encourage the de-carbonization of communities. Chief among these is the Canada Greener Homes Affordability Program. This program, announced on July 16, 2024,[138] is a part of the Green Buildings Strategy. Other notable programs include the Emissions Reduction Advancement Program and the Low Carbon Economy Fund. These support emissions reduction initiatives by focusing on the advancement of clean technologies, improving energy efficiency, and supporting projects that help Canada achieve its climate targets. Buildings are a key gap in the federal policy approach, as efforts to stimulate retrofits and improve the performance of new residential and commercial buildings are proceeding slowly or stalled, in part due to federal/provincial/territorial jurisdictional issues.[139]

135 Xiaoying You, "AI Analysed 1,500 Policies to Cut Emissions. These Ones Worked," Nature, August 23, 2024. https://doi.org/10.1038/d41586-024-02717-7.

136 Pembina Institute, "Canada's Clean Fuel Standards: Setting the Record Straight," February 2021. https://www.pembina.org/pub/canadas-clean-fuel-standard-setting-the-record-straight.

137 Government of Canada, "The Electric Vehicle Availability Standard," 2023. https://www.canada.ca/en/environment-climate-change/news/2023/12/canadas-electric-vehicle-availability-standard-regulated-targets-for-zero-emission-vehicles.html.

138 Government of Canada, "Government of Canada's New Canada Green Buildings Strategy to Help Canadians Save Money on their Energy Bills," July 16, 2024. https://www.canada.ca/en/innovation-science-economic-development/news/2024/07/government-of-canadas-new-canada-green-buildings-strategy-to-help-canadians-save-money-on-their-energy-bills.html.

139 Brendan Haley, "What's in the Canada Green Buildings Strategy," Efficiency Canada, July 25, 2024. https://www.efficiencycanada.org/canada-green-buildings-strategy/.

The federal government supports or has established institutions involved in climate mitigation, including funding for the Federation of Canadian Municipalities Green Municipal Fund. This fund[140] was set up in 2001 and supports climate mitigations studies and projects with a set of programs that provide grants and low interest loans. More recently, the federal government has set up the Canadian Infrastructure Bank, which provides financing for green infrastructure including building retrofits, electric transit buses, and low-carbon district energy systems.

GHG Reporting Standards

The federal government produces the National Inventory Report (NIR) which is Canada's official GHG inventory. The reports give methodologies for calculating emissions from fuels, electricity, and land use, as well as other methodologies for aspects such as land use. Municipalities can use this knowledge in tracking their emissions and seeking to understand the climate implications of municipal initiatives. However, the geographic scope is limited to the provinces and territories.

Provincial Policy

Provinces have wide-ranging control over energy, transportation, building codes, and municipal affairs and land-use planning.

Under the Pan-Canadian Framework, Ontario oversees a system of output-based carbon pricing in the industrial sector, including electricity, which is regulated under the Emissions Standards Performance program.[141] This program sets an aggressive standard for emissions from thermal plants of 310g CO_2e per kilowatt hour (kWh) of power produced. To the extent that thermal plants exceed this value, they must pay carbon pricing per unit of energy produced. Proceeds of the output pricing are used to help fund projects which reduce industrial GHG emissions.

140 Federation of Canadian Municipalities, "Green Municipal Fund: Helping Municipalities Create a Sustainable and Prosperous Future," n.d. https://greenmunicipalfund.ca/.

141 Government of Ontario.

Economy

The OP offers an opportunity to design how the city will grow and change, and leverage the numerous opportunities available, including a skilled workforce, strong community, diversity, and new mobility technologies.

With its industrial roots in manufacturing, Kitchener was historically known for its production of textiles, automotive parts, and food processing. While traditional manufacturing has declined over the years, Kitchener's economy has moved into advanced manufacturing of automation, robotics, and precision engineering, so much so that—along with Waterloo—the city has become one of Canada's leading technology clusters. This is demonstrated through the many innovation hubs, tech companies, and startups that have established themselves in Kitchener.

Kitchener's economy, in real GDP, rose by a 21-year high of 5.5% in 2021, and a further 3.8% in 2022. In 2023, this expansion slowed to 1.3%, meaning it matched Ontario after it had outpaced it for 13 years. It is anticipated that growth will stay the same in 2024, and increase to 2.8% in 2025.[142]

Energy Poverty

Energy poverty occurs when households cannot afford, or are unable to access, the levels of energy needed to meet their daily requirements including healthy indoor temperatures throughout the year.[143] Energy poverty is associated with lower rates of general and mental health, and predictors of higher levels of illness, and therefore, increased risk of hospitalization and death.[144] A household that is struggling to heat and cool their homes, or use their lights and appliances, is more likely to sacrifice other essential goods, such as groceries or medications, in order to pay an energy bill.[145]

Measuring energy poverty in Canada can be difficult, as particular metrics—including home energy costs relative to household income, self reporting of comfort, access to electricity and clean energy technologies, and utility disconnection—are not tracked. Households with a disproportionately high home-energy cost burden are used as a proxy

142 The Conference Board of Canada, "Major City Insights: Kitchener–Cambridge–Waterloo," May 28, 2024. https://www.conferenceboard.ca/in-fact/major-city-insights_kitchener-cambridge-waterloo_may2024/.

143 McGill University Newsroom, "Energy Poverty in Canada: An Overlooked Health and Equity Issue," n.d. https://www.mcgill.ca/newsroom/channels/news/energy-poverty-canada-355502.

144 McGill University Newsroom, "Energy Poverty in Canada: An Overlooked Health and Equity Issue."

145 Canadian Urban Sustainability Practitioners, "The Energy Poverty and Equity Explorer," n.d. https://energypoverty.ca/.

for energy poverty.[146] Canadian Urban Sustainability Practitioners (CUSP) has developed a tool that visualizes home-energy cost burden based on census tract area.[147] Figure A4.6. highlights an example of its use.

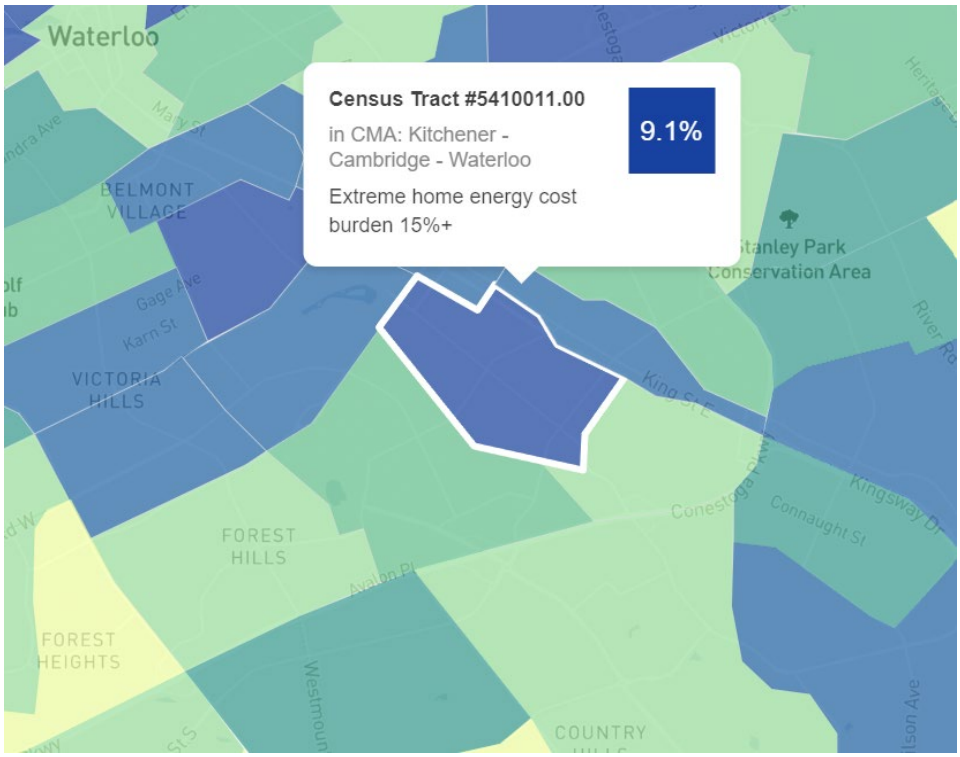

Figure A4.6. Snapshot from CUSP's website of a census tract area in Kitchener with a relatively high energy cost burden.[148]

HealthyPlan.City has developed another visual tool whereby equity can be explored by city. These are aggregated by elements of the built environment (i.e., flood susceptibility, healthy food outlets, or tree canopy cover) and various vulnerable populations (i.e., visible minorities, low-income, older adults, or children).[149] Such a tool is useful for understanding how equity-based policies can be developed and where their focus should be. As an example, Figure A4.7 captures air pollution and newly arrived immigrants in Kitchener. It is noted that 57% of newly arrived immigrants, or 14,000 individuals, live in areas where additional resources targeting air pollution could improve equity in the city.

146 Canadian Urban Sustainability Practitioners, "The Energy Poverty and Equity Explorer."

147 Canadian Urban Sustainability Practitioners, "The Energy Poverty and Equity Explorer: Housing and Demographics Theme," n.d. https://energypoverty.ca/mappingtool/.

148 Canadian Urban Sustainability Practitioners (CUSP), "The Energy Poverty and Equity Explorer: Housing and Demographics Theme."

149 Dalla Lana School of Public Health, University of Toronto, "HealthyPlan.City," n.d. https://healthyplan.city/en.

Figure A4.7. Snapshot from HealthyPlan.City of equity priority, in terms of newly arrived immigrants being exposed to air pollution in central Kitchener.[150]

150 HealthyPlan.City. "Explore Equity in Your City," accessed January 1, 2025, https://healthyplan.city/en.

Vulnerabilities

Physical and ecological infrastructure are both vulnerable and sources of resilience.

Vulnerability to climate hazards can be broken down to three components: adaptive capacity, sensitivity, and exposure. Adaptive capacity describes a system's ability to respond to and recover from the impacts of climate events and hazards. It includes existing actions that help reduce vulnerability to climate change. Sensitivity describes the state of the physical system (e.g., the condition of buildings, natural environment, roads). Exposure describes how much a given system may be spatially exposed to a hazard occurrence (e.g., communities located in areas prone to high-frequency flooding).

Exploring these aspects of Kitchener's population, systems, programs, physical infrastructure, and economic structures requires a detailed analysis of the impacts of climate hazards on these elements.

Ecological Systems

Ecological systems are vulnerable to climate impacts for a number of reasons. Urban parks, green spaces, and intact natural areas can be seen as complementary systems which comprise a diverse array of species, forested areas, wetlands, and waterways, and provide a variety of environmental and social benefits. A healthy natural heritage system provides essential ecosystem services such as climate regulation, water distribution, and air filtration, as well as benefits such as recreational areas and activities, erosion control, and access to clean water.

Climate change is already impacting, and will continue to impact, Kitchener's natural heritage system. Along with other climate stressors, extreme heat can cause direct impacts to species, such as changes to population, distribution, and abundance; water quality and quantity; and the frequency and intensity of events (e.g., pest outbreaks). Increases in extreme heat may also impact our soils (e.g., harder, less fertile soils), reducing the vegetation's ability to grow. Climate change also exacerbates existing stressors such as threats to biodiversity, habitat loss and fragmentation, and loss of ecosystems. Certain species and ecosystems lack the ability to adjust to or cope with changing environments, making them less adaptable to changes in climate.

Heat

Higher temperatures and more extreme drought will also cause stress to Kitchener's flora and fauna by making them more susceptible to pests and diseases. Many species will move northward to find more suitable conditions, while climate-resilient species will continue to exist. Therefore, Kitchener's species composition may look significantly different in the future.

Green spaces, particularly those with sufficient canopy cover to provide shade, are an essential part of the cooling system of the city. These spaces are not explicitly identified within this review, as existing natural areas already provide cooling benefits that are seen in the present-day temperature variations across the city.

Trees, which provide valuable cooling and shelter during extreme heat events, will also experience longer and more frequent periods of heat stress. Trees can withstand short periods of extreme heat; however, prolonged periods of high heat can lead to significant tree damage and tree loss, especially when coupled with extended periods of drought. Changes to the extent of the tree canopy or the loss of additional natural spaces can be considered in the next stage of this analysis, in which adaptation actions are assessed for their impacts on the community.

Water systems are also vulnerable to periods of high temperature. Higher temperatures and more frequent extreme heat events can cause changes to water flow that result in more low-flow conditions and higher evaporation rates, which can reduce and degrade aquatic habitat. A rise in temperatures may also cause changes to our groundwater system, as higher evaporation rates may reduce the amount of water that is soaked into the ground.

As temperatures continue to warm, Kitchener will also experience warmer water temperatures, which have a lower dissolved oxygen content that can negatively affect fish, amphibians, and other aquatic life. As water temperatures continue to rise, cool-water species may not be able to survive the temperature changes, leading to the loss of these and other aquatic species.

Warmer waters are more prone to algal blooms, such as toxic blue-green algae, and bacterial growth. Reduced water quality can restrict the recreational use of water systems, including lakes and streams, which often serve as essential cooling resources for community members during heat events.

Riverine Flooding

Flooding has the potential to trigger erosion of creek- and lake-adjacent lands upstream and carry sediments from the surrounding environment along the Grand River watershed. This process is a function of the natural system where snowmelt in spring (the freshet) results in nutrient transfers downstream. Climate change impacts, as well as proximity of flooding to the built environment, may present changes in sediments that can alter the organic composition, chemical composition, and turbidity of water. The organic and chemical composition can affect the overall quality and useability of water systems. For example, contamination concerns may present biohazards if flood water becomes contaminated with agricultural waste or other pollutants, and changes in the turbidity of water can negatively impact fish populations.

Flooding overland could result in water pooling in areas not typically covered with water and debris. Stagnant pools of water in warmer seasons are potential sites for mosquito breeding, which can act as vectors for diseases.

Invasive Species

Invasive species are a growing threat to the environment and economy in Ontario and beyond. Invasive species are plants, animals, and microorganisms introduced into areas outside of their natural distribution by direct (physical displacement) or indirect (changing climate) human action, resulting in a threat to the environment, economy, society, and/or human health.[151]

Climate change is affecting the growth and spread of invasive species in a number of ways. The warming climate increases the number of growing degree days and reduces the number of frost days. Both factor into an extended growing season and allow invasive plant species to migrate northward, with less risk of death from cold. The reduction in the number of very cold days has resulted in warmer winters and the loss of a thick snowpack, allowing insects that carry diseases to survive the winter and thrive. Additionally, disturbances such as ice storms or prolonged droughts can open new habitat areas to colonization by fast-growing invasive species that outcompete the native flora.

Physical Infrastructure

Physical infrastructure will be challenged by more intense precipitation, higher winds, and potentially increased freeze-thaw cycles. Kitchener's Corporate Climate Action Plan listed damage to buildings, power infrastructure, and transportation systems from high wind and freezing rain along with multi-factored risk from flooding as high priorities for action. Addressing situations that overwhelm the stormwater system was listed as a medium priority for action.

Although many challenges related to physical infrastructure are beyond the direct or complete control of the municipality, it is important to consider the municipality's ability to influence outcomes. Encouraging property owners to increase the resiliency and energy efficiency of their buildings will make the entire community more resilient during climate-induced severe weather events. Buildings that can hold their heat during power interruptions or resist floodwaters will reduce the level of community impact when severe weather occurs.

The reduction of severe weather impacts can have longer-term benefits. For example, the avoidance of flooding is both a climate mitigation and adaptation measure. Two UK-based studies are particularly interesting in this regard. The insurance company Aviva estimated that recovering a typical semi-detached residence from a flood had a carbon footprint of 14 tonnes of CO_2 equivalent.[152] A Bristol University estimated direct and indirect CO_2 equivalent emissions from road repairs after a 70-hour flood event could eliminate up to 4% of the monthly emissions reductions the modelled community had achieved.[153]

151 Government of Canada. An invasive alien Species Strategy for Canada, Ottawa, ON. 2004.

152 Aviva Plc. "Carbon footprint of restoring a flooded home can be equivalent to six and a half return transatlantic flights." 2023. February 9, 2023. https://www.aviva.com/newsroom/news-releases/2023/02/carbon-footprint-of-restoring-a-flooded-home-can-be-equivalent-to-six-and-a-half-return-transatlantic-flights/.

153 University of Bristol. "Estimating the Carbon Footprint of Post-flood Urban Road Network Restoration: A Case Study in Carlisle." n.d. https://research-information.bris.ac.uk/en/projects/estimating-the-carbon-footprint-of-post-flood-urban-road-network-.

Kitchener has had progressive programs and policies around stormwater management for many years. It has its own stormwater utility which collects fees based on area generating stormwater and permeability and permeability of surfaces. The funds collected to finance stormwater management improvements. In 2015, the City noted stats at open houses which concerned updates to the 2001 Integrated Stormwater Management Master Plan. The City noted that since 2011, 4,000 credits had been issued for the installation of rain gardens, rain barrels, cisterns, and permeable pavement.

The same open houses noted several areas where stormwater pipe capacity is inadequate for only a five-year flood. Considering these estimates of five-year storm surcharging were developed with climate data that are at least a decade old, this is a source of potentially serious concern. The 2020 asset management plan for stormwater and the 2021 asset management plan for roads and sidewalks make reference to climate adaptation. In the stormwater asset management plan, there is discussion of "improved modelling of all watercourse and surface elevations to determine high risk flooding locations" which started between 2016 and 2018. It is not clear if this modelling exercise is focusing on surcharged pipe locations, but consideration should be made to fast track analysis in these locations.

The City's Integrated Stormwater Management Master Plan makes a laudable connection between best practices and water quality, with climate adaptation being a newer area of concern. The concern for stormwater quality has an important link to climate adaptation. Urban heat islands generate much hotter surfaces, which in turn heat surface run-off water during periods of precipitation, aggravating heating trends in Kitchener's streams and rivers.[154] It is notable that the Waterloo Region Climate Change and Health and Vulnerability Assessment states that Kitchener will be one of the most impacted areas from urban heat islands.

The City's recent asset management plans make only light reference to climate adaptation. The 2021 road and sidewalk asset management plan trends temperature anomalies and maintenance activities and costs. It makes reference to having assets that can withstand the impacts of climate change, and to being able to maintain services in the face of climate change. Other than making recommendations around more sustainable road-paving activities, and continuing to monitor climate-related maintenance activities, it mostly recommends reflecting climate adaptation in further versions of the plan.

The 2020 stormwater asset management plan is strongly focused on non-climate issues such as asset condition, consumption, and growth. On climate-influenced issues, the flooding attributable to the stormwater system and areas of permeable pavement are tracked, but no targets are discussed. The percentage of properties resilient to 5- and 100-year storms is listed as a service performance measure, but the plan states that data collection is in progress.

154 US EPA. "Heat Island Impacts." August 20, 2024. https://www.epa.gov/heatislands/heat-island-impacts#:~:text=High%20temperatures%20of%20pavement%20and,rivers%2C%20ponds%2C%20and%20lakes.

Socio-Economic Vulnerability

At least one-quarter of Kitchener's population is highly vulnerable to climate hazards, either because of income or physical considerations such as age.

Vulnerability of individuals to climate change hazards varies by hazard. A person's increased vulnerability to flooding impacts is influenced by their physical abilities and socio-economic factors. Those who experience more than one factor are increasingly vulnerable. People over 65 are more at risk of negative impacts and death from flooding because of physical disabilities, reduced mobility, and a lack of access to medicine and medical equipment, particularly when residing in housing that is not single-floor. Additionally, studies have found that older people are less likely to respond to evacuation or public safety orders, and may have physical difficulties with preparing their homes to protect against damages from flooding.[155] After a flood, many people experience trauma or struggle with the aftermath of damages. Older people, especially those who are socially isolated, may experience stress due to the disruption, lost property, or the challenges associated with insurance claims and repairs.[156]

Socio-economic factors influence vulnerability to flooding in several ways. Persons living in hazard-prone housing may have reduced ability to prepare for and evacuate during emergencies, relying heavily on emergency services where available. They may lack the financial resources for preparedness measures, or the vehicles and funding to evacuate.[157] Those living in low-income households are also more likely to be renters or homeowners who are "house poor" (living in a home with an unaffordable mortgage).[158] People living in these situations may have reduced abilities to protect their homes from flood impacts (including by installing protective physical structures and purchasing flood or disaster insurance), and difficulty recovering from the financial hardships associated with flooding events.

155 Fielding, Jane, Kate Burningham, Diana Thrush, Rob Catt, and Department of Sociology and Centre for Environmental Strategy, University of Surrey. "Public Response to Flood Warning." Report. R&D Technical Report SC020116. Environment Agency, 2007. https://assets.publishing.service.gov.uk/media/602d3a81d3bf7f721c13a3ba/Public_response_to_flood_warning_technical_report.pdf.

156 Whittle, R., W. Medd, H. Deeming, E. Kashefi, M. Mort, C. Twigger Ross, G. Walker, and N. Watson. "After the Rain – Learning the Lessons From Flood Recovery in Hull," n.d. https://www.lancaster.ac.uk/lec/sites/cswm/hullfloodsproject/AFTERTHERAINFINALREPORT.pdf.

157 SAMHSA, Disaster Technical Assistance Center, Unknown Fothergill, and Unknown Peek. "Supplemental Research Bulletin: Greater Impact: How Disasters Affect People of Low Socioeconomic Status." Supplemental Research Bulletin, July 2017. https://www.samhsa.gov/sites/default/files/dtac/srb-low-ses_2.pdf.

158 Statistics Canada. "Housing Experiences in Canada: People in poverty." 2022. https://www150.statcan.gc.ca/n1/pub/46-28-0001/2021001/article/00017-eng.htm

Vulnerability to heat echoes vulnerability to other climate hazards. People over 65 and those with lower incomes are more at risk of serious consequences or death during heat events, as they are physically more vulnerable and/or have reduced access to space cooling. Climate change is increasing the frequency of heat waves that put people at risk, including high daytime temperatures and warm nights.

Approximately 10.7% of households in Kitchener are earning less than $30,000 annually. In 2020, the median, after-tax household income in the city was $76,500. According to the Ontario Living Wage Network, a living wage for Kitchener and surrounding areas is $20.60/hr, equating to almost $43,000 annually.[159] The distribution of household incomes, as well as the location of low-income individuals is shown in Figures A4.8. and A4.9.

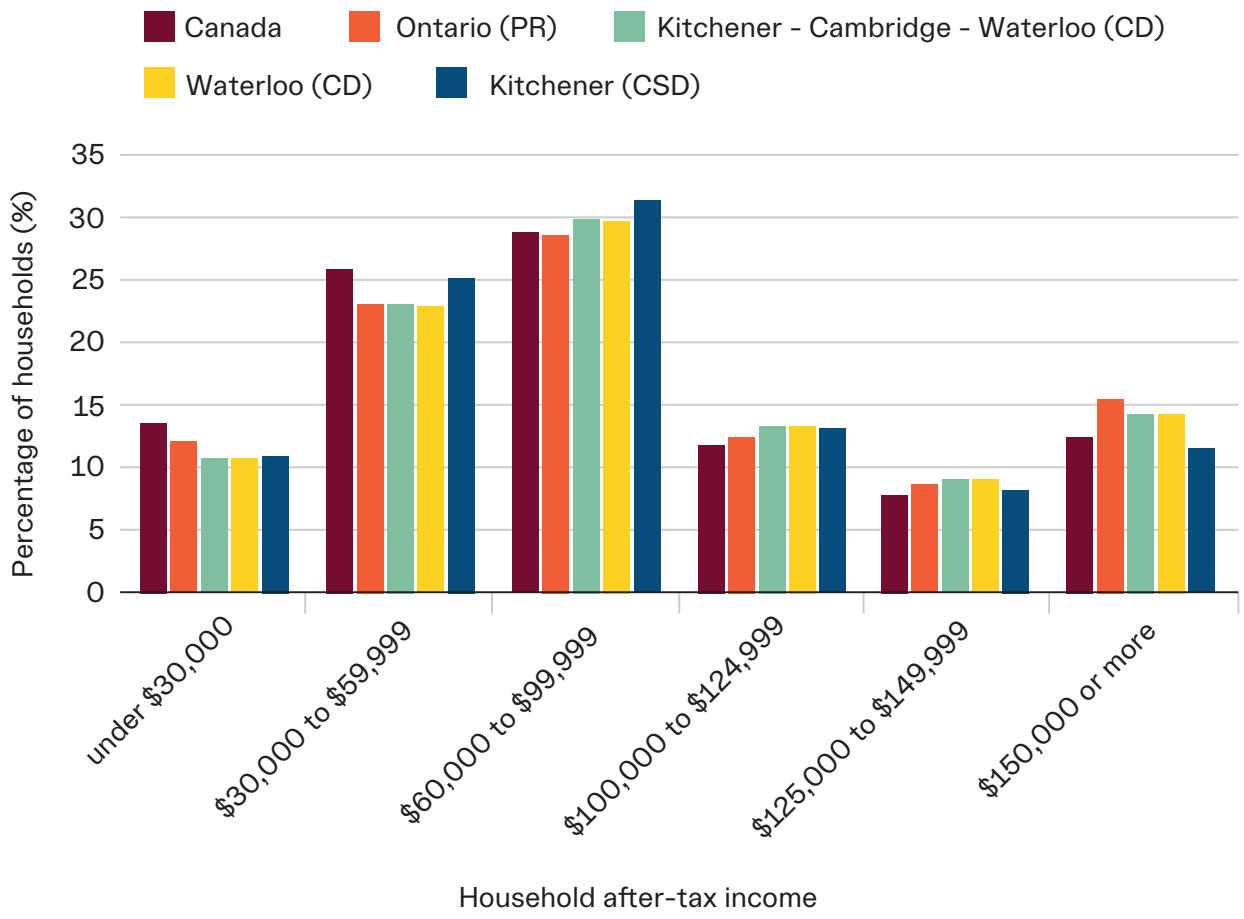

Figure A4.8. Household income for Kitchener and surrounding areas, 2020.[160]

159 Ontario Living Wage Network. "2023 Living Wage Rates," 2023. https://www.ontariolivingwage.ca/2023_living_wage_rates.

160 Government of Canada, Statistics Canada. "Focus on Geography Series, 2021 Census - Kitchener (Census Subdivision)," October 4, 2023. https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/page.cfm?topic=5&lang=E&dguid=2021A00053530013#.

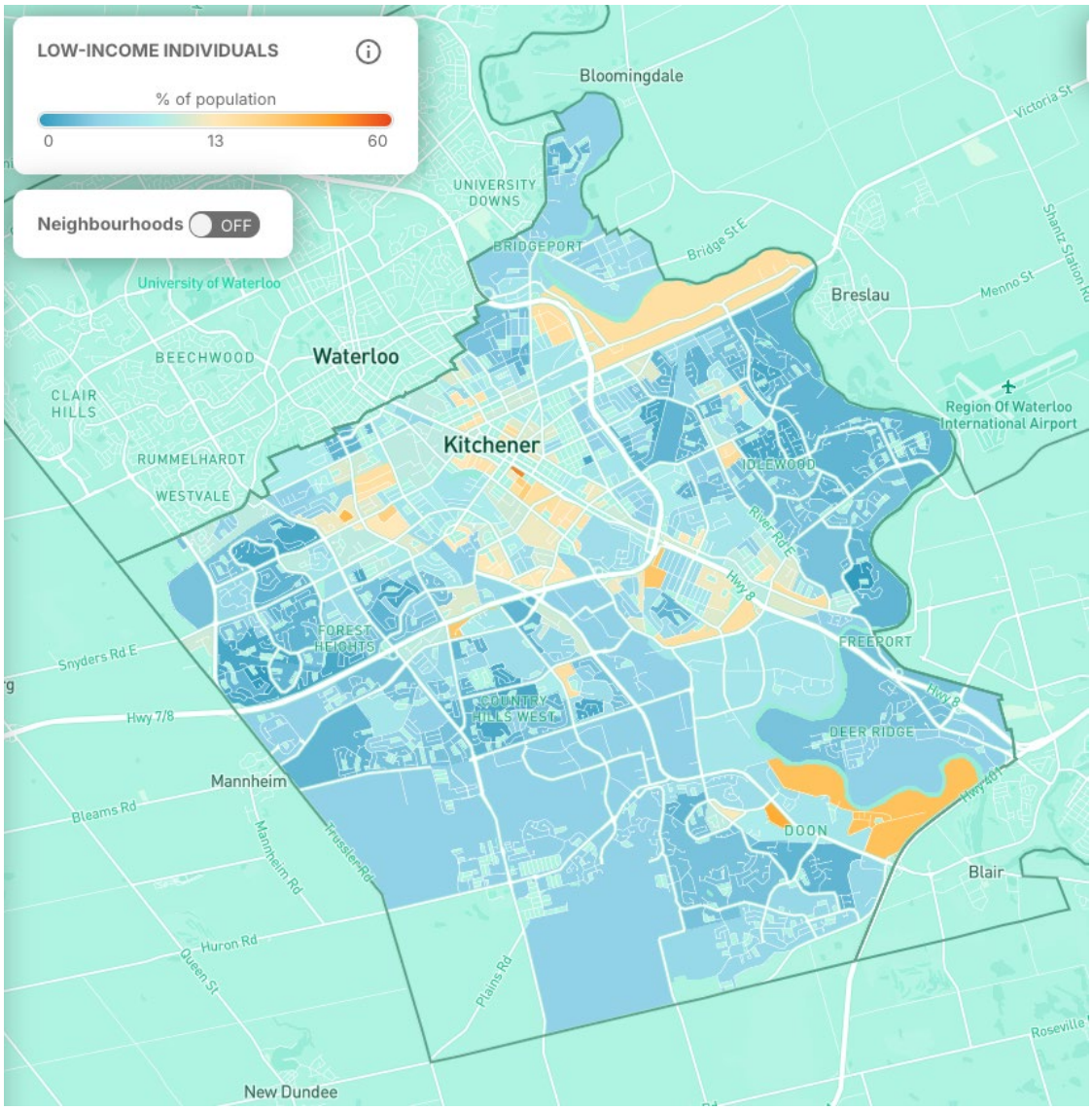

Figure A4.9. Distribution of individuals with low incomes across Kitchener, 2020.[161]

161 "HealthyPlan," n.d. https://healthyplan.city/en. "Low income individuals" are defined as living below the after-tax low-income threshold, which is determined by Statistics Canada and varies based on family size and region.

Language barriers can also impact individuals by preventing them from understanding preparedness information and emergency warnings issued by health authorities or the government. Those who do not speak English or French may be unaware of the support and services available to community members to prepare for climate emergencies, as well as those available during an emergency event. This can be further exacerbated for individuals who live alone and face language barriers, as they may not have community members who are able to check in on them during these heat events and provide assistance if needed. Approximately 2.3% of the population of Kitchener speak neither French nor English, and as such are more vulnerable to climate emergencies.[162]

Approximately 15% of Kitchener's population is over the age of 65.[163] Statistically, elderly people are more vulnerable to heat and flooding impacts, and may be more vulnerable to climate change impacts as a result.

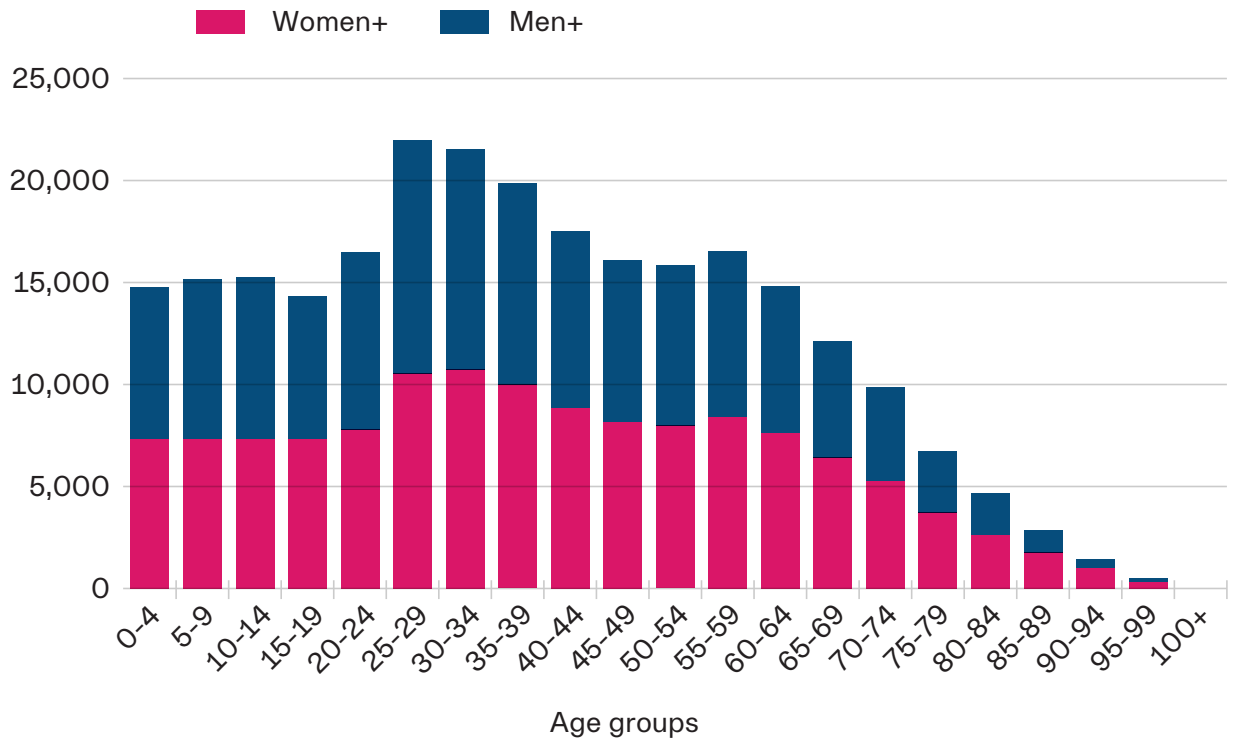

Figure A4.10. Distribution of age and gender, Kitchener, 2021.[164]

162 Government of Canada, Statistics Canada. "Focus on Geography Series, 2021 Census - Kitchener (Census Subdivision)," October 4, 2023. https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/page.cfm?topic=6&lang=E&dguid=2021A00053530013.

163 Government of Canada, Statistics Canada. "Focus on Geography Series, 2021 Census - Kitchener (Census Subdivision)," October 4, 2023. https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/page.cfm?topic=6&lang=E&dguid=2021A00053530013.

164 Government of Canada, Statistics Canada. "Focus on Geography Series, 2021 Census - Kitchener (Census Subdivision)," October 4, 2023. https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/page.cfm?topic=6&lang=E&dguid=2021A00053530013.

Climate change is having both acute and chronic impacts; these impacts will become worse.

The Region of Waterloo completed a Climate Change and Health Vulnerability Assessment (CCHVA) to explore the impacts of climate change on the vulnerability of people and systems within the Region.[165] The CCHVA assesses several climate hazards in reference to specific vulnerable populations.

Extreme Temperatures

Extreme heat days are expected to increase from 10 to 61 annually by the 2080s in Waterloo Region. Kitchener will be one of the most highly impacted areas from the urban heat island effect, as the city has a higher proportion of impermeable surfaces and a lower tree canopy cover than other areas of the region. The proportion of the population aged 65 and older is expected to increase, and a high proportion of new immigrants and other minority groups may have a lower adaptive capacity in the face of extreme temperatures.

Housing insufficiency is 5% across the region, lower than the provincial average of 6.1%. People who experience housing insecurity and insufficiency are particularly vulnerable to extreme heat and cold. Almost 15% of the population of Waterloo Region live in apartment buildings with five or more storeys. People living in upper levels of apartment buildings may experience greater exposure to extreme heat, particularly during power outages.

Access to public air-conditioned spaces is uneven across Kitchener, increasing the vulnerability of those living in areas with reduced access to cooling centres or emergency spaces.

Ultraviolet Radiation Exposure

Areas with low tree canopy cover may be more exposed to ultraviolet radiation due to reduced shade cover. Kitchener is more densely populated but has lower proportions of natural climate zones (i.e., a spatial measure of "greenness") than surrounding areas. People living or working in areas with reduced tree canopy coverage may be more susceptible to impacts from ultraviolet radiation exposure.

165 Chris G Buse et al., "Climate Change and Health Vulnerability Assessment for Waterloo Region, Wellington County, Dufferin County, and the City of Guelph," by Region of Waterloo Public Health and Wellington-Dufferin-Guelph Public Health, Region of Waterloo Public Health and Wellington-Dufferin-Guelph Public Health Unit, 2022. https://www.regionofwaterloo.ca/en/health-and-wellness/resources/Documents/Climate-Change-and-Health-Vulnerability-Assessment.pdf.

Extreme Weather Events

Annual precipitation levels are expected to increase marginally by 2100, but extreme precipitation events are expected to become more frequent and severe. Severe freezing rain events are expected to increase by up to 30% by 2100. These climate conditions will increase precipitation in the spring, fall, and winter that will increase the potential for flooding, slippery walking and driving conditions, and flash freeze events.

Extreme weather can increase the risk of falls, which is the most common cause of injury in older adults.

Air Quality Degradation

Warming air temperatures, changes in growing seasons, and increased wildfires will likely result in worsening air quality in the region. This will mean an increase in the number of high-risk air quality days for dense urban areas, and earlier onset of pollen season. Older adults, children under the age of 15, and people with pre-existing respiratory conditions are more likely to have negative health impacts from the reduced air quality. Low-income individuals, and people who are unemployed or precariously employed are also at higher risk, as their housing is often located near busy roadways or other sources of emissions.

Vector-Borne and Zoonotic Diseases

Precipitation is expected to increase in the spring and fall, and extreme rainfall events may pose risks for the growth of mosquito populations in the summer if stagnant water is allowed to accumulate following extreme rainfall. Lyme disease, carried by black-legged ticks, is also spreading across southwestern Ontario.

Mental Health Impacts

"A global study of 10,000 children and young people [indicated] that 45% of respondents said their feelings about climate change negatively affected their daily life and functioning. The study also noted that 'Climate anxiety and distress were correlated with perceived inadequate government response and associated feelings of betrayal."[166]

Climate change conditions and impacts may exacerbate mental health conditions into the future. People with strong connections to the land and climate conditions, or whose livelihood is tied to crops, livestock, or other natural resources, may be particularly vulnerable.

The CCHVA is a thorough and comprehensive assessment of the impacts of climate change on the population of Waterloo Region. It explores aspects of vulnerability and adaptive capacity, as well as adaptive actions that can be taken to reduce risk from these climate hazards.

166 Caroline Hickman et al., "Climate Anxiety in Children and Young People and Their Beliefs About Government Responses to Climate Change: A Global Survey," *The Lancet* 5 (December 2021).

The City should use this report as a guidance document in its planning to prioritize and reduce risk across all segments of the population.

Economic Impacts

"Economic costs of extreme weather are both direct (physical damage to infrastructure or buildings) and indirect (revenue loss for businesses, temporary unemployment, health impacts). In the US, the NOAA National Centers for Environmental Information (NCEI) reports annually on billion dollar climate disasters. The latest reporting year, 2023, had the record number of disasters with a price tag of at least $92.9 billion in the US alone."[167]

A goal for the CCAP for Waterloo Region is to "increase the resilience of local energy systems and businesses in a changing climate to enable a thriving regional economy."[168] The CCAP also mentions that the threats of climate change to the local economy could result in structural damage to businesses, including storefronts, mechanical equipment, or inventory. They can harm business continuity through power outages and disruptions to local transportation networks. The safety of workers can also be affected by extreme weather, particularly for those who work outdoors or those who travel frequently.

Cost of Doing Nothing

Climate change is seen as a particularly problematic challenge for businesses, given that it brings to the surface the tension between economic growth and its material consequences. Research shows that continuous critique of corporate practices results in social and environmental issues being responded to with a business-as-usual approach. If short-term profitability fails to result from social and environmental initiatives, companies typically regress with time toward market imperatives.[169]

167 "2023: A Historic Year of U.S. Billion-dollar Weather and Climate Disasters," NOAA Climate.gov, January 8, 2024. https://www.climate.gov/news-features/blogs/beyond-data/2023-historic-year-us-billion-dollar-weather-and-climate-disasters#:~:text=Damages%20from%20the%202023%20disasters,early%20March%20(%246.0%20billion).

168 Region of Waterloo: Planning, Development and Legislative Services. "Community Climate Adaptation Plan for Waterloo Region." 2019. https://www.Regionofwaterloo.ca/En/Living-Here/Resources/Environment/Community-Climate-Adaptation-Plan---Full-ACCESS.Pdf,

169 Wright, Christopher, and Daniel Nyberg. "An Inconvenient Truth: How Organizations Translate Climate Change Into Business As Usual." Academy of Management Journal. Vol. 60, 2017. https://doi.org/10.5465/amj.2015.0718.

One analysis estimates the financial losses in Canada due to climate impacts at $25 billion in 2025, or 50% of the projected 2025 GDP growth, growing to $78–$101 billion per year by mid century, depending on the emissions scenario.[170]

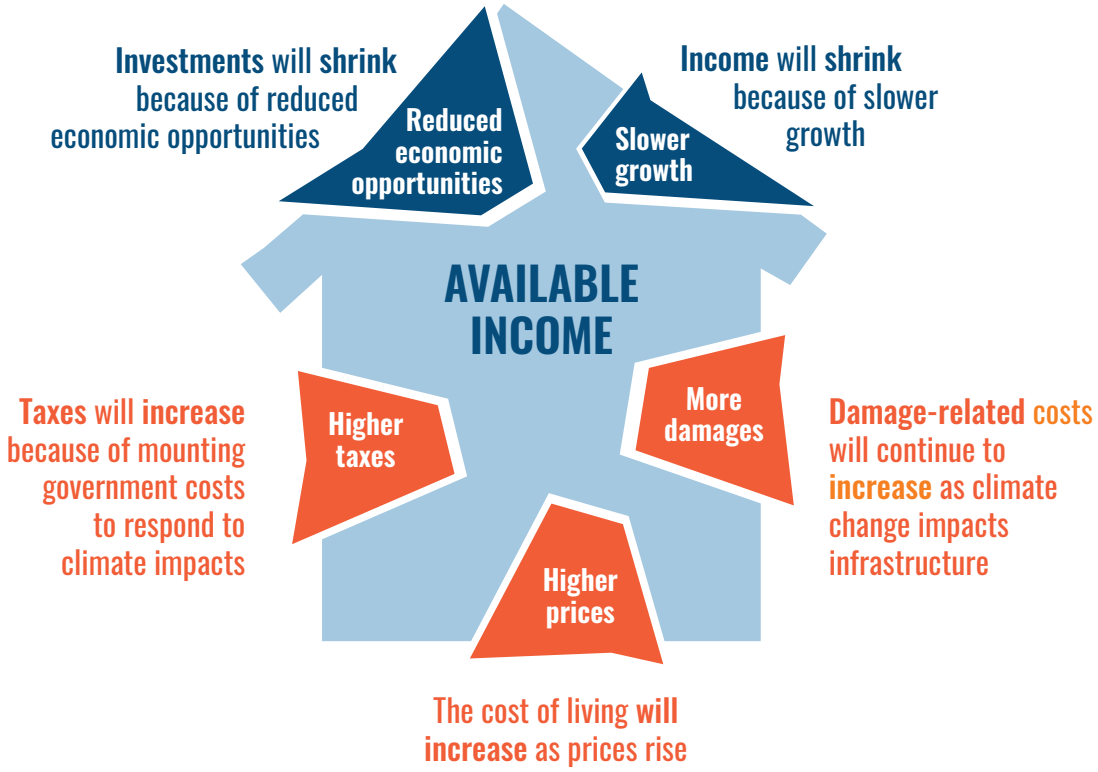

Figure A4.11. The economic impacts of climate change in Canada.[171]

Weighing the costs of action versus inaction is often deemed a priority, but local decision-makers rarely have the time and resources needed to do so. In response, ICLEI Canada has developed a "Cost of Doing Nothing Toolbox," which aims to provide a starting point for municipalities to collect data and examine the costs and impacts of climate change across various knowledge systems, hazards, and sectors.[172] It recognizes that municipal governments are increasingly responsible for larger shares of infrastructure funding compared to the past. A report published by the Financial Accountability Office in Ontario (FAO) stated that "municipalities own 52% of public infrastructure in Ontario, with much of it ageing, which amounts to a total infrastructure backlog of $52.1 billion."[173] Separately, there are a number of Business Continuity

170 Institut climatique du Canada. "Damage Control Report: Reducing Climate Impacts." Canadian Climate Institute, November 11, 2024. https://climateinstitute.ca/reports/damage-control/.

171 Institut climatique du Canada. "Damage Control Report: Reducing Climate Impacts."

172 ICLEI Canada. "Cost of Doing Nothing," n.d. https://icleicanada.org/project/codn/.

173 Yang, Mavis, Sabrina Afroz, Nicolas Rhodes, and Financial Accountability Office. "Municipal Infrastructure." Report. Financial Accountability Office of Ontario, 2021. https://www.fao-on.org/web/default/files/publications/EC2103%20Municipal%20Infrastructure/Municipal%20Infrastructure%20Review-EN.pdf.

Toolkits available online. One of them, published by Alert Waterloo Region,[174] makes reference to severe weather risks but addresses them as part of a wider approach to also mitigate operational, infrastructural, security, and personal risks.

The costs of doing nothing include several key areas where businesses face substantial risk if they do not respond to climate change through robust adaptation and mitigation measures, including physical risks to assets and infrastructure, damaging their assets and impacting the supply chain, increased insurance,[175] interruptions to business continuity, and availability of staff.

Insurance

Severe weather events associated with climate change are on the rise across Canada. The Insurance Bureau of Canada (IBC) recently reported that the number of catastrophic events associated with climate change has steadily increased over the last four decades. Table A4.3. includes catastrophic events that impacted Kitchener, extracted from an IBC report that included events between 1983 to 2022.[176] Notably, all such catastrophic events occurred between 2018 and 2022. These events include winter storms, windstorms, flooding, and water events. The table does not include the latest flash flood events in southern Ontario in July 2024, which caused over $940 million in insured damages across southern Ontario.[177] Given the increasing frequency of these extreme events, the IBC has repeatedly called on federal and provincial governments to invest in climate adaptation.[178]

174 Region of Waterloo. Business Continuity Toolkit, n.d. https://www.alertwr.ca/en/resourcesGeneral/Business-Continuity-Toolkit_access.pdf.

175 Flitter, Emily. "As Hurricanes Strike, Insurance Costs Soar for Commercial Real Estate." The New York Times, October 8, 2024, sec. Business. https://www.nytimes.com/2024/10/08/business/hurricane-commercial-real-estate-insurance.html.

176 Insurance Bureau of Canada. "FACTS of the Property and Casualty Insurance Industry in Canada 2023," 2023. https://a-us.storyblok.com/f/1003207/x/487fb75d80/2023-ibc-fact-book.pdf.

177 Insurance Bureau of Canada. "July Flash Floods in Toronto and Southern Ontario Caused Over $940 Million in Insured Damage," n.d. https://www.ibc.ca/news-insights/news/july-flash-floods-in-toronto-and-southern-ontario-caused-over-940-million-in-insured-damage.

178 Insurance Bureau of Canada. "Summer 2024 Shatters Records for Severe Weather Damage: Over $7 Billion in Insured Losses From Floods, Fires and Hailstorms," n.d. https://www.ibc.ca/news-insights/news/summer-2024-shatters-records-for-severe-weather-damage-over-7-billion-in-insured-losses-from-floods-fires-and-hailstorms.

Table A4.3. Catastrophic losses by event involving Kitchener (1983–2022).

Date	Impacted Locations	Event Type	Loss in 2021 Dollars*
April 14–17, 2018	Greater Toronto Area, Leamington, Hamilton, Guelph, **Kitchener**, Waterloo, London, Chatham-Kent, Ottawa ON; Gatineau QC	Winter storm/ Flooding/Water/ Windstorm	$288,258,000
March 13–16, 2019	Greater Toronto Area, **Kitchener**, Bolton, Peterborough ON; Quebec; New Brunswick; Nova Scotia	Flooding/Water/ Windstorm/ Winter storm	$162,069,000
January 11–12, 2020	Greater Toronto Area, **Kitchener**, Innisfil, New Hamburg ON; Montérégie QC	Water/Flooding/ Windstorm/ Winter storm	$110,242,000
May 21, 2022	Ottawa, GTA, **Kitchener-Waterloo**, Outaouais, Lanaudiere, Laurentides, ON, QC	Windstorm/ Water/ Lightning	$1,266,425,000

* *Includes Losses plus Loss Adjustment Expenses associated with all impacted locations, not just Kitchener*

Extreme events in Canada are now costing insurance companies billions of dollars each year. To account for the increased likelihood of damage from climate-related events, insurance companies are raising homeowners' insurance premiums.[179] Figure A4.12. highlights the average annual Consumer Price Index (CPI) in Ontario between 1990 and 2023 for all items compared with homeowners' home and mortgage insurance.[180] Over this period, the cost of homeowners' home and mortgage insurance increased by 360% compared to just over 100% for all items. While several factors influence insurance premiums, including labour and material costs associated with rebuilding homes, a portion of this increase can be attributed to the rising number of extreme events associated with climate change.

179 Marisa McGillivray, "Insights into the impact of extreme weather trends in Canada on homeowners insurance profitability and consumers," May 15, 2024, Analysis in Brief, Statistics Canada. https://www150.statcan.gc.ca/n1/pub/11-621-m/11-621-m2024003-eng.htm.

180 Statistics Canada. Table 18-10-0005-01, "Consumer Price Index, annual average, not seasonally adjusted." https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810000501.

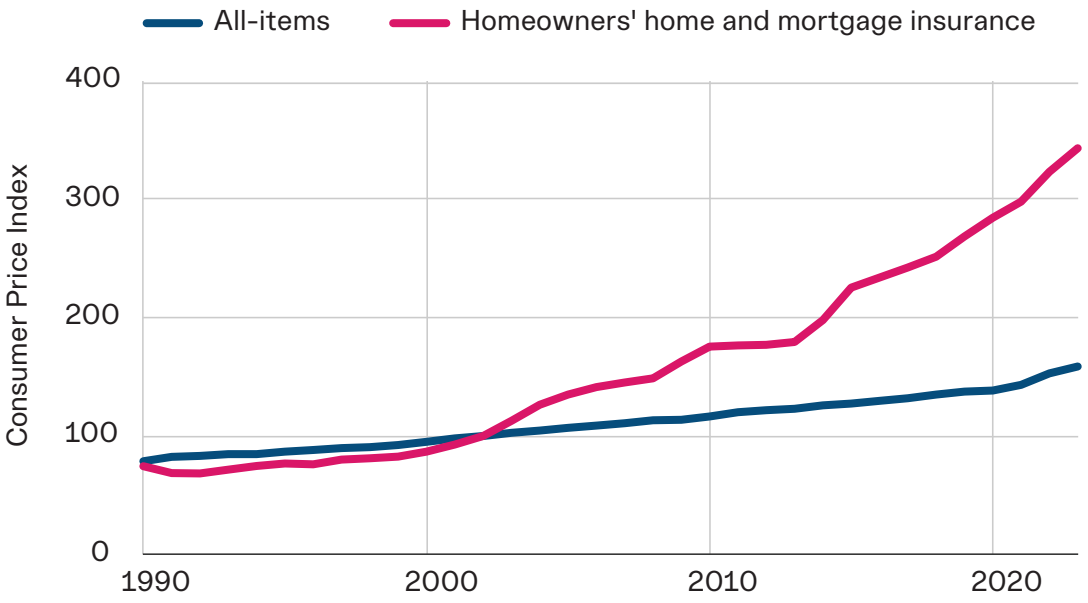

Figure A4.12. Average Annual Consumer Price Index in Ontario, 1990–2023.

Business Impacts

In addition to homeowners, climate change is also having an impact on businesses across the country.[181] In 2024, Statistics Canada found that roughly 11% of businesses in Ontario were affected by natural disasters or weather-related emergencies in the previous 12 months. The number of businesses impacted in Ontario varied by industry. For example, only 1 percent of professional, scientific, and technical businesses said they were impacted by extreme weather, compared with over one-third of agriculture, forestry, fishing and hunting businesses.[182]

Figure A4.13. highlights the number of businesses with employees in Kitchener in 2022 by NAICS code compared to the percent of businesses in Ontario impacted by natural disasters or weather-related events by NAICS code. Notably, Kitchener has a high number of businesses in the finance and insurance industry, which has been highly impacted by extreme events. Other impacted industries that have several businesses in Kitchener include retail trade, accommodation and food services, construction, and other services (not including public administration). These local industries may be particularly sensitive to climate change impacts in the near future.

181 Government of Canada, Statistics Canada. "Geography: A Factor in Businesses' Weather-related Impacts and Emergency Preparedness." Statistics Canada, August 8, 2024. https://www.statcan.gc.ca/o1/en/plus/6749-geography-factor-businesses-weather-related-impacts-and-emergency-preparedness.

182 Statistics Canada. Table 33-10-0830-01, "Impact of natural disasters or weather related emergencies on businesses or organizations over the last 12 months, second quarter of 2024." https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3310083001.

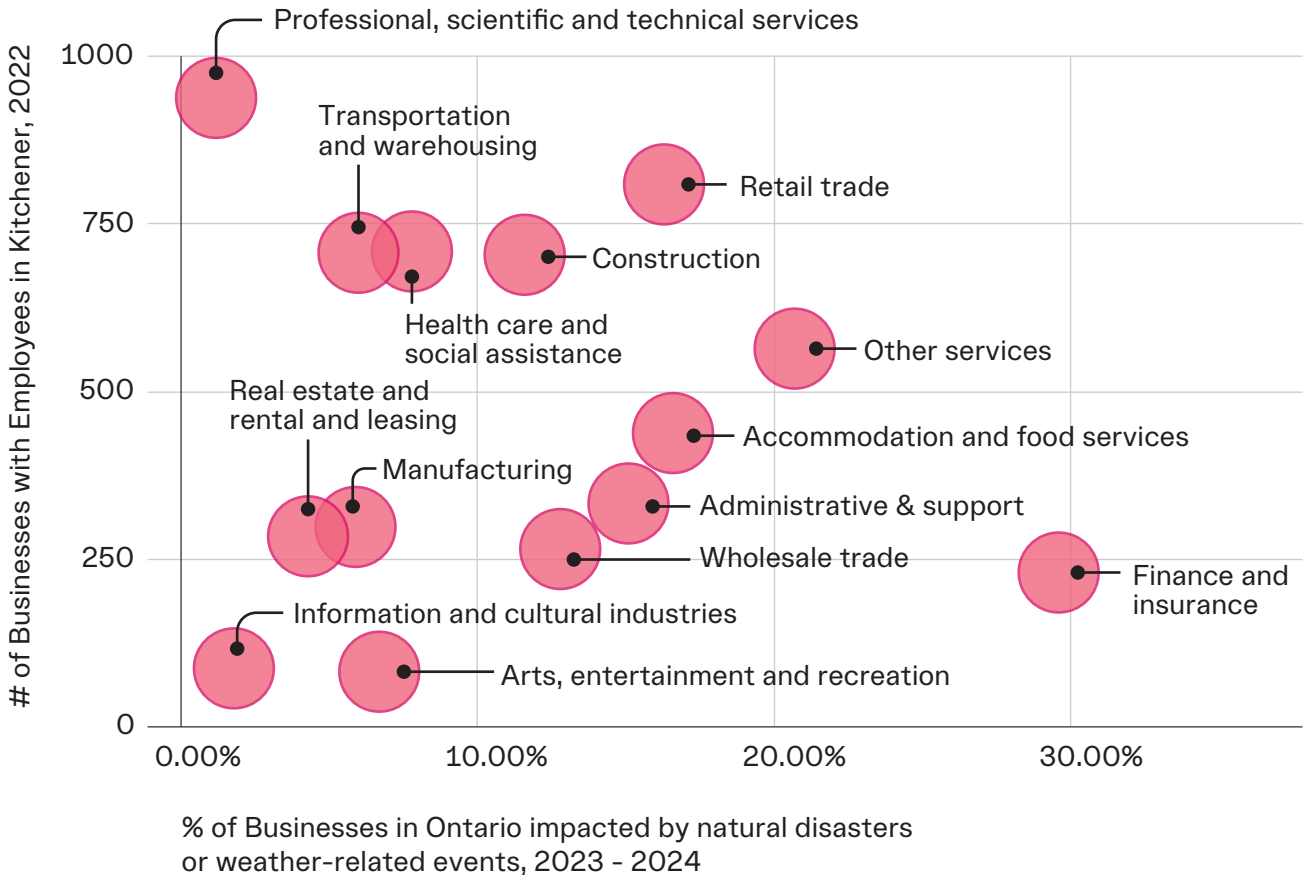

Figure A4.13. Number of businesses in Kitchener vs. percentage of businesses in Ontario impacted by natural disasters or weather-related events by NAICS code.[183]

183 Statistics Canada. Table 33-10-0830-01, "Impact of natural disasters or weather related emergencies on businesses or organizations over the last 12 months, second quarter of 2024." https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3310083001; Statistics Canada. Table 33-10-0663-01, "Canadian Business Counts, with employees, census metropolitan areas and census subdivisions, December 2022." https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3310066301.

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
	Floodplain protection	Development permitted under provincial and municipal policies in regulatory floodplains shall incorporate measures for floodproofing and resilience that accounts for future climate change projections.		Land-use Natural infrastructure Riverine Flood	Natural infrastructure	Flood	Greenspace	Sequestration
	Real time flood monitoring	Kitchener shall work with the GRCA to enhance real-time flood monitoring and public warning systems to reduce flood-related risks to life and property.		Information Education Partnerships	Municipal Leadership	Flood		
	Accessility for early warning systems	Early warning systems for extreme weather events shall provide multilingual alerts and use accessible formats such as large text, braille, and audio messages to reach all community members.		Information Education	Resilience Hubs	Flood Fire Heat Wind		
	Safe centres for vulnerable populations	Accessible cooling, heating and clean air centers shall be established in areas with high concentrations of vulnerable populations, ensuring these facilities are within walking distance, along safe cycling routes or are easily reachable via public transit		Equity	Resilience Hubs	Heat	Equity	
	Neighbourhood resilience hubs	Neighborhood-level resilience hubs shall be established to serve as resource centers for residents to inform, prepare and respond to acute and chronic climate hazards, as well as during and after extreme weather events, providing community activation, shelter, communications, and supplies.		Equity Information	Resilience Hubs	Fire Erosion Heat Wind Flood	Social Capital	
	Safe shelters	Temporary shelters for individuals experiencing homelessness shall be equipped to handle extreme heat, cold, and storms, with adequate resources to support extended stays during prolonged events.		Equity Emergency Management	Resilience Hubs	Fire Flood Heat Wind	Physical health	
	Limit potential invasive species	Kitchener shall identify potential sleeper species and implement measures to prevent their further spread.	Strategy	Biodiversity	Natural infrastructure			
	Encourage stormwater practices	Kitchener shall establish a program to encourage residents and businesses to adopt active stormwater practices.	Programs	Overland flood Water	Safe Water Supply	Extreme rain Flood		
	CRVA for water	Kitchener shall conduct a comprehensive Climate Risk and Vulnerability Assessment to enhance local understanding of water-related risks and hazards.	Information	Information Water	Safe Water Supply	Extreme rain Flood Heat Erosion		
	Regulatory systems for solar	The City shall support regulatory changes to advance the deployment of distributed energy resources, including allowance for virtual net metering and virtual net metering with third party ownership	Information	Leadership Solar Information	Municipal Leadership	Flood Wind Heat	Resiliency Affordability	Electricity
	Monitoring program on flood	Kitchener shall establish a monitoring program to evaluate the effectiveness of flood mitigation measures and adapt policies as needed based on observed outcomes.		Information Flood Reporting	Monitoring progress	Flood		

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
	Vacancy Tax	The Ctiy will implement a vacancy tax to increase the incentive for building occupancy.		Existing houses, New houses	Climate Ready Buildings			Electricity, Natural gas
	Megablocks	The City will implement the megablocks concepts for interested neighbourhoods to enable active transportation, provide greenspace and increase resilience.		Land-use, Existing houses	Climate Ready Buildings		Physical health, Mental health, Greenspace, Resiliency, Air pollution, Equity	
1	Science-based target	The City will adopt a science-based GHG emissions reduction target for corporate operations and the community.	Targets and strategy	Information, Leadership	Municipal Leadership		Mental health	
2	Carbon budget	The City will issue an annual carbon budget along side its capital and operating budgets.	Targets and strategy	Information, Education	Municipal Leadership			
3	Planning principles	The City will apply the following principles to its GHG emissions reduction efforts: Leadership, alignment, leverage, Engagement and emplowerment, Integration, Opportunities, Inclusivity, Fairness, Innovation and Accountability	Targets and strategy	Leadership, Information	Municipal Leadership		Equity	
4	Indigenous knowledge	Kitchener shall partner with Indigenous communities to integrate traditional ecological knowledge into planning processes, ensuring that climate adaptation and land use decisions are informed by both contemporary science and Indigenous perspectives on environmental stewardship.	Targets and strategy	Information, Indigenous knowledge, Partnerships	Municipal Leadership	Fire, Flood, Erosion, Landslide, Heat, Wind		
5	Advocacy	The City will advocate to the Province for policies which support or enables its GHG reduction targets and resilience objectives.	Targets and strategy	Leadership	Municipal Leadership			
6	Fossil fuel treaty	The City will join the Fossil Fuel Non-Proliferation Treaty.	Targets and strategy	Leadership	Municipal Leadership			
7	Consumption-based emissions	The City will complete a consumption-based GHG emissions inventory and identify and implement policies and initiatives to reduce consumption-based GHG emissions.	Targets and strategy	Leadership, Information	Municipal Leadership			Consumption
8	Climate ready infrastructure	Kitchener shall incorporate climate change projections into all environmental, land use and strategic assessments to ensure that future planning and infrastructure are resilient to climate impacts.	Targets and strategy	Information	Municipal Leadership	Flood, Erosion, Heat, Wind, Freeze flaw, Extreme rain		
9	Emissions credit system	Kitchener shall establish a stormwater credit system.	Targets and strategy	Leadership, GHG reduction, Existing houses	Municipal Leadership		Affordability, Innovation, Air pollution	Natural gas

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
10	Innovation pathways		Operations		Municipal Leadership			
11	Renewable electricity	The City will procure 100% renewable electricity for the community, with an opt-out provision.	Operations	Leadership	Municipal Leadership		Air pollution Economic Developm... Employment	Electricity
12	Decarbonise existing municipal buildings	Existing municipal buildings will be decarbonised by 2035.	Operations	Leadership Existing houses	Municipal Leadership		Air pollution	Natural gas
13	Zero emissions new municipal buildings	New municipal buildings will be zero emissions.	Operations	Leadership	Municipal Leadership		Air pollution	Natural gas
14	Municipal solar systems	The City will install solar PV systems at City facilities where appropriate.	Operations	Leadership Solar	Municipal Leadership	Flood Wind Heat	Resiliency Affordability	Electricity
15	Municipal fleets	The City will decarbonise the municipal fleet by 2035.	Operations	Leadership	Municipal Leadership		Air pollution	Gasoline Diesel
16	Resilient municipal infrastrucutre	Kitchener shall use heat-resistant, flood-tolerant, permeable and low carbon materials in the design, construction, and maintenance of roads, bridges, and transit systems to enhance the resilience of transportation infrastructure to climate impacts.	Operations	Embodied emissions Infrastructure	Municipal Leadership	Flood Heat	Employment	
17	Resilient transportation infrastructure	Transportation infrastructure, including bridges and culverts, shall be designed or retrofitted to withstand extreme weather impacts such as heavy rainfall and freeze-thaw cycles.	Operations	Infrastructure	Municipal Leadership	Freeze flaw Extreme rain	Employment	
18	Sustainable procurement	The City will align its procurement policies with its climate action targets and its resilience objectives	Finance	Leadership	Municipal Leadership		Economic Developm...	
19	Social cost of carbon	The City will apply the social cost of carbon when evaluating business cases for policies, infrastructure or other investments.	Finance	Financing	Municipal Leadership			
20	Lifecycle costing	The City shall apply lifecycle costing when evaluating business cases for investments, infrastructure or policies	Finance	Financing	Municipal Leadership			

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
21	Investments	Kitchener will align its investments with its climate mitigation and adaptation targets	Finance	Leadership Financing	Municipal Leadership			
22	Funding mechanisms		Finance	Leadership Financing	Municipal Leadership		Employment	
23	Risk maps	Kitchener shall develop and regularly update climate risk maps that identify areas most vulnerable to extreme weather events, including flooding, high winds, ice storms, and heatwaves.	Information	Information	Municipal Leadership	Fire Flood Erosion Landslide Heat Wind	Resiliency	
24	Update flood risk maps	Flood risk mapping shall be updated every five years, incorporating climate projections and real-time hydrological data to inform land use decisions and emergency response planning.	Information	Information	Municipal Leadership	Flood	Resiliency	
25	Update the CRVA	Kitchener shall regularly update the CRVA to reflect the latest climate projections, data, and emerging climate risks, ensuring that planning projects are based on current and accurate information.	Information	Information	Municipal Leadership	Fire Flood Erosion Landslide Heat Wind		
26	Implementation of the CRVA	Kitchener shall integrate the findings from CRVA processes into all relevant planning and policy frameworks, including land use planning, infrastructure development, and environmental management, to ensure that climate resilience is a foundational consideration in all municipal decisions.	Information	Information	Municipal Leadership	Fire Flood Erosion Landslide Heat Wind		
27	Partner with higher education	Kitchener shall partner with the universities and colleges to develop and implement innovative climate solutions. This collaboration will focus on piloting new adaptation technologies, and developing innovative adaptation policies.	Partnerships	Partnerships	Municipal Leadership	Fire Flood Erosion Landslide Heat Wind		
28	Involve vulnerable communities	Kitchener shall involve representatives from vulnerable communities in the development of climate adaptation policies and emergency response plans, ensuring their needs and perspectives are reflected.	Partnerships	Emergency Management Equity Partnerships	Municipal Leadership	Fire Flood Erosion Landslide Heat Wind		
29	Partnership with GRCA	Kitchener shall continue to collaborate with Grand River Conservation Authority to identify, manage, and protect flood-prone areas and implement regional flood mitigation strategies.	Partnerships	Information Flood Partnerships	Municipal Leadership	Flood		
30	Partner with private sector and non profits	Kitchener shall collaborate with the private sector to encourage businesses to adopt sustainable practices, invest in resilient infrastructure, and integrate climate risk assessments into their operations.	Partnerships	Partnerships	Municipal Leadership	Fire Flood Erosion Landslide Heat Wind	Employment Economic Developm...	
31	Regional Coordination	The City will coordinate with the Region to implement the policies and recommendations in the Region's Adaptation Strategy	Partnerships	Partnerships	Municipal Leadership			

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
32	Risks to health	Kitchener will coordinate with ROWPH on tracking and proactively managing current and emerging chronic and acute climate risks to health (i.e. Lyme disease, heat exposure).	Partnerships	Infrastructure, Information, Partnerships	Municipal Leadership	Heat, Fire	Mental health, Physical health	
33	Professional training	Kitchener shall collaborate with professional associations and educational institutions to develop and promote training programs that enhance the capacity of professionals—including civil engineers, planners, landscape architects, accountants, and others—to apply climate change adaptation tools and information in their practices.	Training	Information, Education	Municipal Leadership	Fire, Flood, Erosion, Landslide, Heat, Wind	Employment	
34	Workforce development	Kitchener shall integrate climate adaptation principles into municipal workforce development programs, ensuring that employees across all departments are trained to incorporate climate resilience into planning, infrastructure development, investments, and service delivery.	Training	Information	Municipal Leadership	Fire, Flood, Erosion, Landslide, Heat, Wind	Employment	
35	Development in hazard lands	Development shall be discouraged in lands prone to extreme weather impacts, such as riverine floodplains, steep slopes, wildland-urban interfaces that may experience wildfires, and lands with unstable soils.	Land-use	Land-use	Natural infrastructure	Fire, Flood, Landslide	Mental health, Greenspace	Sequestration
36	Protecting ecosystems	Kitchener shall prioritize the management and restoration of ecosystems already impacted by climate change, ensuring their ability to adapt to future climate impacts.	Land-use	Biodiversity, Natural infrastructure	Natural infrastructure		Greenspace, Biodiversity	Sequestration
37	Protect wetlands	Wetlands shall be protected and enhanced as critical natural infrastructure for flood mitigation. Development applications impacting wetlands must demonstrate no net loss of wetland area or function.	Land-use	Overland flood, Natural infrastructure	Natural infrastructure	Flood, Extreme rain	Biodiversity, Greenspace	Sequestration
38	Restore wetlands	Kitchener shall prioritize the protection and restoration of wetlands for their role in mitigating the impacts of extreme rainfall and reducing downstream flood risks.	Land-use	Overland flood, Natural infrastructure	Natural infrastructure	Flood, Extreme rain	Biodiversity, Greenspace, Employment	Sequestration
39	Protect and expand urban forests	Kitchener shall support the protection, enhancement, and expansion of urban forests as a key strategy for climate adaptation on public and private lands. This includes preserving and increasing tree canopy coverage, and promoting diverse and climate-resilient species.	Land-use	Biodiversity, Forests, Natural infrastructure	Natural infrastructure	Flood, Heat	Greenspace, Mental health, Air pollution	Sequestration
40	Natural cooling zones	Kitchener shall incorporate zoning provisions to protect and enhance natural cooling zones, within and beyond the Natural Heritage System and Ecological Restoration Areas, and require climate-resilient landscaping for developments within areas identified as vulnerable to heat stress.	Land-use	Natural infrastructure	Natural infrastructure	Heat	Greenspace, Air pollution, Biodiversity	Sequestration
41	Buffer zones	Buffer zones shall be required around natural hazard areas and wetlands to reduce risk to human health and safety and property damage from extreme weather events.	Land-use	Land-use, Natural infrastructure	Natural infrastructure	Flood	Mental health, Greenspace	Sequestration
42	Riparian buffer zones	Riparian buffer zones along waterways shall be maintained and enhanced to absorb storm surges and reduce erosion caused by extreme weather events.	Land-use	Riverine Flood	Natural infrastructure	Flood	Greenspace	Sequestration

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
43	Connecting green spaces for heat	Kitchener will protect and connect green spaces to ensure species migration and ecosystem health under changing climate conditions.	Land-use	Biodiversity, Forests	Natural infrastructure	Heat, Flood	Greenspace, Mental health, Air pollution	Sequestration
44	Tree canopy	Kitchener shall require a minimum tree canopy coverage of 30% in all new residential, commercial, and institutional developments to mitigate the urban heat island effect. Mature trees shall be protected through appropriate zoning and site plan controls.	Land-use	Forests, Natural infrastructure	Natural infrastructure	Heat, Flood	Greenspace, Mental health, Air pollution, Biodiversity	Sequestration
45	Climate projections and natural heritage system	Kitchener shall incorporate climate change projections into the identification and management of Natural Heritage System features, including Ecological Restoration Areas, to ensure long-term resilience and sustainability in the face of changing climate conditions.	Strategy	Information, Land-use, Forests	Natural infrastructure		Greenspace, Biodiversity	Sequestration
46	Infrastructure retreat	Kitchener shall avoid new public investment in current and future hazard lands, decommission existing infrastructure and reroute essential services to safe areas.	Strategy	Flood, Riverine Flood	Natural infrastructure	Flood	Greenspace, Air pollution, Biodiversity	Sequestration
47	Purchase areas with climate risks	Kitchener shall enable the purchase or exchange of residential, commercial, and industrial lands at risk from climate hazards, including flooding and erosion, to mitigate exposure and enhance long-term resilience.	Strategy	Riverine Flood	Natural infrastructure	Flood, Erosion	Greenspace, Biodiversity, Air pollution	Sequestration
48	Restore floodplains	Opportunities for restoring natural floodplain function, including the removal of structures and impermeable surfaces, shall be prioritized in areas with chronic flood risk.	Strategy	Natural infrastructure, Riverine Flood	Natural infrastructure	Flood, Extreme rain	Biodiversity, Greenspace, Employment	Sequestration
49	Urban forests and resilience	Kitchener shall pilot the Urban Forestry Climate Change Response Framework to assess and implement strategies for enhancing the resilience of urban forests to climate change.	Strategy	Forests	Natural infrastructure	Heat, Flood	Greenspace, Air pollution	Sequestration
50	Urban forests and climate projections	Urban forest management practices shall be aligned with climate projections to ensure long-term sustainability and resilience to climate change impacts. Kitchener shall select tree species that are resilient and capable of adapting to future climate conditions, ensuring the long-term health and sustainability of the urban forest.	Strategy	Forests	Natural infrastructure	Heat	Greenspace, Air pollution	
51	Invasive species	Kitchener shall incorporate rapid response measures into climate change policies to prevent the introduction and spread of invasive species.	Strategy	Biodiversity	Natural infrastructure		Biodiversity	
52	Carbon stores	The City shall protect and enhance public and private carbon stores in natural systems.	Strategy	Natural infrastructure	Natural infrastructure	Flood, Heat	Greenspace	Sequestration
53	Climate projections and hazards	Kitchener shall incorporate climate change projections into the identification and management of natural hazards, addressing future risks related to flooding, erosion, wildfires, wind and other climate-related hazards.	Information	Information, Land-use	Natural infrastructure	Flood, Erosion		Sequestration

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
54	Hazard maps	Hazard lands mapping and urban overland flood risk mapping shall be regularly updated in collaboration with the GRCA, ensuring alignment with the latest climate change projections and scientific data.	Information	Land-use, Information	Natural infrastructure	Flood	Greenspace	
55	Local heat risk maps	Kitchener shall employ hyperlocal heat mapping to identify urban heat island hotspots and guide the prioritization of tree planting, green infrastructure investments, and cooling interventions. Heat mapping data shall be updated every five years to inform Official Plan reviews and climate adaptation strategies.	Information	Information, Natural infrastructure	Natural infrastructure	Heat		Sequestration
56	Green infrastructure	Kitchener shall incorporate green infrastructure solutions, such as permeable pavements and vegetation into transportation infrastructure design to reduce heat island effects, improve stormwater management, and increase environmental sustainability.	Operations	Natural infrastructure, Transportation	Natural infrastructure	Heat, Flood, Wind, Fire	Resiliency	Sequestration
57	Permeable surfaces for city infrastructure	Kitchener shall prioritize the use of permeable materials for roads, sidewalks, and parking lots to reduce surface runoff and enhance groundwater recharge.	Operations	Overland flood, Water	Natural infrastructure	Extreme rain, Flood		
58	Permeable surfaces for the community	Kitchener shall require the use of permeable materials for at least 50% of surface areas in parking lots, pathways, and public squares to reduce surface temperatures and enhance groundwater recharge. Roads and sidewalks in new subdivisions shall include reflective or cool pavement materials where feasible.	Operations	Overland flood	Natural infrastructure	Flood		
59	Shading in parks	All new parks and public spaces shall include shaded areas, accessible pathways, and water features to ensure usability and comfort for seniors, children, and individuals with mobility challenges during extreme heat events.	Operations	Biodiversity, Forests	Natural infrastructure	Heat, Flood	Greenspace, Mental health, Air pollution	
60	Natural systems to prevent heat and stormwater	Kitchener shall implement urban forests, green roofs, rain gardens, and wetlands to mitigate the urban heat island effect, improve stormwater management, and enhance biodiversity.	Operations	Forests, Natural infrastructure	Natural infrastructure	Heat, Flood	Greenspace, Mental health, Air pollution, Biodiversity	Sequestration
61	24/7 Carbon free electricity	The City will support the 24/7 Carbon-Free electricity declaration.	Electricity	Electricity	Energy transition			Natural gas
62	The role of Kitchener Utilities	The City will require that Kitchener Utilities develop a strategy for supporting the clean energy transition.	Electricity	Electricity	Energy transition		Affordability, Equity	Natural gas, Propane, Heating oil
63	Support for large solar	The City will identify areas appropriate for large scale solar installations.	Electricity	Electricity	Energy transition		Employment, Equity, Air pollution	Electricity, Natural gas
64	Energy sources map	The City will produce a clean energy sources map to support the development of renewable energy projects.	Electricity	Land-use, Infrastructure, District energy, Thermal energy, Information	Energy transition		Resiliency, Economic Developm..., Energy poverty	

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
65	Incentives for solar	The City shall enable the deployment of DER through zoning, the waiving of fees and through municipal support confirmations for renewable IESO projects in appropriate locations.	Electricity	DER, Solar, Land-use	Energy transition	Flood, Wind, Heat	Resiliency, Affordability	Electricity
66	Fees for electrical upgrades	The City will waive or reduce fees for electrical upgrades for electrification of heating or EV chargers.	Electricity	Information, Thermal energy, Electricity	Energy transition		Air pollution	Natural gas
67	Building energy demand information	The City will work with building owners to identify an energy demand map by energy source and end-use.	Electricity	Land-use, Infrastructure, District energy, Thermal energy, Information	Energy transition		Resiliency	Natural gas
68	Hardened electrical infrastructure	Kitchener shall provide for zoning allowance and staff support for projects designed to harden electrical distribution system infrastructure.	Electricity	Electricity, Infrastructure, Land-use	Energy transition	Flood, Wind, Heat	Resiliency, Affordability	Electricity
69	Clean Heat Zones	The City will identify Clean Heat Zones to faciltiate the decommissioning of the natural gas distribution system.	Thermal	Land-use	Energy transition		Energy poverty, Air pollution	Natural gas
70	Zero Emissions District Energy Zones	The City will identify Zero Emissions District Energy Zones, where connection to cost-competitive zero emissions district energy will be required.	Thermal	Land-use, Infrastructure, District energy, Thermal energy	Energy transition		Economic Developm..., Resiliency	Natural gas
71	Zero combustion zones	The City will incorporate provisions for district energy into secondary plans where relevant.	Thermal	Land-use, District energy, Thermal energy	Energy transition		Resiliency, Economic Developm...	Natural gas
72	End new natural gas connections	The City shall have a policy to end new connections to natural gas.	Thermal	Thermal energy, natural gas	Energy transition	Heat	Affordability, Air pollution, Physical health, Resiliency	Natural gas
73	District energy expansion	The City will require district energy systems to service Zero Emissions District Energy Zones by a specific date.	Thermal	District energy, Thermal energy	Energy transition		Resiliency, Economic Developm...	Natural gas
74	Redundancy in district energy	The City shall ensure that any district energy systems can provide continuity of operation during adverse events.	Thermal	Thermal energy, District energy, Infrastructure	Energy transition	Fire, Flood, Erosion, Landslide, Heat, Wind	Resiliency, Air pollution	Natural gas
75	Resilient heating and cooling	The City shall evaluate the resilience of heating and cooling infrastructure to climate hazards and identify priority investments.	Thermal	Information	Energy transition	Fire, Flood, Erosion, Landslide, Heat, Wind	Resiliency	

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
76	Waste heat from the sewer system	The City will provide coordinated access to waste heat from the sewer system.	Thermal	Information, Thermal energy, Education	Energy transition		Economic Developm...	Natural gas
77	Easements for geothermal	The City will provide easements for geothermal energy.	Thermal	Information, Thermal energy	Energy transition		Economic Developm...	Natural gas
78	Aquifer location	The City will identify aquifer locations to enable geothermal energy while protecting water sources.	Thermal	Thermal energy	Energy transition		Air pollution	Natural gas
79	Geothermal in parks and rights of way	The City will enable district energy in muncipal parks where appropriate and in rights of way.	Thermal	Thermal energy	Energy transition		Air pollution, Economic Developm...	Natural gas
80	Coordinate geothermal development	The City will provide information on geothermal projects and coordinate the development of geothermal across the City, while preserving aquifers.	Thermal	Thermal energy	Energy transition		Economic Developm...	Natural gas
81	Biogas for RNG	The City will identify and implement projects to generate biogas for renewable natural gas	Thermal	Thermal energy	Energy transition		Air pollution, Physical health, Affordability	Natural gas
82	Air source heat pump for AC	The City will require the installation of air source heat pumps when central air conditioners are being replaced.	Thermal	Thermal energy, Information	Energy transition		Economic Developm...	Natural gas
83	Compact communities	Communities can work to improve their jobs / housing balance to shorten commute trips, and encourage mixed-use development to shorten trip distances for shopping, services and recreation. Additionally, a community can engage in regional transportation planning processes to increase the ability for its residents to access regional destinations via public transit or other ride sharing options.	Land-use	Transportation, Land-use	Transforming Transportation D...		Physical health	Gasoline
84	Reducing sprawl	The City will alter or eliminate sprawl-inducing zoning provisions, such as minimum lot and house sizes, setback requirements, and the strict separation of certain land uses.	Land-use	Transportation	Transforming Transportation D...		Physical health, Air pollution, Resiliency	Gasoline
85	Infill development	The City will promote infill development, renovation of existing buildings, and the redevelopment of declining or abandoned commercial areas by offering loans, rehabilitation tax credits, and expedited approval processes and investing in infrastructure.”	Land-use	Land-use	Transforming Transportation D...		Affordability, Physical health, Economic Developm..., Employment	Gasoline
86	Pedestrianization	The City shall increase the use of streets for vehicular transportation modes and activities.	Land-use	Transportation	Transforming Transportation D...		Physical health, Economic Developm..., Social Capital	Gasoline

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
87	Shaded pedestrian routes	Major pedestrian and cycling routes, particularly those connecting transit hubs, schools, and community facilities, and neighbourhood common spaces, shall be designated as urban cooling corridors. These corridors shall feature continuous shade coverage through tree planting, awnings, and other shading structures, as well as accessible water features or misting stations where feasible.	Land-use	Transportation	Transforming Transportation D...		Physical health	Gasoline Diesel
88	Clean last mile delivery	The City will designate a zero emissions last mile delivery zone.	Land-use	Transportation Electricity	Transforming Transportation D...		Air pollution Employment	Diesel
89	Incentives for zero emissions transport	The City will support zero emissions transport including electric vehicles, active transportation, transit, car sharing with incentives, investments in infrastructure and policies and educational programs.	Infrastructure	Transportation	Transforming Transportation D...		Physical health Affordability Equity	Gasoline
90	EV charging on street	The City will ensure that street EV charging is ubiquitous.	Infrastructure	Solar Electricity	Transforming Transportation D...		Affordability Resiliency Employment	Electricity
91	Parking benefit districts	The City shall use parking revenues to increase the public benefit and equity benefit of the streetscapes	Infrastructure	Transportation	Transforming Transportation D...		Equity	Gasoline Diesel
92	Electric micro-mobility	The City will provide infrastructure and incentives to encourage and accelerate the safe deployment of electric micro-mobility.	Infrastructure	Transportation Electricity	Transforming Transportation D...		Physical health Equity Affordability	Gasoline
93	Active transportation infrastructure		Infrastructure		Transforming Transportation D...			
94	Superblock objectives		Superblocks	Infrastructure Land-use Transportation Social capital GHG reduction	Transforming Transportation D...			
95	Superblock design		Superblocks	Infrastructure Land-use Transportation Social capital GHG reduction	Transforming Transportation D...			
96	Transportation in superblocks		Superblocks	Infrastructure Land-use Transportation Social capital GHG reduction	Transforming Transportation D...			
97	Superblock evaluation		Superblocks	Infrastructure Land-use Transportation Social capital GHG reduction	Transforming Transportation D...			

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
98	Resilient, affordable, low carbon buildings label	Kitchener will provide a labelling system to indicate which buildings have higher levels of resilience against climate hazards.	All buildings	Education, Information	Climate Ready Buildings	Heat, Flood, Wind, Fire	Resiliency	
99	Education on resilience, GHG emissions and affordability	Kitchener shall provide residents with educational materials and resources on retrofitting their homes to improve climate resilience. This will include guidance on energy-efficient heating and cooling systems, stormproofing measures, and other climate adaptation strategies.	All buildings	Existing houses, Education	Climate Ready Buildings	Heat, Flood, Wind	Affordability, Energy poverty, Mental health	Electricity, Natural gas
100	Build-back better	The City shall ensure that infrastructure or buildings which are repaired or rebuilt following a severe weather event or other impact are safely located and designed to address the future impacts of climate change.	All buildings	Existing houses, Infrastructure, Affordability	Climate Ready Buildings	Flood, Fire, Wind	Employment, Affordability	Electricity, Natural gas
101	Solar PV on roofs and walls	The City will require the inclusion of solar PV on roofs and walls.	All buildings	Electricity, Leadership	Climate Ready Buildings		Air pollution	Electricity
102	Vehicle to grid charging	The City will work with utilities to develop and implement vehicle-to-grid integration.	All buildings	Transportation	Climate Ready Buildings		Economic Developm..., Resiliency	Gasoline
103	GHG standard for existing buildings	The City will implement a Building Performance Standard for existing buildings.	Existing buildings	Existing houses	Climate Ready Buildings		Affordability, Energy poverty, Physical health, Social Capital, Air pollution, Resiliency	Natural gas, Fuel oil, Propane, Electricity
104	Financial assistance for resilience	Kitchener shall offer financial incentives, such as grants or low-interest loans, to assist in retrofitting homes with energy-efficient heating, cooling, and stormproofing measures, with a scaled incentive based on income level.	Existing buildings	Existing houses	Climate Ready Buildings	Heat, Flood, Wind, Fire	Employment	
105	Best practices in new construction	The City will align the High-Performance Development Standard with best practices from other municipalities in Ontario.	New buildings	New houses	Climate Ready Buildings		Energy poverty	
106	Embodied carbon in new buildings	The City will include embodied emissions targets in the High-Performance Development Standard.	New buildings	New houses, Embodied emissions	Climate Ready Buildings		Employment, Physical health	Consumption
107	Incentives for high performance buildings	The City will include incentives for exceeding the minimum standard in the High-Performance Development Standard.	New buildings	Financing, New houses	Climate Ready Buildings		Energy poverty	Natural gas, Electricity
108	Active transportation for new construtuion	The City will require bike parking and EV charging in the High-Performance Development Standard.	New buildings	New houses	Climate Ready Buildings		Energy poverty, Physical health	Natural gas

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
109	EV charging in new homes	The City will require the installation of EV chargers in new residential construction.	New buildings	Transportation, Electricity	Climate Ready Buildings		Employment	Gasoline
110	Resilient new buildings	Kitchener shall require climate-resilient designs, including enhanced insulation, hurricane-resistant roofs, and flood-proof basements, to ensure new developments are prepared for future climate impacts in Green Development Standards and Building Performance Standards.	New buildings	New houses	Climate Ready Buildings	Heat, Flood, Wind, Fire	Employment	
110	Resilience in green development standards	The Green Development Standard will require the use of wind-resistant building materials and structural reinforcements to withstand the impacts of severe windstorms and ice accumulation.	New buildings	New houses	Climate Ready Buildings	Wind, Extreme rain	Resiliency	
111	Heat mitigation in new buildings	Development proposals for buildings exceeding 5,000 square meters shall incorporate heat mitigation strategies, including green roofs, reflective roofing materials, or equivalent cooling technologies. Incentives, such as density bonusing, shall be provided for developments that exceed municipal heat resilience standards, including those integrating district cooling or renewable energy systems.	New buildings	New houses	Climate Ready Buildings	Heat	Resiliency	
112	Climate resilient social housing	New affordable housing developments must incorporate climate-resilient design, including passive cooling features, floodproofing, and energy-efficient systems, to protect vulnerable residents during extreme weather events.	New buildings	New houses, Equity, Affordability	Climate Ready Buildings	Heat, Flood, Wind, Fire	Resiliency	
113	Low impact development	All site plan approvals shall incorporate low-impact development (LID) principles, including measures to reduce impervious surfaces, manage runoff on-site, and promote natural infiltration as per the Green Development Standard.	Land-use	Overland flood, New houses	Climate Ready Buildings	Flood	Greenspace	
114	Urban heat island zones	New developments must demonstrate integrated cooling measures as part of site plan approval.	Land-use	New houses, Infrastructure	Climate Ready Buildings	Heat	Employment	
115	Floodproofing buildings	New developments in areas subject to overland flooding must include floodproofing measures, such as elevated building foundations, watertight doors, and protective berms.	Land-use	Overland flood	Climate Ready Buildings	Flood	Employment	
116	Flood prone areas	Development proposals in flood-prone areas must demonstrate compliance with floodproofing standards and include stormwater management systems that reduce runoff and improve water retention.	Land-use	New houses, Infrastructure	Climate Ready Buildings	Flood	Employment	
117	Passive solar gain for new construction	The City will require the evaluation of and optimisation of passive solar gain in new developments.	Land-use	Electricity, Leadership	Climate Ready Buildings		Air pollution, Innovation, Economic Developm...	Electricity
118	Solar access protection	The City will develop a bylaw to protect access to solar resources for each building.	Land-use	Energy Efficiency	Climate Ready Buildings		Affordability, Resiliency	Natural gas

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
119	Support sustainable consumption	The City will identify opportunities to reduce GHG emissions from consumption including in the food system, infrastructure and materials, aviation, clothing, vehicles and electronics.	Other	Embodied emissions Infrastructure New houses	Sustainable Consumption		Affordability	Consumption
120	Advertising	Kitchener shall ban fossil fuel advertising.	Other	Leadership	Sustainable Consumption			
121	Circular economy	The City shall develop a circular economy strategy for economic development and waste management.	Waste	Waste	Sustainable Consumption		Economic Developm...	Waste
122	ICI waste	The City shall recyclable/reusable material diversion target, requiring that 75% of a building's weight must be kept out of landfills through reuse or recycling.	Waste	Waste	Sustainable Consumption			Waste
123	Organics waste	The City shall increase rate of organics diversion for biogas production or composting.	Waste	Waste	Sustainable Consumption			Waste
124	Food production for new homes	The City will require allocation for food production in new construction.	Food	Food	Sustainable Consumption		Resiliency Mental health Physical health Greenspace	Consumption
125	Community gardens	The City shall ensure access to community allotments for each neighbourhood, prioritizing vulnerable populations.	Food	Food	Sustainable Consumption		Resiliency Greenspace	Consumption
126	Protect food systems	The City will work to develop sustainable food systems that are inclusive, resilient, safe and diverse, that provide healthy and affordable food to all people in a human rights-based framework, that minimise waste and conserve biodiversity while adapting to and mitigating impacts of climate change;	Food	Food	Sustainable Consumption		Resiliency Employment Economic Developm...	
127	Encourage food production	The City shall review and amend existing urban policies, plans and regulations in order to encourage the establishment of equitable, resilient and sustainable food systems;	Food	Food	Sustainable Consumption		Resiliency Employment Economic Developm...	
128	Markets	The City shall provide policy and programme support for municipal public markets including farmers markets, informal markets, retail and wholesale markets, restaurants, and other food distributors.	Food	Food	Sustainable Consumption		Resiliency Economic Developm...	
129	Food networks	The City shall improve and expand support for infrastructure that link urban buyers to urban, peri-urban and rural sellers while also building social cohesion and trust, supporting cultural exchange and ensuring sustainable livelihood, especially for women and young entrepreneurs.	Food	Food	Sustainable Consumption		Resiliency Employment Economic Developm...	

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
130	Food distribution	The City shall support short food chains, producer organisations, producer-to-consumer networks and platforms, and other market systems that integrate the social and economic infrastructure of urban food system that links urban and rural areas. This could include civil society-led social and solidarity economy initiatives and alternative market systems.	Food	Food	Sustainable Consumption		Resiliency Economic Developm...	Consumption
131	Encourage plant-based diets	The City will encourage plant-based diets through procurement and education.	Food	Food	Sustainable Consumption		Physical health	Consumption
132	Food waste	The City shall save food by facilitating recovery and redistribution for human consumption of safe and nutritious foods, if applicable, that are at risk of being lost, discarded or wasted from production, manufacturing, retail, catering, wholesale and hospitality.	Food	Waste Food	Sustainable Consumption		Resiliency Equity	
133	Land for food production	The City shall protect and enable secure access and tenure to land for sustainable food production in urban and peri-urban areas, including land for community gardeners and smallholder producers, for example through land banks or community land trusts; provide access to municipal land for local agricultural production and promote integration with land use and city development plans and programmes.	Land-use	Food	Sustainable Consumption		Resiliency Mental health	
134	Protect key infrastructure	Key infrastructure such as hospitals, emergency shelters, emergency services buildings and transportation corridors shall be assessed for vulnerability to extreme weather events, with priority given to retrofitting and resilience upgrades, while simultaneously achieving GHG emissions reduction objectives.	Infrastructure	Infrastructure Equity Information	Resilience Hubs	Flood Fire Wind Extreme rain Heat		
135	Safe centres	Public facilities, including libraries and community centers, shall be designated as cooling, heating, and clean air centers during extreme weather events, and updated as required, while simultaneously achieving GHG mitigation objectives.	Infrastructure	Equity Infrastructure Existing houses	Resilience Hubs	Flood Wind Heat Fire	Equity	Electricity Natural gas
136	Resilience hubs in vulnerable neighbourhoods	Resilience hubs shall be established in vulnerable neighborhoods as neighbourhood centres to support programs related to resilience and climate mitigation.	Infrastructure	Equity Information	Resilience Hubs	Fire Erosion Heat Wind Flood	Social Capital	
137	Passive design for public spaces	New public facilities shall incorporate passive cooling design elements, such as natural ventilation, shade structures, and reflective roofing materials, and be strategically located to maximize accessibility for vulnerable populations.	Infrastructure	Infrastructure New houses	Resilience Hubs	Heat		Electricity
138	Access to splashpads	Kitchener will ensure that each neighbourhood in the CIty has walking or cycling access to a splashpad.	Infrastructure	Infrastructure Transportation	Resilience Hubs	Heat	Mental health Physical health	Gasoline Diesel
139	Safe infrastructure for vulnerable communities	Kitchener shall prioritize infrastructure upgrades and public service delivery in neighbourhoods with high vulnerability to extreme weather events, ensuring equitable access to resources and support.	Infrastructure	Infrastructure Equity Natural infrastructure	Resilience Hubs	Heat	Greenspace	
140	Heat protection for vulnerable populations	Heat mitigation efforts shall prioritize neighborhoods with higher concentrations of vulnerable populations, such as seniors, low-income residents, and individuals with mobility challenges. Tree planting, shaded transit stops, and access to cooling centers shall be prioritized in these areas to enhance resilience and equity.	Infrastructure	Equity Existing houses	Resilience Hubs	Heat		

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
141	Manage climate anxiety	Kitchener will develop a strategy to respond to climate anxiety in coordination with Community Services, Infrastructure Services and ROWPH.	Programs	Information, Infrastructure, Partnerships	Resilience Hubs	Fire, Erosion, Heat, Wind, Flood	Mental health, Greenspace	
142	Programs at resilience hubs	Targeted programs shall be developed and delivered through resilience hubs to assist low-income households, seniors, and individuals with disabilities in preparing for and recovering from extreme weather events.	Programs	Equity, Education, Existing houses	Resilience Hubs	Fire, Flood, Heat, Wind	Mental health, Physical health, Energy poverty	Fuel oil, Propane
143	Build back better for vulnerable populations	Kitchener shall support vulnerable residents in accessing disaster recovery assistance programs and insurance claims for damages caused by extreme weather events.	Programs	Equity, Build back better	Resilience Hubs	Fire, Flood, Heat, Wind	Mental health, Affordability	
144	Financial support for vulnerable populations	Kitchener shall advocate for programs that provide financial relief for vulnerable households struggling with high energy costs during extreme heat or cold events.	Programs	Equity, Emergency Management	Resilience Hubs	Fire, Flood, Heat, Wind	Energy poverty	Fuel oil, Propane
145	Partner with NGOs	The City shall establish partnerships with non-governmental organizations and social service providers shall be established to extend support services to vulnerable populations during and after extreme weather events.	Programs	Information, Equity	Resilience Hubs			
146	Vulnerability index	A vulnerability index shall be developed and maintained, using data on income, age, housing quality, and climate exposure to guide municipal interventions.	Information	Equity, Information	Resilience Hubs	Fire, Flood, Erosion, Landslide, Heat, Wind		
147	Vulnerable neighbourhood maps	Kitchener shall use demographic and climate risk mapping to identify neighbourhoods with high concentrations of vulnerable populations, ensuring targeted interventions for extreme weather preparedness and response.	Information	Equity, Information	Resilience Hubs	Fire, Flood, Erosion, Landslide, Heat, Wind		
148	Citizen science	Kitchener shall engage residents in data collection and reporting initiatives to enhance local knowledge, promote community involvement, and support informed decision-making in climate resilience efforts.	Information	Information, Education	Resilience Hubs	Fire, Flood, Erosion, Landslide, Heat, Wind	Resiliency	
149	Community CRVA	Kitchener shall conduct a community-wide CRVA to identify and evaluate climate-related risks and vulnerabilities across all sectors, including infrastructure, housing, public health, and natural systems.	Information	Information, Flood, Equity	Resilience Hubs	Fire, Flood, Erosion, Landslide, Heat, Wind		
150	Public education on flood	Kitchener shall conduct regular public awareness campaigns on flood preparedness, including guidance on property-level floodproofing and emergency evacuation protocols.	Information	Education	Resilience Hubs	Flood		
151	Public education on heat	Kitchener shall conduct regular public awareness campaigns on household-level heat mitigation strategies, such as tree planting, energy-efficient cooling systems, and proper insulation techniques.	Information	Education	Resilience Hubs	Heat		

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
152	Climate literacy	The City shall implement a program to build climate literacy amongst community members.	Information	Education	Resilience Hubs		Resiliency Mental health	
153	Protection of water sources		Information	Water Natural infrastructure	Safe Water Supply			
154	Water and climate projections	Kitchener shall assess the vulnerability of the municipal water distribution systems, to the impacts of higher temperatures and changing hydrologic patterns.	Information	Water Information	Safe Water Supply	Heat Erosion Flood		
155	Water system and climate projections	Kitchener shall plan and design new water infrastructure with future climate impacts in mind, including strategies to enhance water storage capacity, diversify water supply sources, and improve overall system resilience.	Information	Water Information	Safe Water Supply	Heat Flood		
156	Real time monitoring for water quality	Kitchener shall implement monitoring tools and real-time data collection systems to track water temperatures and algae blooms. This will help mitigate the risks to drinking water quality and human health by enabling proactive management of algae bloom impacts.	Information	Information Water	Safe Water Supply	Extreme rain Flood Erosion Heat		
157	Extreme weather emergency response	Kitchener shall maintain and update an Extreme Weather Emergency Response Plan, incorporating strategies for evacuation, shelter provision, and resource distribution during extreme weather events	Information	Information Emergency Management	Preparing for emergencies	Flood Fire		
157	Water conservation	Kitchener shall promote community awareness of water conservation practices that homeowners can implement to reduce water consumption and support sustainable water management.	Programs	Education Water	Safe Water Supply			
158	Education on emergency response	Ongoing public education campaigns will raise awareness about personal preparedness for extreme weather, including floods, wildfires, and heatwaves. These campaigns should emphasize the importance of emergency kits, evacuation routes, and home retrofitting.	Information	Information Education	Preparing for emergencies	Flood Fire Heat Wind		
158	Municipal water conservation	Kitchener shall adopt water conservation practices in municipal facilities to reduce water consumption.	Programs	Water	Safe Water Supply			
159	Early warning systems	Real-time early warning systems for extreme weather events shall be established, using mobile alerts and local communication networks to inform residents and businesses.	Information	Information Education	Preparing for emergencies	Flood Fire Heat Wind		
159	Low-impact development	Kitchener shall require new developments to adhere to Low-Impact Development (LID) standards to promote groundwater retention and enhance sustainable water management practices.	Programs	Overland flood Water	Safe Water Supply	Extreme rain Flood	Biodiversity Greenspace	

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
160	Emergency response for vulnerable populations	Emergency response plans shall incorporate specific provisions for the evacuation, sheltering, and care of vulnerable populations, such as, but not only, seniors, children, and individuals with disabilities.	Infrastructure	Equity Emergency Management	Preparing for emergencies	Flood Fire		
160	Stormwater utility	The City's stormwater utility will collect fees based on impermeable surface area.	Programs	Water Overland flood	Safe Water Supply	Flood		
161	Accessibility for emergency infrastructure	Municipal infrastructure upgrades shall include barrier-free design to ensure that evacuation routes, transit stops, and public facilities remain accessible to all residents, including those with disabilities.	Infrastructure	Infrastructure Equity	Preparing for emergencies			
161	Enhanced stormwater credit system	Kitchener shall establish a stormwater credit system.	Programs	Overland flood	Safe Water Supply	Extreme rain Flood		
162	Access routes in areas vulnerable to flood	Subdivisions in areas prone to flooding must include emergency access routes that remain operational during flood events and comply with flood-resilient design standards.	Infrastructure	Transportation	Preparing for emergencies	Flood		
162	Innovative stormwater mangement	Kitchener will continue to test and assess innovative stormwater management projects that account for changing climatic conditions.	Programs	Overland flood Water Information	Safe Water Supply	Extreme rain Flood		
163	Emergency response for transportation	Kitchener shall develop and implement emergency response plans for transportation systems that include strategies for rapid recovery and restoration of services after extreme weather events, ensuring minimal disruption to residents and businesses.	Infrastructure	Transportation	Preparing for emergencies	Heat Flood Wind Fire	Resiliency	Gasoline Diesel
164	Resilient social housing		Infrastructure	Equity	Preparing for emergencies			
165	Learning from extreme weather events	Following extreme weather events, Kitchener shall conduct reviews to assess response effectiveness, identify gaps, and improve future emergency management strategies.	Monitoring	Information Monitoring	Monitoring progress	Flood Fire Wind	Resiliency	
166	Climate sensors	Kitchener shall deploy sensors to monitor temperature, air quality, water levels, and other climate-related variables to support informed climate resilience decisions.	Monitoring	Information	Monitoring progress		Resiliency	
167	Transportation for vulnerable people during an emergency	Emergency response plans shall include transportation options for vulnerable individuals who may lack access to private vehicles during extreme weather events, with priority given to seniors and individuals with disabilities.	Infrastructure	Equity Transportation	Preparing for emergencies	Flood Fire Wind Extreme rain Heat		

Order	Label	Policy Language	Detailed themes	Themes	Big Moves	Climate hazards	Co-benefits	GHG Inventory
167	Impact on climate change	Kitchener shall apply a monitoring and evaluation strategy to assess the impacts of climate change on the City and the effectiveness of the City's response.	Monitoring	Information, Reporting	Monitoring progress	Fire, Flood, Erosion, Landslide, Heat, Wind		
168	Impact on vulnerable populations	Kitchener shall track and report on the effectiveness of climate adaptation measures in reducing risks to vulnerable populations, revising policies as needed to improve outcomes.	Monitoring	Information, Equity, Reporting	Monitoring progress	Fire, Flood, Erosion, Landslide, Heat, Wind		
169	Indicators	The City will report on annual on indicators which track climate trends and implementation of policies relating to resiliency.	Monitoring	Monitoring	Monitoring progress			
170	Annual report on climate risks	The City will report annually on transition and physical risks and opportunities to the City's operations and the community according to the requirements of the Canadian Sustainability Standards Board.	Monitoring	Reporting	Monitoring progress		Economic Developm...	
171	Reporting platforms		Monitoring	Reporting	Monitoring progress			
172	Services during extreme weather	Kitchener shall partner with ROWPH to provide outreach services during heatwaves and cold snaps, including wellness checks and distribution of supplies such as fans, air purifiers, blankets, and weatherproof clothing.	Programs	Equity, Partnerships	Preparing for emergencies	Fire, Flood, Heat, Wind	Physical health	
173	Community training	Kitchener will train community members, including vulnerable individuals, in emergency preparedness, first aid, and localized response strategies for extreme weather events.	Training	Education, Emergency Management	Preparing for emergencies	Fire, Flood, Erosion, Landslide, Heat, Wind		