Community Emissions Reduction Planning: A Guide for Municipalities

DRAFT

Ontario

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Contents

Guide for Readers 4
Acronyms 8

Executive Summary 11
- The Pivotal Role of Municipalities 12
- Aligning Municipal Goals and Objectives 12
- Municipal operations 16
- The Energy and Emissions Planning Outcomes 17

Part A:
Rationale & Context for Emissions Planning 19

- 1. Introduction 20
- 2. Provincial policy 22
  - The Climate Change Mitigation & Low-carbon Economy Act
  - Ontario Climate Action Plan
  - The Planning Act
  - Provincial Policy Statement
- 3. The Role of Municipalities 31
  - Direct Control and Indirect Influence
  - Infrastructure, Land-use Planning and Lock-in
- 4. Guiding Principles of Energy and Emissions Planning 42
  - Leadership
  - Alignment
  - Leverage
  - Engagement and Empowerment
  - Integration
  - Opportunities
  - Inclusivity
  - Fairness
  - Innovation
  - Accountability

Part B:
The Energy & Emissions Planning Process 45

- 5. Energy & Emissions Plan Development
- 5.1 A Map of the Planning Process
- 5.2 Building on Previous Work
- 5.3 Details of Key Planning Process Elements 53
  - Stage 1: Preparation
  - Stage 2: Inventories
  - Stage 3: Target Setting
  - Stage 4: Actions and Scenarios Development
  - Stage 5: Implementation
  - Stage 6: Monitoring and Evaluation
- 5.4 Energy and Emissions Planning Process Conclusions 155

Part C:
Resources 157

6. Engagement: A Cross-cutting Theme 158
- 6.1 Objectives
- 6.2 Principles of engagement
- 6.3 Processes
- 6.4 Plan elements for public input consideration

7. Planning Support 165

8. Tools and resources 164
- Stage 1: Preparation
- Stage 2: Inventories
- Stage 3: Target Setting
- Stage 4: Actions and Alternative Scenario Development
- Stage 5: Implementation
- Stage 6: Monitoring and Evaluation

9. Glossary 173

10. References 176

Appendix 1: Findings from the research summaries 180
Appendix 2: Sample terms of reference 188
Appendix 3: Sample data request 195
Appendix 4: GPC Reporting 202
Appendix 5: Sector-specific Considerations for Inventories 204
Appendix 6: A Synopsis of Co-benefits of Low Carbon Actions 208
Appendix 7: GHG inventory assumptions 217
Appendix 8: Spheres of Influence Method 220
Appendix 9: Energy and Emissions Models, Assumptions & Calibration 223
Appendix 10: Multi-criteria Analysis for Prioritization & Decision-making 225
Appendix 11: Municipal Land-use Policies to Support GHG Mitigation in Ontario 229
Appendix 12: Sample Energy and Emissions Plan Contents 233

Guide for Readers

This Guideline has been prepared to support provincial land-use planning direction related to the completion of energy and emissions plans. The plans will typically include community-wide and municipal/corporate greenhouse gas (GHG) inventories, the setting of emissions reduction targets, and the development of strategies to reduce GHG emissions.

The Government of Ontario has established provincial GHG reduction targets of 15% below 1990 levels by 2020, 37% below 1990 levels by 2030, and 80% below 1990 levels by 2050. This Guideline describes how the activities of municipalities are vital to achieving these targets and for planning low-carbon communities..

The Guideline has two core objectives: to educate planners, other municipal staff, citizens, and stakeholders on the municipal opportunities to reduce energy and GHG emissions (in particular for land-use policy); and to provide guidance on methods and techniques to incorporate consideration of energy and GHG emissions into municipal activities of all types. To support the second objective, a detailed planning process is described.

The Guideline is divided into three modules.

Part A:
Rationale and Context for Emissions Planning

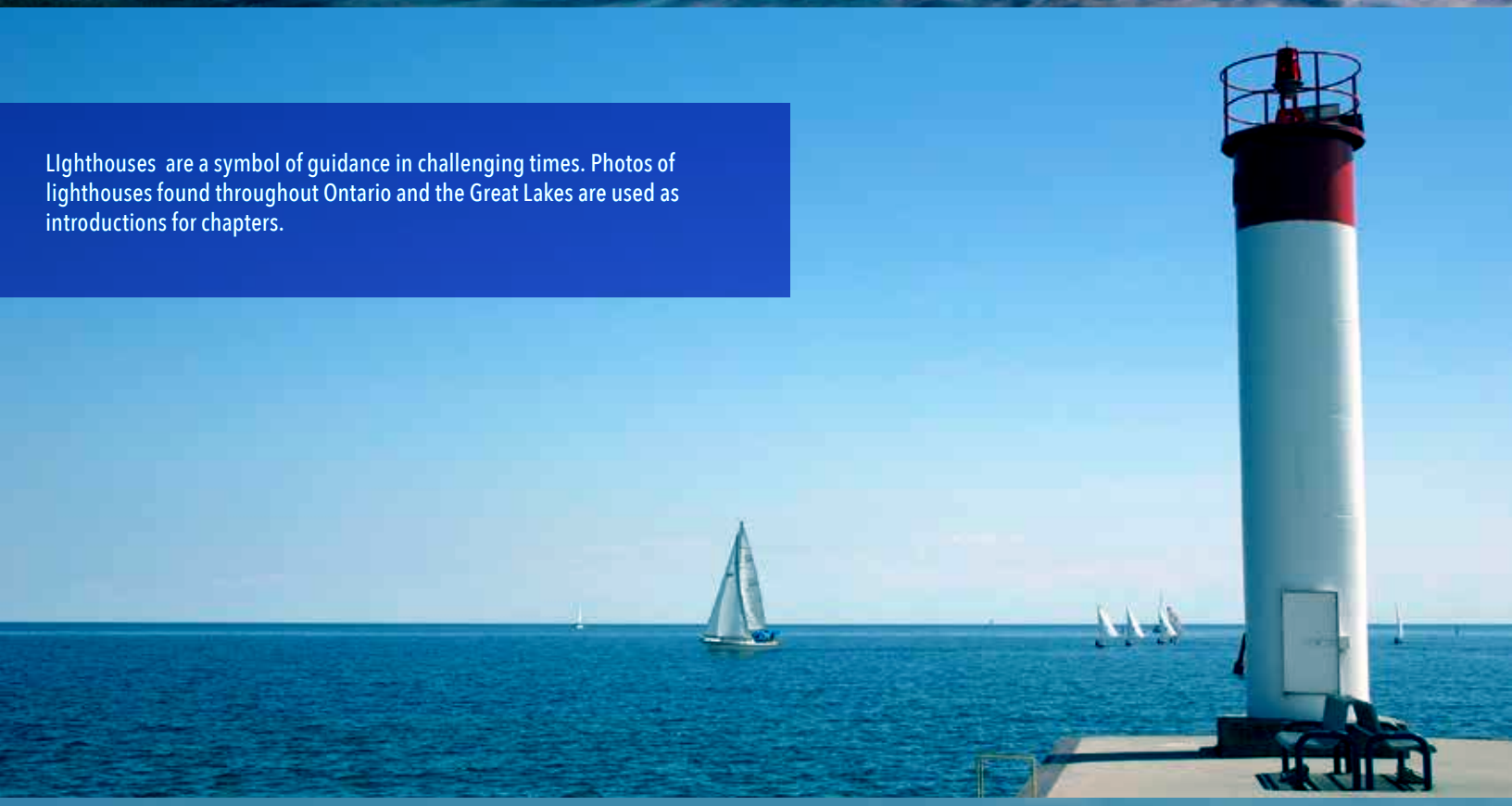
Part B:
The Energy and Emissions Planning Process

Part C:
Tools and Resources

Throughout the Guideline there are:

- Example practices from municipalities;
- Summary tables;
- Illustrations from studies and academic literature; and
- Tools or methods that can be used to support analysis.

LIghthouses are a symbol of guidance in challenging times. Photos of lighthouses found throughout Ontario and the Great Lakes are used as introductions for chapters.



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Acronyms

ACRONYM	DEFINITION
BAU	Business as usual
CCAP	Climate Change Action Plan (Ontario)
CDM	Conservation and Demand Management Plan
CEEP	Community energy and emissions plan
CEEM	Community energy and emissions model
CEIP	Community energy investment plan
CNCA	Carbon Neutral Cities Alliance
CO2e	Carbon dioxide equivalents
CURB	Climate action for urban sustainability (GHG model)
DPA	Development permit area
EUI	Energy use intensity
FCM	Federation of Canadian Municipalities
GHG	Greenhouse gas emissions
GMF	Green Municipal Fund
GPC	Global Protocol for Community-Scale GHG Emissions Inventories
HDD	Heating degree days
ICLEI	ICLEI – Local Governments for Sustainability
IPCC	Intergovernmental Panel on Climate Change
LAP	Local Action Plan
IRR	Internal rate of return
LGOP	Local Government Operations Protocol
LIC	Local improvement charge
MOECC	Ministry of Environment and Climate Change
MAC	Marginal abatement cost
MCA	Multi-criteria analysis
MPAC	Municipal Property Assessment Corporation
NGO	Non governmental organization
NPV	Net present value
OCP	Official Community Plan
PACE	Property assessed clean energy
PCP	Partners for Climate Protection
PPMF	Programs, protocols, methods and frameworks
PPS	Provincial Policy Statement
ROI	Return on investment
SCC	Social cost of carbon

A Note on Terms

In this Guideline, 'local government' refers to entities providing government services in a specific geographic area. A 'municipality' is defined as everything within a defined geographic area including dwellings, businesses, and transportation systems. 'Emissions planning' refers to the process of incorporating consideration of GHG emissions and energy into the policies and operations of a municipality. Community energy and emissions planning is considered to be equivalent to activities frequently described as municipal energy planning, climate action planning (mitigation and adaptation) and low carbon planning.

Executive Summary

THE CONTEXT

This Guideline is intended to help municipalities in Ontario develop quantitative, targeted strategies for supporting their communities in making the transition to a low carbon future. The increasing role of municipalities in responding to climate change is a long term, global trend that began in Ontario nearly 30 years ago.

The Guideline is intended to support Ontario municipalities for two key purposes:

1. To support actions under Ontario's Five Year Climate Change Action Plan 2016-2020 (CCAP). CCAP envisions a significant role for municipalities in the fight against climate change with two new funding programs: the Municipal Action Plan Program which supports community GHG reduction planning, and the Municipal GHG Challenge Fund which supports community GHG reduction projects. The Guideline will serve as a resource tool for municipalities that are participating in these two programs.
2. New policy direction in the Growth Plan for the Greater Golden Horseshoe, 2017 (Policy 4.2.10.2) made under the Coordinated Provincial Plans Review encourages municipalities to develop GHG reduction plans, through official plan conformity, to develop strategies to reduce greenhouse gas emissions within their communities, to complete greenhouse gas inventories for a range of sources, and to establish interim and long-term greenhouse gas reduction targets that support provincial targets and reflect the goal of low-carbon communities and to monitor progress towards the achievement of these targets.

Beyond providing guidance on how to comply with these new mandates, the Guideline also helps municipalities of all sizes and contexts understand their influence on greenhouse gas emissions, and how to plan their communities so that the goal of reducing greenhouse gas emissions is aligned with other community social and economic goals and can be used to provide direction on other provincial policies related to climate change.

The Provincial Policy Statement, 2014 (PPS) contains policies related to climate change. For example, Section 1.8.1 states "Planning authorities shall support energy conservation and efficiency, improved air quality, reduced greenhouse gas emissions, and climate change adaptation through land-use and development patterns." Municipalities or planning authorities are required to amend their official plans to be consistent with PPS policies including policies on climate change.

The recent amendment of the Planning Act through Bill 68 (Modernizing Ontario's Municipal Legislation Act, 2017) includes as a matter of provincial interest "the mitigation of greenhouse gas emissions and adaptation to a changing climate".

Further, the Building Better Communities and Conserving Watershed Act, 2017 (Bill 139) will amend the Planning Act to support climate change action by requiring climate change mitigation and adaptation policies in municipal official plans. The Guideline could be used to carry out a background study to identify actions that reduce greenhouse gas emissions and to inform climate change mitigation policies in municipal official plans.

THE PIVOTAL ROLE OF MUNICIPALITIES

Municipalities have a pervasive if mostly indirect impact on the level of greenhouse gas emissions in the community, although the GHG impacts of municipal land-use and infrastructure policies and practices are often not recognized.

Many municipal planning decisions made today will still be having environmental impacts well into the future. In the case of infrastructure investments and land-use plans, particularly those related to intensification in urban areas, density in greenfield areas and the creation of complete, low-carbon communities, the environmental consequences continue for centuries. This leads to "lock-in": a situation where past decisions limit the options and increase the costs for future decisions. In the context of community energy and emissions planning, this makes the longest term decisions among the most urgent.

ALIGNING MUNICIPAL GOALS AND OBJECTIVES

There is very often alignment between the priority goals and aspirations of community planning and the objective of lowering greenhouse gas emissions. In fact, a great deal of the moderation of greenhouse gas emissions growth that has already taken place has been a side effect of trends and measures that have been driven by goals other than GHG emission reduction. For example, energy efficiency developments can be key elements of strategies for local economic development, job creation and self-reliance. Public health policy advocates promote a variety of measures that also reduce greenhouse gas emissions, including active transportation infrastructure, green roofs, urban forestry, and reduced emissions from fossil fuel combustion.

THE ENERGY AND EMISSIONS PLANNING PROCESS

Community energy and emissions planning begins by developing a quantitative understanding of the community's greenhouse gas emissions (the inventory) and systematically identifying the ways in which municipalities can, and often already do, influence the level of community emissions.

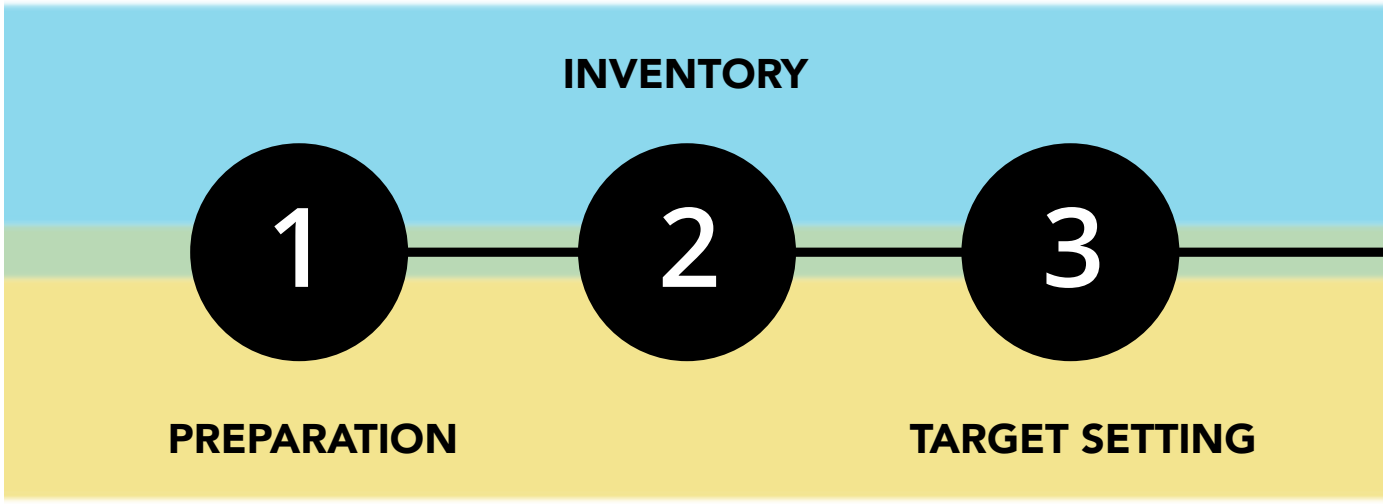
6 Stages to a Low-Carbon Municipality

Community Process

Set up a steering committee.

Identify & establish the partnerships needed to produce the emissions inventory.

Engage influencers & stakeholders in setting the target. Or, explain the rationale of the current target.



Develop a terms of reference, identify the governance structure and complete a situational analysis that describes the planning context.

Undertake a GHG inventory (corporate and community). Analyse municipal expenditures and spheres of influence.

Establish short, medium and long-term GHG targets.

Technical Process

LEVEL OF COMPLEXITY

FOR IMPLEMENTATION

BASIC

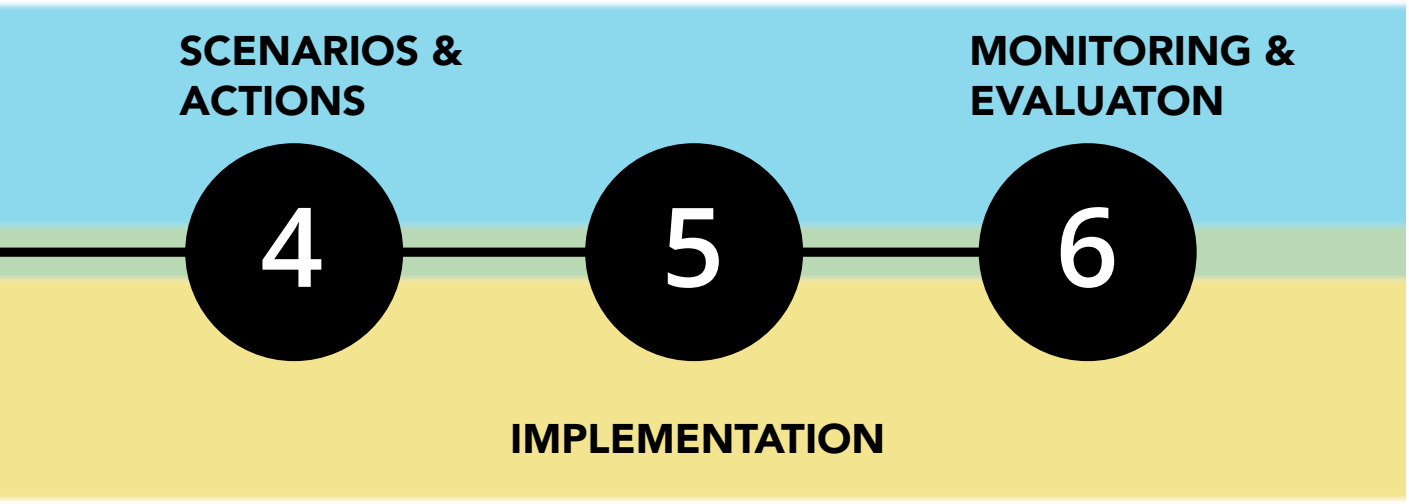
INTERMEDIATE

ADVANCED

Work with influencers & stakeholders to identify alignments/conflicts between planning goals & aspirations.

Implement identified policies, partnerships, bylaws & other opportunities identified in the plan. Deploy the support of influencers & stakeholders.

Work with partners to share data, assess progress, and continuously improve the plan.



Complete a business as usual scenario and identify low carbon actions. Develop low carbon scenarios that include the actions. Undertake analysis of the co-benefits associated with the scenarios.

Identify policies and mechanisms to implement the preferred low carbon scenario. Integrate the community energy and emissions plan with the Official Plan and other policies, plans and strategies. Develop an investment strategy.

Develop and implement a monitoring and evaluation plan.

BASIC

INTERMEDIATE

ADVANCED

The Guideline includes six stages in the development of a community energy and emissions plan (CEEP) and each stage builds on the preceding one. Tasks are described for each of the stages, with detailed methodological guidance and references to complementary existing tools and resources. Tasks give rise to outcomes and the combination of all the outcomes constitutes the community energy and emissions plan. Municipalities may also elect to apply methods other than those described in this guideline in order to achieve the outcomes described in Table 2.

This Guideline recognizes the varying complexities of municipal efforts in undertaking community energy and emissions planning. The Guideline has been developed to allow for flexibility for municipalities across the province to participate in programs and undertake actions based on local circumstances. To this end, the Guideline describes three streams for each stage: basic, intermediate and advanced. Municipalities can choose the stream, or combination of streams, that best suits their context. The outcomes for each stage are similar; however, the process to arrive at those outcomes varies. For simplicity, this Guideline assumes a general correlation between the population of the municipality and the sophistication of the approach, but small municipalities may also elect to choose the intermediate or advanced stream depending on resources and ambition.

Engagement

The engagement process should involve a steering committee with diverse stakeholders from within the local government and more broadly in the community. The structure of this committee will vary according to the context of the municipality. Various municipal staff, decision-makers, stakeholders and the public will also be involved throughout the planning process. There are numerous ways to structure engagement in planning process inputs, plan content development, document reviews, and other aspects of the planning process.

Table 1. Suggested roles in the development of a CEEP

	Public	**Steering committee**	**Municipal staff**	**Council**
Terms of reference (Stage 1)		Participate	Lead	Approve
Plan development (Stages 2–6)	Participate	Participate	Participate	Participate
Draft CEEP	Review	Review/Recommend	Review	Review
Final CEEP				Approve

Municipal operations

The Guideline describes the method for completing a GHG inventory and strategies to reduce GHG emissions from local government operations. GHG emissions from local government operations are typically a small portion of the total GHG emissions from a community. Understanding and managing these GHG emissions is important firstly in terms of reducing costs, secondly to demonstrate leadership and thirdly to learn about the implementation of strategies first hand. In developing the corporate GHG inventory, the municipality should follow the accounting protocols of the Federation of Canadian Municipalities and ICLEI-Local Government for Sustainability's Partners for Climate Protection program or the Local Government Operations Protocol. While the corporate and community GHG inventories are undertaken separately, the CEEP as a whole applies an integrated lens to corporate and community GHG emissions.

THE ENERGY AND EMISSIONS PLANNING OUTCOMES

Each of the six stages of the CEEP have specific outcomes. In combination, these outcomes form the municipality's community energy and emissions plan, which incorporates the GHG inventory and GHG emissions reduction targets. The CEEP supports the actions under the CCAP, including requirements of the Municipal GHG Challenge Fund and the climate change policies of the Growth Plan for the Greater Golden Horseshoe, 2017, as well as supporting municipalities in the implementation of other provincial direction related to climate change action and identifying a low carbon pathway that delivers multiple community benefits.

Table 2. The stages and outcomes of the CEEP

Stage	Required outcomes	Relative level of effort	Page reference
Preparation	Terms of reference Situational analysis that describes the current planning context	20%	56
Inventories	GHG inventory (corporate and community) Spheres of influence analysis Financial inventory	15%	63
Target setting	GHG targets	5%	90
Actions and alternative scenarios development	Actions catalogues Scenarios Analysis of co-benefits	25%	97
Implementation	Policies and mechanisms analysis Integration with the Official Plan and other policies, plans and strategies Investment strategy	30%	127
Monitoring and evaluation	Monitoring and evaluation plan	5%	148
Community Energy and Emissions Plan			

CONCLUSION

The Government of Ontario has established provincial GHG reduction targets of 15% below 1990 levels by 2020, 37% below 1990 levels by 2030, and 80% below 1990 levels by 2050. These targets require a transformation in the energy system and built environment, a transformation which can result in multiple other societal benefits, for example on health and economic development. At the municipal scale, the official plan and other existing municipal planning tools implicitly influence GHG emissions by determining land-use patterns, transportation and transit options, and other characteristics of the built environment and can be used to create complete, low-carbon communities. The community energy and emissions planning process quantifies these relationships and identifies strategies to reduce GHG emissions while considering additional benefits for employment, economic development, improved health outcomes and others. This Guideline is a step-by-step approach to developing a GHG inventory, identifying GHG targets and developing a community energy and emissions plan.

PART A: RATIONALE & CONTEXT FOR COMMUNITY ENERGY & EMISSIONS PLANNING

KILLARNEY LIGHTHOUSE OVERLOOKING GEORGIAN BAY, ONTARIO

Introduction

This Guideline is intended to help municipalities in Ontario develop quantitative, targeted strategies for supporting their communities in making the transition to a low carbon future. The increasing role of municipalities in responding to climate change is a long-term, global trend that began in Ontario nearly 30 years ago. The impetus for producing this Guideline for Ontario municipalities at this time is two-fold:

- To support actions under the 2016 Ontario Climate Change Action Plan (CCAP). CCAP introduced two new municipal funding programs: the Municipal Action Plan Program which supports community GHG reduction planning, and the Municipal GHG Challenge Fund which supports community GHG reduction projects.

- Commitments made under the Coordinated Provincial Plans Review encourage municipalities to develop GHG reduction plans, GHG inventories, and establish GHG reduction targets. New policies in the Growth Plan for the Greater Golden Horseshoe require municipalities to incorporate emission reduction strategies in their official plans. The recent amendments of the Planning Act through Bill 68 (Modernizing Ontario's Municipal Legislation Act, 2017) include “the mitigation of greenhouse gas emissions and adaptation to a changing climate" as a matter of provincial interest, and through the Building Better Communities and Conserving Watershed Act, 2017 (Bill 139) will include requirements in the Planning Act to support climate change action by requiring climate change mitigation and adaptation policies in municipal official plans.

Beyond providing guidance on how to comply with these new mandates, this Guideline is intended to help municipalities of all sizes and contexts understand their influence on greenhouse gas emissions, and how to plan their communities so that the goal of reducing greenhouse gas emissions is aligned with other community social and economic goals.

While the Guideline focuses on the relationship between land-use planning and community energy use and emissions, it is intended for all municipal staff. The most successful local community energy and emissions planning draws on the full range of municipal government experience and expertise: engineers, financial managers, community engagement specialists, economic development strategists, public health workers, community housing managers, elected officials, and the list goes on. Indeed, anyone interested in how their community can make the transition to a low carbon, sustainable future will find useful material in this Guideline.

ENERGY AND EMISSIONS PLANNING IMPETUS

The infrastructure planning and financing decisions made today will determine the world's climate and development outcomes for the next century. Taken together, these decisions will lead to the building of either low-emission, climate-resilient infrastructure that increases economic opportunity or more of what we have already, effectively locking the world into a carbon-intensive pathway with sprawling human settlements, hazardous pollution, and heightened vulnerability to climate change.[1]

1 Cities Climate Finance Leadership Alliance. (2015). The State of City Climate Finance. Retrieved from http://wedocs.unep.org/bitstream/handle/20.500.11822/7523/-The_State_of_City_Climate_Finance-2015CCFLA_State-of-City-Climate-Finance_2015.pdf.pdf?sequence=3&isAllowed=y

2. Provincial policy

Purpose of this chapter:	To describe policy drivers for municipal action on climate change

The Climate Change Mitigation and Low-carbon Economy Act (2016)

The Climate Change Mitigation and Low-carbon Economy Act (2016) (referred to below as "the Low-carbon Economy Act") requires that Ontario develop a long-term framework for action on climate change. The Government of Ontario has established GHG reduction targets of 15% below 1990 levels by 2020, 37% below 1990 levels by 2030, and 80% below 1990 levels by 2050. The Low-carbon Economy Act established a cap-and-trade program that sets a price on carbon emissions by limiting the amount of greenhouse gas pollution that can come from the economy (the cap) and then allowing program participants to trade amongst themselves to cover their emissions if they exceed the cap.

Ontario's Five-Year Climate Change Action Plan, 2016-2020

The Climate Action Plan guides the investment of the cap-and-trade revenues and includes actions in every sector in the near term and is revised every five years. A dedicated section of the Climate Action Plan addresses municipalities with actions (Table 3). In addition, actions in other sectors will also contribute to municipal efforts (Table 4).

Table 3. Energy and emissions planning initiatives designed to support municipalities.

Strengthen climate change policies in the municipal land-use planning process	Support municipal and other stakeholder climate action	Reduce congestion and improve economic productivity
» Require electric vehicle charging in surface lots » Set green development standards » Make climate change planning a priority » Put climate change in official plans » Eliminate minimum parking requirements	» Establish a Challenge Fund » Support community energy planning » Support community energy mapping and platforms	» Help manage congestion » Reduce single-passenger vehicle trips through Transportation Demand Management Plans

Table 4. Additional initiatives that will support energy and emissions planning.

Transportation	Buildings and homes	Other
» Develop a renewable fuel standard for gasoline » Pilot waste and agricultural methane as a fuel source » Maintain incentives for electric vehicles » Provincial and federal governments to explore eliminating HST on zero emission vehicles » Free overnight electric vehicle charging » More charging stations » Electric-vehicle-ready homes and workplaces » Electric and Hydrogen Advancement Program » Improve commuter cycling network » Improve competitiveness of short-line railways » Accelerate Regional Express Rail Deployment	» Retrofit social housing apartments » Protect tenants from the price of carbon » Provide incentives for apartment building retrofits » Boost low-carbon technology in homes » Near Net Zero Carbon Home Incentive » Update the Building Code » Introduce a renewable content requirement for natural gas	» Develop a provincial land-use carbon inventory to assess emissions and removals of GHGs by forests, agriculture and other lands.

LAND-USE PLANNING

Land-use planning policy in Ontario influences the shape and configuration of buildings and the way in which people move around the landscape.

The Planning Act

The Planning Act sets out the ground rules for land-use planning in Ontario, describing how land-uses may be controlled, and who may control them. The Planning Act grants municipalities the authority to create Official Plans, Zoning By-laws, to establish governing bodies and planning oversight of land-use within the municipality. The Planning Act also establishes a public process to engage everyone within a municipality in its decision making.

A recent amendment through Bill 68 (Modernizing Ontario's Municipal

Legislation Act, 2017) includes "the mitigation of greenhouse gas emissions and adaptation to a changing climate" as a matter of provincial interest. This means that all decisions under the Planning Act, including decisions on matters that end up before appeal, shall have regard to this provision. The Building Better Communities and Conserving Watershed Act, 2017 (Bill 139) will include requirements in the Planning Act to support climate change action by requiring climate change mitigation and adaptation policies in municipal official plans.

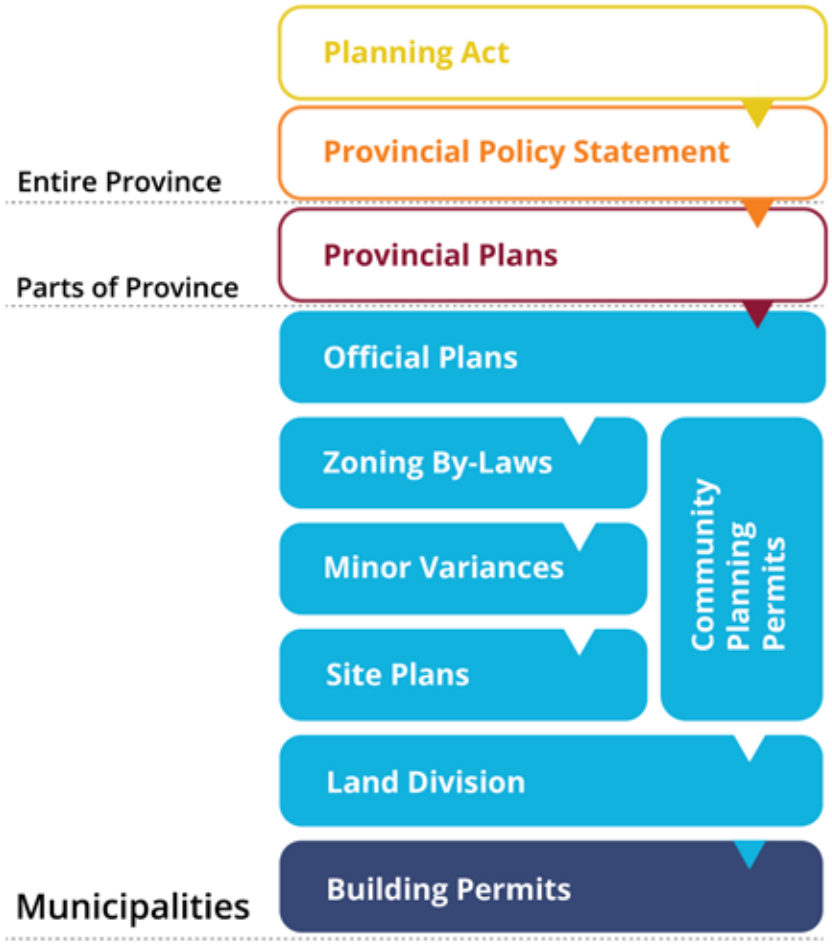


Figure 1. Land-use planning system in Ontario[1]

1 Ministry of Municipal Affairs. (2016). *Review of the Ontario Municipal Board- Public consultation document.* Retrieved from http://www.mah.gov.on.ca/AssetFactory.aspx?did=15814

Provincial Policy Statement

The Provincial Policy Statement (PPS) is issued under authority of the Planning Act and provides policy direction on matters of provincial interest related to land-use planning and development. The PPS sets policy foundation for regulating the development and use of land. The PPS, 2014 provides policy direction for municipalities and planning authorities to support energy conservation and efficiency, improved air quality, reduced greenhouse gas emissions, and climate change adaptation through land-use and development patterns. Planning authorities are also required to consider the potential impacts of climate change that may increase the risks associated with natural hazards. All decisions affecting land-use planning matters, including decisions made by municipalities "shall be consistent with" the PPS. Section 1.8 of the PPS (Energy conservation, air quality and climate change) provides detailed climate change policies, and other relevant policies can be found in the following sections:

1. Use of efficient land-use patterns (PPS, Section 1.1)
2. Encourage the use of multi-modal transportation systems (PPS, Section 1.6.7.3)
3. Intensification and Redevelopment (PPS, Section 1.1.3.3)
4. Building strong, liveable and safe communities (PPS, Section 1.1.1)
5. Using efficient transportation networks (PPS, Section 1.6.7)
6. Wise use and management of resources (PPS, Section 2.0)

The Building Better Communities and Conserving Watershed Act, 2017 (Bill 139) will amend the Planning Act to include the following requirement: 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.

Growth Plan for the Greater Golden Horseshoe, and other provincial plans

The Growth Plan for the Greater Golden Horseshoe[2], released in May 2017 and in force as of July 1, 2017, includes two key policies within section 4.2.10 on climate change:

1. Upper- and single-tier municipalities will develop policies in their official plans to identify actions that will reduce greenhouse gas emissions and address climate change adaptation goals, [...]

2. In planning to reduce greenhouse gas emissions and address the impacts of climate change, municipalities are encouraged to:

2 Government of Ontario. (2017). Growth plan for the Greater Golden Horseshoe. Retrieved from http://placestogrow.ca/images/pdfs/ggh2017/en/growth%20plan%20%282017%29.pdf

a. Develop strategies to reduce greenhouse gas emissions and improve resilience through the identification of vulnerabilities to climate change, land-use planning, planning for infrastructure, including transit and energy, green infrastructure, and low impact development, and the conservation objectives in policy 4.2.9.1;

b. Develop greenhouse gas inventories for transportation, buildings, waste management and municipal operations; and

c. Establish municipal interim and long-term greenhouse gas emission reduction targets that support provincial targets and reflect consideration of the goal of low-carbon communities and monitor and report on progress made towards the achievement of these targets.

The emphasis on mitigation and adaptation is restated and reinforced in the Greenbelt Plan, the Oak Ridges Moraine Conservation Plan and the Niagara Escarpment Plan.

The Growth Plan for the Greater Golden Horseshoe requires that upper- and single-tier municipalities develop policies in their official plans to identify actions that will reduce greenhouse gas emissions.

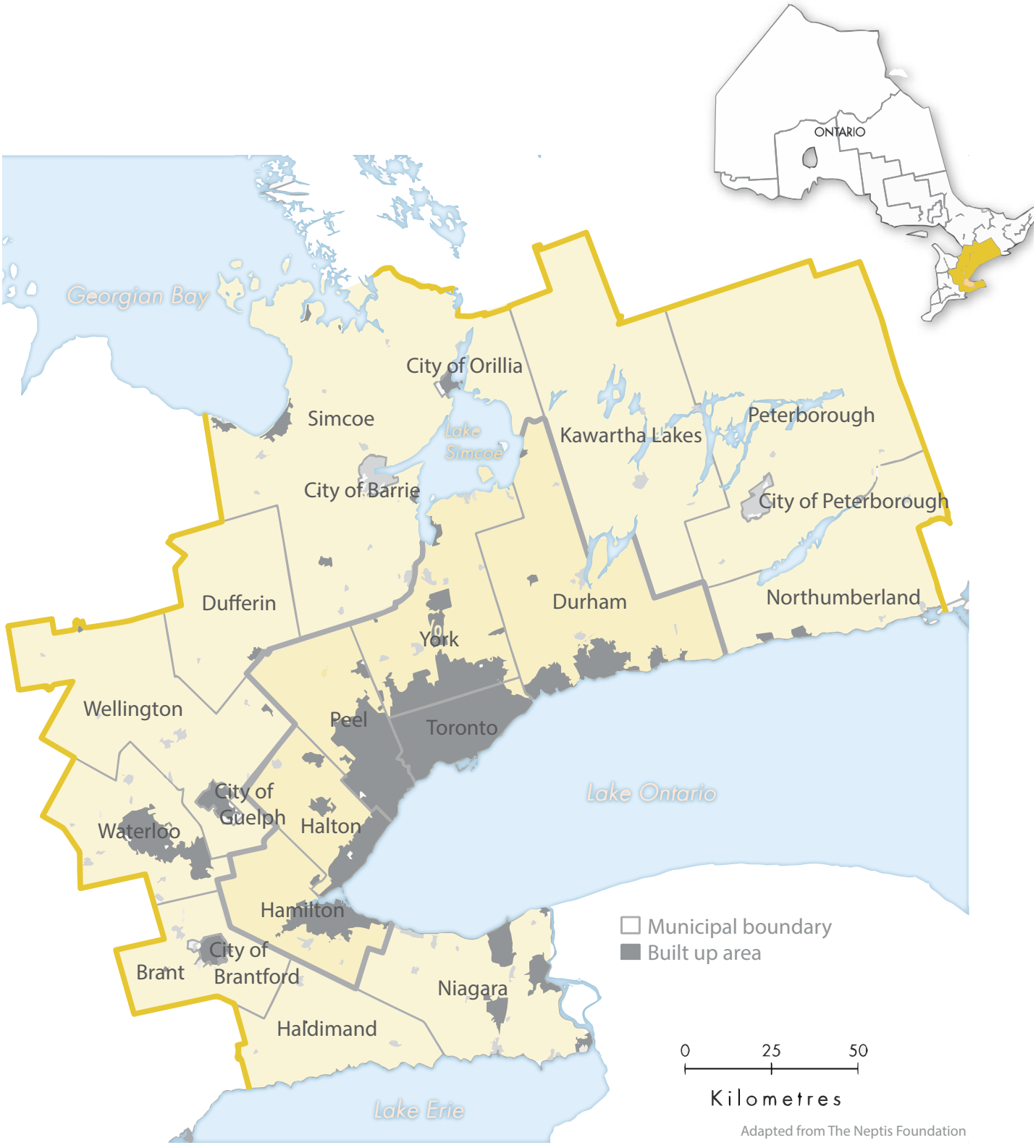


Figure 2. A map of Ontario's Golden Horseshoe region.

ONTARIO'S GREENHOUSE GAS EMISSIONS AND THE PROVINCE'S EMISSION TARGETS

In 2015, Ontario greenhouse gas emissions totalled 166 Mt CO2e—12.0 tonnes per capita. The largest sources of greenhouse gas emissions are the tailpipes of personal and commercial vehicles (37%), the chimneys and vents of residential and commercial building furnaces (20%), and the smokestacks of industrial boilers and kilns (14%). Fossil fueled electricity contributes 4% to the total. All totalled, fossil fuel combustion accounts for 76% of Ontario's greenhouse gas emissions, with the remainder split between industrial process gases (13%) and agricultural practices (8%), and methane from landfills and other waste treatment operations (5%).

Table 5. Ontario's GHG emissions

Ontario Greenhouse Gas Emissions in 2015 (Mt CO2e)

	Energy (fossil fuels)	Other processes	Total
Residential Buildings	20.7		20.7
Commercial Buildings	12.5		12.5
Personal and Commercial Transportation	61.2		61.2
Manufacturing & Construction	22.2	21.8	44
Waste		9	9
Agriculture and Forestry	1.4	9.7	11.4
Electricity Generation	6.2		6.2
Total	126	40.1	166

Note: Adjustments are due to rounding.

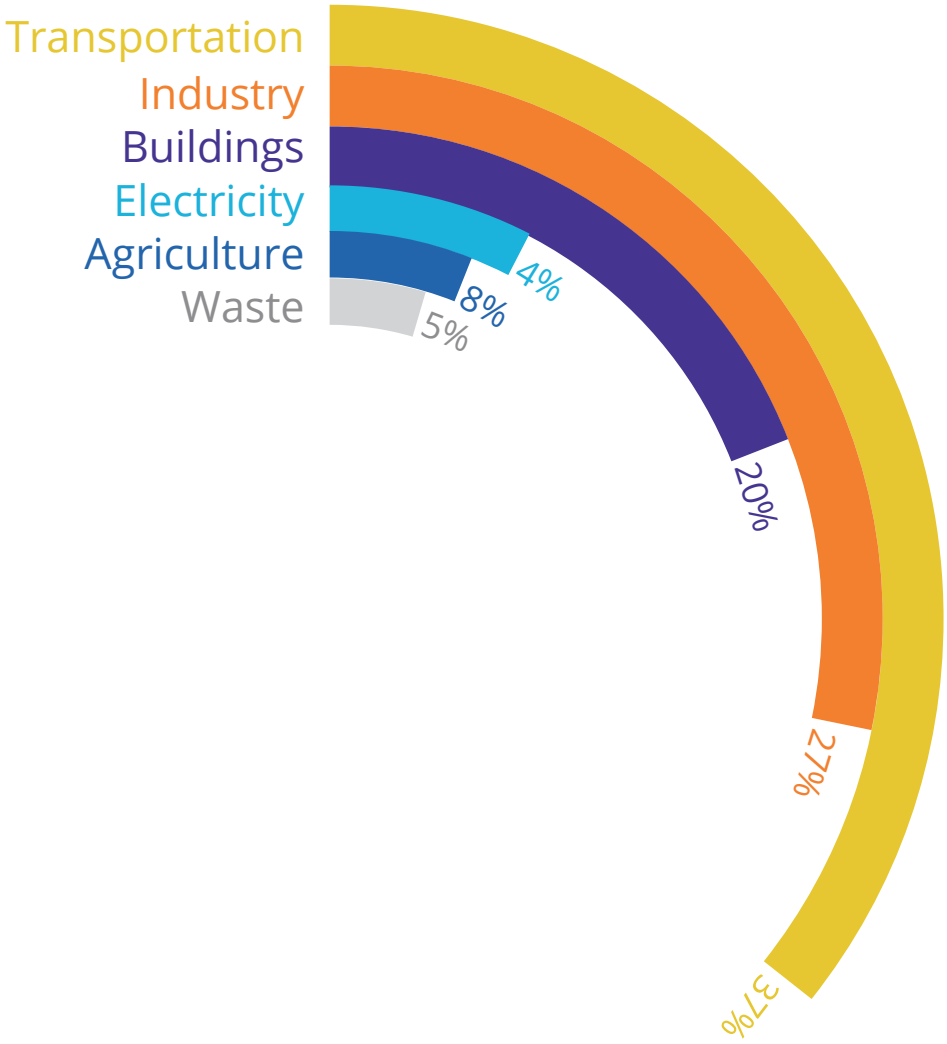


Figure 3. Illustration of relative importance of major sources of GHG emissions in Ontario[3].

The Government of Ontario has established GHG reduction targets of 15% below 1990 levels by 2020, 37% below 1990 levels by 2030, and 80% below 1990 levels by 2050. In 2013, Ontario's GHG emissions were 171 Mt CO_2e, 6% below 1990 levels. Table 6 shows the targeted emission levels and how they translate into per capita emissions, given the currently expected population growth.

3 From Ontario Climate Action Plan, 2016.

Table 6. Ontario's GHG emissions targets

	Ontario population (millions)	Actual or Targeted GHG Emissions (Megatonnes CO2e)	Average per capita emissions (tonnes CO2e)
1990	10.30	182	17.7
2013	13.56	171	12.6
2021	14.98	146	9.7
2031	16.66	115	6.9
2050 est	19.75	36	1.8

Note: The emissions for 2021 and 2031 are actually the provincial target emissions for 2020 and 2030, respectively

Note: The 2050 population has been estimated by extrapolating the growth rate in the Ministry of Finance population projection, which goes to 2041.

The targets are consistent with the commitments made by Canada in the Paris Accord, which in turn are based on an understanding of what it will take to limit average global warming to less than 2 degrees Celsius, considered to be the maximum temperature change that can be risked if humankind is to avoid dangerous and potentially catastrophic climate change impacts. Given the central role that fossil fuels play in the Province's energy system, the targets also imply transformational change in buildings, vehicles and transportation systems, industrial production systems, and communities. The efficiency of energy use must be much greater, the role of electricity in providing heat and transportation services must increase, the electricity supply must remain essentially carbon free, a sustainable biofuels industry must be established, and innovation will be required to reduce demand for energy services.

3. The Role of Municipalities

Purpose of this chapter:	To describe the role of municipalities in reducing GHG emissions

DIRECT CONTROL AND INDIRECT INFLUENCE

Municipalities have a pervasive if mostly indirect impact on the level of greenhouse gas emissions in the community, although the GHG impacts of municipal policies and practices are often not recognized. Community energy and emissions planning begins by developing a quantitative understanding of the community's greenhouse gas emissions (the inventory) and systematically identifying the ways in which municipalities can, and often already do, influence the level of community emissions.

The Official Plan and other existing planning tools implicitly influence GHG emissions by determining land-use patterns and other characteristics of the built environment. The community energy and emissions planning process quantifies these relationships and identifies strategies to reduce GHG emissions while considering additional benefits for employment, economic development, improved health outcomes and others.

Table 7 illustrates some direct and indirect control that local governments exert over community greenhouse gas emissions.

Table 7. Authority of local governments on energy and GHG emissions.

Local government as...	Authority	Sample actions	Community energy and emissions planning techniques	Potential impact on GHG emissions reductions
Energy consumers	Direct control	Retrofits of municipal buildings, construction of high performance municipal buildings, purchase of zero emissions vehicles, landfill gas recovery.	Corporate GHG inventory and plan.	Low

Local government as…	Authority	Sample actions	Community energy and emissions planning techniques	Potential impact on GHG emissions reductions
Investors	Indirect control	Renewable natural gas from a landfill, zero emissions transit system, cycling infrastructure, electric vehicle charging stations, recycling programs, public/ private partnerships	Situational analysis [review of capital budgets]	Medium-High
Influencers	Indirect control	Official Plan policies, Property Assessed Clean Energy (PACE) programs	Modelling and scenario-planning	High

Local governments are creatively developing policies and actions that either enhance or are outside of their traditional spheres of authority in order to reduce GHG emissions, focussing on the investment and influence roles. Property Assessed Clean Energy (PACE) programs are an example in which municipalities use their tax authority to enable retrofits of residential or commercial buildings on a neighbourhood or community-wide scale.

Municipalities also play a key role in implementing and facilitating the implementation of policies of higher levels of government, as illustrated in Table 8.

Table 8. Municipal energy and emissions policy roles.[4]

Municipal government role	Municipal role examples	Corresponding national or provincial government role
Policy architect & leader: Primary body responsible for policy design, formulation, application, implementation and enforcement	» Land-use planning » Design/development of transit systems or transportation policies » Development of infrastructure projects » Waste management regulations	» Establish national policy frameworks » Enable municipal government action through: » Capacity building and information sharing » Access to funding » Legal and policy alignment
Critical implementer: Responsible for key application, implementation, or enforcement actions related to a policy	» Building code implementation and compliance-checking » Implementation of regionally coordinated, cross-jurisdictional infrastructure projects or transportation policies	» Policy design and/or standard setting » Regional coordination » Enabling city government implementation role

4 Adapted from: Broekhoff, D., Erickson, P., & Lee, C. M. (2015). *What cities do best: Piecing together an efficient global climate governance*. Stockholm Environment Institute Seattle, WA, US. Retrieved from http://ledsgp.org/wp-content/uploads/2015/12/SEI-WP-2015-15-Cities-vertical-climate-governance.pdf

Municipal government role	Municipal role examples	Corresponding national or provincial government role
Complementary partner: Undertakes separate, complementary actions that contribute to the effectiveness, uptake, penetration, or success of a policy led by higher levels of government	» Complementary information and outreach, green standards development and implementation, certification and incentive programs for improved building energy efficiency and reduced GHG emissions through urban design measures. » Permitting or active installation of electric vehicle charging stations » Permitting, tax incentives and/or subsidies for commercial and residential distributed energy resources	» Policy design and/or standard-setting » Primary implementation and enforcement » Coordination/integration of actions within and across different levels of government » Enabling municipal government complementary actions (through capacity building, funding or legal reform).

INFRASTRUCTURE, LAND-USE PLANNING AND LOCK-IN

Figure 4 illustrates the varying lengths of time that the environmental implications of different types of municipal planning decisions continue to be experienced. Many municipal planning decisions made today will still be having environmental impacts 100 years from now. In the case of infrastructure investments and land-use plans, the environmental consequences continue for centuries. This leads to "lock-in": a situation where past decisions limit the options and increase the costs for future decisions. In the context of community energy and emissions planning, this makes the longest term decisions also among the most important.

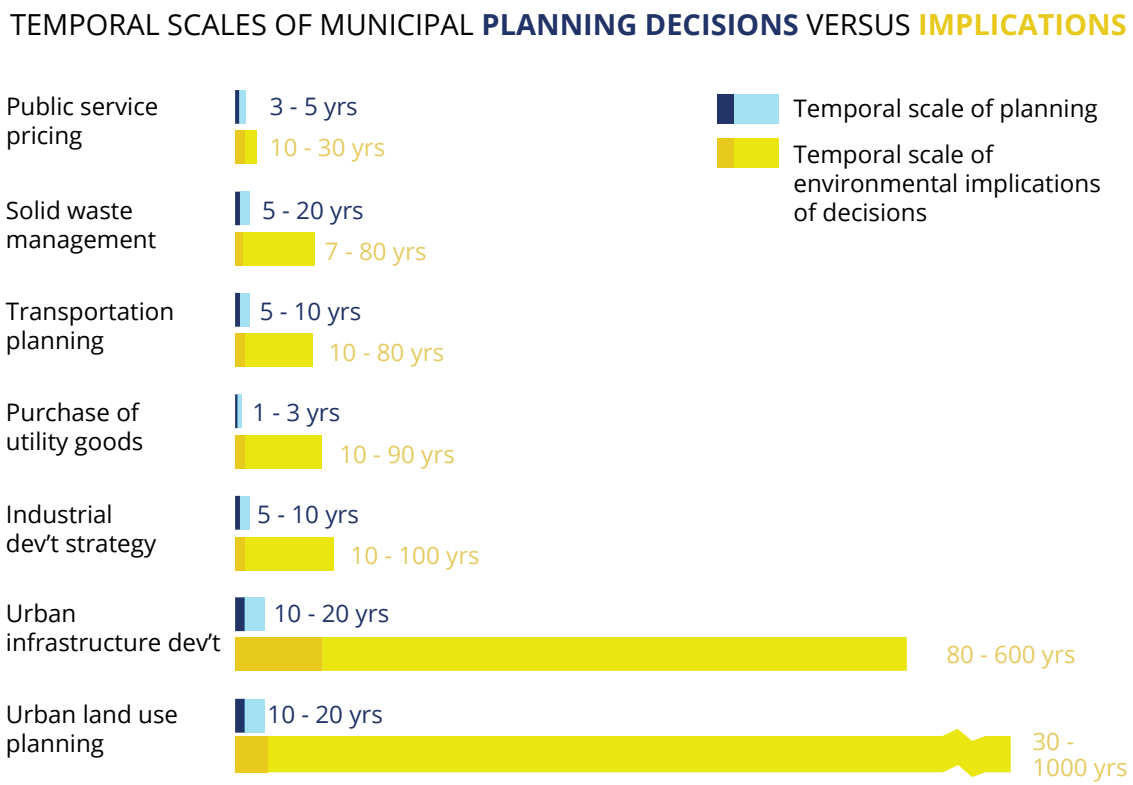


Figure 4. The temporal implications of municipal decisions.[5]

5 Adapted from: Bai, X., McAllister, R. R., Beaty, R. M., & Taylor, B. (2010). Urban policy and governance in a global environment: complex systems, scale mismatches and public participation. *Current Opinion in Environmental Sustainability*, *2*(3), 129–135. https://doi.org/10.1016/j.cosust.2010.05.008

LOCK-IN AND PATH DEPENDENCE: ATLANTA VS. BARCELONA

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. Whereas Barcelona can consider solutions such as district energy and enhanced transit to generate positive economic returns, these solutions 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. [For Ontario municipalities, the fundamental tools of land-use planning are Official Plans and Zoning By-laws.]

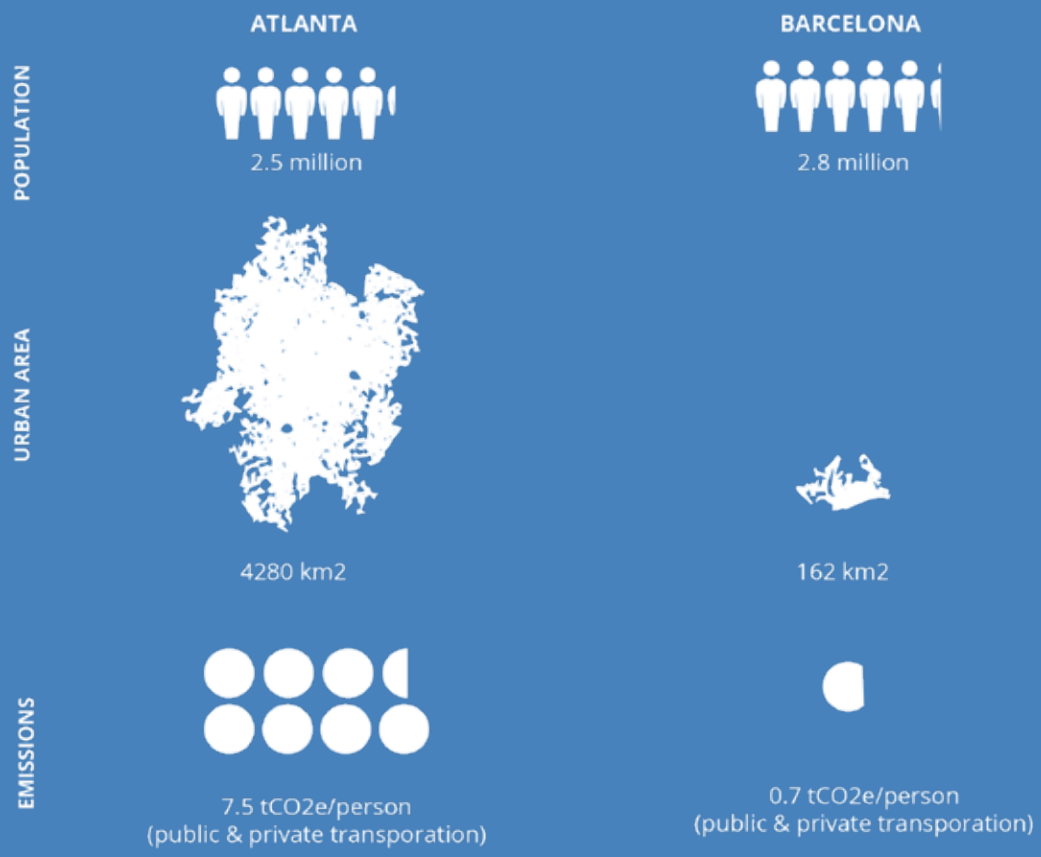


Figure 5. A tale of two cities: the influence of land-use planning on Transportation GHG emissions[6]

Municipalities mitigate against the negative effects of lock-in by planning for low-carbon communities through the use of land-use policy tools and approaches, consistent with provincial direction such as:

- increasing intensification targets in existing settlement areas;

6 Adapted from: Global Commission on the Economy and Climate. (2014). *Better growth, better climate: The new climate economy report.* Retrieved from http://newclimateeconomy.report/2014/wp-content/uploads/sites/2/2014/08/NCE-Global-Report_web.pdf

- increasing density targets in designated greenfield areas;
- creating compact, complete communities (e.g. increasing mixed-use – commercial, residential, and employment – zones) and prioritizing transit-oriented development (to reduce dependence on private automobiles); and,
- maximizing the use of existing and planned transit options.

Achieving these land-use planning objectives, when implemented together, will contribute greatly toward achieving the Province's GHG emissions reduction targets.

ENGAGEMENT, ALIGNMENT AND INTEGRATION – KEYS TO EFFECTIVE LOCAL GOVERNMENT GHG PLANNING

There is very often alignment between the priority goals and aspirations of community planning and the objective of lowering greenhouse gas emissions. In fact, a great deal of the moderation of greenhouse gas emissions growth that has already taken place has been a side effect of trends and measures that have been driven by goals other than GHG emission reduction. To take a few examples:

- Energy efficiency developments can be key elements of strategies for local economic development, job creation and self-reliance. Ontario households, firms and institutions spend around $40 billion per year on fossil fuels, most of which leaves their community and leaves the province. Even in a small rural community of 10,000, gasoline and natural gas expenditures drain several million dollars annually from the local economy. Efficiency investments redirect that flow to local employment and economic development. Energy NorthEast (now Acadia Centre) found that efficiency programs in Canada return $3 to $5 in savings for every $1 of program spending, and generate 30 to 52 job-years per million dollars of program spending.
- The trend toward redensification of urban communities and higher density, greenfield development in suburban and rural communities is favoured by local governments seeking to minimize the per capita cost of infrastructure while stretching capital budgets as far as possible.
- Public health policy advocates promote a variety of measures that also reduce greenhouse gas emissions, including active transportation infrastructure, green roofs, urban forestry, and reduced emissions from fossil fuel combustion, the leading source of air pollution and smog precursors.
- Community economic development strategies very often include the objective of attracting innovative firms that are driving the growth of Ontario's knowledge-based, service-oriented economy. This includes the clean energy technologies and services that are essential to the low carbon transition. One analysis suggests the global economic opportunity of investments in low-carbon urban actions is $16.6 trillion[7]—the financial savings resulting from energy savings and lower cost generation in transportation, buildings and waste sectors. Technological and social innovations are occurring rapidly and the community energy and emissions plan is an opportunity to identify and plan for innovation, ensuring that benefits are maximized for those who need it the most.

These synergies between actions to reduce greenhouse gas emissions and other community objectives, along with many other co-benefits of community energy and emissions planning, underscore the importance of integration and engagement. Climate change targets and actions are more likely to succeed where they align with community goals, aspirations and policies for public health,

7 Gouldson, A. P., Colenbrander, S., Sudmant, A., Godfrey, N., Millward-Hopkins, J., Fang, W., & Zhao, X. (2015). Accelerating low carbon development in the world's cities. Retrieved from http://eprints.whiterose.ac.uk/90740/

fiscal efficiency, self-reliance, economic prosperity, resilience, inclusiveness, full employment, and community planning and development.

More reading:

SSG. (2017). Technical paper #4: Considerations of co-benefits and co-harms associated with low carbon actions for TransformTO.

https://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Climate%20and%20Energy%20Goals/Transform%20TO/PDFs/REPORTS/SSG%20Reports/Tech%20Paper4%20Cobenefits.pdf

Resource:

Floater, G., Heeckt, C., Ulterino, M., Mackie, L., Rode, P., Bhardwaj, A., … Huxley, R. (2016). Co-benefits of urban climate action: A framework for cities. LSE Cities.

Retrieved from http://www.c40.org/researches/c40-lse-cobenefits

Effective community energy and emissions planning unifies many other municipal planning exercises. For example, in order to evaluate emissions trajectories, energy and emissions planning considers land-use patterns (Official Plan), transportation investments (Transportation Master Plan), and waste volume and treatment estimates (Solid Waste Management Plan). In turn, energy and emissions plan recommendations will likely alter policies on land-use planning, infrastructure deployment and upgrading, transportation, and waste management—as well as touch on social housing and equity considerations. Additionally, the plan will have implications for economic development and employment opportunities, which can be reflected in an Economic Development Strategy. Beyond the municipality, the plan may also influence the planning of energy utilities.

Figure 6. Energy and emissions planning incorporates many dimensions of municipal planning.

Energy and emissions planning incorporates many dimensions of municipal planning, and requires the involvement of multiple city government departments, stakeholders and communities, with particular attention to marginalized groups, in all phases of planning and implementation. Successful low carbon community transition requires grassroots citizen involvement and financial investment (municipality + private sector). Active citizen, household, business and investor engagement is the best route to successful energy and emissions action implementation. Many municipalities already have community engagement strategies and processes, specifically for purposes of outreach to First Nations, newcomer, youth, and other marginalized communities, and these can be adapted for climate change related program planning.

CALGARY DEVELOPMENT OPTIONS FINANCIAL CO-BENEFITS

A development options comparison for the City of Calgary calculated 33% cost savings for dense versus dispersed development, with capital cost savings of $11.2 billion (road construction, transit costs, water and wastewater infrastructure) and operating costs savings of $130 million (provision of fire stations, recreation centres, and schools, as well as shorter distances to commute for services) per year over the next 60 years.

Tool: Community Lifecycle Infrastructure Costing Tool: http://www.cscd.gov.bc.ca/lgd/greencommunities/sustainable_development.htm

THE ENERGY AND EMISSIONS PLANNING ETHOS: REDUCE, IMPROVE, SWITCH

Reduce, Improve, Switch is a simple mantra to follow in performing energy and emissions planning. Adapted from similar approaches such as Reduce-Reuse-Recycle (from the waste sector), and Avoid-Shift-Improve[8] (from the transportation sector), it provides guidance on an overall approach to community energy and emissions planning.

The logic of the approach is that by avoiding energy consumption, retrofit requirements (improve) and the need to generate renewable energy (switch) are both reduced. If switch occurred first, the capacity of the renewable energy installed would be greater, implying a higher cost; and once improve and reduce had been implemented, renewable energy capacity would be greater than demand. Table 9 describes this framework for sample actions in different sectors.

Table 9. Reduce, Improve, Shift framework for community energy and emissions planning.

	SAMPLE ACTIONS		
	Buildings	**Transportation**	**Waste**
REDUCE *Reduce energy consumption and optimize energy demand.*	Build efficient and low carbon new buildings.	Build compact, complete communities and transit-oriented development. In rural areas, develop nodes or village centres.	Implement strategies to prevent the creation of waste.
IMPROVE *Increase energy use efficiency.*	Upgrade to energy efficient lighting systems. Perform energy retrofits for existing buildings. Introduce energy storage and district energy.	Improve fuel efficiency of the vehicle fleet.	Improve the efficiency of waste collection practices.
SWITCH *Shift to low carbon energy sources.*	Source energy from renewable sources.	Switch to electric vehicles that use renewable energy sources.	Collect fugitive emissions from landfills for use as renewable natural gas.

8 GIZ. (2011). *Sustainable urban transport: Avoid-shift-improve*. Retrieved from http://www.sutp.org/files/contents/documents/resources/E_Fact-Sheets-and-Policy-Briefs/SUTP_GIZ_FS_Avoid-Shift-Improve_EN.pdf

4. Guiding Principles of Energy and Emissions Planning

Purpose of this chapter:	To describe the primary principles of community energy and emissions planning
Key guidance:	Use the principles described in this chapter to frame the community energy and emissions plan.

There are now hundreds of local governments around the world committed to climate change mitigation. Their accumulated experience provides valuable insights into the interrelated principles that contribute to successful municipal action on climate change. Carrying these principles through municipal energy and emissions planning processes will help to ensure enduring, meaningful outcomes that maximize benefits for community members.

Leadership

Innovation in community energy and emissions planning in Canadian municipalities has been defined by leadership as opposed to regulation. Mayors, councils, citizens and staff have sought to mobilize municipal powers to address climate change through fora such as the Federation of Canadian Municipalities Partners for Climate Protection (PCP), Quality Urban Systems of Tomorrow (QUEST) and the Clean Air Council. While other responsibilities of municipalities—such as land-use planning—are clearly defined in law and practice, the practice of community energy and emissions planning is evolving, primarily as a result of municipal leadership.

Climate action planning requires changes to established frameworks and practices, and these in turn are most likely to succeed when they are inspired by an understanding of how they will benefit the community, and are encouraged and supported by both the leadership of elected officials and senior managers in the municipality. Taking action on climate change requires a champion, ideally at the executive level (e.g. CAO/Council), as many decisions require Council approval. Developing and implementing vision requires leadership, which requires experience, opportunity and will.

Alignment

Climate change targets and actions are more likely to succeed where they align with community goals, aspirations and policies for public health, fiscal efficiency, self-reliance, economic prosperity, resilience, inclusiveness, full employment and community planning and development.

Leverage

Beyond its own direct use of energy, the key to local government success in lowering community emissions is in its ability to leverage its control and influence over decisions, investments and behaviours in the community that determine emissions levels. The most effective role of local government varies with the particular circumstances and opportunity, and exercising effective leverage requires understanding what needs to happen to achieve a low carbon outcome, who the key players are in realizing each outcome, and how local government can use its powers, financial resources and influence to accelerate the desired transition.

Engagement and Empowerment

Successful low carbon community transition requires grassroots citizen involvement and financial investment (municipality + private sector). Active citizen, household, business and investor engagement is the best route to successful energy and emissions action implementation.

The most effective energy and emissions plans reflect local circumstances and local knowledge. Climate literacy for municipal leadership and staff, and community stakeholder relations that are mutually empowering are key to achieving the multiple benefits of the transition to low carbon communities.

Integration

The transition to a low carbon future requires embedding the low carbon objective in all aspects of community planning, policy, and infrastructure investments. In combination with the principle of alignment, integration is a powerful approach to advancing low carbon urban forms. Coordination with other municipalities and relevant entities is also an important strategy, particularly for those with significant interconnectivity.

Opportunities

Taking advantage of opportunities can play a key role in developing momentum in the transition to a low carbon community. Such opportunities may be direct—such as financial support available from federal and provincial governments—or indirect—such as a proposal to redevelop a brownfield site or social housing, public health or youth employment initiatives. Seizing opportunity requires understanding the various ways government influences community emissions, so that opportunities to advance the low carbon objective will be recognized when they arise.

Inclusivity

Many of the most important emissions reduction actions require partnerships within municipal departments and between the municipality and other

organizations. Energy and emissions plans need to involve multiple city government departments, stakeholders and communities, with particular attention to marginalized groups, in all phases of planning and implementation.

Fairness

The design of energy and emissions plans needs to ensure that their activities equitably address the risks of climate change and share the costs and benefits of action across the municipality. Considerations include impact on access to services, household incomes, economic opportunities, investment in infrastructure, and others.

Innovation

Energy and emissions planning is an evolving field and the need for innovation is urgent in order to develop and secure pathways to deep GHG emissions reductions. Innovation requires a willingness to take risks, to fail, and to learn.

Accountability

Transparency is key to ensuring that energy and emissions plans are accountable. Transparency includes following an open decision-making process, and setting goals that can be measured, reported, independently verified, and evaluated. Using transparent modelling and assumptions instills trust in the justification for actions and policy changes. Ensuring that energy and emissions planning processes and documentation are accessible for all enhances participation in the processes and encourages community support for actions.

PART B: THE ENERGY & EMISSIONS PLANNING PROCESS

LIGHTHOUSE AT GRAND BEND, ONTARIO

5. Energy & Emissions Plan Development

Purpose of this chapter:	To provide an overview of the community energy and emissions planning process.
Key guidance:	Apply the process described here to identify where the local government is currently on the energy and emissions planning pathway, and to learn more about the tasks involved in developing energy and emission plans.

Ontario municipalities vary in size, mandate, and the services they provide. Responsibility for services is divided in different ways in the tiered system of local governance throughout the province, thus there is no single approach to developing community energy and emissions plans. Varied local circumstances create localized opportunities that are best engaged at the municipal level, underscoring the importance of creating energy and emissions plans by local governments.

5.1 A MAP OF THE PLANNING PROCESS

Like any example of sustainability-related planning, community energy and emissions planning follows a circular process, ever refining and progressing toward new goals. The process described here involves six stages, closely parallelling the milestones of the PCP program. The three steps of the Municipal Energy Plan process are also incorporated within these six stages. Note that while the stages are ordered 1 to 6, municipalities may not take this sequential approach or may apply the stages in a different order as a result of local circumstances.

The Energy and Emissions Planning Process

1. Preparation
    - ◊ The plan objectives, partners, data sources, process approach, etc. are identified.
2. Inventory
    - ◊ An energy use and emissions production inventory (sources, amounts) is completed for a base year, providing the basis of future scenarios 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. 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 the actions within that scenario are prioritized.

5. Implementation
   - The policies and actions developed are implemented by the municipality and its partners.

6. Monitoring and evaluation
   - Implementation of the policies and actions are monitored for their effectiveness. Feedback is applied to the next iteration of the planning process.

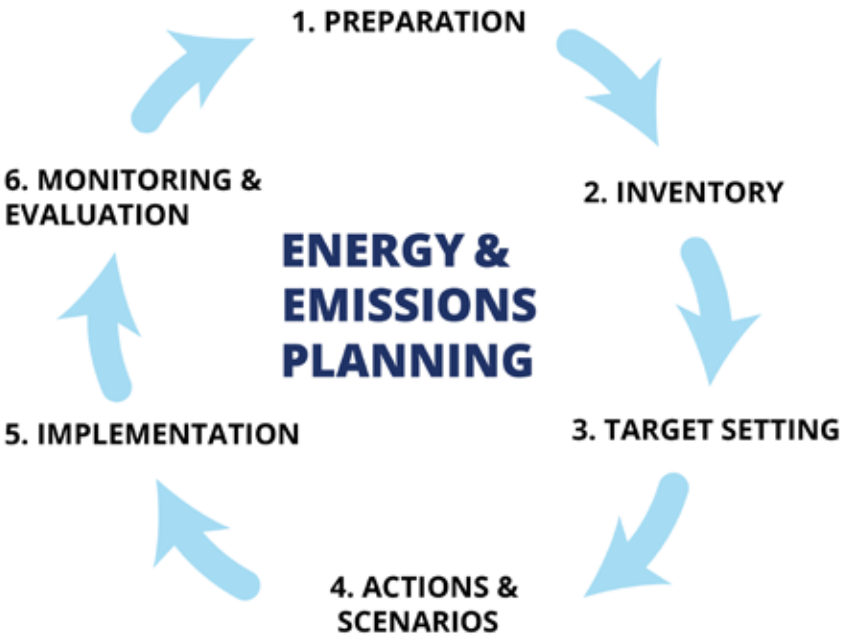


Figure 7. The energy and emissions planning process.

Three Stream Options for Plan Development

This Guideline describes three streams for each energy and emissions plan development stage: basic, intermediate and advanced. Municipalities can choose the stream, or combination of streams, that best suits their context. The outcomes for each stage are similar; however, the process to arrive at those outcomes varies. For simplicity, this Guideline assumes a general correlation between the population of the municipality and the sophistication of the approach. Some municipalities may undertake this process with internal resources, particularly at the basic level. Consultants will likely be engaged to support modelling of actions and scenarios for the intermediate and advanced levels. If desired, a municipality can build its capacity to perform this type of analysis using

open source models and tools that are available.

Table 10. Considerations for the three streams.

	Basic	Intermediate	Advanced
Duration of the planning process	<1 year	1-2 years	1-2 years
Approximate budget for a consultant to be contracted for the planning process	$75,000-$125,000	$100,000-$200,000	$150,000-$500,000

Each subsection of this part of the Guideline includes descriptions of the three streams. Table 11 describes the variation amongst the stages at a high level. Streams are designed to be followed throughout all the stages, as each stage builds on an earlier one.

Table 11. Planning streams.

Stage	Streams		
	Basic	Intermediate	Advanced
1. Preparation	**Similar approach for all streams.**		
2. Inventory	GPC inventory using the Partners for Climate Protection tool, GPC Basic.	Custom inventory, using GPC Basic, spatial analysis	Custom inventory, using GPC Basic+, spatial analysis
3. Target setting	**Similar approach for all streams.**		
4. Actions & scenarios	Qualitative approach to identifying actions based on principles, opportunities, pressing issues and/or best practices.	Simple (energy and emissions) quantitative modelling to evaluate land-use policies and develop future scenarios.	Comprehensive (energy, emissions, co-benefits, financing, etc.) quantitative modelling to evaluate land-use policies and develop future scenarios.
5. Implementation	Emphasis on policies.	Detailed implementation plan with action and policy prioritization.	Detailed implementation plan with action and policy prioritization, with detailed financial analysis to support investments.
6. Monitoring & evaluation	**Similar approach for all streams.**		

Table 12. Energy and emissions planning process overview

1 PREPARATION

BASIC
INTERMEDIATE
ADVANCED

Tasks	Description	Approach: Level of Complexity		
		Basic	Intermediate	Advanced
1.1 Terms of reference/ project charter	Describes the objectives of the process, who will be involved and how, the schedule and the outcomes	Variable		
1.2 Governance and leadership	Provides guidance on the approach to encourage leadership and different governance/organizational structures to support plan development	Variable		
1.3 Situational analysis	Describes the current planning context, including: » Climate and ecosystem » Demographics » Policies by other levels of government » Policies and strategies of the local government, » Built environment characteristics » Transportation systems » Other relevant factors	Variable		
Tools				
Engagement activities		Steering committee	Community advisory group	Citizens jury

2 INVENTORY

BASIC
INTERMEDIATE
ADVANCED

Tasks	Description	Approach: Level of Complexity		
		Basic	Intermediate	Advanced
2.1 Data request	The GHG inventory is a snapshot of energy use and emissions production, and their driving factors. The year for which the most complete and reliable data is available can be set as the 'baseline year'	PCP	GPC Basic [LGOP for corporate emissions]	GPC Basic+ [LGOP for corporate emissions]
2.2 Data collection				
2.3 GHG inventory				
2.4 Spheres of influence	An analysis of the GHG emissions or activities that the local government can influence	Variable		
2.5 Financial inventory	An analysis of the GHG impact of existing expenditures by the local government and other entities in the community.	Variable		
Tools		PCP Milestone Tool	City Inventory Reporting and Information System	CityInSight
Engagement activities		Steering committee	Steering committee + community mapping	Steering committee + community mapping + advisory committee

3 TARGET SETTING

BASIC
INTERMEDIATE
ADVANCED

Tasks	Description	Approach: Level of Complexity		
		Basic	Intermediate	Advanced
3.1 Set an emissions reduction target for the community	Establishment of a GHG target consistent with or exceeding the provincial targets	Adopt Provincial targets for each time period	Use recommended approach in the Guideline	

4 ACTIONS & SCENARIOS

BASIC
INTERMEDIATE
ADVANCED

Tasks	Description	Approach: Level of Complexity		
		Basic	Intermediate	Advanced
4.1 Actions identification	Develop a catalogue of potential municipal actions	Best practices from other municipalities	Identification by steering committee and best practices	Identification through public engagement, best practices and steering committee
4.2 Alternative scenarios development	Bundle the actions into alternative energy and emissions future scenarios. Land-use patterns need to be one dimension of the scenarios	Staff development of scenarios; scenarios may be qualitative	Scenario- planning workshop; scenarios are modelled	
4.3 Modelling	Quantitatively evaluate the emissions impact of the scenarios versus the reference scenario	Qualitative assessment	Excel-based tool with GIS analysis	CityInSight/ Urban Footprint
4.4 Analysis of co-benefits	Evaluate the impact of the scenarios and actions on a range of co-benefits	Qualitative assessment	Non-spatial quantitative analysis	Spatial quantitative analysis
4.5 Preferred scenario	Select a preferred scenario	Qualitative assessment		
4.6 Prioritization	Prioritize the actions within the scenario	Discussion/ voting	Multi-criteria analysis	Multi-criteria analysis + engagement
Tools		PCP Milestone Tool	Climate action for URBan sustainability (CURB)	CityInSight/ Urban Footprint
Engagement activities		SWOT analysis	Crowdsourcing, workshops	Crowdsourcing, workshops, focus groups, participatory decision-making

5 IMPLEMENTATION

BASIC
INTERMEDIATE
ADVANCED

Tasks	Description	Approach: Level of Complexity		
		Basic	Intermediate	Advanced
5.1 Policies and mechanisms identification	Identification of policies and other mechanisms to achieve the actions	Policies and mechanisms are identified to implement the actions		
5.2. Investment strategy	Evaluation of the financial requirements for the actions and how to secure the required funding	Project-level analysis		Integrated, inter-departmental analysis, financial modelling
5.3 Integration	Ensure that the actions are reflected in all local government policies and actions	Implementation roles and responsibilities are assigned to a department. The Official Plan is revised to reflect the CEEP. Implementation roles and responsibilities are assigned across departments. The Official Plan and other plans or policies are revised to reflect the CEEP		
Tools		Municipal organizational chart	Workplans	Workplans, departmental policy documents and processes, business planning
Engagement activities		None	Senior staff engagement	Senior and junior staff engagement, financial industry

6 MONITORING & EVALUATION

BASIC
INTERMEDIATE
ADVANCED

Tasks	Description	Approach: Level of Complexity		
		Basic	Intermediate	Advanced
6.1. Monitoring and evaluation plan	A monitoring and evaluation plan, including indicators and surveys, is developed	Simple pass/ fail evaluation	Annual indicators assessment, updating of plan	Frequent tracking of indicators and departmental roles and responsibilities updates
6.2 Implementation	Governance strategies are identified and the plan is implemented	Responsible department implements the plan	Responsible departments implement policies and actions for which they are responsible	Departments coordinate plan
Tools		Workplans, indicators checklist	Workplans, indicators assessment matrix, plan update mechanisms	Workplans, indicators assessment matrix, plan update mechanisms, integrated reporting tools
Engagement activities		Council reports	Council and staff reports, senior staff engagement	Council and staff reports, senior and junior staff engagement, public reporting and engagement

5.2 BUILDING ON PREVIOUS WORK

Many Ontario municipalities have been or are currently engaged in energy and emissions planning or municipal energy planning. The Guideline provides a roadmap for municipalities to identify where they are at and what the next steps are in new or ongoing energy and emissions planning work. Using this pathway, a municipality can identify what work is already complete and enter into the process at the appropriate stage.

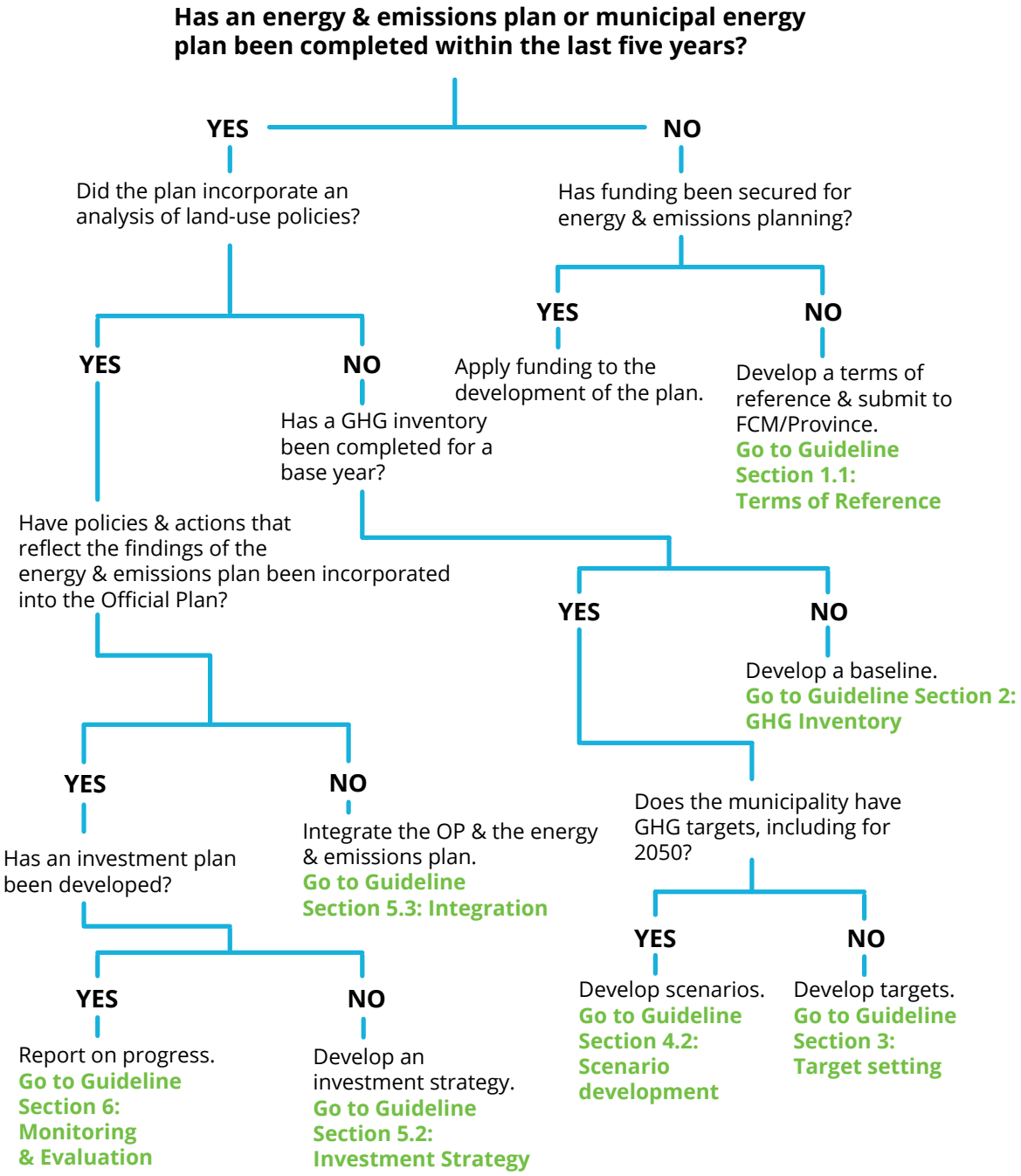


Figure 8. A roadmap for energy and emissions planning.

5.3 DETAILS OF KEY PLANNING PROCESS ELEMENTS

Stage 1: Preparation

»OUTPUTS:

- » **TERMS OF REFERENCE/PROJECT CHARTER;**
- » **SITUATIONAL ANALYSIS**

Before embarking on the energy and emissions plan development process, there are several preparatory steps to be undertaken. Understanding the reasons for undertaking the planning, setting the direction for the process, determining roles and responsibilities, and understanding the context in which the planning process is taking place are all important elements to confirm before commencing the planning process. Table 13 (following page) summarizes some planning preparation tasks, which are further described in this section.

Table 13. Planning preparation tasks.

Tasks	Description	Approach: Level of Complexity		
		Basic	Intermediate	Advanced
Stage 1: Preparation				
1.1 Terms of reference/ project charter	Describes the objectives of the process, who will be involved and how, the schedule and the outcomes.	The terms of reference or project charter can be adjusted to reflect the local context. A sample terms of reference that supports the advanced approach is included in Appendix 2.		
1.2 Governance and leadership	Provides guidance on the approach to encourage leadership and different governance/ organizational structures to support plan development.	The governance and leadership approach will vary according to the practices of each municipality and the recommended approach is applicable to all municipalities.		
1.3 Situational analysis	Describes the current planning context, including: » Climate and ecosystem; » Demographics; » Policies by other levels of government; » Policies and strategies of the local government; » Built environment characteristics; » Transportation systems; and » Other relevant factors.	The themes reviewed in the situational analysis will be similar for most municipalities; however, the extent of the analysis will vary according to the size and complexity of the municipality.		

Engagement

Various municipal staff, decision-makers, stakeholders and the public will be involved throughout the planning process. There are numerous ways to structure engagement for the community energy and planning process, and the specific approach will be reflect the local context. Table 1314 suggests a few central structures for engagement.
13

Table 14. Engagement structures.

Basic	Intermediate	Advanced
Internal steering committee: A committee composed of staff from different departments guides the project, reviewing documents and outcomes, prior to going to Council. Individuals and entities with a significant impact on GHG emissions can be engaged through an advisory committee.	External steering committee: A steering committee composed of representatives of the municipality and other stakeholders. The committee guides the process of developing the CEEP. The committee helps to develop the terms of reference/ project charter and reviews key documents.	Citizens panel: A multi-stage process in which randomly selected citizens go through an educational process in order to make recommendations on the development of the CEEP.

Example: Citizens' Panel on Edmonton's Energy and Climate Challenges.

https://www.edmonton.ca/city_government/city_vision_and_strategic_plan/citizens-panel-energy-climate.aspx

TASK 1.1: TERMS OF REFERENCE/PROJECT CHARTER

RELEVANT STREAMS

Developing Terms of Reference (ToR) or a Project Charter for the planning process is useful in defining the project objectives and scope. Municipal decision-makers, municipal staff, and stakeholders can all be involved in the development of these documents. Sample questions to address in the Terms of Reference development are presented in Table 15.

Table 15. Considerations in developing the terms of reference/project charter.

Aspect	Consideration
Vision	» What is the local government's vision of a low carbon future?
Objectives	» How does the plan address land-use planning? » How does the plan integrate with other plans, including the Official Plan? » How does the plan address co-benefits? » What aspects of the municipality will the plan address? For example, agriculture, forestry or land-use.
Governance/management	» Who is responsible for the plan in the local government? » Who will manage the plan's development? » Who will undertake the analysis and prepare the plan? » What is the approval process?
Engagement	» Will there be a steering/advisory committee? Who will participate in it? » What are the target audiences for engagement? » What engagement mechanisms will be used?
Deliverables (scope)	» What stages of work are required to deliver the plan? » What are the outcomes of the plan?

Aspect	Consideration
Implementation	» What policy mechanisms should be considered? » Who will be responsible for implementation?
Financial resources	» How will the planning process be financed? » How will implementation be financed?
Other considerations	» What are the risks to project? » Are there any constraints that should be noted?

The Terms of Reference can be shared with municipal staff, stakeholders, funding agencies, and others so that they understand the details of the plan. A sample terms of reference is included in Appendix 2.

TASK 1.2: GOVERNANCE AND LEADERSHIP

RELEVANT STREAMS

The Terms of Reference and Project Charter will help determine the governance structure for the planning process, which will vary according to the scale and context of the municipality. Some considerations include:

- *Authority*: The governance structure should involve senior staff and elected officials. It is important that decision-makers are involved in the process, for understanding of energy and emissions issues and to send a signal that the municipality is taking plan development seriously.
- *Leadership*: The governance structure should support and empower leaders to shape the process. A leader in this process is anyone with unusual commitment to advance climate change policies or actions. They may be involved in an advisory or steering committee and could be in local government and/or the broader community.
- *Multi-disciplinary*: The governance structure should incorporate a variety of disciplines and representatives from various departments, reflecting the different spheres affected by climate change.
- *Engaged*: Participants who can provide their full attention and critical feedback should be engaged.

One department—ideally the sustainability or planning department, if the municipality has these resources available—should be lead and appoint a

project manager. An internal interdisciplinary project management committee should involve a range of municipal departments such as planning, engineering, transportation, economic development and parks & recreation, as the energy and emissions plan will consider inputs from, and likely affect responsibilities and workloads in, all of these departments.

External stakeholders like community leaders and individuals with relevant expertise can comprise a high-level steering/advisory/management committee. This committee can be supported by the project manager to steward the plan. The configuration of project manager, internal and external stakeholders will vary by municipality, and should reflect local practices.

Governance responsibilities also include the plan approval process. While this process will vary according to the governance practices of different municipalities, Table 16 provides a suggested approach.

Table 16. Suggested roles in plan development.

	Public	Steering committee	Municipal staff	Council
Terms of reference		Participate	Lead	Approve
Plan development	Participate	Participate	Participate	Participate
Draft report	Review	Review/Recommend	Review	Review
Final report				Approve

Leadership by the Mayor in Halton Hills

The Town's current planning around climate action is framed by its Mayor's Community Energy Plan. The primary driver for the Town's participation in mitigation and adaptation planning came from the Mayor, whose view was that it was imperative to address the issue of climate change. As a first step, the Town's Green Plan was completed and then adopted by council in 2007. Following the recommendations of the Green Plan, an Office of Sustainability was established, and then the 2013 Municipal Energy Plan completed. These actions have led to the gradual recruitment of a collection of council members who have played a key role in providing political support for these initiatives.

TASK 1.3: SITUATIONAL ANALYSIS

RELEVANT STREAMS

There is basic information required to situate the plan, providing building blocks for its development. A situational analysis provides a comprehensive synopsis of the considerations that will influence plan development, and helps establish which energy and emissions actions will be appropriate for the local context.

Table 17. Sample scope of a situational analysis.

Category	Description
Climate and ecosystem	Describe the current and future climatic conditions. Describe the local ecosystem.
Population and demographics	Describe the current demographic context including age structure, immigration and emigration, and population change.
Geography	Describe settlement patterns, land-use, terrain, etc.
Economy and finances	Describe the economy of the community, households and local government (e.g. local GDP, major employers, average incomes, unemployment and poverty, cost of housing, the municipal budget).
Buildings	Describe the built environment (e.g. buildings by type/age, infrastructure, tenure).
Transportation	Describe the transportation system (e.g. roads, transit, walking and cycling).
Energy	Describe the energy system (e.g. sources, fuels used, energy systems in buildings, utilities, EV infrastructure).
Policies	Complete a policy review of relevant municipal, regional, provincial and national policies. Municipal and regional policies, plans and strategies should be reviewed to identify synergies and conflicts with the direction of the plan.

The process of completing the situational analysis will begin to identify energy and emissions policy and action opportunities.

Stage 2: Inventories

»OUTPUTS:

- » **GHG INVENTORY;**
- » **SPHERES OF INFLUENCE ASSESSMENT;**
- » **FINANCIAL ASSESSMENT**

Performing a GHG inventory involves identifying GHG emissions sources, gathering data from governments, utilities, and third parties, processing and organizing the data, and reporting it in a standardized manner. Depending on the GHG sources, data availability, and characteristics of the municipality (e.g. large, small, urban, rural, etc.), inventorying tasks may range from simple to complex. A municipality may seek advice from the province or FCM to help determine if creating a GHG inventory is something best done in-house or through engagement of a third party (e.g. consultant). Often, municipalities can independently monitor, evaluate and evolve inventories that are initially produced with the support of a consulting team.

Table 18 provides some typical tasks required in creating a GHG inventory. It also suggests a varying complexity of approaches that can be taken by a municipality, depending on its capacity. Municipalities can increase the complexity of their approach as they gain more experience and/or capacity.

Table 18. Typical GHG inventory tasks.

Tasks	Description	Approach: Level of Complexity		
		Basic	Intermediate	Advanced
Stage 2: Inventories				
2.1 Data request	The GHG inventory is a snapshot of energy use and emissions production, and their driving factors. The year for which the most complete and reliable data is available can be set as the 'baseline year'.	Apply the PCP inventory tool, which is pre-populated with relevant assumptions.	A GPC Basic inventory involves detailed calculations [LGOP for corporate emissions]	A GPC Basic+ inventory involves reporting on additional areas beyond the GPC basic [LGOP for corporate emissions].
2.2 Data collection				
2.3 GHG inventory				

Tasks	Description	Approach: Level of Complexity		
		Basic	Intermediate	Advanced
2.4 Spheres of influence	An analysis of the GHG emissions or activities that the local government can influence.	The spheres of influence analysis can be relatively simple or complex depending on the scale of the municipality.		
2.5 Financial inventory	An analysis of the GHG impact of existing expenditures by the local government and other entities in the community.	The financial inventory can be simple or complex depending on the scale of the municipality.		

TASK 2.1: DATA REQUEST

RELEVANT STREAMS

Data is a major consideration for completing the inventory and modelling. Questions include:

- What type of inventory will be completed?
- What sectors will be included in the inventory?
- Who has the required data?
- Is a data confidentiality agreement required?
- What are the privacy issues if any?
- What format is the data in?
- How can the data be accessed?
- What is the level of confidence in the data?

A systematic approach to data should identify the data required for the community and/or corporate inventories and for modelling future projections. A checklist of all the data required for the planning process and its potential sources is the "data request".

Table 19. Data collection efforts.

	Basic	Intermediate	Advanced
Description	Total GHG emissions are inventoried without seeking to evaluate the drivers of those emissions.	Energy and GHG emissions are represented spatially.	GHG emissions are calculated based on the factors that drive emissions.
Sample data requested	» Total electricity consumption; » Total natural gas consumption; » Estimates of other energy sources; » Estimates of gasoline and diesel consumption; and » Solid waste totals.	» Natural gas consumption by sector and postal code; » Electricity consumption by sector and postal code; and » Vehicle types by location.	» Building type and shape; » Energy equipment (furnaces, air conditioning, etc); » Vehicle types and efficiencies; and » Trip length.
Estimated duration of data collection	2 weeks to 1 month	1–3 months	3+ months

A sample data request for the advanced approach is included in Appendix 3.

TASK 2.2: DATA COLLECTION

RELEVANT STREAMS

The data collection process is an opportunity to liaise with different departments and stakeholders. The expected outputs of the plan should be made clear so that data providers supply the correct data and understand how the plan will support or modify their work.

Data collected can be cross referenced with the data request to ensure completeness. A naming protocol for document and data should be established and data should be stored in a secure location. Careful documentation ensures that future efforts can replicate the same data collection processes, ensuring comparability.

TASK 2.3: GHG INVENTORY

RELEVANT STREAMS

Inventories are fundamental to energy and emissions planning work, setting the foundation for projections and modelling. There can be many details to consider in performing an inventory (hence the length of this Guideline section), but the remaining work of the planning process, as well as that for future inventories and energy and emissions planning, will be made much easier for the effort invested up front. Table 20 summarizes the characteristics of typical inventories, for different scales of effort.

Table 20. Characteristics of community-scale GHG inventories.

	Basic	Intermediate	Advanced
Description	A basic inventory is completed using the PCP tool. PCP's platform provides standard assumptions that can be used.	A custom GHG inventory is completed using the GPC accounting system. The inventory is completed to the level of GPC basic. The inventory includes spatial information.	A custom GHG inventory is completed using the GPC accounting system. The inventory is completed to the level of GPC+. The inventory is developed in a model that enables analysis of future scenarios.
Characteristics	The relationship between the drivers of GHG emissions such as land-use and other variables is hidden in this approach.	Comprehensive data collection is required and GHG emissions must be calculated using standard formula. Because the inventory includes spatial information, insight into land-use policies is possible.	The inventory can be used as the basis for generating future scenarios. The integration of the inventory and land-use patterns and policies is fully supported.
Approach	The PCP tool can be used to support this approach.	The Guideline describes the relevant steps.	
Outputs	Corporate: PCP or LGOP municipal inventory. Community: GPC compliant GHG inventory.		

GHG Inventory Principles

The GHG inventory informs and encourages action in lowering the community's carbon footprint. It guides where and how to target initiatives to reduce emissions. The GPC defines the following principles for use in compiling GHG inventories.

- *Relevance:* The reported GHG emissions shall appropriately reflect emissions occurring as a result of activities and consumption patterns of the city.
- *Completeness:* Cities shall account for all required emissions sources within the inventory boundary. Any exclusion of emission sources shall be justified and clearly explained
- *Consistency:* Emissions calculations shall be consistent in approach, boundary, and methodology.
- *Transparency:* Activity data, emission sources, emission factors, and accounting methodologies require adequate documentation and disclosure to enable verification
- *Accuracy:* The calculation of GHG emissions shall not systematically overstate or understate actual GHG emissions.

GHG Inventory and Reporting Standards

At the outset of preparing an inventory, it is useful and recommended to choose an inventory and reporting standard as a guideline. There are several global reporting standards, methodologies and models to choose from. Their application will depend on the energy and emissions planning extent and approach of the municipality.

Table 21. GHG inventory and reporting standards.

Title	Description	Applicability	Considerations	Complexity
Global Protocol for Community Scale GHG Emission Inventories (GPC)	Accounting and reporting standard for community- scale GHG inventories.	Guidance on how to complete a community GHG inventory.	Applicable to all local governments.	**Intermediate, Advanced**
Local Government Operations Protocol (LGOP)	Accounting standard for local government operations.	Guidance on how to complete a corporate GHG inventory.	Applicable to all local governments. Designed for US municipalities.	**Basic, Intermediate, Advanced**
City Inventory Reporting and Information System	Excel-based tool for managing and reporting city greenhouse gas inventory data	Tool for completing community-scale GHG inventories.	Applicable to all local governments.	**Intermediate**
Partners for Climate Protection Milestone Tool (PCP)	A web-based tool for GHG inventories and projections for community and corporate inventories. Pre-populated with assumptions for each province.	Tool for completing community and corporate GHG inventories.	PCP members only. Currently being updated.	**Basic**
CityInSight	A systems-dynamics model used for generating land-use, energy and emissions scenarios.	Tool for generating scenarios.	Open source but complex to apply.	**Intermediate, Advanced**

The PCP Milestone Tool, GPC, and the LGOP provide guidance on the assembly of GHG inventories. Each of these lays out the sectors that should be covered in the inventory, their data requirements, calculation methodologies, inclusion/exclusion protocols, and options for different levels of municipal resources and data availability.

The simplest of these to follow is the PCP Protocol using its Milestone Tool, which generates corporate and community inventories and projections. While the PCP Protocol will be updated to be compatible with GPC, its primary weakness is that it does not involve spatial inputs or outputs, and as such does not provide insight on the impacts of land-use planning decisions.

A more comprehensive approach uses the LGOP for the corporate inventory and GPC for the community inventory. Both protocols provide detailed guidance on methods to calculate emissions, with options for different levels of data availability. The GPC has been officially adopted as the standard emissions inventory accounting framework of C40 and the Global Covenant of Mayors, which collectively represent close to 650 cities worldwide.

The GPC requires cities to measure and disclose a comprehensive inventory of GHG emissions and to total these emissions using two distinct but complementary approaches. One captures emissions from both production and consumption activities or sectors taking place within the city boundary, including some emissions released outside the city boundary. The other categorizes all emissions into "scopes," depending on where they physically occur. Table 22 defines the 3 scopes and Figure 9 illustrates how the scopes incorporate GHG emissions from different sectors.

Table 22. GHG inventory scopes.

Scope	Definitions
1	GHG emissions from sources located within the municipal boundary.
2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the municipal boundary.
3	All other GHG emissions that occur outside the municipal boundary as a result of activities taking place within the municipal boundary.

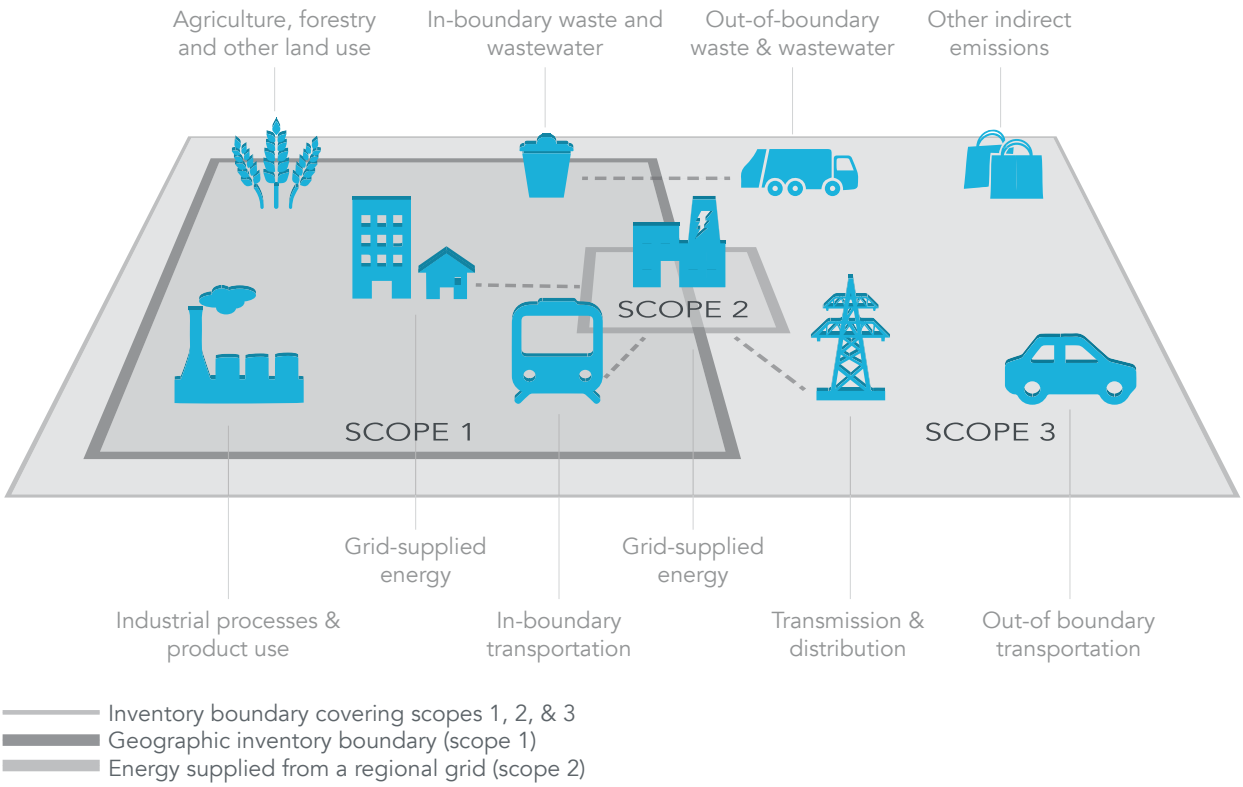


Figure 9. The relationship between emissions scopes and sectors.[9]

GPC has two levels of reporting.

1. BASIC level includes emissions from stationary energy, transportation.
2. BASIC+ requires additional reporting on Scope 3 emissions resulting from stationary energy, transportation and waste, as well as emissions from industrial processes and product use, and agriculture, forestry and other land-use.
3. BASIC level of reporting is the minimum standard for municipalities in Ontario, with BASIC+ as an advanced option. Appendix 4 provides a detailed review of BASIC and BASIC+ requirements.

9 Adopted from: World Resources institute, C40 Cities, & ICLEI. (2014). *Global protocol for community-scale greenhouse gas emissions inventories*. Retrieved from http://c40-production-images.s3.amazonaws.com/other_uploads/images/143_GHGP_GPC_1.0.original.pdf?1426866613

Geographic vs Consumption Inventories

RELEVANT STREAM

There are two distinct approaches for completing a GHG inventory. The geographic inventory focuses on emissions resulting from the consumption of energy and production of waste within the geographic boundary of the municipality. A consumption-based GHG inventory accounts for emissions resulting from the consumption of goods and services consumed, irrespective of where the GHG emissions occur (Figure 10).

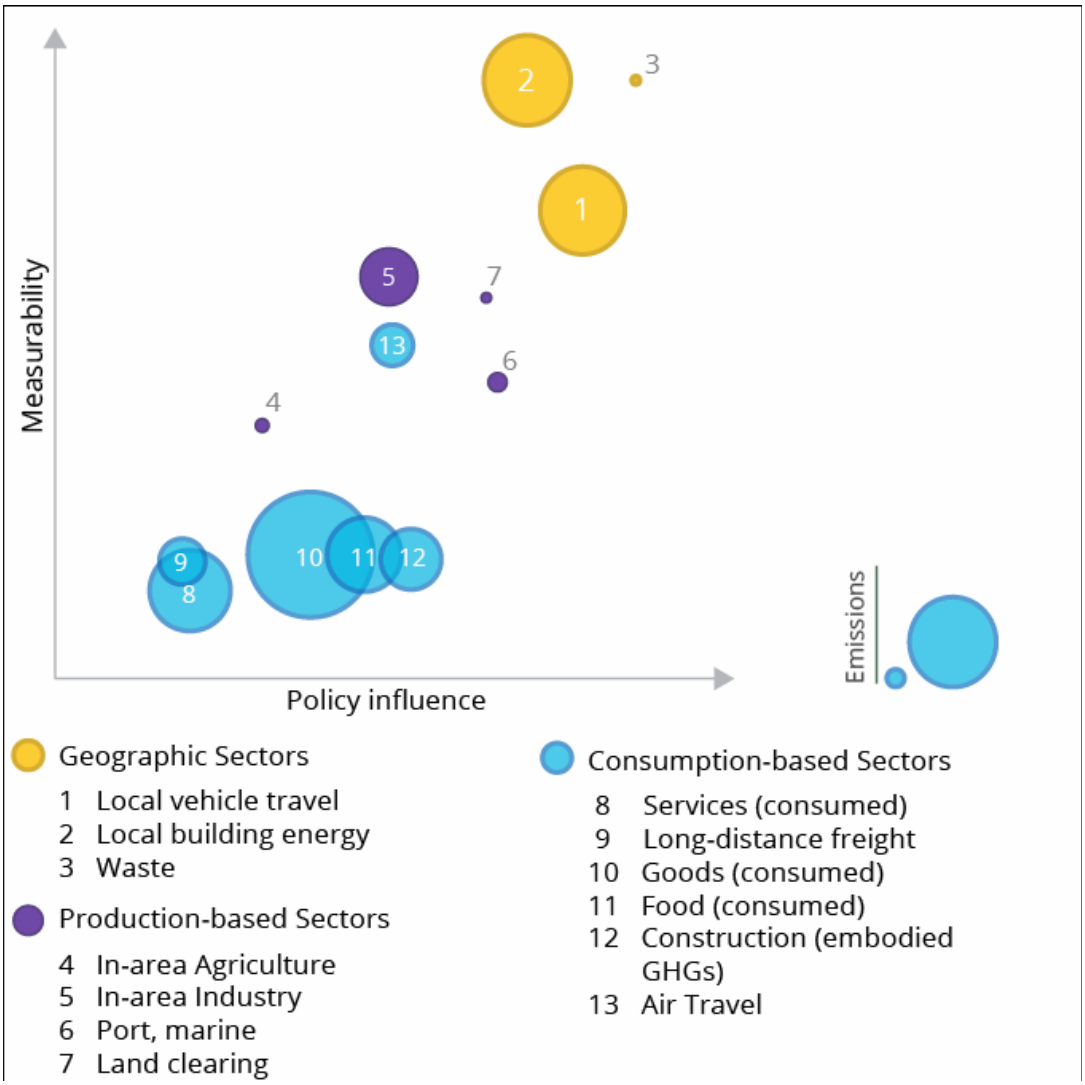


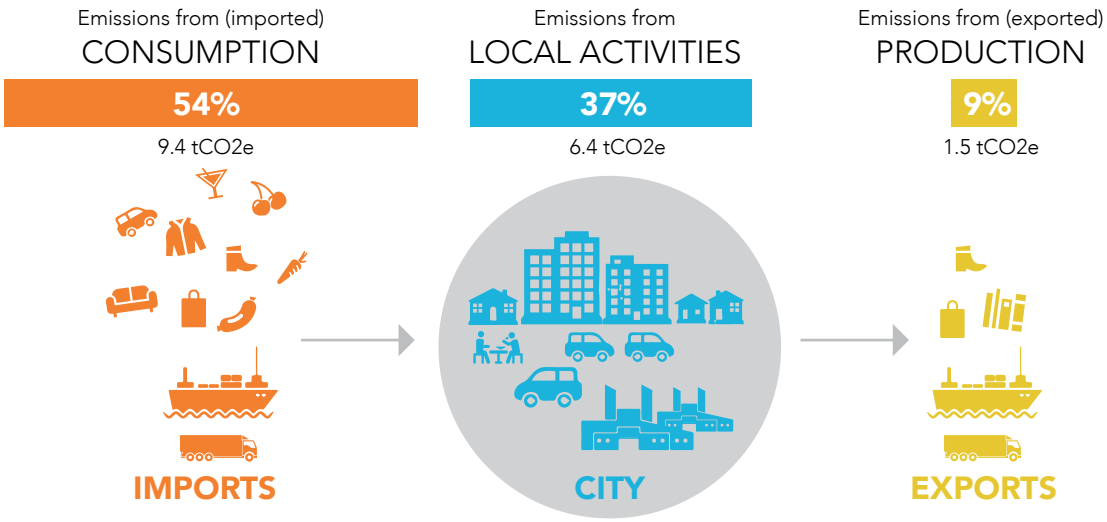
Figure 10. Geographic vs consumption-based inventories.[10]

10 Adapted from: Erickson, P., & Lazarus, M. (2012). Revisiting community-scale greenhouse gas inventories. *Environmental Science & Technology*, *46*(9), 4693–4694. https://doi.org/10.1021/es301366b

Consumption-based inventories provide insight into GHG emissions that are not addressed within a geographic inventory. For example, recycling would receive greater emphasis in a consumption-based inventory because it reduces upstream GHG emissions resulting from the production of goods, which a geographic-based inventory does not capture. In general, the GHG emissions tracked in a consumption-based inventory are more challenging to influence due to the limited consumption-influencing powers available to municipalities. Consumption-based inventories provide a stronger case for action on food production and consumption, and waste diversion, than geographic inventories.

Example: Stockholm Environment Institute. (2011). Consumption-based emissions inventory for San Francisco.

https://sfenvironment.org/sites/default/files/fliers/files/sf_consumption_based_emissions_inventory.pdf



EMISSIONS INCLUDED

INVENTORY TYPE	Consumption	Local activities	Production
Total emissions	✓	✓	✓
Consumption-based inventory	✓	✓	
Sector-based inventory		✓	✓

Figure 11. Insights from a consumption-based inventory for Portland, Oregon.[11]

11 Adapted from: City of Portland, & Multnomah County. (2015). *Climate action plan.* Retrieved from https://www.portlandoregon.gov/bps/article/531984

Consumption-based inventories are recommended as an advanced option for Ontario municipalities, completed in addition to a geographic inventory. Methods for consumption-based inventories are not addressed in this Guideline.

Example: City of Portland, & Multnomah County. (2015). *Climate action plan*.

https://www.portlandoregon.gov/bps/article/531984

Geographic Boundary Inventory Considerations

RELEVANT STREAMS

GHG inventories based on geographic boundaries consider geographic area, GHG gas types, emissions sectors/sources, and time span covered. GPC establishes recommended boundaries for a community-scale GHG inventory, summarized in Table 23.

Table 23. Boundary inventory considerations.

Category	Corporate	Community
Geographic	Operational control	The municipal boundary
Time period	12 months	12 months
Greenhouse gases	Carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O). Optional: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), and nitrogen trifluoride (NF3)	
Sectors	» Buildings and other facilities » Streetlights and traffic signals » Water delivery facilities » Vehicle fleet » Energy generation facilities » Solid waste facilities » Wastewater facilities » Other processes and fugitive emissions	» Stationary energy » Transportation » Waste and wastewater » Industrial processes and product use (IPPU) » Agriculture, forestry, and other land-use (AFOLU)

Category	Corporate	Community
Resource	Local Government Operations Protocol	Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories

Establishing a Baseline Year

RELEVANT STREAMS

The baseline year is the reference point against which GHG targets are referenced. In modelling, it is the year for which the model is calibrated to ensure consistency with observed data. Ontario's provincial target uses a baseline year of 1990; however, it is not practical for municipalities to track down data from 1990. 2011 or 2016 are appropriate baseline years because they were census years—most building and population data is available. It is important to develop a comprehensive and consistent inventory for the baseline year. Where there are data gaps, the baseline year can be reverse calculated from a more recent GHG inventory.

Municipal Corporate vs Community Inventories

RELEVANT STREAMS

There are two categories of GHG inventories that municipalities commonly undertake. The municipal inventory tracks emissions associated with the operations of the municipality (the corporation). The community inventory tracks emissions associated with the people who live within the geographic boundary of the community. Emissions associated with the corporate inventory are a small portion of the total GHG emissions of the community. The corporate inventory enables the local government to manage emissions directly under its control and is typically more precise, relying on observed data. Data collection and analysis for the community inventory is more complex and requires the use of assumptions as well as data collection from other organizations. The Guideline recommends that municipalities complete both corporate and community inventories. The Guideline includes greater emphasis on community inventories as they are a more complicated process.

Table 24. Comparison of municipal corporate and community inventories.

Sector	Corporate inventory	Community inventory
Buildings	Buildings and other facilities (including streetlights and traffic signals) operated by the municipality.	All buildings in the municipal boundary.
Transportation	Energy consumed by vehicles owned or operated by the municipality.	Energy consumed to move people and goods in the municipal boundary.
Energy systems	Energy consumed as a result of the activities of the municipality; energy consumed by energy generation facilities operated by the municipality.	Energy consumed as a result of activities in the municipal boundary; energy consumed by energy generation facilities within the municipal boundary.
Waste	Energy used by waste and wastewater facilities operated by the municipality.	Emissions from waste and wastewater produced by people living or working within the municipal boundary.
Fugitive emissions	Fugitive emissions from the municipal facilities.	Fugitive emissions resulting from activities within the municipal boundary.

Inventory Spatial Analysis Considerations

RELEVANT STREAMS

In order to relate GHG emissions to land-use planning, a spatial (land-based) analysis should be completed. This requires inventories to include spatial data (i.e. GIS). Several Ontario municipalities have completed energy maps, an aspect of spatial analysis.

Table 25. Sample energy and emissions spatial considerations.

Type	Calculation	Use case	Future projections
People and employment density	People and jobs per area (people and jobs/hectare)	Can be used as a measure of the 'people' density of a local government. Note that even if people and jobs are added, the number of buildings does not necessarily change. This can be used as an indicator of locations to target transit in particular.	Illustrates development patterns of the local government as population and jobs are added.
Buildings density	Number of units or square metres per area (units/hectare or square metres/ hectare)	An indicator of the density of heated and cooled space (energy use). New buildings do not necessarily increase total energy use if they are high efficiency and/or existing buildings are retrofit.	Indicates the nature of change in building stock as different types of buildings or dwellings are added.
Energy Density	Energy consumed per area of developable land (GJ/ha or GJ/ m2)	Can be used to compare the energy impacts of land-use for growth nodes, corridors, or other areas in the city. Areas of high energy densities are potential sites for district energy systems.	As building density increases overall energy density increases.
Energy Use Intensity (EUI)	Energy consumed per area of floorspace (GJ/m2 or kWh/ m2)	Can show the average EUI for all buildings in a zone or parcel. If the information is granular enough, it will show over time how retrofitting or other measures can improve EUIs.	EUI's can only change by decreasing energy demand (e.g. by increasing efficiencies/envelope etc.) or by changing building types (e.g. single family home to mid-rise apartment).

Type	Calculation	Use case	Future projections
Energy Per Capita	Energy consumed per person (GJ/cap)	Can be used to compare how much energy is consumed by each resident or worker. This metric can be used to understand how energy efficiently a neighbourhood is able to accommodate residents.	As building density increases, more people live within a zone, resulting in higher overall energy demand. On a per capita basis, energy/capita should decrease over time with increased density and efficiencies, as people are more likely to be living in apartments.
VKT Per Capita	Kilometres by mode per person from the origin	Can be used to compare the extent of travel by different modes in different areas. Areas with high levels of vehicular travel can be identified for interventions such as travel planning or transit.	Indicates how travel behaviour changes over time.

Spatial analysis provides insight on the geography of energy use and other drivers that influence emissions, directly linking energy and emissions plans to land-use planning and Official Plan policies.

Figures 12 to Figure 14 illustrate three different perspectives on stationary energy use in the residential sector.[12]

12 Graphics prepared for the City of Markham's Municipal Energy Plan by SSG and whatIf? Technologies.

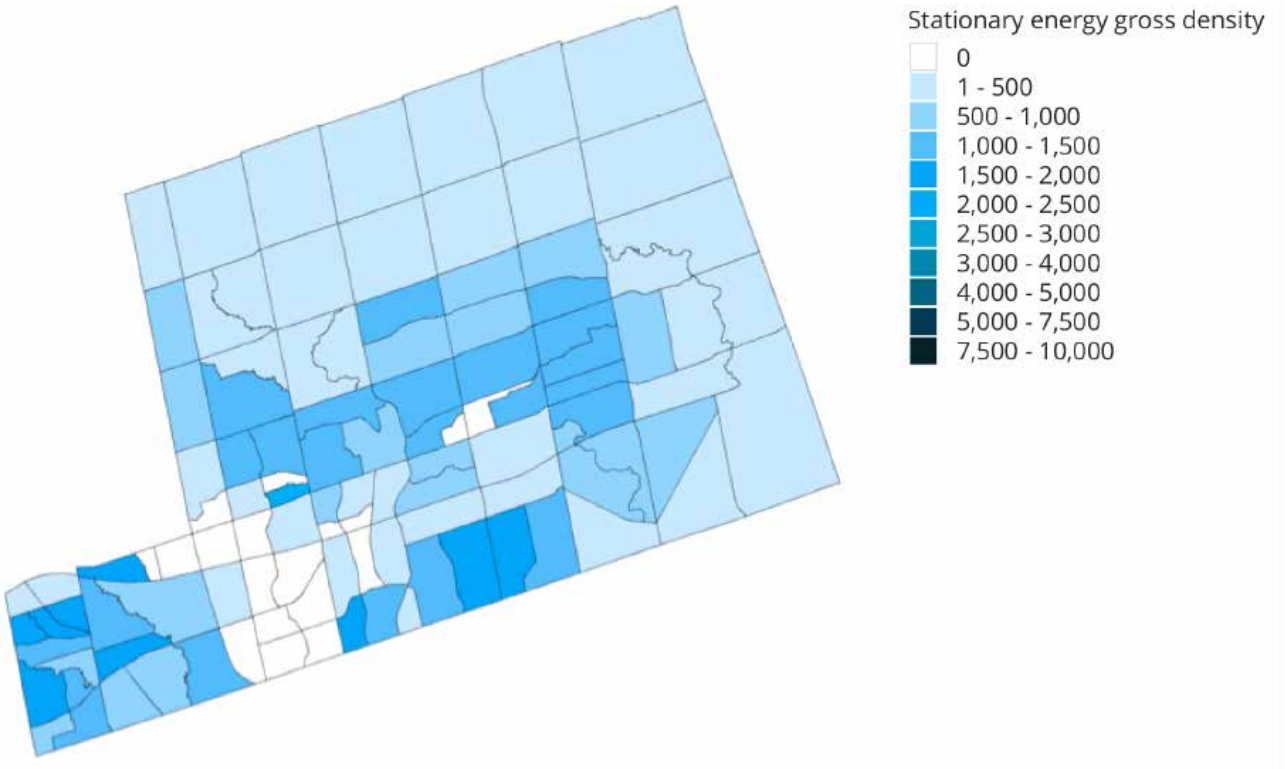


Figure 12. An example of stationary energy ***density*** *mapping (in gigajoules per hectare).*

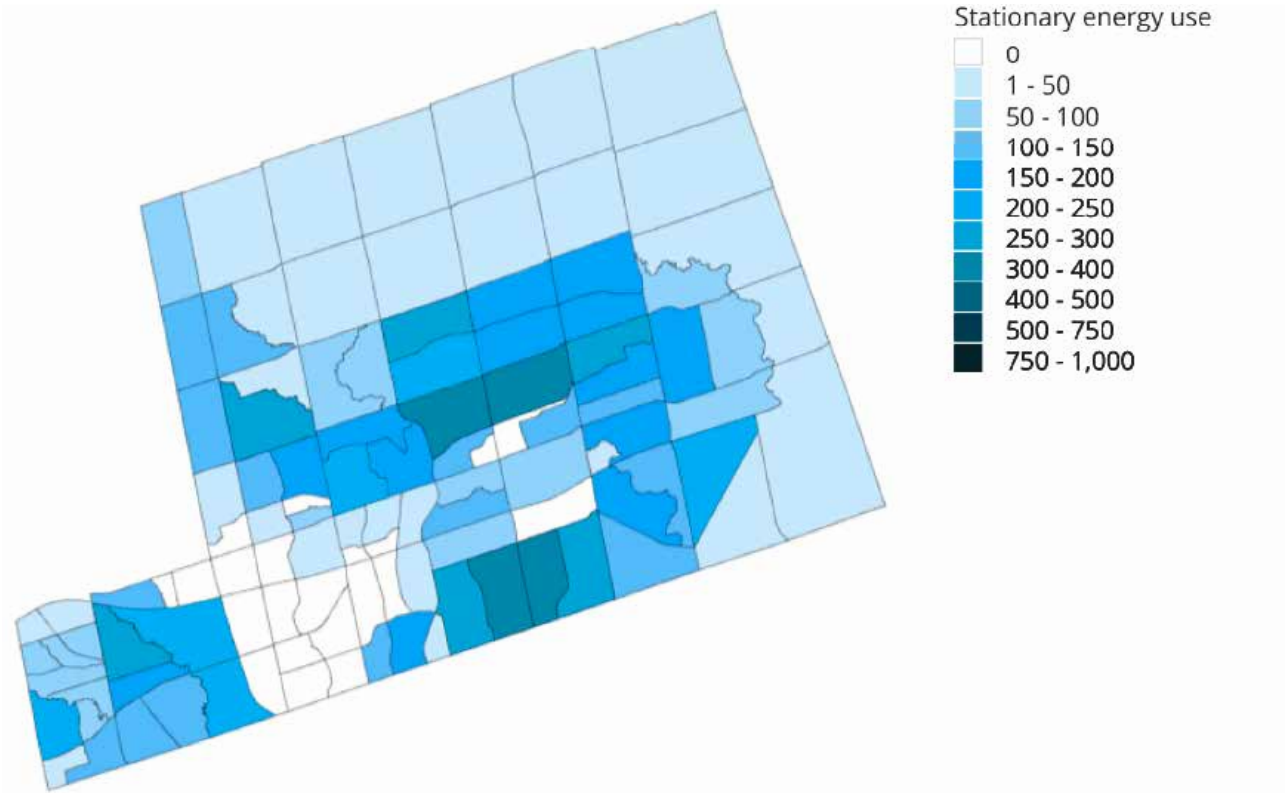


Figure 13. An example of stationary energy ***use*** *mapping (in terajoules).*

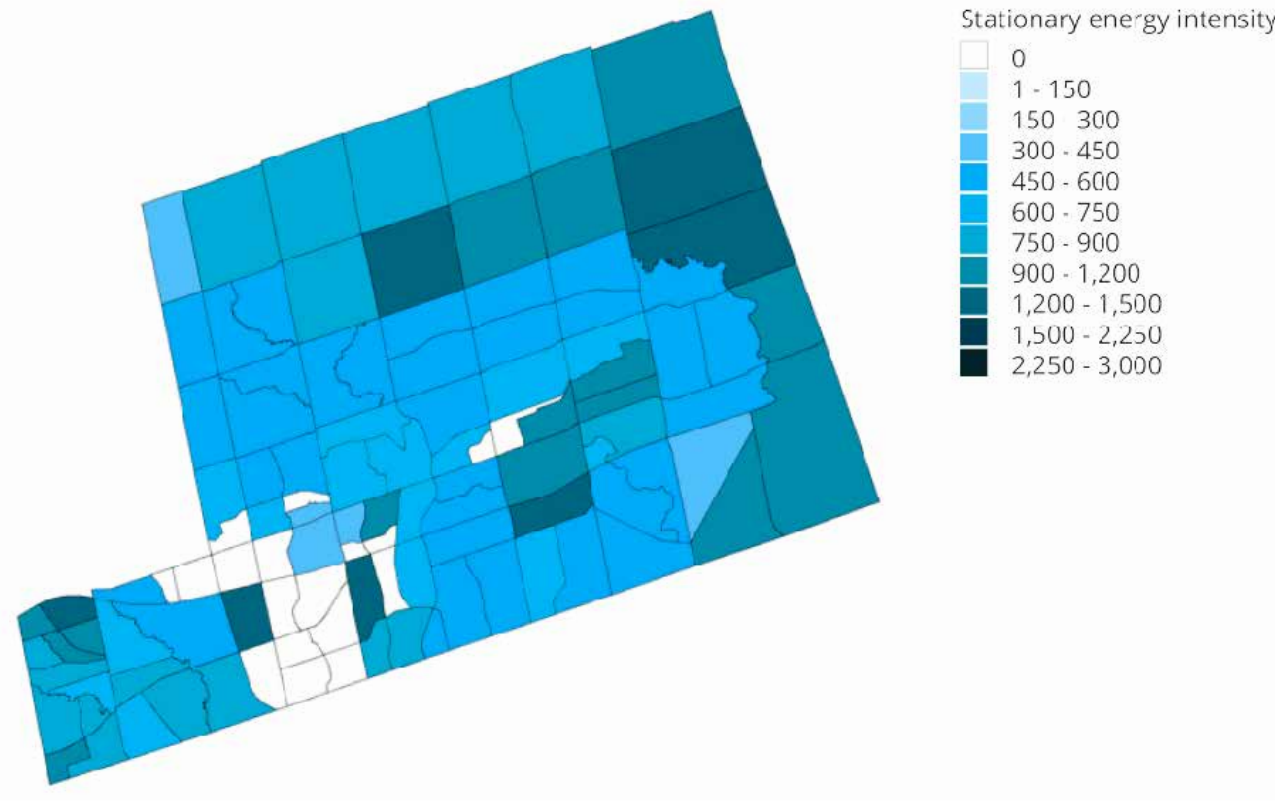


Figure 14. An example of stationary energy ***density*** *mapping (in megajoules per square metre).*

Sector-specific Considerations for Inventories

RELEVANT STREAMS

There are a variety of emissions sources (i.e. scopes) and data treatments to consider for each emissions sector of a GHG inventory. Additional guidance on this topic is provided in Appendix 5.

Collecting Emissions Data Versus Estimating

RELEVANT STREAMS

A community emissions inventory requires estimating some data based on underlying causal factors (e.g. automobile emissions can be estimated using the number of registered vehicles, estimated length and number of trips, vehicle fuel efficiencies, and fuel use). The inventory also requires understanding the causes of energy use and emissions production; even if certain data is known, it may not be enough to inform action. For example, knowing the total amount of natural gas sold in a community is sufficient for computing the emissions, but it is also necessary to know how the gas was used and for what purposes (e.g. how much for heating homes, and how much for office buildings, etc.). As a result, a community GHG inventory calculates GHG emissions from the *drivers* of the GHG emissions. Figure 15 is an example of such a calculation for transportation emissions.

$$CO_2 \text{ Emissions} = (A/B) * C * D * E$$

where
- A is the number of person trips made using the mode
- B is the number of people per vehicle (capacity factor)
- C is the trip length
- D is the fuel consumption per vehicle mile
- E is the CO_2 emissions per unit of fuel

Figure 15. Example of emissions calculation for transportation that considers emissions transportation drivers.

An inventory in 40 hours

The City of London updates its GHG inventory annually. The first inventory was completed in 1994, and was updated in 1999. The method used at that time was evaluated by ICLEI to ensure it was valid and this approach is used today. Electricity and natural gas are straightforward, based on data provided by the utilities. Transportation GHG emissions are calculated using retail sales data purchased from Kent Group, an approach that is straightforward in comparison with analyzed origin-destination information and is appropriate for London as a geographically defined city. The cost of the Kent data is $200/year and the approach is consistent year over year, facilitating the identification of trends over time. The City also purchases vehicle registration data from Polk (now IHS) in order to track vehicle ownership rates, which have been growing four times faster than population growth. The Kent data indicates, however, that vehicles are using less fuel per vehicle. Since signing on to the Compact of Mayors, the City has begun to report on GHG emissions from aviation and rail on a per capita basis using provincial numbers. Total GHG emissions in London have declined. In 2015, London's greenhouse gas emissions were about 3.2 million tonnes of equivalent carbon dioxide, a reduction of 8% below 1990 levels and 18%below 2007 levels.

Mapping the Inventory to Key Stakeholders

RELEVANT STREAMS

Following the completion of the GHG inventory, it is useful to the rest of the planning process to identify stakeholders and key decision-makers who influence community emissions, a process that is a key part of the engagement strategy. These are potential partners in developing low carbon objectives and implementing low carbon actions, and the success of the plan requires understanding stakeholder priorities and addressing their critical issues. For example, the thermal efficiency of new housing is influenced by the building code and its enforcement, the skills and practices of the housebuilder, the preferences of the buyers, the marketing strategy of the developer, etc. Achieving low carbon housing requires a plan that aligns with these stakeholders' motivations. Table 26 maps the emissions sectors, high-level emissions drivers, factors in emissions levels, and key decision-makers. A tailored version of this table should be developed for each plan to identify stakeholders.

Table 26. Examples of stakeholders by emissions sector.

Emissions Sector	Key Stakeholders
Residential	» Building and home owners » Builders and construction industry » Architects » Banks and mortgagors » Occupants and tenants » Condo boards » Real estate industry » Gas and electric utilities » Building technology suppliers
Personal Transportation	» Vehicle operators » Vehicle manufacturers and suppliers » Transit organizations » Infrastructure providers » Highway operators and concessionaires » Parking authorities » Developers
Commercial Buildings	» Owners, occupants, and tenants » Energy and asset managers » Commercial real estate developers » Gas and electric utilities » Financiers, investors » Architects » Construction industry

Emissions Sector	Key Stakeholders
Institutional Buildings	» Owners » Occupants » Energy and asset managers » Government finance managers » Elected officials » Community agencies, boards, commissions
Goods Movement	» Supply chain managers » Logistics companies » Vehicle operators » Infrastructure providers (local, provincial, federal governments) » Regulators (local, provincial, national and international) » Fleet managers » Vehicle manufacturers » Consumers
Manufacturing	» Plant managers » Investors » Shareholders » Equipment suppliers » Energy utilities » Policy makers » Regulators

Business as an advocate for climate action in Boston

The City of Boston coordinates with the business and institutional communities to advance sustainability goals. A major organization supporting this work is the Boston Green Ribbon Commission, formed in 2010 by business, university, health care, philanthropic, and community leaders to support implementation of the Mayor's climate action plan. The Commission has three key roles:

- Advise the City on the implementation of its Climate Action Plan.
- Engage sector leadership in aligning their assets and initiatives to support the plan outcomes.
- Lead, by practicing and promoting best practice examples within and across sectors that advance the Climate Action Plan goals.

Inventory Continual Improvement

RELEVANT STREAMS

GHG inventories evolve from one year to the next for various reasons: data sources can become available or unavailable; local governments may merge with their neighbours; calculation errors may be discovered. The GPC provides guidance on when a local government should revise its previous inventories, indicating that changes should only be made if the implications are significant (Table 27). While GPC does not define significant, it is recommended that historical inventories should be revised if there is an impact of greater than 5%.

Table 27. Inventory recalculation triggers (adopted from GPC).

Change	Example	Recalculation needed? (significance)
Change in inventory boundary	A community is included in or set aside from a city's administrative boundary	Yes
	Change in goal boundary from BASIC to BASIC+, or from 6 GHGs to 7 GHGs	Yes
	Shutdown of a power plant	No
	Build of a new cement factory	No
Change in calculation methods	Change in calculation method for landfilled solid waste	Yes
	Adoption of a more accurate activity data instead of a scaled-down national figure	Yes
	Change in global warming potential factors used	No
	Change in electricity emissions factors	No
Discovery of significant errors	Discovery of significant mistakes in calculations	Yes

TASK 2.4: SPHERES OF INFLUENCE

RELEVANT STREAMS

The final step in completing the inventory is to evaluate the local government's spheres of influence in emissions reduction, determining which emissions sources and volumes the government can effectively influence and which it cannot. To be effective in leading a community-wide transition to low carbon, the local government must lead by example by addressing its own emissions (which typically account for 5–10% of total community emissions), as well as strategically leveraging its planning, infrastructure investment, permitting and regulatory activities, procurement, and other powers and influences.

As previously discussed, municipalities have different types of influence on emissions, which vary by region, size and type: upper tier (regions and counties) and lower tier (cities, towns, municipalities, and townships). At times, upper and

lower are combined into a single tier, which assumes the responsibilities of both.[13]

Upper tier municipalities often co-ordinate service delivery between lower tier municipalities in their area or provide area-wide services. Emissions-relevant municipal services typically include:

- Waste management;
- Water & sewage;
- Regional roads (as designated in Official Plans);
- Natural heritage (possibly through MOU with Conservation Authorities);
- Emergency services (police, ambulance);
- Health unit;
- Long term care; and
- Mass transit.

Lower tier municipalities are primary service providers, which includes emissions-relevant services like:

- Tax collection;
- Building permit issuance;
- Land development (Planning Act applications);
- Fire & emergency management;
- Public works (roads maintenance); and
- Parks & recreation facilities.

In order to determine where to focus its emissions reduction efforts, local governments can perform a simple spheres of influence assessment, outlined below.

Table 28. Approach to spheres of influence assessment.

	Basic	Intermediate	Advanced
Description	Municipal levers can be identified for each of the major sources of GHG emissions through a process of inquiry. For example, if the major source of GHG emissions is from transportation, the discussion can focus on what levers the municipality has over the variables that influence transportation GHG emissions.	A method has been developed by C40 to systematically evaluate spheres of influence.	

13 Municipal Affairs and Housing, Ministry of. "Municipal Councillors Guide: Section 2". Queen's Printer for Ontario. http://www.mah.gov.on.ca/Page8391.aspx

	Basic	Intermediate	Advanced
Approach	A workshop can be used to qualitatively identify the influence of the municipality on major sources of GHG emissions.	The spheres of influence method is described in the Guideline appendices.	
Output	Short document that describes the levers that the municipality can apply against the major sources of GHG emissions.	Report with charts that illustrate the spheres of influence.	

Spheres of Influence Method

RELEVANT STREAMS

A three-step method for assessing the emissions influences of a municipality—developed by C40 and adapted for the Ontario context—is described below. The method can also be used later in the planning process to evaluate the municipality's approach to specific actions.

- Step 1: Identify major emissions sectors (e.g. transportation or buildings).
- Step 2: Review the inventory to identify those causal factors over which municipality has direct or indirect influence. Add any other factors that are relevant to the particular context to ensure a complete list.
- Step 3: Apply the assessment of local government's influence to each of these areas (from C40, information in Appendix 8 of this Guideline).

The assessment of spheres of influence is a representation of the current powers of local government. It will likely identify gaps between the required emissions reductions and the influence local government can wield. There are two approaches to bridging these gaps: partnering with entities that have influence, and developing new services to meet the requirement.

There are four main categories of influence for municipalities:

- Own or operate;
- Control budget;
- Set or enforce regulations or policies; and
- Set vision.

All energy and emissions actions a municipality is able to take will fall into one or more of these categories

More information on spheres of influence is available in Appendix 8.

Resource: ARUP. (2015). Powering climate action: cities as global changemakers.
https://issuu.com/c40cities/docs/powering_climate_action_full_report

TASK 2.5: FINANCIAL ASSESSMENT

RELEVANT STREAMS

An assessment of municipal expenditures can guide local governments as part of the situational analysis, using the idea of "follow the money" to bolster GHG mitigation. The financial assessment may also highlight some early opportunities to implement actions to reduce GHG emissions. Here is a suggested seven-step financial assessment framework:

- *Step 1:* Review pending and planned spending across municipal departments. Identify the top 10 capital investments planned in the next five years and the top 10 ongoing expenditures in the annual budget.
- *Step 2:* "Ask the climate question" as to the impact of these expenditures on GHGs. Evaluate the impact of investments or expenditures on GHG emissions.
- Step 3: Identify opportunities. Consider whether there are opportunities to adjust, modify, redirect, reorient, or relocate spending to maximize GHG reduction (e.g. how can a new development reduce emissions by incorporating transit, energy efficiency, active transportation, renewable energy production, etc.?). Discuss whether the incremental cost of possible changes would be major, significant, negligible, or generate net savings.
- *Step 4:* Assess practicality. Once an opportunity is identified, review the current status of the project/policy/program/expenditure, what it took to get it there, key decision makers, key stakeholders, and their priority concerns, in order to assess the practicality of making a shift. Explore how

the activity could incorporate GHG mitigation with the staff in charge of the activity.

- *Step 5:* Conduct more detailed analyses. Once there is an initial engagement from the department in charge of the project, more detailed analysis will be required to assess implementation steps, costs and benefits.

- *Step 6:* Integrate the financial opportunities in the community energy and emissions plan. The same process can be used to identify the impacts of municipal spending on climate resilience. Both mitigation and adaptation could be considered in this same exercise, which would shed light on synergistic, low-carbon resilience opportunities. For example, a recreation centre could potentially be designed as a community cooling centre during heat waves, or a shelter-in-place location with energy backup and storage to ride out severe storms.

- *Step 7:* Consider investments by other levels of government. Beyond the analysis of municipal government investments and expenditures, community energy and emissions planning requires an understanding of the planned investments in the community by other levels of government and the private sector, how those investments will influence greenhouse gas emissions, and how municipal government influence could be brought to bear to achieve a low carbon outcome. Although municipal government is a significant player when it comes to investment—particularly in infrastructure—many investments are made by the private sector, and identifying and leveraging opportunities to lower the emission impacts of all investment in the community is key to a successful municipal action plan for achieving GHG emissions reductions.

Stage 2 Conclusion

The GHG emissions inventory may seem a daunting task, but it doesn't have to be. There are many considerations, but all are sensible and most are straightforward. In addition to the information in this Guideline, the GPC, LGOP, PCP and C40 documentation on performing emissions inventories guidance.

Stage 3: Target Setting

»OUTPUTS:

» TARGETS THAT ALIGN WITH THE PROVINCIAL TARGETS

After completing the GHG emissions inventory, a municipality has insight into the emissions reduction challenge at hand. Taking into consideration provincial and international emissions reduction targets, municipalities can begin to estimate and establish their own targets. Table 29 outlines this task.

Table 29. Stage 3 tasks

Tasks	Description	Complexity of approach		
		Basic	Intermediate	Advanced
Stage 3: Target Setting				
3.1 Set an emissions reduction target for the community	Establish a GHG target consistent with or exceeding the provincial targets.	Adopt provincial targets for each time period.	Use recommended target setting approach in the Guideline.	

TASK 3.1: EMISSIONS REDUCTION TARGET SETTING

RELEVANT STREAMS

Municipalities should consider aligning emissions reduction targets with provincial targets, while also setting targets that allow for flexibility to account for the local and regional context. Targets that exceed those of the province are also valid. There is nothing preventing a municipality from adopting more ambitious reduction targets through adjustments to timelines or actions towards achieving deeper emissions reductions. Municipalities with existing targets should evaluate whether or not to revise their target after applying the recommended approach described below.

Provincial Targets

The province has established GHG emission targets for 2030 and 2050: 115 Mt CO_2e and 36 Mt CO_2e, respectively (Figure 16). These targets are based on achieving a 37% reduction in emissions by 2030 and an 80% reduction by 2050, in both cases as compared with the international reference year of 1990.

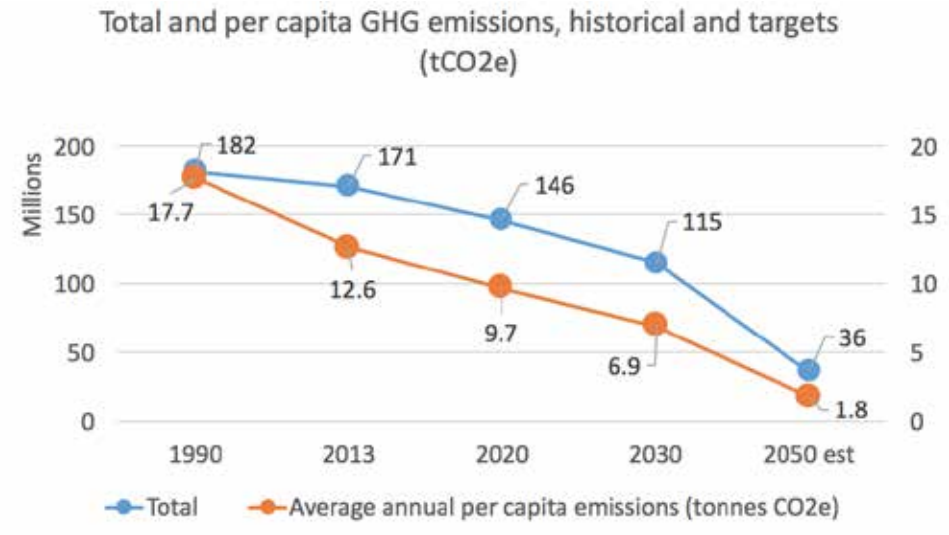


Figure 16. Ontario total and per capita GHG emissions, historical and targeted.

Notable Issues

There are several issues of note in setting municipal targets to be supportive and consistent with the provincial objectives:

- The Ontario population is projected to increase significantly in the decades ahead, exceeding 16 million by 2030 and 19 million by 2050.[14]
- Given the province's targets, deep reductions will be required in every sector; no one or two sectors are responsible for producing enough emissions to carry the burden of an 85% reduction.
- Ontario populations are expected to increasingly urbanize. The economy is expected to continue to be dominated by the service sector. These expected demographic and economic trends will increase the portion of the province's GHG emissions that fall under the direct or indirect control and influence of municipal governments.
- Population growth is projected to be overwhelmingly concentrated in southern Ontario, especially in the Greater Toronto Hamilton Area. Opportunities for decarbonizing are different in populous, growing, urban areas than in smaller, rural communities.

14 Ontario Ministry of Finance, http://www.fin.gov.on.ca/en/economy/demographics/projections

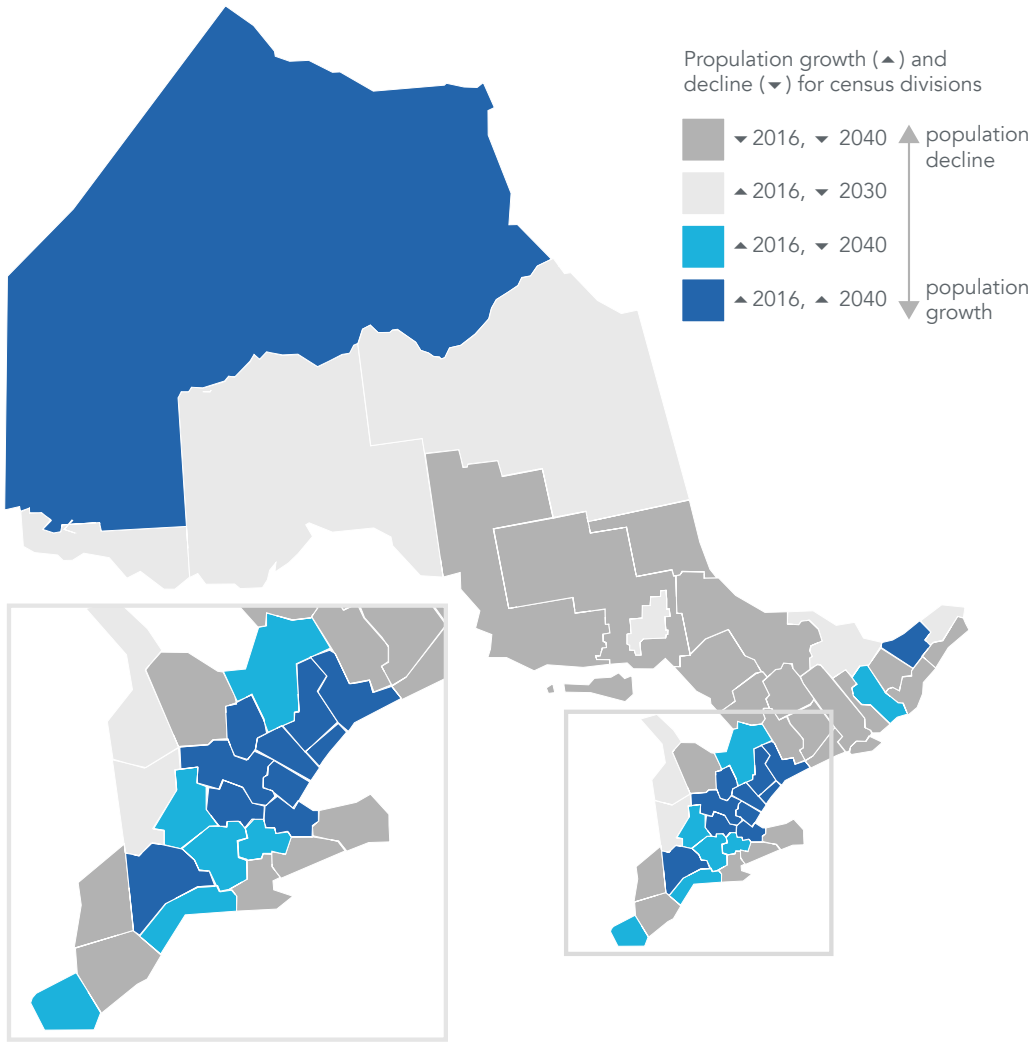
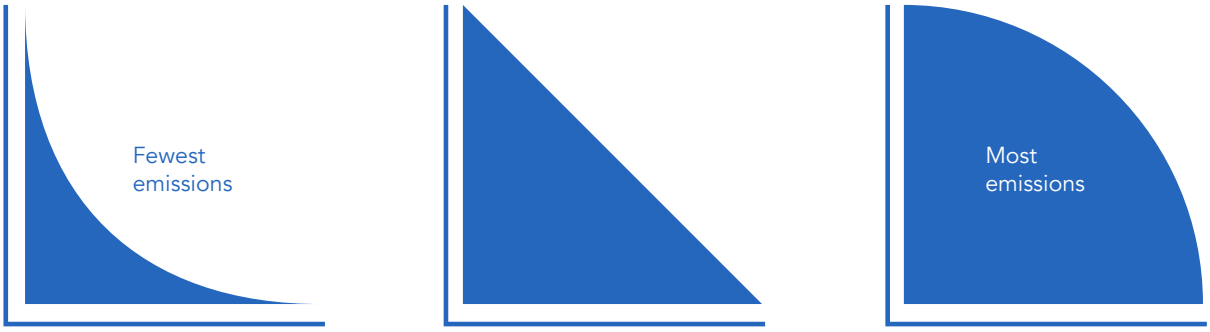


Figure 17. Projected population growth/decline by census division between 2016 to 2041.[15]

Setting Interim Targets

The importance of setting interim targets and the timing of action implementation is illustrated by Figure 18. Delaying action implementation and neglecting to set interim targets results in the requirement of a steep decline in GHG emissions close to the target year in order to achieve the emissions reduction target (rightmost illustration). At this point, the required reductions will probably be unachievable, and/or the transition will be so rapid that the emissions reduction actions will have major social impacts. Delaying action and neglecting to set interim targets also results in more emissions produced over the period to the target year. Conversely, imminent action implementation and setting interim targets results in the fewest emissions over the period (leftmost illustration).

15 Ontario Ministry of Finance. (2017). Ontario population projections update, 2016–2041. Retrieved August 7, 2017, from http://www.fin.gov.on.ca/en/economy/demographics/projections/



4. Emissions reductions associated with timing of actions and setting interim targets.

Recommended Method for Aligning Targets

While municipalities may choose to set alternative targets based on what is realistic and suitable for their municipality it is recommended that municipalities consider adopting targets for 2020, 2030 and 2050, in parallel to the province's targets. The following table portions out the province's GHG budget, as defined by the provincial targets on a per capita basis, and accounts for regional variation.

Table 30. Per-Capita GHG emissions in Ontario, historical and targeted.

Year	Ontario population	Actual or Targeted GHG Emissions (tonnes CO2e)	Average annual per capita emissions (tonnes CO2e)
1990	10,295,832	182,000,000	17.7
2013	13,556,200	171,000,000	12.6
2020	14,980,400	146,000,000	9.7
2030	16,658,300	115,000,000	6.9
2050 est.	19,754,035	36,400,000	1.8

Notes: 1. The population projections are for 2021 and 2031, due to availability of data. 2. The 2050 population has been estimated by extrapolating the growth rate in the Ministry of Finance population projection, which extends to 2041.

The process to align municipal emissions reduction targets with the province's has three main steps.

- ***Step 1:*** Identify or develop a population projection until 2050 for the municipality. Population projections are available from the Ontario Ministry of Finance out until 2041. The municipality will need to make a projection from 2041 to 2050 using a straight line projection.
- ***Step 2:*** Calculate the municipal GHG emissions allocation. Multiply the average per capita GHG emissions by the projected population in 2020, 2030 and 2050.

» ***Step 3:*** Calibrate the target against the municipal GHG inventory.

Table 31. Calculating the municipal emissions allocation.

Year	Municipality population	Per capita GHG emissions (tCO2e)	Municipal Allocation (tCO2e)	Notes
Base year: 2013	10,000	12.6	126,000	Compare this number with the municipal GHG inventory.
2020	15,000	9.7	145,500	
2030	20,000	6.9	138,000	
2050 est.	30,000	1.8	54,000	

The per capita GHG emissions include emissions from industry and other sources which the municipality cannot easily influence. If the GHG inventory for the base year is less than the municipal allocation for the base year, adjust the allocation using a calibration factor. The calibration factor is calculated by dividing the 2013 GHG inventory by the municipal allocation. If the GHG inventory is greater than the provincial allocation, this is likely the result of regional differences in driving patterns, the size of dwellings, and other factors. Do not adjust the target upwards as this could result in municipal targets that in aggregate exceed the provincial target.

If a 2013 GHG inventory is not available, an inventory from the period 2011-2014 can also be used. If no inventory is available, the municipal allocation can be adopted as the target.

Table 32. Calibrating against the GHG target.

Year	Municipality A population	Per capita GHG emissions (tCO2e)	Provincial allocation (tCO2e)	GHG inventory	Calibration factor<?>	Target (tCO2e)
Base year: 2013	10,000	12.6	126,000	100,000	0.79	
2020	15,000	9.7	145,500		0.79	115,500
2030	20,000	6.9	138,000		0.79	109,500
2050 est.	30,000	1.8	54,000		0.79	43,000

A Carbon Budget

The target resulting from this process constitutes a carbon budget for the municipality for each time period—the total amount of carbon all emissions-producing activity in the municipality cannot exceed if the targets are to be achieved.

More reading: ARUP, & C40. (n.d.). *Deadline 2020.*

http://www.c40.org/researches/deadline-2020

More Ambitious Targets

Some municipalities may elect to adopt more ambitious targets, with either a more aggressive timeline or deeper emissions reductions. Examples include 100% renewable energy or net zero GHG emissions by 2050 or earlier. These approaches also address the intention of the Guideline, although municipalities should accompany this target with additional interim targets.

Example: Oxford County. (n.d.). *Draft 100% renewable energy plan.*

http://www.oxfordcounty.ca/Portals/15/Documents/SpeakUpOxford/2016/100RE/OCDraft100REPlan20160622.pdf

Lower and Upper Tier Governments

The method also ensures that targets are consistent for both lower and upper tier governments. To identify its target, an upper tier government needs to sum the targets of lower tier governments.

Table 33. Calculating a GHG target for a Region.

Year	Municipality 1 target	Municipality 2 target	Region target
Base year: 2013	10,000	15,000	25,000
2020	15,000	15,000	30,000
2030	20,000	25,000	45,000
2050 est.	30,000	35,000	65,000

Stage 4: Actions and Scenarios Development

»OUTPUTS:

- » **LOW CARBON PATHWAY;**
- » **CO-BENEFITS ANALYSIS**

Following the identification of a target, the municipality needs to determine and implement actions to achieve it. In the context of this Guideline, an action is defined as an intervention undertaken by the local government or other parties which results directly or indirectly in GHG emissions reductions. An action can be a policy, a by-law, a financing program, an investment, an educational program or another approach that has a physical impact on energy and GHG emissions.

Tasks	Description	Complexity of approach		
		Basic	Intermediate	Advanced
Stage 4: Actions and Alternative Scenarios Development				
4.1 Actions identification	Develop a catalogue of potential municipal actions.	Best practices from other municipalities.	Identification by steering committee and best practices.	Identification through public engagement, best practices and steering committee.
4.2 Alternative scenarios development	Bundle the actions into alternative energy and emissions future scenarios. Land-use patterns need to be one dimension of the scenarios.	Staff development of scenarios; scenarios may be qualitative.	Scenario planning workshops, scenarios are modelled.	
4.3 Modelling	Quantitatively evaluate the emissions impact of the scenarios versus the reference scenario.	Qualitative assessment.	Quantitative modelling.	Integrated energy, emissions and spatial modelling.
4.4 Analysis of co-benefits	Evaluate the impact of the scenarios and actions on a range of co-benefits.	Qualitative assessment.	Non-spatial quantitative analysis.	Spatial quantitative analysis.
4.5 Preferred scenario	Select a preferred scenario.	Qualitative assessment.		
4.6 Prioritization	Prioritize the actions within the scenario.	Discussion/voting.	Multi-criteria analysis.	Multi-criteria analysis + engagement.
Tools		PCP Milestone Tool.	Climate action for URBan sustainability (CURB).	CityInSight/ Urban Footprint.

33

Table 34. Sample engagement activities.

	Basic	Intermediate	Advanced
Engagement activities	SWOT analysis, committees.	Committees, crowdsourcing on web-based platforms, workshops.	Committees, crowdsourcing on web-based platforms, workshops, focus groups, participatory decision making.

[TransformTO, the City of Toronto's low carbon planning process included scenario planning and analysis of co-benefits

- Baseline and Build-as-planned: this component involved the development of an baseline emissions inventory for 2011, the development of a build-as-planned (BAP) scenario to 2050, and development of a series of energy maps.
- 2020 Analysis: the quantification of reduction potentials of key measures or strategies to achieve Toronto's 2020 target.
- 80x50 Low Carbon Scenario: explores the potential pathways of achieving Toronto's 2050 target; it involved the modelling and quantification of reduction potentials of key low carbon actions to support this effort have been modelled in the form of a Low Carbon scenario
- Analysis of Health, Economic Prosperity and Social Equity: a research paper detailing a synopsis of the literature describing co-benefits and co-harms of actions and policies designed to reduce greenhouse gas (GHG) emissions, focusing on health, social equity and economic prosperity.
- Multi-criteria analysis (MCA): MCA was used to identify (through quantitative and qualitative analysis) the co-benefits of bundles of actions against criteria which were identified in the co-benefits literature review and weighted the Modelling Advisory Group (MAG). Amongst others, criteria included public health, clean air and quality affordable housing.
- Financial analysis: a detailed financial analysis of the BAP and low carbon scenario, including capital, operating and maintenance costs of all components within the actions, and all sectors, including employment.

Final Report: All of the above components are synthesized in a detailed and extensive final report.

TASK 4.1: ACTIONS IDENTIFICATION

The identification of actions is a two-stage process: identifying a long-list of actions, then narrowing the options to a short-list.

Actions Long-List

RELEVANT STREAMS

The process of developing the long-list is a brainstorming exercise in which no actions should be immediately ruled out. Key sources of ideas are summarized in Table 35.

Table 35. Sample ideas sources for long-list actions.

Sources	Description
Review the situational analysis	The situational analysis includes a review of expenditures by the municipality, potential partnerships, land-use policy, review of policy from other levels of government and best practices from other jurisdictions.
Review the GHG emissions Inventory	The inventory provides insight into the major sources of GHG emissions in the community and therefore provides an indication of opportunities for investments in low carbon actions.
Community engagement	The community engagement process will identify actions that may not have been considered by the local government, are important to the community or address local priorities and co-benefits.
Best practices	A municipality can learn from the efforts of other municipalities, identifying what has worked and what has not and translating those experiences into the local context.
Review academic papers and reports	Academics and researchers publish papers and reports on municipal actions to reduce GHG emissions.

Actions Short List

RELEVANT STREAMS

The short-list consists of actions that make strides towards the emissions reduction target and are appropriate for the local context. They can be bundled into scenarios and modelled.

As guidance for selecting actions, the municipality should consider these questions:[16]

- Is the action appropriate to the scale of the municipality, now and/or in the future?
- Is the action likely to have a significant impact on current or future GHG emissions?
- Does the action avoid making irreversible decisions and getting locked into patterns or technologies that would be difficult and costly to reverse if new information or changing preferences arise?
- Does the action perform well under a broad range of possible futures, rather than just being optimal for the most likely future?
- Does the action achieve multiple policy goals and therefore garner support?

The process of selecting the short-list of actions can involve the project team, a steering committee or the community in a workshop, whichever is most appropriate for the context.

Actions should address the major emissions sectors, including buildings, the energy system, transportation, waste, and agriculture, forestry and land-use. If one of these systems is not a major source of GHG emissions as identified in the GHG inventory, the municipality may elect to set it aside. For example, if the municipality has limited area available for agriculture or forestry, this sector may not be considered.

Table 36 provides an example of a set of actions that can be used as a template.

16 Fay, M., Hallegatte, S., Vogt-Schilb, A., Rozenberg, J., Narloch, U., & Kerr, T. M. (2015). Decarbonizing development: three steps to a zero-carbon future. Washington, DC: World Bank Group.

Table 36. The cheat list: 20 key municipal energy and emissions actions.[17]

	Action	Justification	Impact	Estimated magnitude of GHG reductions
	LAND-USE			
1	Concentrate future development in areas appropriate for district energy and accessible to transit	Land-use planning enables broader deployment of transit and district energy, and increased proximity for walking and cycling.	Reduce energy consumption	Medium-high
2	Green/sustainable community design and development	Green/sustainable planning and design components/standards can reduce community energy footprints and enhance energy efficiency.	Reduce energy consumption	Medium
	TRANSPORTATION			
3	Enhanced transit	Enhanced transit can displace vehicle use and achieves economies of scale.	Reduce energy consumption, fuel switch	Medium
4	Transportation demand management	Transportation demand management can help people shift to lower carbon modes of travel.	Reduce energy consumption	Medium
5	Enhanced walking and cycling infrastructure	New infrastructure can provide conditions that enable people to walk and cycle as opposed to drive.	Reduce energy consumption	Low
6	Increased adoption of electric vehicles	Electric vehicles are more efficient than gasoline powered vehicles and result in fewer GHG emissions.	Reduce energy consumption, fuel switch	High
	BUILDINGS			
	Future buildings			
7	Require advanced energy performance	It is more cost effective to build high efficiency buildings than to retrofit them afterwards.	Reduce energy consumption	High
	Existing buildings			
8	Retrofit dwellings	The existing building stock needs to be retrofit to minimize energy consumption, particularly electricity in order to offset additional electricity demand in the transportation sector. Retrofits also tend to be cost effective.	Reduce energy consumption	High
9	Retrofit commercial buildings		Reduce energy consumption	High

17 The estimated impact is based on modelled results from a number of municipalities in Ontario.

	Action	Justification	Impact	Estimated magnitude of GHG reductions
10	Re-commission commercial buildings	Re-commissioning represents a tune-up of the building systems to ensure they are operating at maximum efficiency.	Reduce energy consumption	Low
	ENERGY SYSTEMS			
11	Incorporate solar photovoltaic systems into new construction	Solar PV can be integrated into the built environment, displacing electricity from the grid from non-renewable sources.	Generate renewable energy	Low
12	Incorporate solar photovoltaic systems on roofs of existing buildings		Generate renewable energy	Low
13	Introduce zero carbon district energy systems	District energy is used to provide renewable heat sources, displacing natural gas. District heat also results in economies of scale.	Generate renewable energy, fuel switch	Variable
14	Install electric heat pumps for space heating	Electric heat pumps are an efficient way to use electricity to displace natural gas for heating.	Fuel switch	High
15	Install distributed energy storage	Energy storage increases the efficiency with which distributed renewable such as solar PV can be used.	Store renewable energy	Low
16	Increase the use of renewable natural gas in district energy systems	Renewable natural gas can be used in industry to displace natural gas consumption.	Fuel switch	Variable
	INDUSTRY			
17	Industrial process efficiency improvements	There are significant opportunities for industrial energy efficiency gains.	Reduce energy consumption	Variable
	FREIGHT			
18	Transition to zero emissions vehicles	Electric vehicles are more efficient than gasoline powered vehicles and result in lower GHG emissions.	Reduce energy consumption, fuel switch	Medium
	WASTE			
19	Increase waste diversion rates	Waste which goes to a landfill results in GHG emissions.	Reduce waste	Medium
20	Generate biogas from wastewater	Methane resulting from wastewater treatment can be transformed into a renewable energy source.	Generate renewable energy	Low
	AGRICULTURE, FORESTRY & LAND-USE			
21	Increase forest area or restore wetlands	Forests and wetlands absorb and store carbon from the atmosphere	Increase storage of carbon	Low

Case study: North Cowichan Climate Action and Energy Plan.

North Cowichan is a small rural municipality on Vancouver Island. The District considered mitigation and adaptation actions in the same plan.

Mitigation Actions	Adaptation Actions
» 1. Create a transportation planning program with dedicated staff » 1a. Implement a Smarter Travel Choices Program » 1b. Establish a taxi-bus rural public transit system » 1c. Increase community biodiesel purchases and require municipal fleet biodiesel use » 1d. Join Project Get Ready and transition the municipal fleet to electric vehicles	» 1. Establish a climate change adaptation working group.
» 2. Ensure strict Implementation of OCP Development Guidelines	» 2. Mainstream adaptation into existing planning, operations and decision-making processes.
» 3. Employ municipal energy policy mechanisms	» 3. Identify high priority risks and opportunities to define and prioritize actions.
» 4. Implement a community solar energy program	» 4. Engage stakeholders and citizens.
» 5. Establish a municipal energy utility	» 5. Establish and maintain partnerships and networks.
» 6. Reduce municipal building energy use	» 6. Identify funding opportunities and strategies.
» 7. Create an agricultural development centre	» 7. Commit to monitoring, reporting and revision of strategies.

TASK 4.2: SCENARIO DEVELOPMENT

RELEVANT STREAMS

Once a short-list of actions has been developed, the next step is to bundle those actions into scenarios. A scenario may contain a selection of actions or all of the actions, at different levels of ambition. Scenarios are used to explore possible futures for the community in order to understand the implications of different actions and how actions interact with each other.

Table 37. Scenario development approaches.

	Basic	Intermediate	Advanced
Approach	Develop narrative scenarios that describe a possible future for the municipality.	Develop future land-use scenarios for the municipality and quantitatively evaluate them in a model.	
Tools	n/A	UrbanFootprint	CityInSight
Outcomes	Document with a conceptual description of possible futures.	Representation of future land-use patterns in a model.	Coherent quantitative representation of the future energy system in a model.

What is a Scenario?

A scenario is a comprehensive representation of a possible future. Scenarios help decision-makers explore cause and effect; for example, envisioning high, low or no population growth or an economic upturn or downturn. A scenario emphasizes the process of change rather than a particular point in the future. Scenarios need to address all the aspects that influence the urban energy system including assumptions on population, land-use, buildings, energy systems, transportation systems, etc. in a coherent package.

How are Scenarios Used?

In community energy and emissions planning, scenarios are used to explore different types of actions and to identify a low carbon trajectory. The application of scenarios provides a framework for bundling the actions into a coherent picture of the future. Their use provides various insights, as summarized in Table 37.

Table 38. Uses of scenarios in energy and emissions planning.

Use	Description	Sample Questions
Decision-making	"Future proof" a portfolio of activities and proposed actions.	What is the impact of changing climate on heating and cooling loads and potential district energy locations?
Prioritization	Determine where and how to allocate infrastructure investments.	Where should future development be located to support frequent transit?
Testing	GHG reductions impacts of taking actions to differing extents.	How much money can be saved by retrofitting the building stock in the community?
Oversight	Add perspective and insight to transportation, land-use planning or other planning processes.	How do different land-use patterns impact total vehicle kilometres travelled?
Integrative	Explore the impact of different interventions on the community as a whole.	What is the impact of introducing heat pumps and electric vehicles on total electricity demand?
Generative	Generate innovative ideas, programs, products, and services.	What mechanisms can be used to support retrofits in low income households?
Timing	Understand the timing of interventions.	What is the optimal order of actions to maximize benefits to the local community?
Scanning	Monitor for major technological or technical shifts.	How do autonomous vehicles impact land-use planning and GHG emissions?
Anticipatory	Prepare for major changes in the future.	Where should district energy systems be located?
Engaging	Support engagement around complicated and difficult issues in a safe (hypothetical) way.	What are the implications of scenarios on employment and energy costs?

How are Scenarios Developed?

Scenarios should be designed to explore key issues or discussions in the community. For example, a discussion around the form of future development could be used to frame scenarios around suburban development versus a compact downtown. While the form of future development is the focus, the scenarios can also incorporate all or some of the short-list actions. Population projections are generally held constant across all the scenarios in order to clearly assess the impact of policies and strategies on a per capita basis. However, different population projections and economic development trajectories may also be reflected in the scenarios.

The following guidelines inform scenario development:

- *Use two or four scenarios.* Each scenario should be characterised by a theme that represents the key emphasis of the scenario. An odd number of scenarios should be avoided as the tendency is always to choose the middle one as the preferred scenario.
- *Challenge conventional wisdom.* The scenarios should explore both potential and unusual futures, and the results of these two different approaches can provide insight on the future of the community. Examples could include 'net- zero' or 'net positive' scenarios for the community.

- *Use highly differentiated futures.* The scenarios should represent very different futures so that it is possible to evaluate the impacts of the differences between the scenarios.
- *Present alternatives.* Efforts should be made to avoid a 'preferred' future scenario. Alternative courses of action should be identified in different scenarios in order to avoid scenarios that replicate an established vision for the future.
- *Scenarios should focus on specific issues.* Scenarios should reflect near-term decision-making concerns, but should not directly answer the focal question.
- *Scenarios should be plausible*, given the current world situation. A scenario that assumes that technology will solve all the world's problems is not realistic because it relies on a highly improbable outcome.
- *Scenario names should be memorable*, so they can easily be evoked and referred to.

Table 39 describes four sample scenarios, illustrating a possible approach to scenario development.

Table 39. Sample scenarios.

Scenario	1. Reference	2. Compact growth	3. Deep reductions	4. Local economic development
Theme	Existing policies and plans are implemented.	Future growth is concentrated in the downtown core	Maximize efforts to reduce GHG emissions.	Emphasis on job creation and businesses opportunities.

Case Study: City of Toronto

Build as planned scenario	Low carbon scenario
The BAP projection covers the time period from 2012 to 2050, and is designed to illustrate energy use and GHG emissions for the City of Toronto if no additional policies, actions or strategies are implemented; that is, it reflects plans, policies, programs and/or projects at the municipal, provincial and federal levels that have been funded (e.g. provincial electric vehicle incentives) or are currently being implemented (e.g. federal fuel efficiency regulations).	The Low Carbon Scenario explores a potential pathway for achieving Toronto's 2050 target; reducing emissions by 80% by 2050 over 1990 levels, known as 80x50.

The Reference Scenario

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Typically, one scenario will reflect the energy and emissions future that will arrive if the municipality does not undertake any additional actions; this scenario is defined as the reference scenario, business as usual (BAU) or business as planned (BAP). Various projections may be available to help inform the development of the reference scenario (Table 40). If these are not accessible, the municipality can develop assumptions according to its best judgement, emphasising that there is no perfect answer.

Table 40. Framing the reference scenario.

Projection Types	Considerations	Implications	Potential data sources
Population	» Will the the population grow, remain flat or decline? » Will the number of people per dwelling grow, remain flat or decline?	» The change in population determines the number of new dwellings required and the number of new jobs generated.	» Official plan projections; Ministry of Finance population projections.
Employment	» What will the employment rate be? » How will the size of workplace change for different sectors?	» The number of jobs and area of space r equired for those jobs determines the additional commercial or industrial floor space required.	» Economic development strategies.

Projection Types	Considerations	Implications	Potential data sources
Land-use planning	» Where will the new dwellings be located? » Where will new non-residential dwellings be located? » How can natural areas be protected or enhanced?	» The location of the buildings influences how people move around and the potential for decentralized energy. Natural areas store carbon.	» Official plan projections, transportation modelling projections.
Buildings	» How will the size of dwellings change? » How will the mix of dwellings change? » How will the design of buildings change with respect to energy efficiency?	» The size, type and design of buildings influences their energy consumption.	» Building code projections
Vehicles	» How will vehicle technologies change? » How will vehicle efficiency change? » How will commercial transportation technologies change? » How will commercial transportation trip length change?	» The types of vehicles influences the energy consumption and the type of fuel that is used.	» Federal fuel efficiency regulations
Mode share	» How will people's perspective on transit, walking and cycling change? » How will the transit system evolve?	» The mode of transportation impacts energy use and GHG emissions.	» Transportation master plan
Solid waste	» How will waste generation patterns change? » How will waste diversions rates change? » How will the landfill management processes change?	» Solid waste management impacts GHG emissions from landfills.	» Solid waste management plan

The most straightforward approach to projections is to integrate existing projections or targets from municipal, provincial or federal policies. In the absence of projections, the municipality can identify its best estimate or set new targets. For example, if there is no existing target for solid waste diversion, this process can be used to establish such a target within one or more of the scenarios.

Comparison of the reference scenario target year emissions to the emissions reduction target for that year yields the emissions reduction gap between where a community's emissions level is headed, versus where it is recommended or required to be (Figure 19).

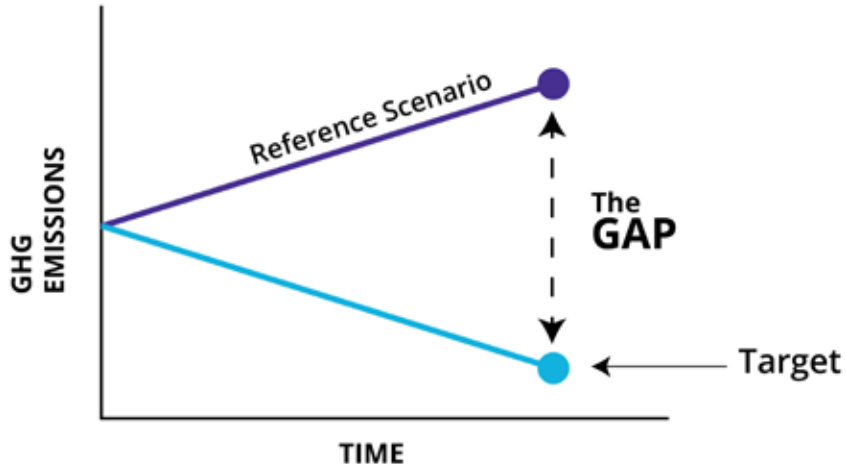

Figure 18. The gap between the target and the reference scenario.

Low Carbon Scenarios

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The assumptions for each low carbon scenario should be described in detail and quantified wherever possible. In some modelling approaches, such as an optimization model, the action will be implemented according to its relative costs. In other approaches, the actions are defined by the project team.

Table 41. Sample questions to answer for scenario development.

	Action	Sample Questions
	LAND-USE	
1	Concentrate future development in areas appropriate for district energy and transit accessibility	How many future dwellings will be redirected? Where will the dwellings be located? What form will the dwellings take?
	TRANSPORTATION	
2	Enhanced transit	Where will transit be added? What type of transit will be added? What will the capacity of the added transit be?

	Action	Sample Questions
3	Transportation demand management	What type of programs will be introduced? Where will the programs be introduced? What impact will the programs have?
4	Enhanced walking and cycling infrastructure	What kind of infrastructure will be added? Where will the infrastructure be added?
5	Increased adoption of electric vehicles	How many vehicles will be added? How efficient will the vehicles be?
	BUILDINGS	
	Future buildings	
6	Require advanced energy performance	When will the requirements be applied? To how many dwellings/buildings will the requirements be applied? What level of energy savings will be achieved?
	Existing buildings	
7	Retrofit dwellings	How many dwellings will be retrofit each year? Which types of dwellings will be retrofit? What energy savings will result from the retrofits?
8	Retrofit commercial buildings	How much floor area will be retrofit each year? What type of buildings will be retrofit? What energy savings will result from the retrofits?
9	Re-commission commercial buildings	How much floor area will be recommissioned each year? What type of buildings will be recommissioned? What energy savings will result?
	ENERGY SYSTEM	
10	Incorporate solar photovoltaic systems into new construction.	How many buildings will include solar PV? How large will the solar PV systems be? When will the systems be installed? Will the systems be different for different types of buildings?
11	Incorporate solar photovoltaic systems on roofs of existing buildings.	
12	Introduce zero carbon district energy systems	Where will the district energy systems be installed? What will be the energy sources? How many buildings will be connected to the systems?
13	Install electric heat pumps for space heating	What will the efficiency of the heat pumps be? How many heat pumps will be installed?
14	Install distributed energy storage	What type and size of storage will be installed? Where will the storage be installed?
15	Increase the use of renewable natural gas	Where will the renewable natural gas come from? How will the renewable natural gas be used?
	INDUSTRY	
16	Industrial process efficiency improvements	What type of improvements will be introduced? In what sectors will the improvements be applied? What energy savings will result?
	FREIGHT	
17	Transition to zero emissions vehicles	How many vehicles will be added? What type of vehicles will be replaced?
	WASTE	

	Action	Sample Questions
18	Increase waste diversion rates	What will the diversion rate be? Will the diversion apply to all solid waste types?
19	Generate biogas from wastewater	What volume of biogas will be generated? Where will the biogas be used?
	AGRICULTURE, FORESTRY & LAND-USE	
20	Increase forest area	How much forest will be added? How much carbon can the forest store?

For many of the actions, a time-related question can be explored, e.g. when will the action commence? Over what time period will it occur?

City of Surrey's actions and targets

From the City's modelling work, public input and policy review, action recommendations were made in 5 categories: land-use, transportation, buildings, district energy, and waste. The primary directions of these actions are:

- Developing complete, compact, connected corridors to support transit and district energy;
- Developing rapid transit, improved bus service, and active transportation infrastructure;
- Performing building energy retrofits;
- Creating green car strategies;
- Creating a framework to meet steadily rising building energy standards to deliver energy savings; and
- Providing guidance to build on the city's zero waste agenda.

The key targets of the plan are:

- Increase proportion of Surrey residents within a 5 minute walk to Frequent Transit Stations 10% by 2020 and 21% by 2040;
- Reduce personal vehicle driving distances 4% by 2020 and 9% by 2040 • Increase bicycle route kilometers 57% by 2020 and 148% by 2040;
- Improve building energy performance 10% beyond typical new construction by 2040 • Increase the annual retrofit rate of existing buildings to 2% from 1% by 2040;
- Meet City-owned DE energy requirements with 40% renewables by 2020 and 75% renewables by 2040 (illustrative and modeling purposes only; see section for notes); and
- Divert 75% of solid waste to recycling and composting by 2020 and 85% by 2040.

Pursuing the directions in its CEEP, Surrey could reduce emissions by 47% on a per capita basis and by 41% on a total community wide basis by 2040. Community-wide, Surrey aims to reduce emissions 33% by 2020, and 80% by 2050, relative to 2009 levels.

TASK 4.3: MODELLING

RELEVANT STREAMS

The relationship between land-use planning, the form of the built environment, transportation systems, energy consumption and GHG emissions is complex and varies from one municipality to the next. While there are common themes and specific actions that likely make sense in every context, in order to relate potential outcomes of actions to targets and policies—and to understand the financial implications—a model is generally required.

A model is a concept of an existing or proposed real system. Models are used to explore the results of scenarios and to evaluate the impacts of actions. They typically consist of a computer program that requires inputs and assumptions, and generates results.

Many planners work with models, most commonly for spatial population projections and for transportation planning. Energy and emissions models incorporate consideration of land-use planning, transportation engineering, waste management, building design, GHG emissions accounting, and other aspects. For this reason, a community energy and emissions model can be used to support a number of planning exercises simultaneously. There is no clear consensus on what this type of model is called in the literature, but the Government of BC has defined them as community energy and emissions models (CEEMs).
Scenarios should be represented in a model in as much detail as possible. A spatial model facilitates the analysis of different land-use policies on transportation patterns, the provision of district energy, and the form of buildings. The model should also illustrate the introduction of different technologies and their impacts on GHG emissions and energy consumption.

The framework of Reduce, Improve, Switch provides guidance on the order in which the actions can be implemented. If an action reduces energy consumption, it should occur prior to an action that requires the introduction of new technologies. This approach results in saved energy costs, and reduced capital costs for new technologies.

Selecting a Model

RELEVANT STREAMS

The following specifications are recommended in considering which model to select to perform scenario analysis.

Table 42. Model characteristics.

Basic specifications	Desirable attributes
» Analyze land-use patterns	» Assess financial implications
» Incorporate future scenarios	» Assess co-benefits, health impacts, and financial impacts
» Evaluate policy levers and other actions	» Transparent assumptions and data treatment (i.e. open source)
» Construct scenarios	
» Represent building and transportation systems	
» Analyze GHG emissions and energy	

It is important to understand the underlying assumptions that a model makes about how the world works. For example, some models assume that humans make decisions based on economic signals, while other models are driven by historical patterns of behaviour, and still others are constrained by physical characteristics of the world. Each approach has strengths and limitations that are important to consider. In order to better understand these assumptions, local government should ask the model creators how their model addresses:

- Economic trends;
- Population trends (residents + employment);
- Land-use development (number of units and/or floor area of new construction, demolitions, renovation);
- Transportation behaviour;
- Technological development;
- Government legislation, policies and initiatives; and
- GHG emissions (i.e. are the GHG emissions analyzed bounded by a geographical boundary or are they the result of the behaviour of a population, irrespective of where they are emitted? Is a specific GHG accounting protocol used?)

The Importance of 'Integrated' Models

It is important to note that some models are 'integrated' and some are not. In an integrated model, the way in which the actions are modelled has implications for the GHG reductions associated with each action. In non-integrated models, action effects have no implications on other actions, which is typically inaccurate. For example, the GHG reduction associated with enhanced transit is much greater if the vehicle fleet is assumed to be primarily fuelled by gasoline, than if electric vehicles have been introduced. Similarly, the GHG reductions associated with building retrofits are greater if they are undertaken prior to replacing natural gas furnaces with electric heat pumps. Integrated models better reflect real world actions and their impacts.

Refer to Appendix 9 for more information on selecting a model, establishing modelling assumptions, and calibrating models.

Read more: Condon, P. M., Cavens, D., & Miller, N. (2009). *Urban planning tools for climate change mitigation*. **Cambridge: Lincoln Institute of Land Policy.**

Managing Modelling Uncertainty

RELEVANT STREAMS

The modelling process incorporates considerable uncertainty, a characteristic of any exploration of the future. The first strategy for managing this uncertainty is transparency: documenting the modelling approach, inputs and assumptions in an accessible manner. A second strategy is to explicitly acknowledge the uncertainty, avoiding any claims of prediction. A third strategy is sensitivity testing: adjusting variables by 10% or more to evaluate the impact of the variable on the overall result. This approach seeks to address the questions: What if our assumption for this variable is wrong? To what degree does that influence the result? A fourth strategy is tied to monitoring and evaluation, so that the modelling and policies evolve as new information is collected and analyzed.

Considering Disruption

RELEVANT STREAMS

Technological developments are always on the cusp of instigating considerable disruption into municipal operations and the delivery of energy in a municipality. The modelling of energy and emissions scenarios is an opportunity to explore the potential impacts of these technologies on social, ecological and economic outcomes—to capture opportunities and manage impacts.

Table 43. Example disruptive technologies.

Technology	Possible Impacts
Electric vehicles	Stress on the electric grid, job losses in production, maintenance and repair, reduced energy and GHG emissions.
Autonomous vehicles	Reduced transit use, smaller vehicle fleet, reduced parking, increased VKT, increased accessibility, fewer driving-related jobs.
Energy storage	More resilient grid, new employment opportunities, reduced GHG emissions, orientation of buildings, new investment opportunities.
Decentralized energy production	More resilient grid, new employment opportunities, reduced GHG emissions, orientation of buildings, new investment opportunities.

Modelling Results: Telling a Story

Once the scenarios have been modelled, visualizations can be used to better understand and communicate their implications. The following figures provide several examples.

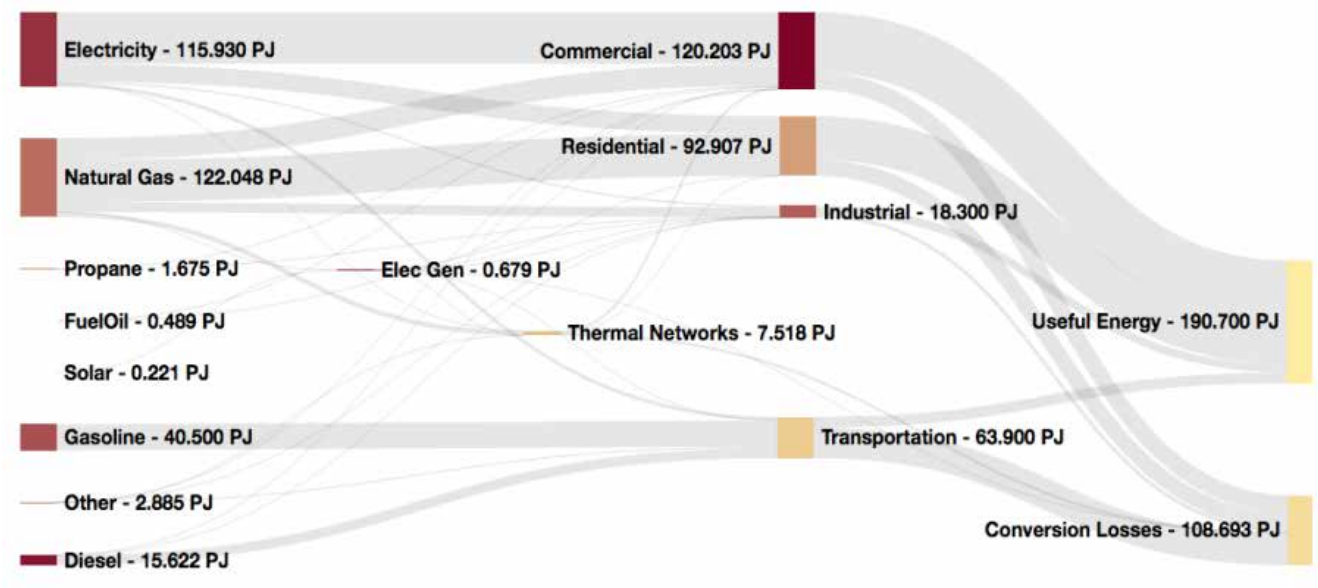


Figure 19. Example of a Sankey diagram.

A Sankey diagram illustrates how energy sources are used. In Figure 20, natural gas and electricity are the dominant fuel sources—most of the electricity flows into the commercial sector and most of the natural gas flows into the residential sector. Just over one third of the total energy is lost. A comparison of Sankey diagrams for different scenarios illustrates the transformation of the energy system.

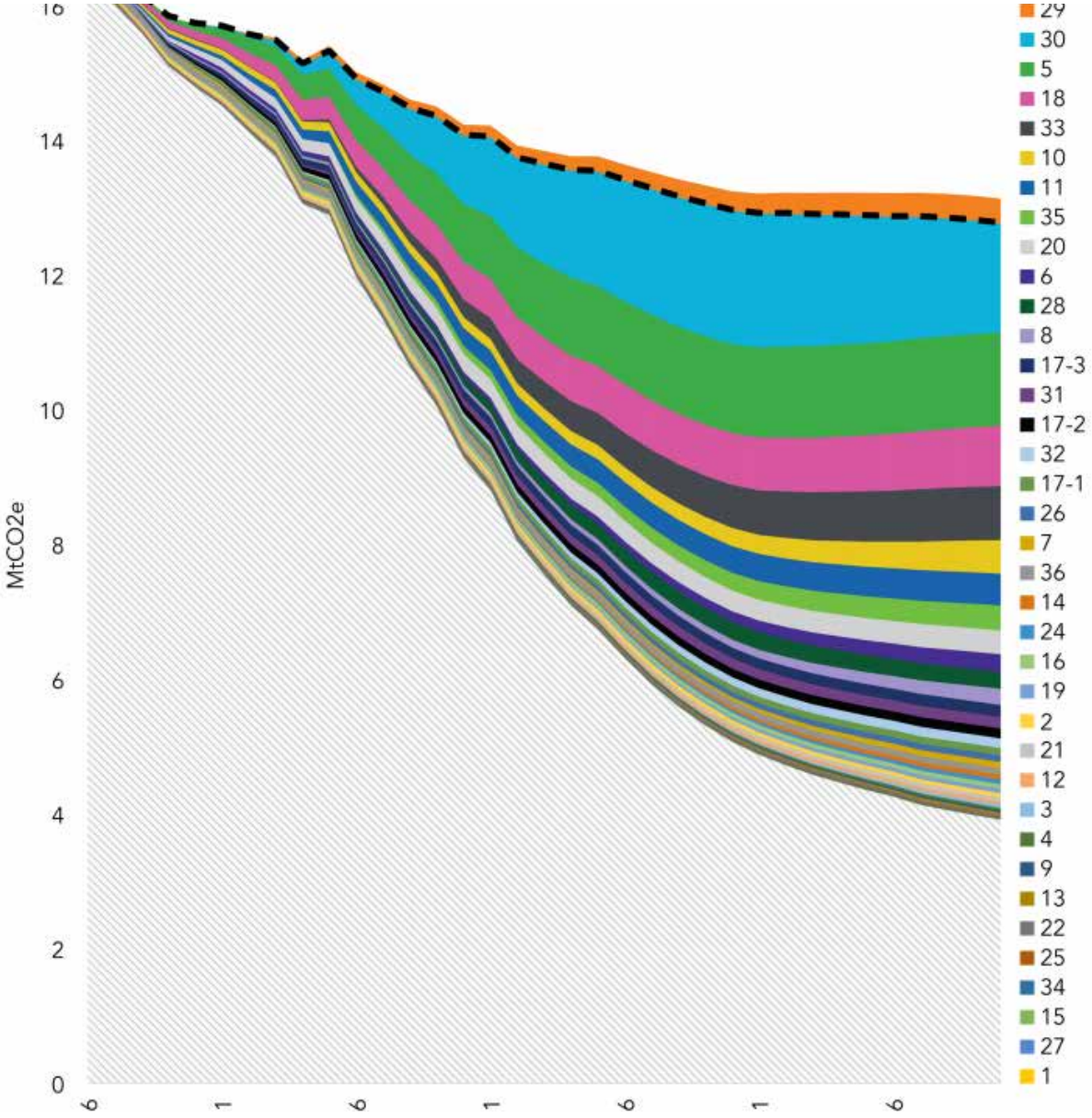


Figure 20. Example of a wedge diagram.[18]

A wedges diagram illustrates the relative contribution of different actions to a low carbon scenario. While it is quickly apparent which actions make the most significant contribution, wedge diagrams do not convey dependencies between different actions, feedback cycles, or the importance of the order in which actions are implemented.

18 SSG and whatIf? Technologies (2017). TransformTO: Climate action for a healthy, equitable, prosperous Toronto. Retrieved from: https://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Climate%20and%20Energy%20Goals/Transform%20TO/PDFs/REPORTS/SSG%20Reports/170421_TO_Report_final.pdf

In this Guideline, co-benefits or co-harms are assumed to be any benefits or harms additional to the impact on GHG emissions.

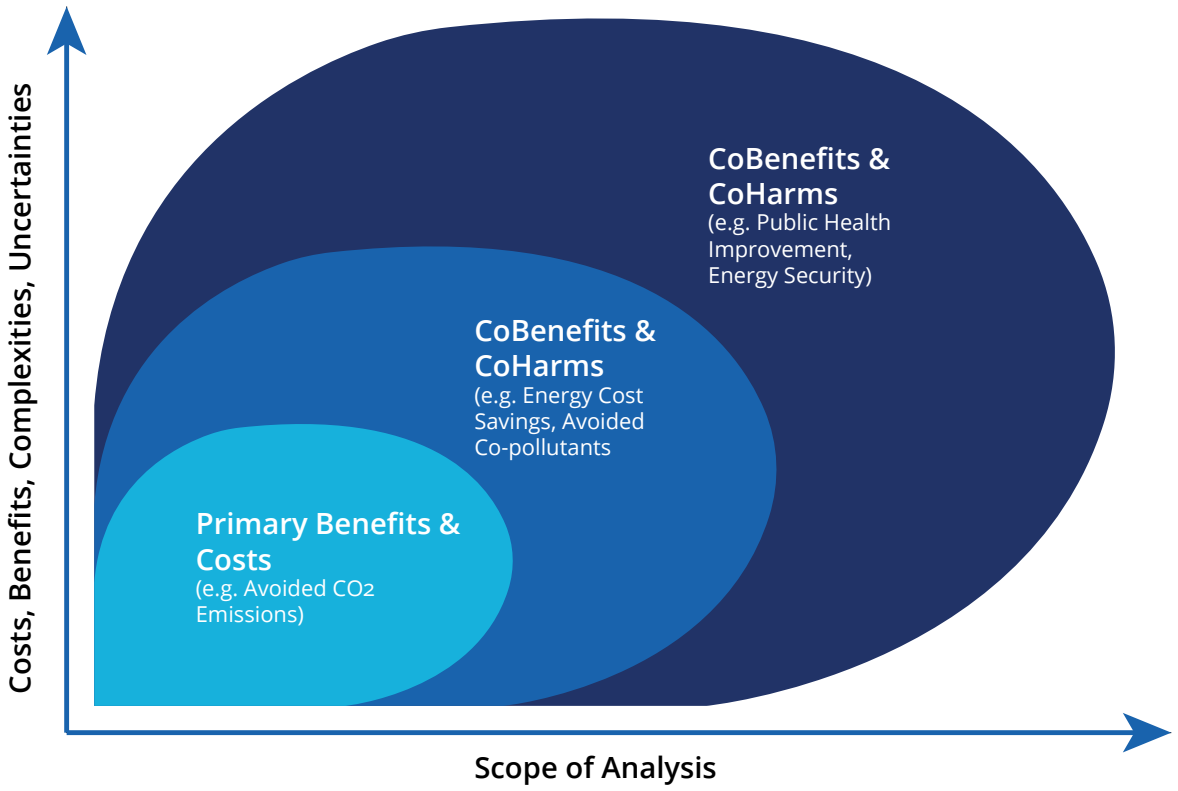


Figure 21. A representation of co-benefits.[19]

Not all co-benefits are equal. They can be evaluated against five factors:[20]

- *Synergies*: Many low carbon actions have multiple socio-economic benefits, including transit, energy efficiency, and compact urban design.

- *Urgency*: Some actions are associated with a higher degree of urgency in order to avoid loss of inertia, lock-in effects, irreversible outcomes, or deferred, elevated costs. Examples include road infrastructure decisions, major ecosystems displacement, and urban form. Some low carbon actions require time to realize their effects, making immediate implementation paramount.

19 Dhakal, S., & Ruth, M. (Eds.). (2017). Creating Low Carbon Cities. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-49730-3

20 Adapted from (Fay et al., 2015).

- *Costs*: Costs of early action is generally lower than later action, in particular because delayed action involves ongoing investments in infrastructure, activities and utilities that are higher emitting than low carbon solutions would be. Examples include district energy, transit, and energy efficiency.
- *Longevity*: Related to urgency, the longevity of planning and development decisions locks cities into their effects for decades, if not centuries.
- *Distribution effects*: Low carbon actions have different impacts on different subsets of the population, including income levels, generations (including future generations), and ethnicities.

The evaluation of co-benefits or co-harms is challenging because the techniques for measuring each impact vary. In some cases, the technique of measuring itself may be inappropriate. As well, cause and effect relationships are often imprecise. Identifying co-benefits as precisely as possible facilitates the engagement of a wider range of stakeholders, who are able to align a diverse set of interests with the community energy and emissions plan. Achieving co-benefits with energy and emissions actions also provides added impetus to implement an action or policy. Table 44 summarizes some approaches to assessing sample co-benefits and co-harms.

Table 44. Assessing sample co-benefits and co-harms.

Co-benefits/ co-harms	Impact	Possible Indicator	Complexity
HEALTH			
Air quality	Reduced combustion of fossil fuels reduces air pollution.	Change in city-wide air pollution levels.	Medium
Physical activity	Decreased driving can result in increased active transportation.	Additional kms walked and cycled per capita.	Medium
Increasing accessibility	Land-use planning patterns that support reduced driving also supports increased accessibility.	Portion of dwellings within 400m of frequent transit.	Low
ECONOMIC PROSPERITY			
Employment	Investments in low carbon actions result in the creation of jobs.	Number of new jobs created.	High

Co-benefits/ co-harms	Impact	Possible Indicator	Complexity
Household incomes	Investment in the energy system can increase energy costs, while increased efficiencies can result in cost savings.	Impact on household energy costs by neighbourhood.	Medium
Economic development	Advancing the low carbon economy results in new business opportunities.	Total investment required to support the low carbon scenario.	High
Municipal finances	Many actions require investments by municipalities, and can also create new revenue streams.	Municipal investment required to support the low carbon scenario.	Moderate
SOCIAL EQUITY			
Poverty	Increased energy efficiency may reduce household energy costs; although investments are required to do so.	Impact on household energy costs by neighbourhood.	High
Elderly	Increased proximity may increase accessibility for the elderly.	Feeling of isolation (identified through survey).	Medium
Children	Increased proximity may increase accessibility for children.	Number of households within walking distance of a school.	Medium

There are many different strategies to translate co-benefits and co-harms into a dollar value, including market valuation, willingness to pay, willingness to accept, and others. If all the relevant co-benefits and co-harms can be assigned a dollar value, economic decision-making techniques such as cost-effectiveness analysis and benefit-cost analysis can be applied.

Energy and Emissions Planning as Community Economic Development in Wawa

A northern town, Wawa has experienced economic hardship with the 1998 closure of an ore mine, and again with a mill closure in 2007. A lack of opportunity prompted an outmigration o`f youth and skilled workers. Wawa is struggling to maintain existing services and generate new revenue. The town has the third highest electricity prices in the province, and spends an annual $800,000 on energy and municipal services. No economic growth is expected in the near future. The community energy plan represents an opportunity to increase self-reliance, encourage economic growth, and manage risk.

Resource: QUEST. (2016). *Methods for measuring the economics of community energy plans: An introduction for community energy managers*.

Retrieved from http://gettingtoimplementation.ca/wp-content/uploads/2016/12/Methods-for-Measuring-the-Economics-of-CEPs-Dec162016-FINALOnline.pdf

TASK 4.5 SELECTION OF A PREFERRED SCENARIO

RELEVANT STREAMS

Based on the outcomes of the co-benefits analysis and the scenario modelling analysis, a preferred scenario should be identified. The preferred scenario becomes the pathway for the municipality to achieve its GHG emissions target. In selecting the preferred scenario, the following considerations should be addressed:

- Does the scenario meet or exceed the GHG target?
- Does the scenario optimize co-benefits?
- Does the scenario make sense for the context of the municipality?
- What is the compelling case for the selection of the preferred scenario?

The next planning steps, including prioritization and implementation, will focus on the actions contained within the preferred scenario.

TASK 4.6 PRIORITIZATION

RELEVANT STREAMS

Following the selection of the preferred scenario, scenario actions are prioritized. The prioritization process is important to identify the order of implementation, so that the municipality does not have too much on its plate at once, pursues actions in the appropriate order, and can achieve some quick wins.

Prioritization is typically an ad-hoc process, which cannot be easily understood by an outside party. Figure 23 illustrates how a decision framework can be used to make the inputs into the decision-making or prioritization.

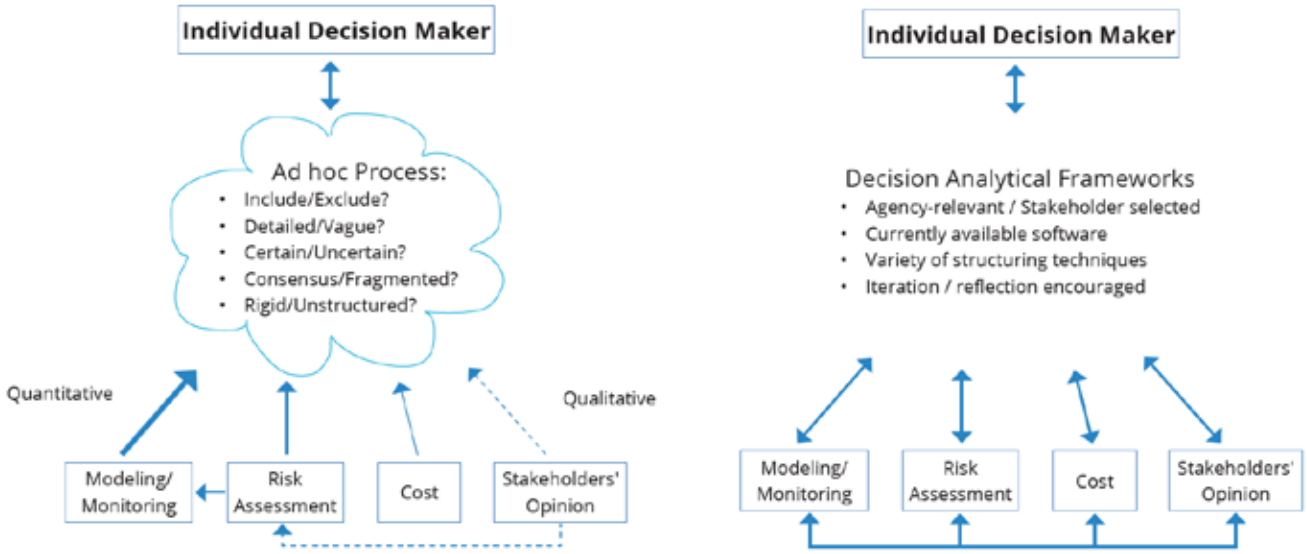


Figure 22. Ad-hoc versus structured decision-making[21]

Prioritization and decision-making frameworks are useful in navigating this process and arriving at outcomes that are transparent, justifiable and defensible. One recommended tool is multi-criteria analysis (MCA, also known as multi-criteria decision analysis). MCA can be set up in a basic spreadsheet and can be as simple or complex as desired. It can manage quantitative, monetary, and qualitative data in a single framework, as well as varying degrees of certainty. An overview of MCA can be found in Appendix 10.

21 Adapted from: Kiker, G. A., Bridges, T. S., Varghese, A., Seager, T. P., & Linkov, I. (2005). Application of multicriteria decision analysis in environmental decision making. *Integrated Environmental Assessment and Management*, *1*(2), 95–108.

»OUTPUT:

» IMPLEMENTATION PLAN

Tasks	Description	Complexity of approach		
		Basic	Intermediate	Advanced
Stage 5: Implementation				
5.1 Policies and mechanisms identification	Identification of policies and other mechanisms to achieve the actions.	Policies and mechanisms are identified to implement the actions.		
5.2. Investment strategy	Evaluation of the financial requirements for the actions and how to secure the required funding.	Project level analysis		Integrated, inter-departmental analysis, financial modelling
5.3 Integration	Ensure that the actions are reflected in all local government policies and actions.	Implementation roles and responsibilities are assigned to a department. The Official Plan is revised to reflect the CEEP.	Implementation roles and responsibilities are assigned across departments. The Official Plan and other plans or policies are revised to reflect the CEEP.	
Tools		Municipal organizational chart	Workplans	Workplans, departmental policy documents and processes, business planning

Table 45. Implementation engagement.

	Basic	Intermediate	Advanced
Engagement activities	Staff, Council	Staff, Council, committees, and other key stakeholders	Staff, Council, committees, community partners, public

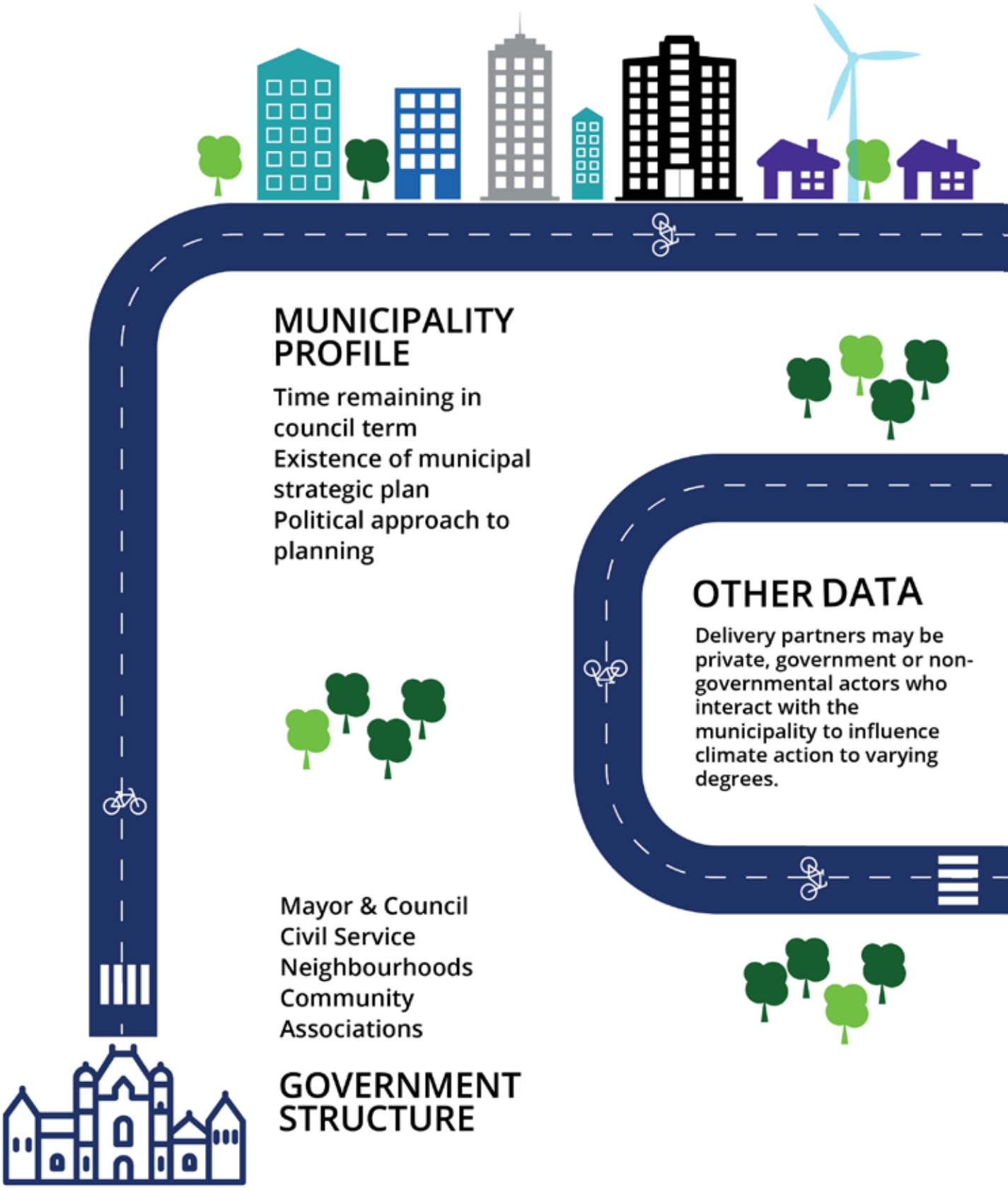
The municipality now has a clearly defined low carbon pathway:

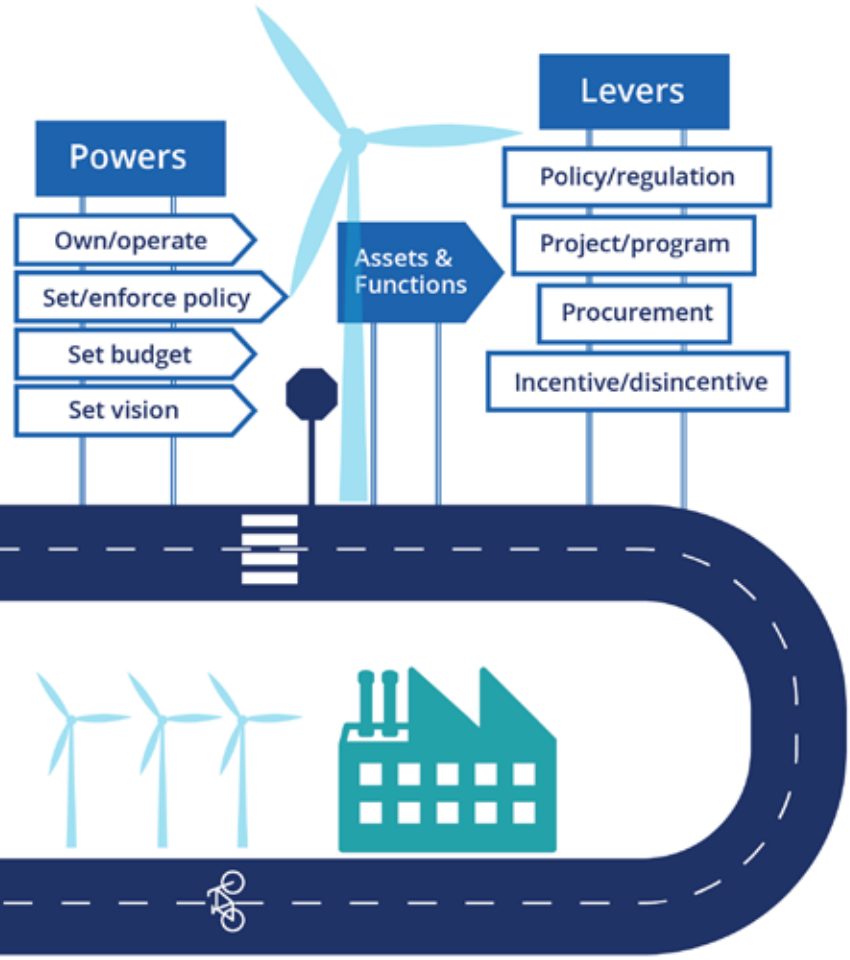
- The local energy and emissions context and baseline inventory has been established;

- The municipal spheres of influence have been established;
    - An emissions reduction target has been set;
    - Scenarios have been modelled to establish the anticipated outcomes of actions and policies;
    - A GHG emissions trajectory has been defined with the selection of the preferred scenario;
    - Co-benefits have been evaluated; and
    - Actions have been prioritized.

The next step is to identify the policies and mechanisms that can be used to support implementation.

COMMUNITY ENERGY & EMISSIONS IMPLEMENTATION PATHWAY

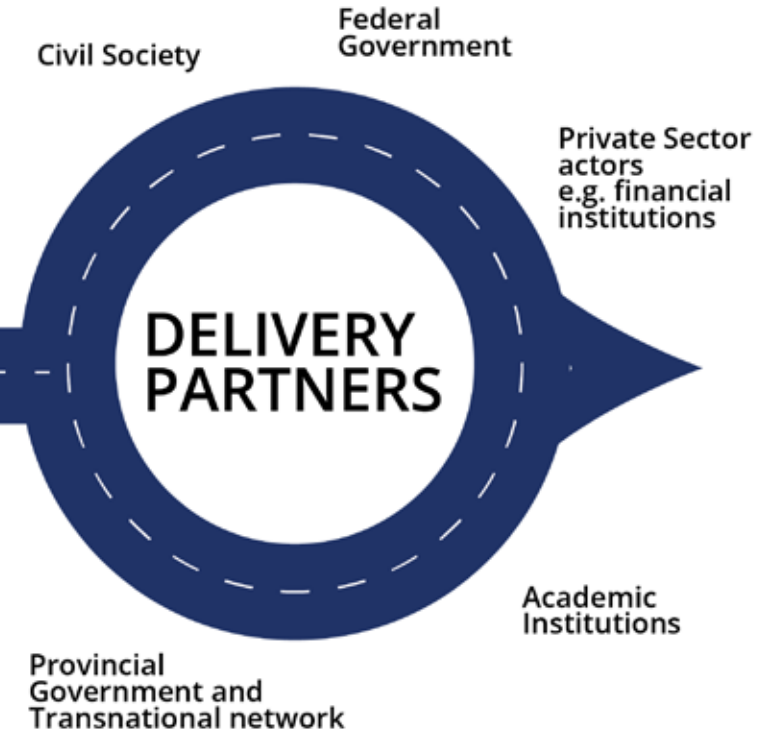




DELIVERY PATHWAYS

STAGES ON THE URBAN GOVERNANCE PATHWAY

The political context & governance structure describe the municipality from an institutional perspective. The assets, such as road infrastructure and functions, such as promoting economic development, are what the municipality exercises power over. The levers deliver change. The delivery partners may help the municipality take further action than it could alone. All result in the delivery of the low carbon pathway.



Increasing the Energy Performance of Buildings in Toronto

The City of Toronto has the authority to set standards for energy efficiency and other environmental attributes through an interpretation of the Planning Act which it applies through the Toronto Green Standard. For any new building being built, the City can set standards based on total energy use intensity, thermal energy demand intensity and GHG intensity for new buildings. Furthermore, the Better Buildings Partnership (established in 1996) and the Home Energy Loan Program provide support to assist homeowners, commercial building owners, and social housing providers to reduce emissions in this sector. With Energy and Water Reporting and Benchmarking for Large Buildings (Ontario Regulation 20/17), Toronto will be able to monitor how effective these programs have been.

Transforming the Electricity System in San Francisco

CleanPowerSF, a Community Choice Aggregation program, offers customers the option of purchasing 33%-50% California-certified renewable energy at current electricity rates, and an option of 100% renewable energy for a slight premium. Administered by the San Francisco Public Utilities Commission (SFPUC), CleanPowerSF is not-for-profit. Ratepayer funds are invested locally in energy efficiency programs and new renewable energy facilities. The mechanism of Community Choice Aggregation is not currently available in Canada but is an example of municipal innovation.

Resource:

California Air Pollution Control Officers Association (2009). Model policies for greenhouse gases in General Plans.

http://www.capcoa.org/wp-content/uploads/downloads/2010/05/CAPCOA-ModelPolicies-6-12-09-915am.pdf

Example:

City of Toronto. (2016). Energy Strategy Terms of Reference.

https://www1.toronto.ca/static_files/CityPlanning/PDF/energy-strategy.pdf

TASK 5.1: POLICIES AND MECHANISMS IDENTIFICATION

RELEVANT STREAMS

There is a standard set of policies available to municipalities that influence land-use patterns and therefore GHG emissions, described in Table 46. For more detail on these tools see Appendix 7.

Table 46. Summary of typical land-use policies that can influence GHG emissions.

Tool	Purpose	Low carbon strategy examples
Official Plans	Describe policies on how land should be used.	Identify goals, objectives and actions to mitigate greenhouse gas emissions. Policies focus on compact, complete communities, supporting intensification, transit-supportive development, mixed-uses and walkability.
Community improvement plans	Specific requirements for a particular area.	Support building retrofit programs with local improvement charges.
Zoning by-laws	Regulate land-uses and physical characteristics of land-use.	Ensure mixed-use and compact development.
Minimum/maximum standards in zoning	Enable zoning by-laws to set standards for building design and form, and neighbourhood design.	Urban design standard can support safe, compact, well-designed, walkable and vibrant streetscapes and communities..
Site plan control	Regulates building and site characteristics.	Require enhanced energy performance in buildings.
Height and density bonusing	Enables municipalities to incur community benefits in exchange for additional height or density beyond zoning requirements.	Can use height and density bonuses to support local improvements to transit facilities and provision of pedestrian and cycling facilities.
Plan of subdivision	Municipality can require specific land-use patterns or configurations.	Require enhanced energy performance in buildings. Require low carbon land-use design (i.e. greenfield allocation).
Community planning permit system	Conditions requiring low carbon actions can be imposed on the issuance of a permit.	Can specify characteristics related to height and density to support compact, complete communities.
Zoning with conditions	Conditions can be required with zoning.	Require enhanced energy performance in buildings.

Within, and in addition to, these policy mechanisms, there are some policies and actions that municipalities typically implement (to varying extents). A list of sample policies and actions can be found in Appendix 13.

Incorporating Climate Action into Guelph's Official Plan

Guelph is the fifth fastest-growing city in Canada with a population growth rate of approximately 2% per year. According to the Ontario Places to Grow plan, Guelph's population is projected to be about 144,500 by the year 2021. Population varies throughout the year because of the influx and departure of the university student population. The City's Official Plan was amended prior to 2014, to include climate change in land development applications. The Claire Maltby Secondary Plan incorporates energy use, climate change and other sustainability requirements front and centre in the planning policy.

Actions Prioritization Revisitation

Following the identification of mechanisms and policies, the municipality likely needs to revisit the actions prioritization, to identify an order for introduction. Community and stakeholder engagement is critical at this phase to ensure a high level of awareness on the direction of the municipality and the benefits of implementing the actions.

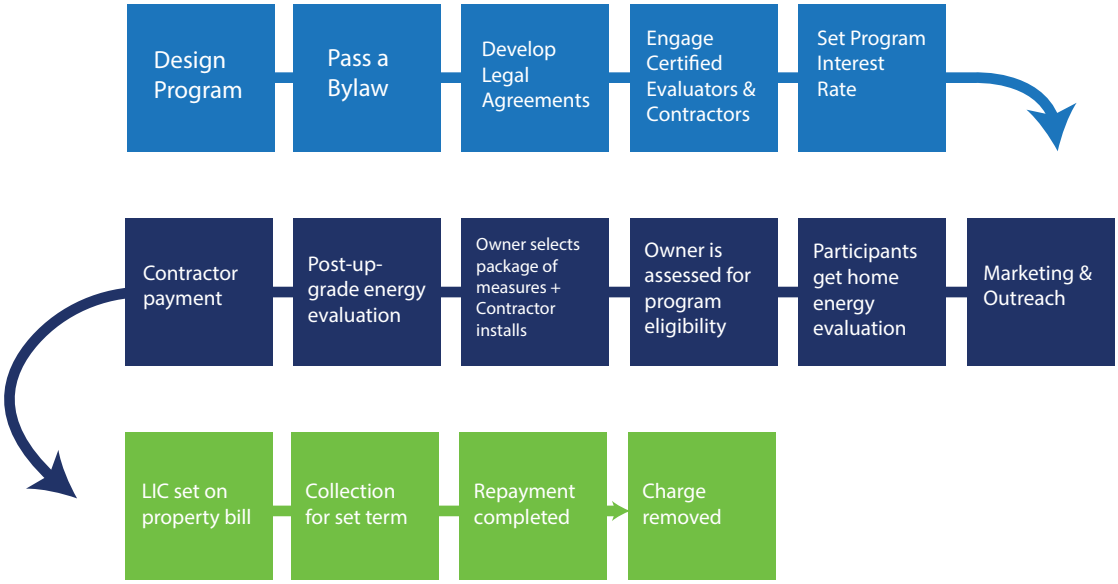


Figure 24. Example of the steps involved in the development of an ocal improvement charge program.[22]

It is recommended that a five-year implementation plan be developed, which identifies what will be achieved each year, who will be responsible, required funding and the required governance process.

Example:
District of North Cowichan (2014). Climate action and energy plan implementation and monitoring framework:

http://www.northcowichan.ca/assets/Departments/Planning~and~Land~Use/docs/CAEP-Implementation-Framework-20141001.pdf

22 Adapted from: Persram, S. (2013). Using local improvements charges to finance residential energy upgrades. CHEERIO http://www.cleanairpartnership.org/wp-content/uploads/2016/08/Primer.pdf

TASK 5.2: Investment Strategy

RELEVANT STREAMS

While some actions, such as land-use, require the development of policies, others require financial investment. In order to achieve an 80% reduction in GHG emissions by 2050, most buildings will need to be retrofit, non-fossil fuel-based heating systems will need to be installed, and the transportation system will need to transition to zero emissions fuels, amongst other changes. This transition will require unprecedented public and private sector investments, totalling billions of dollars each year. In some cases, such as the building industry, major investments are made regularly. They can be fine-tuned to achieve low carbon objectives, as well as co-benefit objectives.

Energy and emissions planning processes have not typically contemplated this scale of investment. However, in order to achieve reduction targets of 80% or more by 2050, planners will need to engage with finance in new ways, as municipalities, in cooperation with other partners, seek to mobilize the finances required.

Resource:

Low Carbon City Lab: Climate finance opportunities for cities and investors.

http://local.climate-kic.org

More reading:

Cities Climate Finance Leadership Alliance. (2015). The state of city climate finance.

http://www.citiesclimatefinance.org/wp-content/uploads/2015/12/CCFLA-State-of-City-Climate-Finance-2015.pdf

Investment in Buildings

Ontarians invested $1.5 trillion in their homes between 1990 and 2015. In 2015 alone, $45 billion was invested in residential buildings–investments that determine housing emissions for decades to come. Home renovations have been the largest and fastest growing component of residential investment for over 25 years. Effective strategies to reduce community emissions must include renovations.

Business Planning

RELEVANT STREAMS

Whether public or private sector investments, the municipality needs to develop detailed business plans for each action, a process that can be incorporated into the modelling stage. In most cases, investments in low carbon actions generate a return, as a result of efficiency gains or avoided costs associated with infrastructure or equipment. There may be physical or legal gaps between the investing party and the party receiving savings—a phenomenon known as split incentive—which can be overcome by careful structuring of financial instruments.

In developing a business case, the municipality should consider standard metrics such as the simple payback, internal rate of return, net present value and the marginal abatement cost. Considering these financial assessments will provide additional insight into action implementation. Figure 26 outlines four steps in the business planning process.

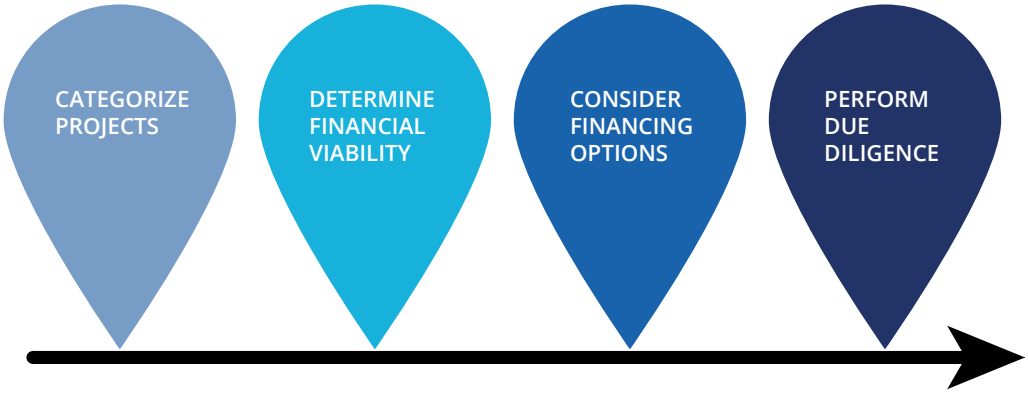


Figure 25. Categorization of projects for financing climate projects.[23]

» Step 1: Categorize Projects

In order to identify the appropriate financing package, actions should be categorized by size (small or large) and nature (centralized or decentralized). However, if a municipality's prioritized projects tend to fall into the same category, more detailed levels of categorization may be required. For example, breaking down projects by infrastructure capital investment versus operational measures.

	Large Scale	Small Scale
Decentralized	Green building codes Improved public transportation	Efficient lighting Household solar hot water
Centralized	Renewables development Water treatment system location	Biomass energy Landfill gas capture

Figure 26. Categorization matrix for energy and emissions financial investment.[24]

23 Chapter 2, "Cities", Better Growth, Better Climate, The New Climate Economy: The Global Commission on the Economy and Climate, 2014, http://2014.newclimateeconomy.report

24 The World Bank. Sustainable Energy and Emissions Planning. Accessed from http://wbi.worldbank.org/energy/sueep-sustainable-urban-energy-and-emissions-planning/stage-5-implementation

Different extents of financial analysis can then be assigned to each category, recognisizg the significance of the investment and the potential funding sources.

» Step 2: Determine Financial Viability

Actions are considered financially viable if the return on investment reaches an agreed-upon threshold, and the identified risks are tolerable and can likely be mitigated during implementation. A risk assessment and financial analysis are needed before deciding on financing options for viable climate actions.

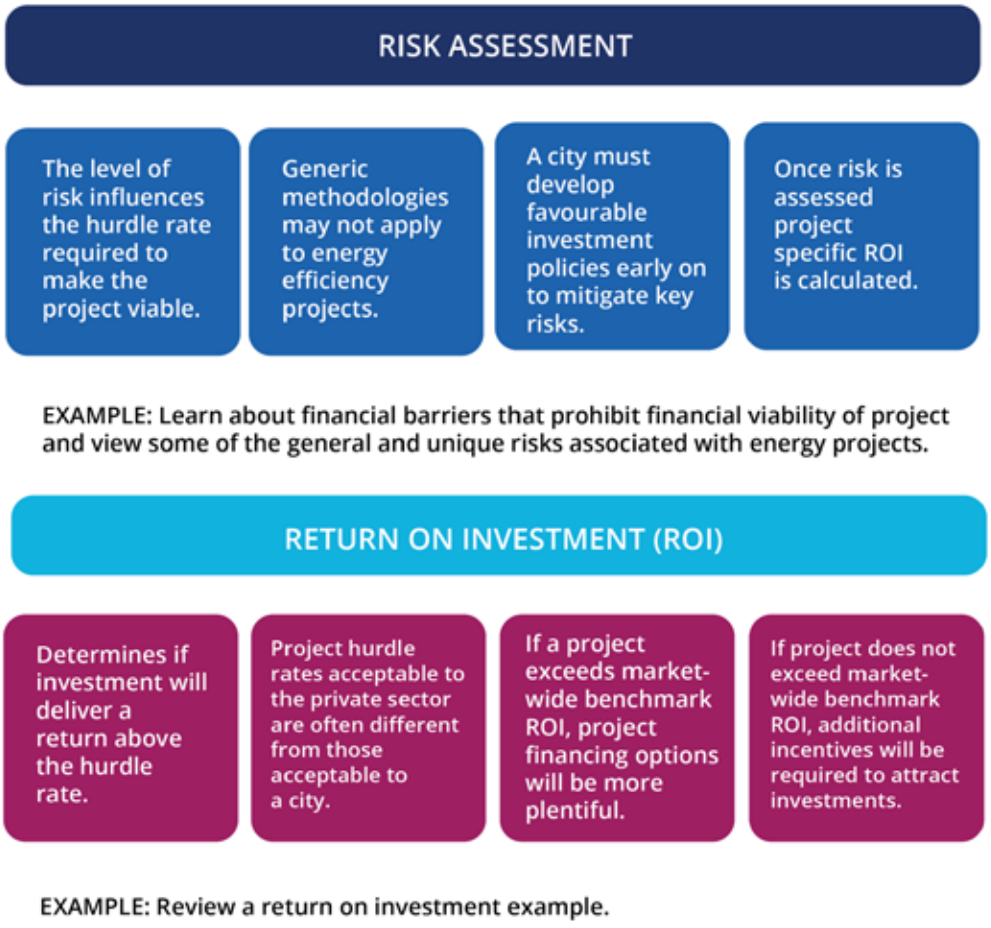


Figure 27. A sample set of considerations when assessing financial viability.[25]

» Step 3: Consider Financing Options

There are both internal and external financial options for financing, depending on the categorization, risk, financial viability, and scale. The first decision is whether the municipality will finance the action with existing or new revenue sources or seek external financing, either from investors or grants, or with cross-sector

25 The World Bank. Sustainable Energy and Emissions Planning. Accessed from http://wbi.worldbank.org/energy/sueep-sustainable-urban-energy-and-emissions-planning/stage-5-implementation

partnerships. Careful consideration of the legal and regulatory context is required. Table 47 includes possible financing strategies.

Table 47. Potential financing options for energy and emissions actions.

Source	Financing category	Financial mechanisms
Municipal budget	Taxes	» Value capture tools » Tax increment financing
	User fees	» Density bonuses » Developer impact fee » Traffic congestion charge » Electric vehicle charging
Funders	Investor financing	» General obligation » Green or climate bond » Neighbourhood bonds » Energy efficiency loan » Property-assessed clean energy » Revolving loan fund » Infrastructure bank financing
	Donor grants	» Provincial grants (Challenge Fund) » Federal infrastructure funding » Green Municipal Fund
Partners	Cross-sector partnerships	» Public private partnership » Community choice aggregation » Group purchasing

- **Step 4: Perform Due Diligence**

The municipality needs to ensure that the business case meets the policy and regulatory requirements, including return requirements, risk tolerance and debt ceiling. Examples of the questions to answer prior to finalizing a financing package include:

- What are the important or unusual features of the action?
- What is the total cost of the financing package?
- What is the source of payment and the source of security?

- The municipal general fund
- Municipal tax revenues
- Revenues of a municipal subsidiary
- Contractual payments to be received from other levels of government

- What is the plan for payment of the principal and interest?
- What could happen that could fundamentally alter the arrangement?
- What could go wrong in the short, intermediate and long term?
- If the unexpected happens, what is the contingency plan?

Resource:

HIP Investor (2016). Financing sustainable cities scan & toolkit.

http://www.cityofpaloalto.org/civicax/filebank/documents/57008

Investing in Compact, Connected Cities

Compact and connected cities illustrate how a coordinated investment in low-emission infrastructure can be translated into investment decisions on the ground. According to the New Climate Economy 2014 report: Better Growth, Better Climate, a shift to more coordinated, compact urban development could reduce infrastructure capital requirements by more than $3 trillion over the next 15 years (or $200 billion a year) and significantly reduce emissions largely by limiting urban sprawl and the additional infrastructure it requires. For example, denser transit-oriented city planning can reduce the amount of road infrastructure required. Building more compact, connected cities can also result in social, health, and environmental benefits not fully captured in the estimate.[63]

Green Bonds and Climate Bonds

A "green bond" is a bond whose funds are exclusively committed to finance or re-finance "green" projects, assets or business activities.[66] A green bond is a fixed-income financial instrument for raising capital from investors through the debt capital market. A climate bond is a type of green bond. Typically, the bond issuer raises a fixed amount of capital from investors over a set period of time (the "maturity"), repaying the capital (the "principal") when the bond matures and paying an agreed amount of interest ("coupons") along the way.[67]

In 2007, green bonds were launched by a few development banks such as the European Investment Bank and the World Bank, and have grown considerably since then. According to the Climate Bonds Initiative, "[t]he green bond market has taken off in recent years, with the market really starting to take off in 2015 when USD 42 billion was issued; almost four times the 2013 issuance (USD 11 billion). This momentum has continued strong, with USD 200 billion in green bonds currently outstanding. There are projects for possibly USD 130 billion to be issued in 2017."[68]

Resource:

Green City Bonds Coalition (2016). How to issue a green muni bond: The green muni bonds playbook.

https://www.climatebonds.net/files/files/Green%20City%20Playbook.pdf

Green bond references [26] [27] [28].

26 ICMA (2015), Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bond, March.

27 The Climate Bonds Initiative. *Explaining Green Bonds.* Accessed from https://www.climatebonds.net/market/explaining-green-bonds

28 The Climate Bonds Initiative. *Explaining Green Bonds.* Accessed from https://www.climatebonds.net/market/explaining-green-bonds

TASK 5.3: INTEGRATION

RELEVANT STREAMS

The role of the energy and emissions plan within the overall planning context of a municipality varies from one context to another. A key consideration is the integration of the community energy and emissions plan with other major plans such as the Official Plan, transportation plan, waste management plan, economic development plan, and others.

Integration with City Plans

Integration and alignment of plans can decrease GHG emissions, increase resilience and bolster economic development. On the other hand, it can happen that an official plan prioritizes development in efficient locations, but external funding from other government agencies—whether local, provincial or federal—promotes development in more remote areas via incentives, infrastructure investments or construction of government facilities, such as hospitals. Thus, integration and alignment is important: within municipal departments, with other municipalities in the region sharing infrastructure systems and markets, and with provincial and federal ministries and programs. Regional coordination is especially important for reducing transportation emissions.

Table 48. Energy and emission plan integration with other plans.

Plan	CEEP consideration	Impact on others plans
Official Plan	Official Plan land-use policies should be evaluated for their emissions impacts (i.e. through scenarios).	The Official Plan should be revised to reflect the CEEP's recommended policies or actions.
Transportation Master Plan	The impact of proposed changes to and investments in transportation should be evaluated in a scenario.	The Transportation Master Plan should be updated to reflect the CEEP's actions and targets.
Solid Waste Plan	Actions to reduce waste generation or to treat waste should be evaluated in a scenario.	The Solid Waste Plan should reflect the actions contained in the CEEP.
Economic Development Plan	The extent to which actions have effects on investments, household incomes, and job creation should be assessed.	The CEEP will involve opportunities for businesses, new employment and investments. The Economic Development Plan can support these efforts, or an economic development strategy may be developed focussed on the actions in the CEEP.

Plan	CEEP consideration	Impact on others plans
Other plans and strategies	Other plans and strategies should be reviewed and reflected in a scenario, where relevant.	Actions or policies in the CEEP should be reflected in the relevant plans or strategies.

The principal city plans through which the Climate Action Plan is implemented are identified in the figure below.

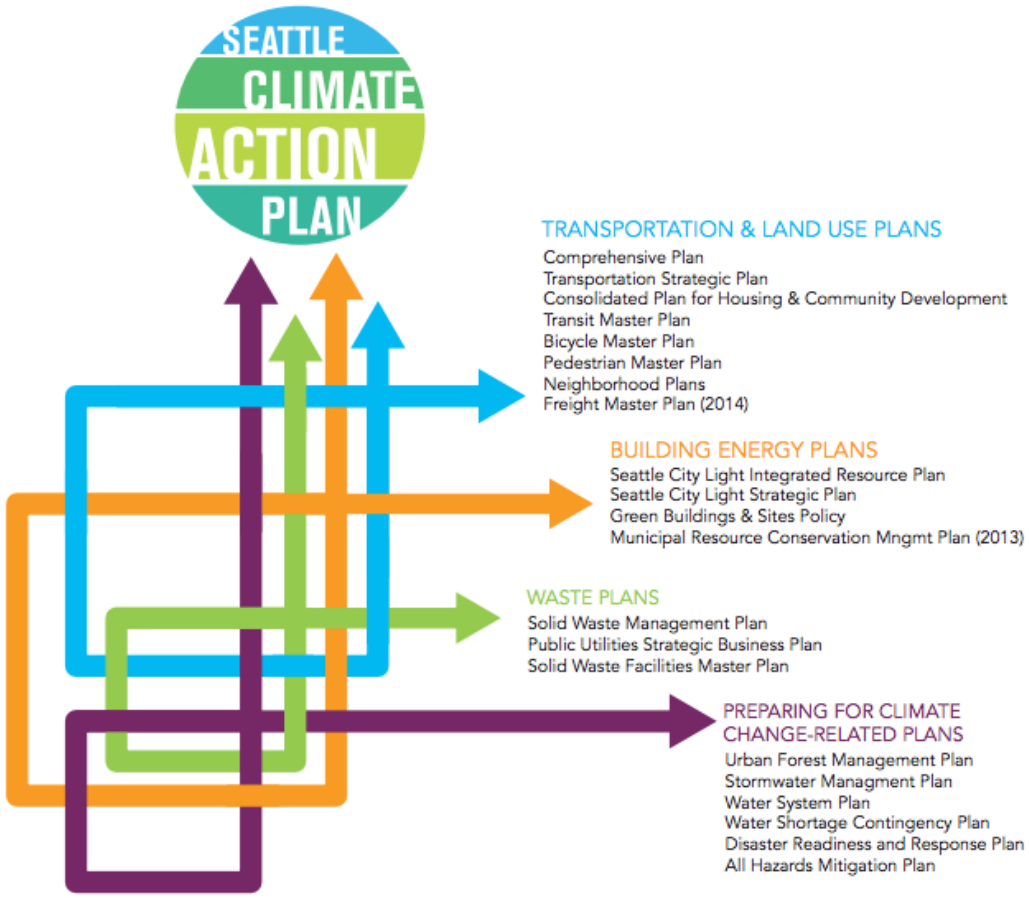


Figure 28. Diagram showing how Seattle's Climate Action Plan (2013) considers, and is integrated into, the City's other planning efforts.

Integrated Planning in Markham

The City of Markham is taking part in Ontario's Municipal Energy Plan Program, and is currently in the process of developing a Municipal Energy Plan (MEP). The plan is expected to be complete in the fall of 2017.

Preceding the development of the MEP, Markham developed Greenprint in 2011, Markham's integrated community sustainability plan (ICSP). Greenprint, under the Energy & Climate priority, includes an objective of achieving net zero energy and emissions by 2050, which has been one of the drivers for developing the MEP. In addition to the MEP, the City is also undertaking Community Energy Planning (CEP) at the neighbourhood scale. City staff have incorporated policies from York Region's New Communities Guidelines from York Region's Official Plan and Markham's new Official Plan, and have developed a Terms of Reference for future Community Energy Plans (CEPs) to accompany Secondary Plans. The intent is to have CEPs developed and submitted as part of the subdivision secondary planning process.

Increasing the Energy Performance of Buildings in Toronto The City of Toronto has the authority to set standards for energy efficiency and other environmental attributes through an interpretation of the Planning Act which it applies through the Toronto Green Standard. For any new building being built, the City can set standards based on total energy use intensity, thermal energy demand intensity and GHG intensity for new buildings. Furthermore, the Better Buildings Partnership (established in 1996) and the Home Energy Loan Program provide support to assist homeowners, commercial building owners, and social housing providers to reduce emissions in this sector. With Energy and Water Reporting and Benchmarking for Large Buildings (Ontario Regulation 20/17), Toronto will be able to monitor how effective these programs have been.

Integrated Planning in Seattle

Seattle's process produced a CAP that is implemented through related plans that are developed with and executed across multiple City departments. The CAP works with and through these plans by:

- Providing a planning and monitoring framework for achieving climate change goals.
- Highlighting critical actions for reducing emissions and fostering resilience to climate impacts.

Municipal Structural Integration

Integral to the success of the final strategy and implementation of actions is the ability to integrate learnings into organizational processes, such as policy development and implementation of plans and strategies, and structures, such as departmental mandates and job descriptions. The ability to learn and adapt in the course of work (as opposed to perfecting through repetition) requires fostering a particular culture. The degree to which the local government can embed the knowledge gained through the monitoring and evaluation processes described above will be key to success in implementation. Characteristics of a learning organization are as follows:[29]

1. The organization recognizes, supports and is able to benefit from formal and informal structures.
2. The organization is open to innovation both in terms of the way it is managed, and in operational activities.
3. The organization supports creative thinking, innovation and exploration of change from the personal to organizational level, allowing this to contribute to more formal governance and accountability structures.
4. The organization encourages and supports learning from experience at various levels (e.g. through attention to what is being learnt e.g. facts and skills, incorporation of learning from evaluations, support for action learning sets and other enquiry processes, etc.) towards improving practices, policies and programmes.
5. The organization recognizes that attention needs to be paid to all stages of the learning cycle (experience, reflection, conceptualization, and planning implementation) for learning to occur and change to happen. Indicative attributes include:
    - Actively seeking new ideas and other ways of working, including examples from outside the organization;

29 UK Climate Change Adaptation Program.

» Dissonant information that does not fit with current practice and thinking and experience is not seen as taboo but welcomed and actively explored;

» The creation of and support for 'informal space' to experiment and innovate, and that processes of dialogue are supported that enhance collaboration rather than debate and argument that may exacerbate conflict;

» Support is provided for processes of learning and enquiry e.g. action learning sets, learning histories, appreciative enquiry at all levels of the organization; and

» 'Mistakes' are seen as an opportunity to learn.

Stage 6: Monitoring and Evaluation

Tasks	Description	Complexity of approach		
		Basic	Intermediate	Advanced
6.1. Monitoring and evaluation plan	A monitoring and evaluation plan is developed, including indicators and surveys.	Simple pass/fail evaluation.	Annual indicators assessment, updating of plan.	Frequent tracking of indicators and departmental roles and responsibilities updates.
6.2 Implementation	Governance strategies are identified and the plan is implemented.	Responsible department implements the plan.	Responsible departments implement policies and actions for which they are responsible.	Departments coordinate plan implementation, reporting and updating.
Tools		Workplans, indicators checklist.	Workplans, indicators assessment matrix, plan update mechanisms.	Workplans, indicators assessment matrix, plan update mechanisms, integrated reporting tools.

Table 49. Sample engagement activities for monitoring and evaluation.

	Basic	Intermediate	Advanced
Engagement activities	Council reports	Council and staff reports, senior staff engagement.	Council and staff reports, senior and junior staff engagement, public reporting and engagement.

A process of monitoring and evaluation will track the community energy and emissions plan's progress and effectiveness, while facilitating its evolution. This process will enable the local government to track how well actions achieve objectives, the impact of changing policies and technologies on the effectiveness of those actions, the impact of those actions on GHG emissions, and the impact of the actions on co-benefits.

TASK 6.1: MONITORING AND EVALUATION PLAN

Table 49 details a sample monitoring and evaluation cycle, illustrating the type of data collected and collection frequency.

Table 50. Monitoring and evaluation activities.

Activity	Purpose	Description	Frequency
Annual work plan and review	Review work to-date and set annual priority actions	Annual report with prioritized actions	Annual
Annual indicator report	Track effectiveness of actions	Annual report on set of indicators with an analysis of the results	Annual
Inventory	Update GHG emissions profile	Re-calculate the GHG emissions inventory	Every 2 years
Update the community energy and emissions plan	Update the CEEP to reflect changing conditions	Work through each stage of the community energy and emissions planning process	Every 5–8 years

Annual work plan and review

Each year a work plan for the community energy and emissions plan should be developed. The work plan should identify all relevant activities to achieve the actions and policies in the plan, the responsible parties, the budget and the schedule. Each year the results of the previous year's work plan should be reviewed to inform the development of subsequent work plans.

Annual indicator report

There are two aspects involved in the application of indicators: collecting data on indicators (monitoring), and interpreting the results of those indicators (evaluation). Over time, the municipality can also evaluate its effectiveness in embedding the knowledge and wisdom gained through this process into the organization.
From the perspective of climate change mitigation, there are multiple purposes for which data is collected: to evaluate the effectiveness of the actions, to evaluate the impact of the actions on the community, and to evaluate the uptake of the lessons from the evaluation. Many of the indicators address two or more of these purposes which results in the challenge of discerning cause and effect.

Table 51. Types of indicators.

Indicator Category	Question
1. Effectiveness indicators	Are the actions achieving their objectives?
2. Impact indicators	What is the impact of the actions on the community?
3. Learning indicators	Is the local government incorporating the knowledge gained?

The indicators identified for tracking the implementation of the community energy and emissions plan have the following characteristics:

- Process-based approach: Seeks to illustrate trends rather than specific outcomes. By using process indicators it is possible to consider whether the direction of travel is correct given the current information.
- Ability to tell a story: A good indicator represents a number of different inputs and outcomes so that it provides a quick snapshot of a complex situation.
- Availability of data: Local governments are already able to access the data.

Effectiveness Indicators

These indicators will be designed to evaluate whether or not policies or actions are having an effect; they will vary from municipality to municipality according to the specifics of the community energy and emissions plan. For example, if a plan includes a PACE program, an indicator would be the number of inquiries about the PACE program, the number of households or businesses that participated in the PACE program and the average energy savings. The results of the indicators are then compared against the assumption in the modelling to monitor whether or not the municipality is on track with projections. Indicators should be developed for each action or policy.

Impact Indicators

The following indicators track macro trends and drivers of GHG emissions in the municipality; these are designed to be reported on each year.

Table 52. Recommended community-scale indicators.

Indicator	Trend	Data sources
Total new dwellings by type	An indication of the growth of the building stock.	Building permits
Average total floor area of new dwellings	An indication as to whether there is more or less additional floor space to heat or cool.	Building permits

Indicator	Trend	Data sources
Diversity of dwelling types	An indication of the types of dwellings and whether or not they have shared walls.	Building permits
Total new non-residential floorspace by type	An indication of the growth of the building stock.	Buildings permits
Total demolitions	An indication of the change in the building stock.	Demolition permits
Percent of dwellings units that are downtown versus on the periphery	An indication as to whether residential development is occurring in areas more appropriate for walking, cycling and transit or not.	Downtown and periphery can be defined as appropriate for the municipality. Use building permits and GIS analysis.
Percent of non-residential floorspace that is occurring in the built-up area or in major transit station areas versus on the periphery	An indication as to whether residential development is occurring in areas more appropriate for walking, cycling and transit or not.	Downtown and periphery can be defined as appropriate for the municipality. Use building permits and GIS analysis.
Number of dwellings that are within 400m of a transit stop	Indication of transit accessibility.	GIS layers of transit and building footprint.
Annual or monthly energy price by fuel (electricity, natural gas, gasoline, diesel) ($/GJ)	Energy costs are an important indicator of opportunities for energy savings and renewable energy, household, municipal and business energy costs.	Electricity and natural gas rates are available from Ontario Energy Board; Fuels are available from for major urban centres from Statistics Canada CANSIM Table 326-0009 and for specific locations from sites such as GasBuddy.com
Total energy consumption by sector for natural gas and electricity (GJ)	An indication of trends in energy use in buildings.	Available on request from utilities
Total solar PV installs (# of installation)	An indication of extent of decentralized renewable energy.	Building permits if required.
Total gasoline sales ($)	An indication of GHG emissions from vehicles.	Available for purchase from Kent Group Ltd.
Total vehicle fleet by vehicle class (#)	An indication of the number of low or zero emissions vehicles and whether the fleet is becoming more or less efficient.	Available on request from MTO, or for purchase from Polk.
Total VKT per capita	An indication of transportation GHG emissions.	Transportation model, not available for many municipalities.
Total and per capita transit trips	An indication of whether non-vehicular trips are increasing or not.	Available from the transit agency.
Length of physically separated cycling lanes	An indicator of opportunity for people of all ages to cycle.	Municipality
Total solid waste by composition	Indication of major sources of waste.	Municipality or regional government. Data for ICI may not be available.

Indicator	Trend	Data sources
Total solid waste diverted	Indication of diversion efforts.	Municipality or regional government. Data for ICI may not be available.
Total solid waste to landfill	Indication of waste that will contribute to GHG emissions.	Municipality or regional government. Data for ICI may not be available.

Table 53. Recommended corporate indicators.

Indicator	Trend	Data sources
Total VKT	Indication of transportation patterns associated with municipal services.	Municipal data: odometer readings
% of municipally-owned vehicles that are electric or zero carbon	Indication of leadership by the municipality.	Municipal data: vehicle purchase orders
Total energy consumption by fuel (electricity, natural gas, gasoline, diesel, other) (GJ)	Indication of increase or decrease in efficiency.	Municipal data: accounting data
Total renewable energy generated by the municipality (GJ)	Indication of the effort to install renewable energy.	Municipal data: utility reports
Average energy use intensity of municipal buildings (GJ/m^2)	Measure of the energy energy performance of the building stock.	Municipal data: utility reports
Total emissions by sector (tCO2e)	Indication of the emissions trends for the local government.	Municipal data: GHG inventory

Learning Indicators

Learning indicators track the organizational response to the community energy and emissions plan and the lessons resulting from the implementation of the plan.

Table 54. Recommended learning indicators.

Indicator	Trend	Data source
# of job descriptions that include climate change or GHG emissions.	Indication of the extent to which climate change planning is embedded in the organization.	Municipal data
% of major planning activities that included consideration of climate change and GHG emissions.	Indication of the extent to which climate change planning is embedded in the organization.	Assessment of plans completed (neighbourhood, community, transportation, etc.)
Description of major infrastructures projects that includes a GHG mitigation aspect.	Indication of how municipal expenditures are contributing to GHG emissions reductions.	Assessment of infrastructure projects
Percent of Council reports where consideration of climate change, GHG emissions and mitigation and/or adaptation is discussed.	Increased % of reports indicates increased literacy on climate change	Council reports

EACH

Earth Day in London, Ontario

A progress report on the implementation of the City of London's Community Energy Action Plan program activities is released on Earth Day (April 22nd) each year. It includes reporting on these indicators:

Category	Indicator
Energy Performance	» Total annual energy use (terajoules) » Percentage change in total energy use from peak energy use year (2007) » Per-person annual energy efficiency (gigajoules per person) » Percentage change in energy efficiency from peak energy year (2007)
Economic Impact	» Total annual energy cost (dollars) » Avoided annual energy costs (compared to 2010 business-as-usual) » Per-person annual energy expenditures (dollars per person) » Percentage change in per-person energy expenditures from baseline year (2010)
Environmental Impact	» Total annual GHG emissions (tonnes CO2e) » Percentage change in total GHG emissions from GHG baseline year (1990) » Percentage change in total GHG emissions from peak GHG emissions year (2007) » Average annual GHG contribution (tonnes CO2e per person) » Percentage change in per-person GHG emissions from GHG baseline year (1990) » Percentage change in per-person GHG emissions from peak GHG year (2007)

External Reporting

Several Canadian municipalities are reporting to external programs. As described earlier in the Guideline, there are several energy and emissions reporting standards, some of which offer external reporting services at no cost. For example, CDP collects data for the Global Covenant of Mayors and CDP's own city reporting process. Reporting provides external validation and feeds into international reporting and analysis of city action on climate change. CDP also has a benchmarking tool municipalities can use to compare their performance against other municipalities. Reporting to provincial counterparts supports accurate provincial inventorying as well.

Table 55. Organizations that track GHG mitigation performance of cities.

Organization	Requirements	Level of effort
PCP	Reporting requirements for each of the milestones.	Low
Global Covenant of Mayors	Questionnaire that includes information on GHG emissions, strategies and commitments.	Moderate
CDP	Questionnaire that includes information on risks, climate adaptation, mitigation, local government operations, strategy and water.	High
BPS	Mandatory: includes reporting on energy and GHG emissions for buildings.	Moderate

The City of Calgary's Annual CDP Reports

The City has found that using the CDP's reporting platform has been particularly useful in both advancing and maintaining its climate action planning efforts for several reasons. Firstly, it has brought together multiple reporting protocols and platforms (GPC, Compact of Mayors). Secondly, it is seen as a potential tool to attract businesses that report under the same platform and may be interested in investing in City efforts. Thirdly, participation was part of a resolution at a big city mayor's caucus that they attended, and the CDP's platform is currently seen as 'the place' for leading cities to voluntarily report. Fourthly, its ongoing reporting requirements have allowed the City to develop a process around yearly reporting that has included regular contact and communications with its other departments.

5.4 ENERGY AND EMISSIONS PLANNING PROCESS CONCLUSIONS

Stages 1 through 6 represent a systematic approach to community energy and emissions planning. Municipalities may elect to vary the order of the stages or emphasize a stage or an aspect of a stage according to their particular context. Each of the six stages of the community energy and emissions planning (CEEP) have specific outcomes. In combination, these outcomes form the municipality's community energy and emissions plan, which incorporates the GHG inventory and GHG emissions reduction targets. The CEEP fulfills the requirements of the Municipal GHG Challenge Fund and the policies of the Growth Plan for the Greater Golden Horseshoe, as well as supporting municipalities in identifying a low carbon pathway that delivers multiple community benefits.

The outcomes of the process are many. First, the municipality will have developed a pathway towards deep GHG emissions reductions and will have a clear picture of the actions, policies and measures required to implement that pathway. Second, the Official Plan and planning policies will incorporate low carbon pathway considerations, guiding land-use policy that enhances GHG emissions reductions.

Table 56. Stages, outcomes and efforts of energy and emissions plan development.

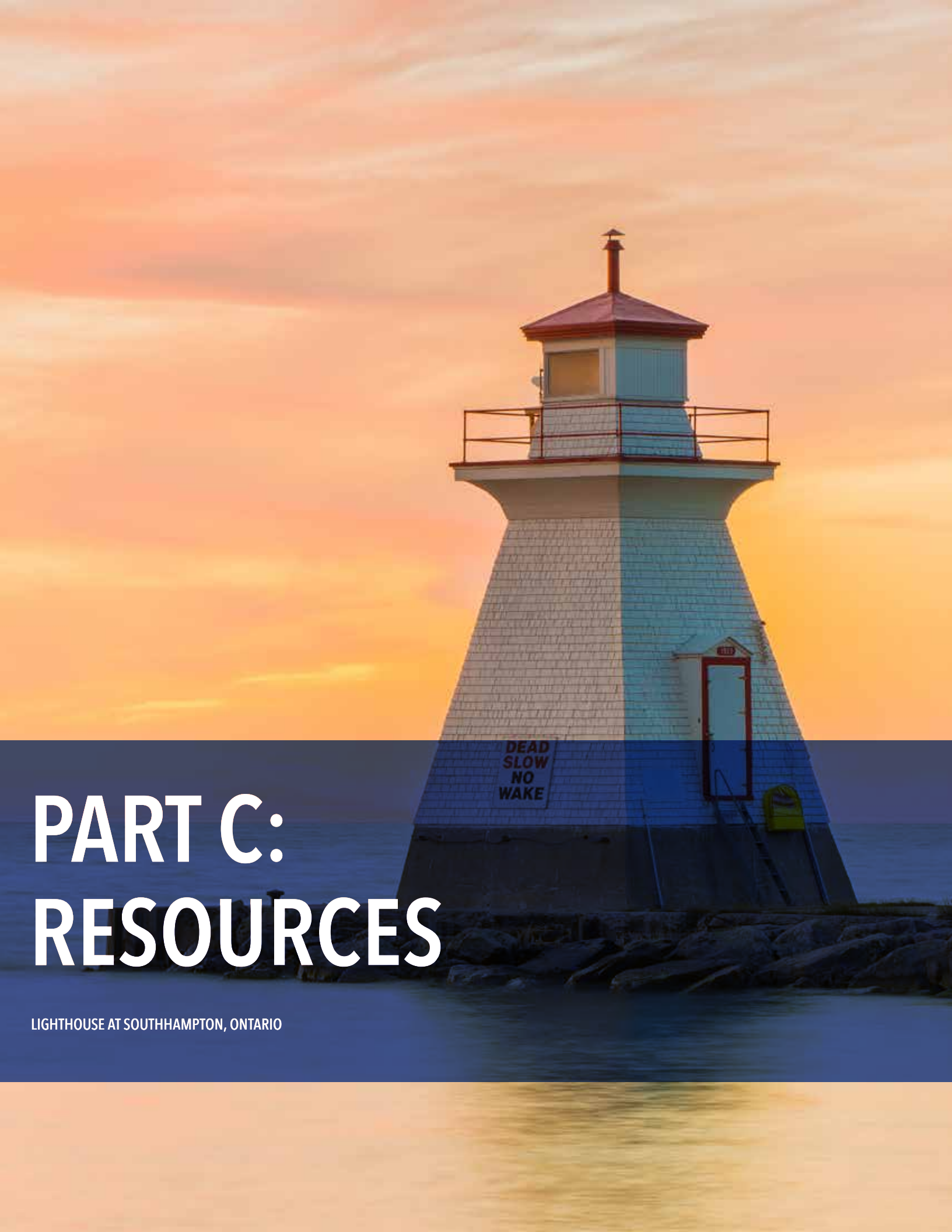
Stage	Required outcomes	Relative level of effort
1. Preparation	» Terms of reference » Situational analysis that describes the current planning context	**20%**
2. Inventories	» GHG inventory (corporate and community) » Spheres of influence analysis » Financial inventory	**15%**
3. Target setting	» GHG targets	**5%**
4. Actions and alternative scenarios development	» Actions catalogues » Scenarios » Analysis of co-benefits	**25%**

Stage	Required outcomes	Relative level of effort
5. Implementation	» Policies and mechanisms analysis » Integration with the Official Plan and other policies, plans and strategies » Investment strategy	**30%**
6. Monitoring and evaluation	» Monitoring and evaluation plan	**5%**

Third, the co-benefits of the low carbon pathway will be broadly understood in terms of their impact on well-being, accessibility, health, the elderly and children, among others. The community energy and emissions plan will be understood as an economic development strategy that will improve the building stock, generate new employment opportunities and reduce energy costs.

There are also some technical side benefits or insights that will result from the process. The municipality will have articulated land-use scenarios based on its current planning policies, an exercise which may or may not have been completed previously, providing new insight into the near and long-term future of the community. Other policies related to transportation and buildings will be scrutinized and quantified to help inform the development of the scenarios. This work will contribute to an improved planning context in general.

Above all, the planning process will transform the threat of climate change into an opportunity to improve people's lives, a symbol of hope against what can seem like an overwhelming challenge.



PART C: RESOURCES

LIGHTHOUSE AT SOUTHHAMPTON, ONTARIO

6. Engagement: A Cross-cutting Theme

Purpose of this chapter:	To present the importance of community engagement in the production of energy and emissions plans, and to suggest engagement technique options.
Key guidance:	Community engagement techniques should be applied throughout the development of the community energy and emissions plan.
Learn about:	» Principles of community engagement » Community engagement strategies

6.1 OBJECTIVES

There are a variety of potential objectives in performing public engagement in the development of community energy and emissions plans, including:

- Informing and educating the public, and building public capacity;
- Collecting public knowledge and opinion inputs;
- Engaging and empowering citizens in civic democratic processes;
- Identifying community champions and influencers; and
- Developing public support for plans and their implementation.

To ensure a well-informed, effective plan that has community traction in its implementation, all of these objectives should be pursued.

As part of planning preparation, the planning process team should identify the stakeholders, organizations, and public to engage at different points in the process, and how best to engage them to achieve the desired results. Consideration must be made for what inputs are needed to develop the plan (e.g. local context, data), who has useful knowledge and experience to contribute (e.g. expert climate change knowledge), who will be responsible for parts of plan implementation (e.g. community partners), and who will be affected by plan implementation (e.g. members of the public). Typical stakeholders in energy and emissions planning processes include:

- The general public
- Subject matter experts;
- Consultants (if employed during the process);
- Electricity, natural gas, and other utilities/energy suppliers (e.g. propane, wood, oil);
- Representatives of the building development and real estate sectors;

- Representatives from non-profit and community organizations;
- Representatives from institutional organizations;
- Representatives of business and industry communities; and
- Representatives from local governments.

6.2 PRINCIPLES OF ENGAGEMENT

The International Association for Public Participation (IAP2) has developed a spectrum of public participation that details five levels of engagement. Using its guidance, the engagement spectrum for community energy and emissions planning includes the items in Table 57. At various points throughout the planning process, these approaches will be used in different combinations.

Table 57. Adaptation of the IAP2 planning participation spectrum.

	Inform	Consult	Involve	Collaborate	Empower
Purpose	To deliver information to the public that articulates the need for a plan, describes the planning process, and expresses the desired outcomes.	To collect public feedback and suggestions for the plan or its components.	To engage the public in a manner that ensures public concerns are properly considered and addressed in the plan.	To partner with the public in policy development and decision-making in the plan.	To place the final policy development and decision-making in the hands of citizens.
Example techniques	Newsletter, website, lectures, media coverage, videos.	Focus groups, surveys/polls, public meetings.	Workshops, interactive websites, interactive meetings.	Participatory decision-making, advisory committees, citizen committees.	Participatory budgeting, citizen juries, citizen decision committees.
Example usage	To inform re: project launch, to provide project updates, to deliver project background information.	To collect local context information, to collect opinion on issues of concern, to gather feedback on a plan proposal.	To develop planning element options and alternatives, to explore ideas and proposals, to debate merits of plan elements.	To host democratic processes (e.g. consensus-building, voting) that help decide policy inclusion.	To host democratic processes through which citizens decide on the plan policies and their implementation parameters.

The City of Toronto has developed 9 Principles for Effective Engagement, through conversations with its citizens. They detail what typically makes public engagement enjoyable and useful. Engagement processes should be:

Transparent

Engagement processes should be transparent by providing clarity on the level of engagement residents can expect, making records of consultation processes available to the public in a timely manner, and clearly indicating how feedback has affected project outcomes.

Timely

Engagement processes should be designed to ensure that feedback is sought at appropriate and meaningful times in a planning process.

Iterative

Engagement processes should be iterative, providing multiple opportunities for participants both to offer feedback and to see how their feedback has been used

Inclusive

Engagement processes should be designed to engage the widest possible audience, and should include strategies to reach under-represented groups, including youth, newcomers and renters.

Innovative

Engagement processes should be designed using innovative methodologies in order to achieve the highest level of engagement possible.

Respectful

Engagement processes should be respectful of the expert knowledge that residents have of their communities, and should promote a respectful and positive environment where people feel comfortable voicing constructive opinions.

Educational

Planning processes should seek to improve the public's understanding of planning issues, with clear objectives to improve planning literacy.

Fun

Where appropriate, engagement processes should be designed to be as fun as possible for participants.

Community-Building

Engagement processes should be designed to encourage community-building by strengthening relationships between members of the community and between members of the community and the City Planning Division.

It is useful practice in preparing a public engagement plan for energy and emissions planning processes to include these engagement principles and the spectrum of public participation as a type of checklist against which to assess the engagement activities. As engagement activities apply more principles and place further along the participation spectrum, the more meaningful and enduring the engagement process.

6.3 PROCESSES

Community energy and emissions plans comprise many types of plan elements: climate change mitigation and adaptation, environmental conservation, social equity, economic development, land-use, transportation, waste management, etc. As such, the processes of developing the plans has the potential to engage the vast majority of citizens in some manner. There are many engagement activities to employ to reach a variety of citizens, stakeholders, community groups, businesses, and institutions. Some typical examples are included in Table 58.

Table 58. Example public engagement activities.

IAP2 Spectrum	Engagement Activity	Sample Use	Expected Sample Outputs
Inform	Planning project website	A project website can house project background information, local climate issue information, ways to engage in the planning process, reports and project updates, a schedule of events, social media feeds, etc. It can be updated throughout the planning process.	The public is made aware and is informed about the project, the issues addressed, the process progress, and how to contribute to plan development.
	Web newsletter and social media posts	Distribution of project information, updates, and invitations in web newsletter format to municipal and partner contacts. The web newsletter can be emailed, posted to social media, and hosted on the project website.	
	Media coverage	Project promotion through municipal staff interviews with TV/radio, press releases	
Consult	Focus groups	Engage representatives of a public sector to provide feedback on how to address an issue or respond to a plan proposal.	Public input is gathered on relevant issues and issues of concern are identified. Plan vision and objectives elements are gathered.
	Surveys and polls	Post a multiple-choice survey on social media and the project website to gather feedback on a project issue.	
	Public meetings	Host a public meeting with small group discussions to identify the issues the plan should address.	
Involve	Workshops	Host a public workshop to develop policy ideas or discuss proposed policy.	Public involvement generates constructive dialogue on proposed policy, evolves ideas to be addressed by the plan, and narrows potential policy options.
	Interactive websites	Use interactive websites to visualize and generate feedback on policy options.	
	Interactive meetings	Host meetings in which participants play key presentation and leadership roles.	
Collaborate	Participatory decision-making process	Host a decision-making process – such as voting – to determine the direction of a plan, the content of a policy, or the manner of a policy's implementation.	Project staff and decision-makers collaborate with the public to arrive at policy decisions and plan content together.
	Advisory committee	Establish an advisory committee with public and stakeholder membership that directs the planning process and has democratic inputs to the plan.	

IAP2 Spectrum	Engagement Activity	Sample Use	Expected Sample Outputs
Empower	Participatory budgeting process	Host a process that enables the public to determine how budget is allocated amongst plan actions.	Members of the public and stakeholders decide the plan policies and actions, and the manner of their implementation.
	Citizen decision committees	Establish citizen decision committees that have – through democratic processes – the power to decide on plan content, policy direction, actions to be taken, and plan implementation mechanics.	

Example:
Edmonton's Citizen's Panel:

https://www.edmonton.ca/city_government/city_vision_and_strategic_plan/citizens-panel-energy-climate.aspx

6.4 PLAN ELEMENTS FOR PUBLIC INPUT CONSIDERATION

Several key energy and emissions plan elements can benefit from public engagement inputs and discussion. Typical elements are summarized in Table 59.

Table 59. Typical plan elements for public input consideration

Plan Element	Public Engagement Contribution
Plan vision statement	Vision statement elements, essence, and manner of expression.
Plan objectives	Objectives identification and expression.
Energy and emissions reduction targets	Establishment of, and rationale for, energy and emissions reduction targets.
Energy and emission actions	Identification of potential actions in pursuing the energy and emissions reduction targets.
Extent of energy and emissions actions	Commentary on the extent to which each action should be taken and what resources to allocate to them.
Action implementation roles and responsibilities	Identification of primary and supporting roles in action implementation, including public partners.
Draft and final plans	Confirmation or refinement suggestions for plan elements.

7. Planning Support

sPurpose of this chapter:	To illustrate the relationship between the method in this guideline and that of other relevant programs

There are several programs that support municipalities in energy and emissions planning processes by providing funding, technical support, and/or guidance. The Guideline incorporates these programs or their aspects where possible to avoid duplicating activities for municipalities. Table 60 describes key programs. Municipalities can subscribe to any of the support or reporting services offered by these programs and organizations in furthering their energy and emissions planning efforts.

Table 60. Energy and emissions planning support programs.

Program	Description	Municipalities enrolled	Resources	Applicability	Complexity of program	Relationship with the Guideline
Federation of Canadian Municipalities Partners for Climate Protection	A network of Canadian municipal governments that have committed to reducing greenhouse gases (GHG) and to acting on climate change.	74	Financial support (Green Municipal Fund, Municipalities for Climate Innovation Program), peer network, capacity building tools and resources throughout the milestone process	All municipalities	Low	Planning approach parallels the PCP's five milestones.
Ontario Ministry of Energy Municipal Energy Plan (MEP)	Provides funding to Ontario municipalities for the development of Municipal Energy Plans (MEP).	36	Financial support	All municipalities	Low	MEP requirements are incorporated.
California's Local Government Operations Protocol (LGOP)	Guidance to support local governments in quantifying and reporting GHG emissions from their operations.	No known applications	Protocol for corporate inventories	All municipalities	High	Recommended as the inventory protocol for corporate inventories.

Program	Description	Municipalities enrolled	Resources	Applicability	Complexity of program	Relationship with the Guideline
Global Greenhouse Gas Protocol	Emissions accounting framework for calculating community-scale GHG inventories.	11	Protocol for community inventories	All municipalities	Medium- high	Recommended as the community inventory tool.
Global Covenant of Mayors	Participation includes requirement to register a commitment, complete an inventory, create reduction targets and a system of measurement, and to establish an action plan.	11	Guidance on planning processes	All municipalities	Medium- high	The Guideline is compatible with the Covenant of Mayors requirements.
Carbon Neutral Cities Alliance	Peer networks to support cities that commit to GHG reductions of 80% or more by 2050.	1	Guidance on carbon neutral cities.	Municipalities with deep GHG emissions reductions	High	Support for plans with a focus on deep emissions reductions.
C40 Cities	A network of megacities (population of 3 million or more), innovator cities which can have a smaller population. Provides dedicated support staff that aid selected cities in program and policy development and implementation.	1	Development of guidance and tools.	Toronto and any other large cities that meet the innovation criteria	High	Target setting method (2 degrees) has been incorporated into the Guideline.

Program	Description	Municipalities enrolled	Resources	Applicability	Complexity of program	Relationship with the Guideline
Broader Public Sector GHG Reporting	Requires that every municipality, post-secondary institution, hospital and school board in Ontario to report its use of energy (natural gas, electricity, etc) on an annual basis and prepare energy conservation and demand management (CDM) plans every five years for subject corporate owned facilities.	All	Program-specific website, email, webinars, brochures.	All municipalities	Low	Corporate GHG inventory is integrated with this reporting.

The Federation of Canadian Municipalities and ICLEI – Local Governments for Sustainability's Partners for Climate Protection (PCP) has a long track record and high level of participation in Ontario. The five milestones of PCP have been maintained as the structure for this Guideline to ensure consistency, while the focus and activities of the milestones have evolved to reflect new approaches in community energy and emissions planning. Table 61 shows the evolution of the PCP to the Guideline. Note that the Guideline introduces a preparatory stage prior to the inventory.

Table 61. An evolution of the PCP five milestone approach.

PCP milestones	Historical PCP approach		Guideline approach
	Corporate emissions reductions	Community emissions reductions	Low carbon community transformation
1. Create a GHG emissions inventory and forecast	Includes buildings, street lighting, waste and wastewater treatment, municipal fleet and corporate solid waste. Forecast is generated based on projections of population.	Includes institutional, commercial, industrial, transportation and residential waste sectors. Forecast is generated based on projections of population, economic growth and fuels.	Inventory GHG emissions according to GPC and/or LGOP. Also assesses spheres of influence of the local government, and the financial levers or opportunities.

PCP milestones	Historical PCP approach		Guideline approach
	Corporate emissions reductions	Community emissions reductions	Low carbon community transformation
2. Set an emissions reduction target	Typically expressed as a percentage reduction below the quantity of emissions released in the baseline year		Focus shifts from reducing emissions from a status quo baseline to a redefined, low carbon community. From remedial to anticipatory. Target may be expressed in various forms – carbon budget, % reduction over baseline or 100% renewable.
3. Develop a local action plan	Integrate with asset management, fleet management, building management, capital budget.	Enhanced energy efficiency and increased use of carbon-free energy in an otherwise "business-as-usual" future.	Design a low carbon community in all of its dimensions (land-use planning, infrastructure, buildings, transportation).
4. Implement the local action plan or a group of activities	The local government has full authority to implement.	Incremental improvements occur, often smaller than the noise of growth as the municipality implements small scale programs in a silo. Overall GHG reductions, if any, result from the actions of other levels of government, such as the phaseout of coal in electricity generation.	A comprehensive approach, integrating all the activities of the city towards the the low carbon objective. New initiatives reach beyond the traditional service area, including city-scale building retrofits, renewable energy utilities, justified by multiple benefits in addition to GHG reductions.
5. Monitor progress and report results	Standard, internal reporting.	Repeat the inventory on a regular basis, possibly quantifying co-benefits.	Focus shifts to the economic, social and other benefits of the transition. Track drivers of emissions in addition to emissions themselves.
6. Engagement Strategy	Limited or none required outside of the municipal organization.	Stakeholder engagement to support the local government plan to reduce community emissions.	Focus shifts from engagement to empowerment. Key player-focussed to identify how the local government can help accelerate low carbon actions and investments.

8. Tools and resources

Purpose of this chapter: | To describe tools that can be used to support community energy and emissions planning

STAGE 1: PREPARATION

Resource	Description	Classification
Human settlements, infrastructure and spatial planning	IPCC chapter on municipalities, detailing a wide range of literature.	Document
Renewable energy in cities	A guidebook on enhancing renewable energy in cities by International Renewable Energy Association.	Document
Framework for long-term deep carbon reduction planning	A detailed synthesis of the processes, strategies, practices, tools, and institutional structures used by leading-edge cities worldwide to plan long-term, deep reductions in carbon emissions.	Document
Municipal Energy Plan Program	The Program provides funding for the development of Municipal Energy Plans.	Program

STAGE 2: INVENTORIES

Resource	Description	Classification
GHG Protocol for Cities	Guidance on completing community-scale GHG emissions inventories.	Protocol
Local Government Operations Tool	Guidance on quantifying and reporting on corporate GHG emissions.	Protocol
City inventory and reporting system	An excel-based tool for completing GHG emissions inventories.	Tool
PCP Milestone Tool	A web-based tool that helps municipalities complete corporate and community GHG inventories, set targets, and develop action plans.	Tool

STAGE 3: TARGET SETTING

Resource	Description	Classification
Science-based targets methods	Detailed guidance on setting targets, geared toward companies but applicable to municipalities.	Method
Deadline 2020	A method for identifying a target that is within 1.5 degrees of warming, developed by C40 and ARUP.	Method
NAZCA	Global platform for reporting on GHG reduction commitments by cities.	Reporting platform

STAGE 4: ACTIONS AND ALTERNATIVE SCENARIO DEVELOPMENT

Resource	Description	Classification
CAPCOA- Quantifying greenhouse gas mitigation measures	A resource for local government to calculate the impact of actions without a detailed model	Method
TRCA- Getting to carbon neutral	Guidance on calculating the GHG impacts of specific actions and strategies to reduce GHG emissions	Document
TAF Building Energy Efficiency Policy Calculator	Excel-based tool allows users to calculate the estimated local impacts of various municipal energy efficiency options that range from tighter building standards to financial incentives and energy reporting.	Tool
Envision Tomorrow	Scenario planning tool used to evaluate current and future growth patterns against a wide range of indicators.	Model
Climate action for urban sustainability (CURB)	An excel-based tool for identifying future low carbon scenarios for municipalities.	Model
CityInSight*	Model designed to evaluate land-use, energy and emissions scenarios for municipalities. CityInSight has been used by Toronto, Markham and the Region of Durham.	Model
UrbanFootprint	Model designed for evaluating land-use scenarios against a wide range of indicators.	Model

*Developed by the authors of the Guideline.

TOOLS FOR SPECIFIC ACTIONS

Resource	Description	Classification
PLUM	Model for developing detailed population, employment and land-use scenarios.	Model
Retscreen	A model for evaluating energy efficiency, renewable energy and cogeneration project feasibility analysis.	Model
Plan4DE (Plan for district energy)*	Model for evaluating the impact of land-use plans on district energy feasibility.	Model
Community Lifecycle Infrastructure Costing Tool	Model to evaluate life cycle costs of different development patterns over 100 years.	Model
PVWatts	Model estimates the energy production and cost of energy of grid-connected photovoltaic (PV) energy systems.	Model
CREST Cost of energy models	Economic cash flow model designed to allow policymakers, regulators, and the renewable energy community to assess project economics, design cost-based incentives.	Model
Jobs and Economic Development Impact (JEDI)	Tool that estimates the economic impacts of constructing and operating power generation and biofuel plants.	Model
Walkscore	Tool for evaluating the walkability of a particular location.	Tool
TAF Building Energy Efficiency Policy Calculator	The Excel-based tool allows users to calculate the estimated local impacts of various municipal energy efficiency options that range from tighter building standards to financial incentives and energy reporting.	Tool

*Developed by the authors of the Guideline.

STAGE 5: IMPLEMENTATION

Resources	Description	Classification
Climate Innovation Program	Funding and training provided by the Federation of Canadian Municipalities	Program
Municipal GHG Challenge Fund	The Challenge Fund provides funding for projects that reduce GHG emissions in municipalities.	Program

Resources	Description	Classification
Getting to implementation	A series of reports and studies by QUEST on implementing community energy plans.	Documents
Low carbon city lab	Project exploring how to support low carbon financing for municipalities	Resource
Neighborly	Community bond tool, not yet available in Canada.	Tool

STAGE 6: MONITORING AND EVALUATION

Resources	Description	Classification
CDP	A platform for disclosing risks and opportunities of climate change on an annual basis.	Reporting platform

9. Glossary

Active transportation is non-motorized travel, including walking, cycling, in-line skating and movements with mobility devices. The active transportation network includes sidewalks, crosswalks, designated road lanes and off-road trails to accommodate active transportation.

Adaptive capacity is the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Community energy and emissions planning refers to the process of incorporating consideration of GHG emissions and energy into the policies and operations of a municipality.

A **consumption-based inventory** is an inventory of GHG emissions resulting from consumption of goods and services associated with a defined population.

Co-benefits have been traditionally used to describe the impacts of energy efficiency beyond reductions in energy demand – i.e. the benefits that occur in addition to a single prioritized policy goal. While these terms have been used interchangeably with multiple benefits in other literature, this publication opts to use multiple benefits in order to avoid a preemptive prioritization of various benefits; different benefits will be of interest to different stakeholders.

Discount factor is the ratio applied to current values in order to derive a value for future annual revenues and costs; it reflects factors such as perceived future risk and the premium that is placed on immediate revenues and deferred costs. Economic prosperity is defined as the capability to flourish.

Effect describes an additional factor (or factors) that can influence how benefits and impacts manifest.

Energy efficiency improvement is an improvement in the ratio of energy consumed to the output produced or service performed. This improvement results in the delivery of more services for the same energy inputs or the same level of services from less energy input.

Equity is the absence of avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically.

A **geographic inventory** is an inventory of the GHG emissions released as a result of human activity in a defined area.

Health is defined as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Indicator is an observable or measurable result that shows evidence of whether an impact has occurred and the nature of that impact. It provides a metric by which one can quantify and define the scale of a resulting change.

Induced impacts refer to impacts that arise further down the causal chain, as a result of indirect impacts (see definition above); examples might include additional spending by the people employed as a result of direct or indirect benefits.

Local government refers to entities providing government services in a specific geographic area.

Marginal abatement cost (MAC) curves are a visual (graphic) illustration of the results of model-based scenarios that convey both the economic co-benefits (costs or savings) of an action or policy and the potential GHG reduction that can be achieved with the action or policy.

Mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases. Mitigation can be accomplished through technological change and substitutions that reduce resource inputs and emissions per unit of output.

Monetization is the attribution of financial value to phenomena, usually by relating a change in status of a good or service to the relevant market value of the good or service.

Multi-criteria analysis describes any structured approach used to determine overall preferences among alternative options. The actual measurement of indicators need not be in monetary terms, but are often based on the quantitative analysis (through scoring, ranking and weighting) of a wide range of qualitative impact categories and criteria. Explicit recognition is given to the fact that a variety of both monetary and nonmonetary objectives may influence policy decisions.

A **municipality** is defined as everything within a defined geographic area including dwellings, businesses, transportation systems, etc.

Net benefit is the measure of the value of an outcome after the cost of delivering the outcome has been accounted for and deducted.

Power is the degree of control or influence mayors exert over assets (such as buses) and functions (such as economic development) across all city sectors.

Resilience is the capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.

Risk is the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as the probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard. In [the IPCC] report, the term risk is used primarily to refer to the risks of climate-change impacts.

Social capital is the links, shared values and understandings in society that enable individuals and groups to trust each other and so work together.

Social equity implies fair access to livelihood, education, and resources; full participation in the political and cultural life of the community; and self-determination in meeting fundamental needs.

Transformation is altering the fundamental attributes of a system, including value systems, regulatory, legislative, or bureaucratic regimes, financial institutions, and technological or biological systems.

Well-being refers to the integrated physiological, psychological and mental state of an individual, a household or group of people. It is broader than health, which typically refers to the physical state of an individual, family or group of people (public health).

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Appendix 1: Findings from the research summaries

This Guideline was developed following a process of research on municipal energy and emissions processes in municipalities, and an investigation of programs and frameworks that support this work. Case studies were prepared for 15 energy and emissions planning programs, protocols, methodologies and frameworks (PPMFs), based on academic papers and reports, and interviews with staff directly involved in the development and application of the PPMFs. Table 60 lists the PPMFs analyzed.

Table 62. Programs, protocols, methodologies and frameworks evaluated for the Guideline.[30]

	Urban	Rural	Community-wide		Application in Ontario
Federation of Canadian Municipalities Partners for Climate Protection (PCP)					**73 municipalities**
Ontario Ministry of Energy Municipal Energy Plan (MEP)					20 applicants (33 municipalities)
BC's Climate Action Charter					
ICLEI's ClearPath					
California's Local Government Operations Protocol (LGOP)					
The Climate Registry					
Global Greenhouse Gas Protocol					11 municipalities
BC Bill 27					
California's SB 375					
Compact of Mayors					11 municipalities
Carbon Neutral Cities Alliance					1 municipality
C40 Cities					1 municipality
Climate Action Revenue Incentive Program (CARIP)					
Municipal Climate Change Action Program (MCCAP)					
Broader Public Sector GHG Reporting					444 municipalities
Applicable to Ontario Municipalities					
Not applicable to Ontario Municipalities					

A similar approach was used to develop case studies for the energy and emissions planning work of 15 municipalities, detailing the development of GHG inventories, setting emissions reduction targets, and preparing community energy and emissions plans. The municipalities represented diverse contexts and sizes, and are recognized for leadership in community energy and emissions planning (Figure 1).

30 This table refers to whether or not a PPMF can be applied to Ontario municipalities. In some cases the general approach, for example of SB 375, could be applied in Ontario.

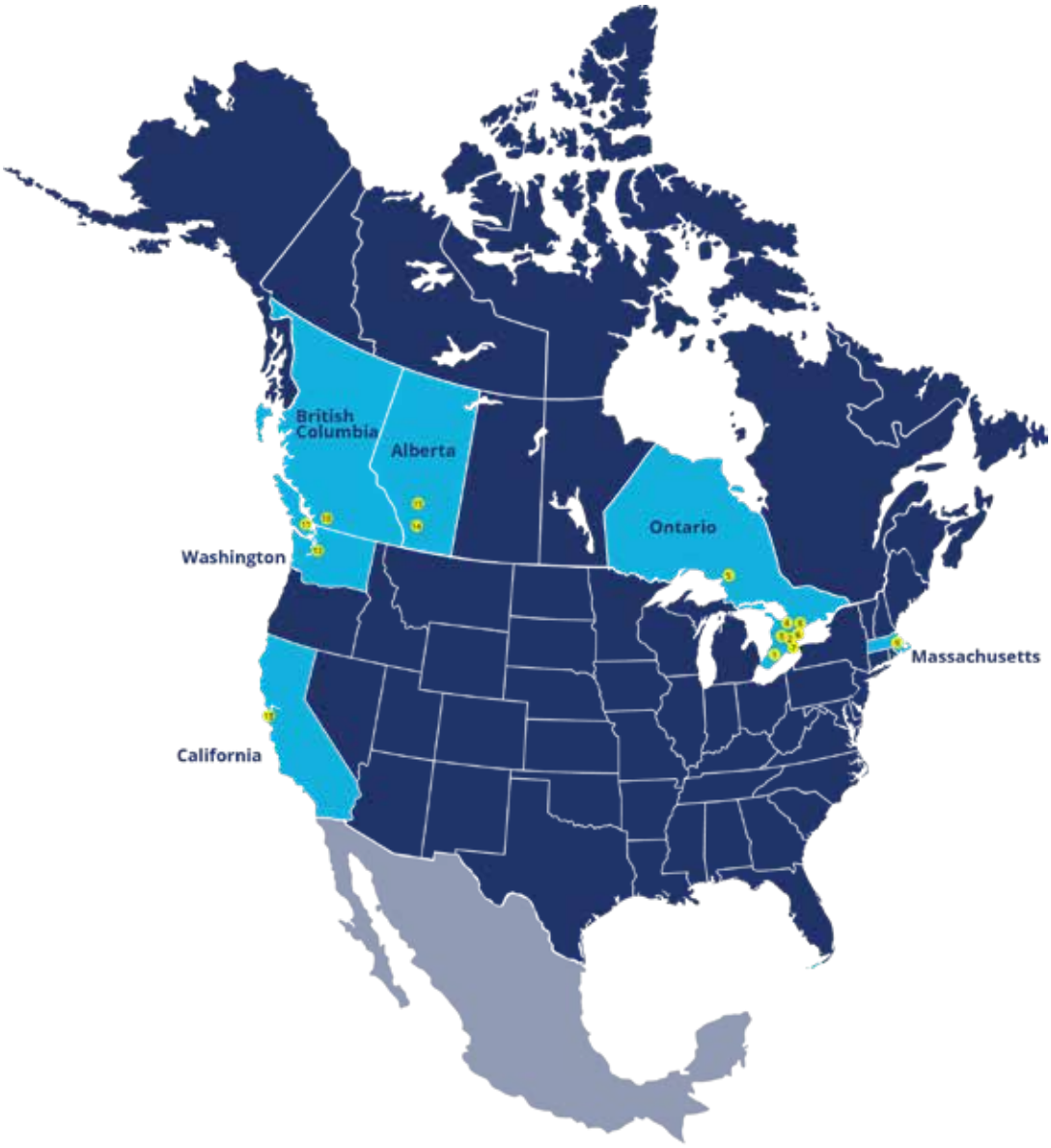

Figure 29. Municipalities analyzed in the process of developing the Guideline.

A third step used concept analysis (qualitative data analysis, QDA) in which textual data is mined in order to identify key concepts and to code (label) data sources. The analysis identified, examined and interpreted patterns to determine connections between concepts and themes such as mitigation, adaptation, land-use planning, economy, finance, health, and employment. QDA was used to evaluate climate action plans, community energy plans, and official plans.

Figure 30. A word cloud representing the most frequent terms used in fifteen Official Plans and land-use plans. In most cases, plans do not consider climate change mitigation.

The Guideline authors contributed their extensive experience in community and municipal corporate energy and emissions planning work. The team of authors includes individuals with more than thirty years of practice in the field and preparation of dozens of projects on the subject across Canada and beyond.

PPMF SCAN – OBSERVATIONS

No additional technical guidance on GHG inventories is required. While GPC is emerging as the international standard for GHG inventories and is being utilized in Ontario already, the guidance may be overly complex for smaller municipalities, particularly at the BASIC+ level. Similarly LGOP is also relatively complex. PCP, which is seeking to harmonize with the GPC, provides guidance on completing both corporate and community-wide inventories that is more accessible to smaller municipalities. The PCP Tool further decreases the effort involved by providing

some automated functions. GPC, LGOP and PCP provide clear documentation of the processes and equations involved in completing a GHG inventory that are directly applicable to Ontario municipalities.

Table 64. Table: Guidance on completing an inventory.

	Corporate	Community-wide
Higher complexity	LGOP	GPC (BASIC+)
Lower complexity	PCP	PCP (aiming for GPC alignment in 2018)

1. There are relatively complex questions around boundaries and transportation, in terms of which GHG emissions to account for. GPC provides guidance on difference approaches and the Guideline can provide additional insight on these approaches. However, it is recommended that options be maintained for municipalities in order to utilize the best approach given a particular context. GPC also provides two levels of reporting, BASIC and BASIC+ and it is recommended that the Guideline maintain both options for municipalities.
2. PPMFs do not provide guidance on data sources in Ontario. With the exception of PCP, the PPMFs reviewed do not provide specific and detailed guidance on sources of data to support the preparation of inventories or target-setting for Ontario municipalities. PCP provides some data, as well as streamlined calculations in the PCP tool, but additional guidance on the availability and strengths and weaknesses of data sources would be useful.
3. It is challenging to identify which PPMFs are most applicable. The number of PPMFs means that it can be difficult for municipalities to navigate which option is more appropriate for a particular context and to understand the requirements of each PPMF and how they relate to each other. For example, the five milestones of the PCP overlap with the requirements of the Compact of Mayors, an overlap which the PCP is seeking to address.
4. The co-benefits of climate action are increasingly emphasised. C40 and CNCA have provided insight on co-benefits of climate action with respect to economic development, health impacts, livability and equity. A framework for evaluating co-benefits is described by C40, but methods for evaluating co-benefits are not addressed by any of the PPMF.
5. Integration of land-use planning/policy is not generally addressed. Just two of the PPMFs directly relate to the GHG impacts of land-use planning/policy, and of these two, SB 375 is the most mature in terms of the sophistication of the results and evaluating performance. However, despite extensive discussion in the literature on the importance of land-use planning/policy as an intervention in preventing lock-in of high-carbon development, there is not commensurate focus within the PPMFs evaluated for this research summary. In particular, there is no guidance on how to evaluate the impact of land-use planning/policies on GHG emissions. The focus of this Guideline is therefore prescient in seeking to provide guidance on the GHG implications of land-use policy.
6. The value and purpose of energy mapping is not addressed. The MEP program includes energy mapping, but there is limited content on the purpose of energy mapping, methods for developing energy maps, and

what constitutes an energy map.

7. There is limited guidance on target setting. With the exception of SB 375 and Bill 27, GHG targets are not related to land-use policy. In the case of Bill 27, the requirement is simply to have a target and supporting actions. SB 375 goes a step further and requires evidence as to how the target will be achieved using transportation modelling. C40's Deadline 2020 also explores the importance of land-use policy in achieving short-term GHG targets. Beyond these examples, the PPMFs do not provide guidance on how to ensure that land-use policies reflect the GHG target and vice versa.
8. There is a need to for guidance on implementation strategies. There is limited guidance on strategies and actions with which GHG targets can be achieved. For example, what policies or actions are most effective? What are the possible governance strategies? Are there financing strategies that can unlock climate action?
9. There is a need for guidance on monitoring and evaluation. PCP, Compact of Mayors and the Climate Action Charter have comprehensive mechanisms for monitoring the performance of municipalities at the macro level. However, the PPMFs do not provide explicit strategies as to how the municipality can monitor and evaluate progress.
10. Some PPMFs provide funding, but broader strategies are required. In terms of planning, both MEP and PCP provide funding. Funding opportunities for implementation are also available through the GMF. However, other funding strategies such as revolving loan funds and green or climate bonds are not described by the PPMFs.

JURISDICTIONS SCAN OBSERVATIONS

1. GHG inventories need to be standardized. There are multiple reasons why establishing GHG inventories are problematic. From the perspective of the province, different protocols are used, different sources of emissions are tracked, different methods for calculating the emissions are used and different data sets are used. The consequence is that it is difficult to evaluate the impact of major investments in energy and emissions planning or implementation. From the perspective of municipalities, the process is too complex or too ambiguous, data collection is too onerous or is incomplete and there is insufficient staff capacity.

2. GHG inventories need to be transparent. It is difficult to access GHG inventories from many municipalities, even if they have completed them, and if the inventory is completed, there is insufficient detail to understand the method, calculations and data sources behind the inventories.

3. Guidance is required to set targets that are integrated with land-use plans. Several municipalities have incorporated climate change considerations into official plans, but these policies are not always aligned with their GHG targets. Guidance is also required on the best way to integrate climate climate change planning in municipal land-use plans (e.g. integrate considerations throughout the plan, or dedicate a section in the plan to climate change).

4. Energy and emissions planning needs to be a core service of municipalities. In some cases energy and emissions planning activities have declined, following political shifts, which can endanger a major public investment. Other municipal services such as transportation and engineering are isolated from these shifts because they are regarded as a core municipal service.

5. The number of PPMFs is confusing but PCP is an important program for municipalities. Most Canadian municipalities are actively engaged with PCP for the five milestone road map, a peer network, financial resources and guidance. Municipalities are frequently engaged in multiple PPMFs with associated costs; it is difficult to determine which PPMFs are most appropriate for a particular context.

6. Mechanisms to evaluate the impact of actions to reduce GHG emissions need to be developed. It is difficult to attribute GHG emissions reductions to specific actions or policies both for the municipality and for the province.

7. Guidance on the relationship between the energy and emissions plan and official plan is required. Currently, these two plans represent parallel planning activities, which may or may not cross over depending on timing and staff interest. The Guideline can provide insight on a formal relationship similar to that of a transportation plan and the official plan.

8. Provincial mandates empower existing leaders within municipalities. One of the key driving forces for climate action are existing leaders within the municipal structure. Provincial mandates for reporting, actions or other purpose allow these leaders to increase the level of activity within the municipality.

9. Grant funding enables energy and emissions plans/municipal energy plans. Municipalities tend to apply to either the Green Municipal Fund or the MEP program for resources to complete an energy and emissions plan or municipal energy plan.

10. Grant funding is important for implementation. While many municipalities have dedicated staff, they have access to limited discretionary funding and are dependent on grants for the development and deployment of programs.

11. There is a need for performance incentives. There is no requirement or mandate for municipalities to achieve their GHG target, and they are therefore less likely to take those targets seriously, either when the target is being identified or when it is being implemented.

12. The level of short-term ambition is constrained by resources, history and vision, whereas the level of long-term ambition is high. Pilot projects are needed to stimulate the ambition of municipalities, to demonstrate how to scale up projects and programs.

13. Municipal governance structures vary. The responsibility for energy and emissions planning is located in different departments in different municipalities and the scope of work varies considerably. There is a need for guidance on possible structures and mandates for municipalities of different sizes.

14. Programs to cultivate leadership will increase the success of energy and emissions plans. Leadership by Mayors and CAOs was identified as a key driver in a number of municipalities. Organizations such as QUEST and Clean Air Partnership provide peer learning opportunities but there is no program that provides context and inspiration to mayors and CAOs. The BC Municipal Climate Leadership Council is an example of such an effort.

15. Co-benefits are emerging as an important strategy to broaden the constituency of support. The term health was found in many of the energy and emissions plans, indicating that municipalities are beginning to see the crossover. Despite the leadership of several municipalities, the impact on the economy and employment of climate action is not well understood.

Appendix 2: Sample terms of reference[31]

Introduction and purpose

The municipality is developing a Community Energy and Emissions Plan (CEEP) to assess current and forecasted greenhouse gas (GHG) emissions and energy use based on projected growth, to review and refine existing GHG and energy reduction targets, and to establish an implementable framework of actions to lead the community towards reaching the identified targets.

This CEEP will be an integrated, community-wide plan with analysis and actions addressing the following key community sectors: land-use, buildings, transportation, energy management, waste management and urban forestry. Community and corporate energy and GHG emissions will be addressed.

A community health and equity lens will explore varying demographic and socio-economic implications of climate change, and potential barriers to climate action. This perspective will build awareness of the important connection between land-use and transportation planning, climate action and community health. This community health and equity lens will also inform the triple bottom line evaluation of options and the development of effective climate actions that consider the needs of diverse community populations.

Background

Climate change presents very real and far reaching challenges for our environment, social well-being, and economic resiliency. At the same time, uncertainty about the long term availability and pricing of current energy sources poses growing concerns and rising costs for residents. Recognizing that transportation and buildings are the two major contributors of community GHG emissions and energy consumption, municipalities and local governments have an important role to play in managing their impact on climate change, and driving energy efficient, sustainable community plans and programs.

To be successful in achieving significant reductions in community GHGs as our community grows over time, the municipality needs to be guided by an integrated, long-term implementation strategy. The CEEP will provide a long-term roadmap for the municipality to achieve GHG reductions that match regional and provincial government commitments. Besides GHG reduction – building efficiency measures, sustainable transportation shifts, renewable energy generation and other opportunities arising from CEEP implementation will enable significant energy cost savings. GHG reduction and renewable energy technologies continue

31 *Adopted from a Request for Proposals from the District of North Vancouver*

to advance and are becoming more cost competitive. Development of a CEEP is timely and will better position the municipality to be ready for, and to adapt to, alternative energy with appropriate planning and infrastructure systems. Current and future redevelopment in our emerging centres presents an urgent need for a CEEP to prevent missed opportunities for change.

Project goals and objectives

It is anticipated that the CEEP will identify a strategic pathway for achieving the following goals:

- Establishing a progressive, impactful and coordinated approach to reducing the municipality's greenhouse gas emissions, conserving energy and reducing community energy costs;
- Building organizational capacity and strengthening integration of GHG reduction and renewable energy management solutions into municipal programs and decision making;
- Establishing a clear role for the municipality in leading change towards an energy efficient and low carbon community that promotes social, economic and environmental health;
- Increasing community awareness and resilience, inspiring innovation and climate action; and
- Fostering a supportive environment for emerging energy technologies and jobs.

Key objectives for the CEEP project include:

- Apply a unique community health lens to the project and build an understanding of the important connection between land-use and transportation choices, climate action, and community health.
- Employ an effective communication strategy to present and gather input on key interim CEEP phases to build community awareness and interest, and to promote successful implementation of the CEEP.
- Build an understanding of the current and projected energy use and GHG emissions for each of the aforementioned key community sectors.
- Work with the municipality and key community stakeholders to develop challenging, yet achievable, community GHG and energy reduction targets to 2050 that are guided by the local opportunities and constraints and the results of GHG modelling.
- Employ modelling, mapping and other tools to test and visually illustrate potential CEEP actions for different community sectors and land-use typologies.
- Embed triple bottom line and integrated systems principles, and the community health lens into the CEEP to capture the diverse spectrum of community interests, and to facilitate integration of sustainable solutions across different disciplines, departments and demographics.

- As one of the key outcomes of the CEEP process, develop a prioritized action plan to guide integration of climate actions into existing municipal programs and to leverage funding for implementation. Identify opportunities for immediate action to establish success and build momentum for CEEP implementation and monitoring.
- Facilitate completion of Partners for Climate Protection Milestones 1–3.
- Learn from and build on the collective municipal experience in preparing and implementing CEEPs, and contribute new ideas and creative solutions for sharing with other local governments.

Scope

The CEEP project is anticipated to unfold under the following key phases:

Stage 1: Preparation
Stage 2: Inventories
Stage 3: Target setting
Stage 4: Actions and alternative scenario development
Stage 5: Implementation
Stage 6: Monitoring and evaluation

Specific work to be completed under each key project phase is described below.

Stage 1: Preparation

1. Conduct background research to develop an understanding of the local, regional and legislative context for the CEEP.

2. Work with the Municipality to review established and emerging community GHG and energy inventory protocols, and establish a practical GHG and energy inventory methodology that can be readily be replicated by municipal staff as part of regular CEEP monitoring efforts.

3. Review the current policies, bylaws and Development Permit Guidelines, programs and reports undertaken by the municipality towards advancing energy sustainability and GHG emission reductions.

4. Review actions already being undertaken by the municipality to reduce GHG emissions and energy use.

5. Meet with interdepartmental staff to build an understanding of municipal plans and programs, to facilitate access to available municipal data sources, and to gather information to help inform and shape the situational analysis.

6. Gather demographic and socio-economic information and community health data from Stats Canada, VCH and other available sources. Build an understanding of the important connection between land-use and

transportation choices, climate action and community health. Explore the varying demographic and socio-economic implications of climate change and potential barriers to climate action.

Stage 2: Inventories

1. Develop a current and projected emissions and energy profile for the municipality and provide a high level understanding of where the municipality is currently heading in terms of energy management and GHG emissions reduction.
2. Use population and economic growth projections to estimate and quantify the forecasted overall and per capita community GHG emissions and energy demand to 2030 and 2050 per the "business as usual" approach (in the absence of coordinated, impactful CEEP implementation). Compare this to the OCP target for community GHG reduction.
3. Work with the interdepartmental staff and community stakeholders to identify the key community climate and energy aspirations, priorities (across the identified community sectors) and a vision to 2050 to inform development of the CEEP.
4. Support the launch and posting of CEEP project information on the municipality's website and through social media.

Stage 3: Target setting

1. As informed by the low carbon and sustainable energy aspirations and priorities (to be explored in Phase 1) and the results of modelling and impact analysis (in Stage 1), identify new community GHG reduction and energy management targets to 2050.
2. Lead a workshop with the interdepartmental staff team on the modelling, impact analysis, trade-offs and target setting. Work with the municipality to engage community stakeholders and Council on the same.

Stage 4: Actions and alternative scenario development

1. Conduct a review of sustainable community energy management and GHG reduction tools and best management practices, and consider their potential for application within the community context, across the suite of identified community sectors, and community demographics. Consideration should be given to, but not limited to: land-use and transportation planning, energy efficient building strategies (for new and existing buildings), transportation demand management, waste management, energy conservation and renewable energy generation, regulatory tools, development permit area guidelines, financial tools, senior government legislation and political advocacy, public education and awareness.

2. Identify a potential set of coordinated actions towards achieving community climate action and sustainable community energy priorities and objectives across the identified community sectors.

3. Using an established and recognized modelling tool (such as a community energy and emissions model), assess and measure the relative GHG reductions and energy savings to be gained from individual actions, or combinations of actions where appropriate. Quantify the estimated energy and GHG emissions savings from each combination of actions.
4. Using triple bottom line and integrated systems concepts and a community health and equity lens, assess the social, economic and environmental costs/benefits, impacts and trade-offs of potential actions. Use this information to foster a discussion on trade-offs and preferred actions with staff and key community stakeholders.
5. Explore and evaluate different opportunities for action within distinct land-use types and urban geographies (e.g. town centres, village centres, corridors, single detached neighbourhoods, and rural areas) and to meet the needs of diverse community populations. Use mapping and/or other visual tools to illustrate findings.
6. Based on the findings from previous phases, identify a short-list of cross-cutting actions that will enable the municipality to achieve the identified community GHG reduction and energy management priorities and targets.

Stage 5: Implementation

1. Compile, review and integrate results of public and stakeholder engagement.

2. Identify current and planned municipal actions towards GHG emissions and energy reduction, as well as deep or "breakthrough" actions requiring innovation, collaboration, and action by senior levels of government, businesses, and residents necessary to reach 2050 targets.
3. Develop an implementation plan outlining short-, medium-, and long-term prioritized actions for each of the identified community sectors. For each action consider the key implementation steps, ease of implementation, sphere of municipal influence, estimated implementation timelines and costs. Ensure that recommended actions reflect the social, economic and environmental analysis from previous phases and consider the needs of diverse community populations.

4. Identify potential barriers to successful implementation of community climate mitigation and sustainable community energy objectives and recommended strategies to mitigate these barriers. Identify key departments, organizations, stakeholders, and community groups whose involvement and/or expertise is needed to enhance implementation of the CEEP action plan.

5. Consolidate key findings from previous phases into a succinct, visual and implementable Draft CEEP. Include the results of comprehensive analysis,

technical details, and background information in an Appendix or as a separate document(s).

6. Enable circulation of the Draft CEEP to interdepartmental staff and community stakeholders for review and comment.

7. Present the Draft CEEP to the Executive Management Team for review and comment.

8. Receive Council, stakeholder and staff input on the Draft CEEP and refine accordingly.

9. Work with the municipality to implement an effective public engagement strategy on the Draft CEEP.

10. Incorporate results of public input received and prepare the final CEEP report for Council consideration of approval.

Stage 6: Monitoring and evaluation

1. Develop a monitoring framework with key metrics and indicators for measuring progress towards implementation of the CEEP and achieving the identified community GHG emissions and energy reduction targets. These indicators should complement and build on the targets and indicators in the Official Community Plan.
2. Present the draft implementation plan and monitoring framework for review and discussion by municipality staff, community stakeholders and Council.

Responsibilities

The municipality will allocate interdepartmental staff resources to help support the success of the CEEP.

>>As specified.

Public and stakeholder engagement

Community stakeholders can add value to the CEEP project by contributing industry knowledge and business-minded thinking, as well as new perspectives and ideas relating to GHG and energy reduction opportunities and technologies. The Proponent will work with the municipality to develop a refined list of relevant community stakeholders, and to develop a strategy for hosting a series of stakeholder workshops at key stages in the CEEP project.
Public engagement on the CEEP will enable information exchange, build awareness, and inspire action and behavioral change towards a more energy efficient and low carbon community. The Proponent will work with the municipality to develop an effective public engagement and communications strategy which may include a combination of:

» Creative ways to work with community partner to build community

energy and awareness of the need for climate action and the measures individuals, households and businesses can take to effect change.

- Launching a dedicated CEEP project web page on the municipality's website to highlight the CEEP progress, present interactive web content, and ways to get involved in the CEEP process.
- Social media and other community outreach (such as brochures and displays at existing community events and venues) linking opportunities to provide input to the CEEP through an online survey.
- Visual tools and videography to relay key messages in a meaningful and engaging manner.
- Connecting with citizen-based municipal advisory committees to gain feedback at various stages in the CEEP project.

Timeline

- As specified, between 1 and 2 year duration

Appendix 3: Sample data request

DATA REQUEST			BASE YEAR 2011	PROJECTION 2012–2051
DEMOGRAPHICS & ECONOMICS				
	Population	# persons	Total by zone	Total by zone
	Households	# households	Total	Total
	Employment	# jobs (place of work)	Total by: Employment by sector (naics/nocs) AND zone; municipal employees broken out	Total by: Employment by sector (naics/nocs) AND zone; municipal employees broken out
BUILDINGS & PROPERTIES				
	Parcel fabric	For the municipality	2011 & MOST RECENT 1. GIS: Parcels fabric shapefile 2. MPAC assessment roll number to parcel ID lookup table. Any other attributes associated with parcels in existing GIS shapefile are helpful	
*	Building footprints	For the municipality	2011 & MOST RECENT GIS: Building footprints shapefile (anything available) Any other attributes associated with building footprints in existing GIS shapefile are helpful	

DATA REQUEST			BASE YEAR 2011	PROJECTION 2012–2051
*	Property assessment roll	For the municipality	2011 & MOST RECENT MPAC tables: GENERAL, Structure (Region/ Municipality should have these tables already) MPAC custom order data request (see list of fields) Key fields: Property code, structure code, building footprint area, number of storeys, total floorspace area, number of units, year built	
	Residential (dwellings)	# dwelling units	Total by structural type AND by zone	Total by structural type AND by zone AND by development type (greenfield / infill / redevelopment)
	Non-residential	sqm floorspace, # buildings	Total by Sector / industry AND by zone	Total by Sector / industry AND by zone
LAND-USE				
	Municipal boundaries		GIS: Regional and municipal boundaries (CD & CSDs?)	
	Zoning		2011 & MOST RECENT GIS: Including zoning codes & descriptions	
	Energy infrastructure		2011 & MOST RECENT GIS: Energy infrastructure; including district energy infrastructure, NG network, PV installations, utilities, pipelines, EV charging.	GIS: Future planned energy infrastructure.
	Land Cover		2011 & MOST RECENT GIS: Agricultural (include type- crop, dairy, etc.), forest (include status- woodlot, protected, or indicate that you don't have this), urban forest (street trees, shrubs, green roofs), roads, parks, vacant, etc.	GIS: Future land-use, growth, and/or zoning (per current OCP maps)

DATA REQUEST			BASE YEAR 2011	PROJECTION 2012–2051
ENERGY				
	Natural gas	GJ preferred; m3 ok	2011–2016 (annual) Total natural gas consumption by as much sectoral and geographic detail as possible; from all natural gas providers. Cost ($/m3) by sector.	
	Electricity	kWh	2011–2016 (annual) Total electricity consumption by as much sectoral and geographic detail as possible; from all electricity providers. Cost ($/kWh) by sector.	
	Fuel oil	GJ preferred; volume ok	2011–2016 (annual) Total fuel consumption by as much sectoral and geographic detail as possible. Cost ($/GJ or $/vol.) by sector.	
	Gas and diesel sales	litres	2011–2016 (annual) Total sales (L) by fuel type.	
	Centralized electricity capacity	MW	2011–2016 (annual) by zone, by technology, by fuel	
	Centralized electricity generation	kWh	2011–2015 (annual) by zone, by technology, by fuel	
	Centralized electricity generation fuel use	GJ	2011–2016 (annual) by zone, by technology, by fuel	

DATA REQUEST			BASE YEAR 2011	PROJECTION 2012–2051
	Decentralized electricity generation (excluding district energy); this is generation that is not grid connected	kWh (elec); GJ (preferred) or volume for fuel use	2011–2016 (annual) Total electricity generated by decentralized plant by zone by fuel/technology types; fuel use by type. Decentralized electricity capacity (MW).	Planned decentralized electricity generation, and/or future expected load, by location, technology, fuel
	District energy and network	kWh (elec); GJ (preferred) or volume for fuel use	2011–2016 (annual) DE plant capacity and generation by fuel/ technology type; fuel use by type; electricity generated from CHP; location of DE system & plant.	Planned DE systems/ expansion, and/ or future expected load, by location, technology, fuel
	Energy costs			
	Residential energy-consuming stocks		zone, fuel type, and stock type water heater types: conventional, solar, on demand, heat pump heat system types: oil, gas, electric, heat pump, combinations air cond types: room, central, heat pump	
TRANSPORTATION				
	Zones (traffic)		GIS: Traffic zones Any additional zone systems used for transportation modelling by the City	
	Household travel survey		Confirm that TTS 2011 is the survey used for regional transportation modelling.	
*	Modelled origin-destination trip matrix	person trip	24hr (not peak hour). By origin zone, destination zone, trip purpose, primary mode (auto, transit, active modes). Modelled zone-to-zone mode share matrices, if available separates from trip matrices.	24hr (not peak hour). By origin zone, destination zone, trip purpose, primary mode. Modelled zone-to-zone mode share matrices, if available separates from trip matrices.

DATA REQUEST			BASE YEAR 2011	PROJECTION 2012–2051
	Distance matrix	km	Zone-to-zone road network distance matrix.	
	Vehicle fleet		2011 Vehicle registration counts for Passenger and Commercial vehicles (MTO) in the region.	
	Corporate vehicle fleet		2011–2016 (annual) By body type (car, light truck); fuel type; technology type (internal combustion, hybrid, electric); weight class	
	Local and regional (in-boundary) transit system		2011–2016 (annual) Route/network GIS files; Fleet by type (subway, commuter train, bus, streetcar); VKT; energy/ fuel use; vehicle fuel consumption per km.	Projected transit VKT by vehicle type (consistent with projected OD trip matrix)
	School bus fleet		2011–2016 (annual) Fleet by fuel type; VKT; fuel consumption.	
	VKT	km	2011–2016 (annual) Any existing studies or estimates of regional VKT (traffic count based or other).	
WASTE				
WASTEWATER	Wastewater BOD concentration	g BOD / m3	BOD concentration by plant	
	Wastewater Nitrogen concentration	mg / L	N concentration of effluent by shed	
	Wastewater treatment volume	m3 / year	Effluent volume discharged by plant; Influent volume by plant	
	Wastewater treatment system	-	Treatment shares (central vs. septic connections)	

DATA REQUEST			BASE YEAR 2011	PROJECTION 2012–2051
		tonne / m3	Sludge (biosolids) generated per influent volume by plant	
		-	Methane recovery fraction by plant; if recovered, where is recovered methane used, and in what sector?	
WASTE	Solid waste produced	tonne / year	2011-2016 (annual) By waste type AND by sector	
	Waste disposal routing		2011–2016 (annual) Fraction of waste generated within city handled within city boundary & handled outside of city, by type	
	Solid waste facilities capacity	tonne	Waste handling facilities capacity (within and outside of city boundary), by facility type	Planned capacity additions, decommissions, technology improvements
	Solid waste facilities	-	% capacity used up by landfill in base year	
		tonne / year	2011–2016 (annual) Quantities of waste taken in by handling facilities within boundary, by facility type. What percentage of waste taken in by handling facilities is imported?	
		-	2011–2016 (annual) Methane recovery fraction by handling facilities; where is recovered methane used?	
	Diversion rates	-	2011–2016 (annual) Recycling and compost diversion rates for residential and ICI waste.	Projected recycling and compost diversion rates for residential and ICI waste.
WATER				

DATA REQUEST			BASE YEAR 2011	PROJECTION 2012–2051
	Water treatment energy use	GJ or kWh / year	2011–2016 (annual) Total energy consumed by water and wastewater treatment plant, by fuel, by location	
	Water distribution energy use	GJ or kWh / year	2011–2016 (annual) Total energy consumed by water and wastewater distribution systems	
INDUSTRY				
	Industrial processes & product use		Any information on industrial processes, production levels & emissions; by location	
	Waste heat		GIS: locations of waste heat producers, amount of waste heat	

Appendix 4: GPC Reporting

GPC ref No.	SCOPE	GHG EMISSIONS SOURCE
I		STATIONARY ENERGY SOURCES
I.1		RESIDENTIAL BUILDINGS
I.1.1	1	Emissions from in-boundary fuel combustion
I.1.2	2	Emissions from consumption of grid-supplied energy
I.1.3	3	Transmission and distribution losses from grid-supplied energy
I.2		COMMERCIAL AND INSTITUTIONAL BUILDINGS/FACILITIES
I.2.1	1	Emissions from in-boundary fuel combustion
I.2.2	2	Emissions from consumption of grid-supplied energy
I.2.3	3	Transmission and distribution losses from grid-supplied energy
I.3		MANUFACTURING INDUSTRY AND CONSTRUCTION
I.3.1	1	Emissions from in-boundary fuel combustion
I.3.2	2	Emissions from consumption of grid-supplied energy
I.3.3	3	Transmission and distribution losses from grid-supplied energy
I.4		ENERGY INDUSTRIES
I.4.1	1	Emissions from in-boundary production of energy used in auxiliary operations
I.4.2	2	Emissions from consumption of grid-supplied energy
I.4.3	3	Transmission and distribution losses from grid-supplied energy
I.4.4	1	Emissions from in-boundary production of grid-supplied energy
I.5		AGRICULTURE, FORESTRY AND FISHING ACTIVITIES
I.5.1	1	Emissions from in-boundary fuel combustion
I.5.2	2	Emissions from consumption of grid-supplied energy
I.5.3	3	Transmission and distribution losses from grid-supplied energy
I.6		NON-SPECIFIED SOURCES
I.6.1	1	Emissions from in-boundary fuel combustion
I.6.2	2	Emissions from consumption of grid-supplied energy
I.6.3	3	Transmission and distribution losses from grid-supplied energy
I.7		FUGITIVE EMISSIONS FROM MINING, PROCESSING, STORAGE, AND TRANSPORTATION OF COAL
I.7.1	1	In-boundary fugitive emissions
I.8		FUGITIVE EMISSIONS FROM OIL AND NATURAL GAS SYSTEMS
I.8.1	1	In-boundary fugitive emissions
II		TRANSPORTATION
II.1		ON-ROAD TRANSPORTATION
II.1.1	1	Emissions from in-boundary transport
II.1.2	2	Emissions from consumption of grid-supplied energy
II.1.3	3	Emissions from transboundary journeys
II.2		RAILWAYS
II.2.1	1	Emissions from in-boundary transport
II.2.2	2	Emissions from consumption of grid-supplied energy
II.2.3	3	Emissions from transboundary journeys
II.3		WATER-BORNE NAVIGATION
II.3.1	1	Emissions from in-boundary transport
II.3.2	2	Emissions from consumption of grid-supplied energy
II.3.3	3	Emissions from transboundary journeys

GPC ref No.	SCOPE	GHG EMISSIONS SOURCE
II.4		AVIATION
II.4.1	1	Emissions from in-boundary transport
II.4.2	2	Emissions from consumption of grid-supplied energy
II.4.3	3	Emissions from transboundary journeys
II.5		OFF-ROAD
II.5.1	1	Emissions from in-boundary transport
II.5.2	2	Emissions from consumption of grid-supplied energy
III		WASTE
III.1		SOLID WASTE DISPOSAL
III.1.1	1	Emissions from waste generated and treated within the city
III.1.2	3	Emissions from waste generated within but treated outside of the city
III.1.3	1	Emissions from waste generated outside the city boundary but treated within the city
III.2		BIOLOGICAL TREATMENT OF WASTE
III.2.1	1	Emissions from waste generated and treated within the city
III.2.2	3	Emissions from waste generated within but treated outside of the city
III.2.3	1	Emissions from waste generated outside the city boundary but treated within the city
III.3		INCINERATION AND OPEN BURNING
III.3.1	1	Emissions from waste generated and treated within the city
III.3.2	3	Emissions from waste generated within but treated outside of the city
III.3.3	1	Emissions from waste generated outside the city boundary but treated within the city
III.4		WASTEWATER TREATMENT AND DISCHARGE
III.4.1	1	Emissions from wastewater generated and treated within the city
III.4.2	3	Emissions from wastewater generated within but treated outside of the city
III.4.3	1	Emissions from wastewater generated outside the city boundary but treated within the city
IV		IPPU
IV.1	1	In-boundary emissions from industrial processes
IV.2	1	In-boundary emissions from product use
V		AGRICULTURE, FORESTRY AND LAND USE (AFOLU)
V.1	1	In-boundary emissions from livestock
V.1	1	In-boundary emissions from land
V.1	1	In-boundary emissions from other agriculture
VI		OTHER INDIRECT EMISSIONS
VI.1	3	Other indirect emissions

Appendix 5: Sector-specific Considerations for Inventories

The following section offers guidance on methods for calculating GHG emissions using an activity-based approach so that the factors which drive GHG emissions are more apparent. The GPC separates GHG emissions accounts according to geographic locations or scope. Scope is not addressed in the calculations below and for guidance on how to report according to the three scopes, refer to the GPC.

Stationary Energy

Buildings (residential, commercial, institutional), manufacturing and construction industries, and power plants are considered stationary energy users. Stationary energy use emissions are calculated in three steps:

- *Step 1*: Data collection

  Total natural gas and electricity consumption from utilities by year and, if possible, separated by rate class/building type. May be also separated by postal code.

  Buildings by type and floor area, from MPAC or municipal records.

- *Step 2*: Build a simple spreadsheet of building energy consumption (Table 23).

Table 65. Stationary energy emissions calculations.

Sector	Formula	Fuels	GHG Emissions	Data sources
Residential buildings	# of buildings * m2/dwelling * GJ/m2 * kgGHG/GJ (EF) for each fuel.	Natural gas, electricity, heating oil, propane, wood, other	CO_2, CH_4, NO_2	The number of dwellings by type and the area of the dwellings (m2) can be sourced from the Municipal Property Assessment Corporation (MPAC). GJ/m2 and the emissions factors are provided in a data table in the appendix.
ICI buildings	# of buildings * m2/building type * GJ/m2 * kgGHG/GJ (EF) for each fuel	Natural gas, electricity, heating oil, propane, wood, other	CO_2, CH_4, NO_2	Floor area can be sourced from MPAC by building type. GJ/m2 and the emissions factor are in a data table in the appendix.

» *Step 3*: Calibrate the results for total natural gas and electricity consumption.

There will be a difference between the totals provided by the energy utility (step 1) and the results from step 2. Adjust the GJ/m2 to align the totals with those provided by the utility. It is important to confirm that the definitions of residential buildings and ICI buildings from MPAC align with those from the utilities. There is no similar data available for wood or propane use, so localized assumptions must be made. If there is municipal-owned district energy, add its fuel consumption to the totals provided by the utilities prior to calibration.

Fugitive Emissions

There primary sources of fugitive emissions within the municipal boundary is the natural gas distribution system. The natural gas utility can provide the fugitive emissions volume.

Table 66. Fugitive emissions calculations.

Sector	Formula	Fuels	GHG emissions	Data sources
Natural gas distribution	GJ * kgCH4/GJ (distribution loss factor)	Natural gas	CH_4	Natural gas utility

Transportation Emissions

Transportation emissions can be estimated through GIS-based trip modelling and/or through fuel use and vehicle data analysis. The latter approach involves three steps:

» *Step 1*: Procure gasoline and diesel use totals from a third party (e.g. Kent Group. Does not include private fuelling facilities).

» *Step 2*: Calculate total fuel consumption and vehicle kilometres travelled (VKT) of vehicles. The number of vehicles by type and average fuel

efficiency is sourced from the Ministry of Transportation. VKT may be available from municipal transportation modelling or a provincial average can be used.

Table 67. On-road transportation emissions calculations.

Sector	Formula	Fuels	GHG emissions	Data sources
Residential vehicles	# of vehicles * km/ vehicle * litres/km * kg GHG/litre	Gasoline, diesel, propane	CO_2, CH_4, NO_2	The number of vehicles by type is available from Ministry of Transportation. Fuel efficiency data is included in a data table in an appendix. Emissions factors are included in the appendix.
Commercial vehicles	# of vehicles * km/ vehicle * litres/km * kg GHG/litre	Gasoline, diesel, propane, natural gas	CO_2, CH_4, NO_2	

- *Step 3*: Calibrate the result. Some residential and commercial fuel used will be purchased outside of the municipal boundaries, while some fuel supplied within the municipal boundary will be purchased by users outside the boundary. The municipality will need to judge whether or not the third party fuel numbers should be adjusted. The km/vehicle number should be adjusted so that the on-road calculation aligns with the adjusted third party fuel use result.

Emissions from railways, water-borne transportation, aviation and off-road transportation calculations will vary by municipality. See the GPC for guidance on these sources.

Solid Waste Emissions

There are two main approaches to calculating solid waste emissions, called 'first order of decay' and 'the methane commitment model'. The former is described in GPC, the latter is calculated in three steps:

- *Step 1*: Determine the per capita annual residential waste tonnage. Subtract any recycled, composted or otherwise diverted waste.
- *Step 2*: Identify waste composition and calculate the degradable organic carbon (see Equation 8.1 in GPC) and methane generation potential (Equation 8.4).
- *Step 3*: Identify the fraction of methane recovered by flaring or energy recovery ("frec"). The oxidation factor (OX) is either 0.1 for well-managed landfills or 0 for unmanaged landfills.

A similar approach is used for commercial waste except the calculation is based on floor space derived from MPAC data, as opposed to population. ICI waste data is typically difficult to access and may be extrapolated from waste audits of a selection of buildings, which is likely more accessible.

Table 68. Waste emissions calculations.

Sector	Formula	Data sources
Residential waste	# of people * kg of waste/person * diversion factor * Lo * (1-frec) * (1-OX)	Waste management department.
Commercial waste	m2 * kg of waste/m2 * diversion factor * Lo * (1-frec) * (1-OX)	Waste management department. ICI waste data is typically difficult to access in Ontario.

Agriculture, Forestry and Land-use

Tracking GHG emissions from agriculture, forestry and land-use is not required for the BASIC level of reporting under GPC, but can be reported under BASIC+. The Province of Ontario is currently completing a provincial land-use carbon inventory that may be able to support inventory calculations in this area. For detailed guidance on calculating these emissions see the the GPC.

Industrial Processes and Product Use

GHG emissions are produced from non-energy related industrial activities, such as the blast furnace in the iron and steel industry, and ammonia and other chemical products manufactured from fossil fuels and used as chemical feedstocks. In addition, products such as refrigerants, foams or aerosol cans also contain GHGs which can be released during use and disposal. For detailed guidance on calculating these emissions see the the GPC.

Appendix 6: A Synopsis of Co-benefits of Low Carbon Actions

Local governments that have successfully integrated energy and emissions actions into their planning and citizen/business engagement activities are realizing significant and multiple co-benefits in their communities. In many cases, actions that reduce GHG emissions also create a vibrant cityscape, improve public health outcomes, reduce municipal operating and capital costs, and support innovation.[32]

Working with C40, LSE Cities has developed a five-sector framework for assessing co-benefits in health, mobility, resources, buildings and economy. The sectors align with municipal policy areas, drawing from a survey of 100 cities.[33] This framework is a standardized approach that can be used to assess co-benefits for a climate action plan.
LSE

Table 69. Framework for assessing co-benefits.

Strategic sectors	City goals (examples)	Policy actions (examples)	Co-benefits	Coordinated governance
Health	Improve outdoor air quality	Reduce vehicle use	Reduced premature deaths and health problems	Health, transport. Land-use, energy, digital, economy, air quality, buildings, tourism
Mobility	Reduce congestion	Reduce vehicle use	Increased economic efficiency, quality of life, air quality	Transport, economy, land-use, digital, energy, education, tourism, air quality
Resources	Improve food security	Promote agricultural production	Increased economic efficiency, quality of life, air quality, green space. Improved resource management.	Food security, waste, water, health, land-use, transport, buildings, energy, education, disaster and emergency
Buildings	Reduce fuel poverty	Increase building energy efficiency	Cost savings	Buildings, energy, health, education
Economy	Support economic growth	Establish cleantech business clusters and incentives	Innovation, productivity, SME growth in tech sector	Economy, education, transport, buildings, digital, water, waste

32 Kamal-Chaoui, L., & Robert, A. (2009). Competitive cities and climate change. Retrieved from http://www.oecd-ilibrary.org/governance/competitive-cities-and-climate-change_218830433146

33 Floater, G., Heeckt, C., Ulterino, M., Mackie, L., Rode, P., Bhardwaj, A., Huxley, R. (2016). *Co-benefits of urban climate action: A framework for cities.* LSE Cities.

MORE READING:

SSG. (2017). Technical paper #4: Considerations of co-benefits and co-harms associated with low carbon actions for TransformTO.

RESOURCE:

Floater, G., Heeckt, C., Ulterino, M., Mackie, L., Rode, P., Bhardwaj, A., … Huxley, R. (2016). Co-benefits of urban climate action: A framework for cities. LSE Cities.

Economic Co-benefits

The transition to a low carbon economy represents a massive economic opportunity. One analysis suggests the global economic opportunity of investments in low-carbon urban actions is $16.6 trillion[34]—the financial savings resulting from energy savings and lower cost generation in transportation, buildings and waste sectors. Coordinated planning of land-use, transportation and infrastructure through strategies such as smart growth and transit oriented development can mobilize major private investment, increase municipal tax revenues and decrease municipal infrastructure spending.

Low carbon land-use policies can generate economic benefits for households, businesses and government in three categories: increased return on investment, cost savings, and quality-of-life improvements, as summarized in Table 8.[35]

Table 70. Economic co-benefits of low carbon land-use policies.

Business	Household	Municipal & Regional	National
Return on Investments			
Access to new markets Reduced investment risks Construction & transit jobs Higher property values Productivity enhancements due to agglomeration	Enhance or preserve housing values Better access to jobs	Higher public revenues Reduced citizen opposition to development Private investment attraction Increased economic efficiency	More efficient use of transportation investments Construction & transit jobs
Savings on Expenditures			

34 Gouldson, A. P., Colenbrander, S., Sudmant, A., Godfrey, N., Millward-Hopkins, J., Fang, W., & Zhao, X. (2015). Accelerating low carbon development in the world's cities. Retrieved from http://eprints.whiterose.ac.uk/90740/

35 These tables and examples are from: C. Kooshian and S. Winkelman, *Growing Wealthier: Smart Growth, Climate Change and Prosperity*. Center for Clean Air Policy, 2011.

Employee health care savings Better information & decision making Reduced parking requirements Reduced energy & water use	Travel cost savings Reduced energy & water use Health care savings Lower taxes for infrastructure services	Infrastructure savings (construction & operation) Reduced costs from urban decline Green infrastructure replaces grey infrastructure	Energy security Health care savings
Improved Quality of Life			
Quality places attract high quality workers Improved environment for small businesses	Better access to services Affordable housing Access to nature & recreation Increased physical activity	Reduced exposure to congestion Thriving public spaces Growth reflects community values Environmental conservation	Reduced emissions

MORE READING:

Gouldson, A., Colenbrander, S., McAnulla, F., Sudmant, A., Kerr, N., Sakai, P., … Kuylenstierna, J. (2014). The economic case for low carbon cities. *A New Climate Economy.*

Employment Co-benefits

The transition to a low carbon economy is expected to have four types of impacts on labour markets:[36]

- Additional jobs will be created in emerging sectors (e.g. electric vehicles and energy efficiency controls);
- Some employment will be shifted (e.g. from fossil fuels to renewables);
- Certain jobs will be eliminated (e.g. vehicle mechanics who specialize in gasoline motors); and
- Many existing jobs will be transformed and redefined.

The transition will require massive infrastructure investment. This mobilization of public and private finance—up to $3.2 billion per city in one estimate[37]—requires many new jobs. For example, the International Energy Agency estimates that 8 to 27 jobs are created for each €1 million invested in energy efficiency.[38] Energy NorthEast (now Acadia Centre) found that efficiency programs in Canada return $3 to $5 in savings for every $1 of program spending, and generate 30 to 52 job-

36 Martinez-Fernandez, C., Hinojosa, C., & Miranda, G. (2010). Green jobs and skills: the local labour market implications of addressing climate change. *Working Document, OECD.* Retrieved from http://www.oecd.org/regional/leed/44683169.pdf

37 Gouldson, A., Colenbrander, S., McAnulla, F., Sudmant, A., Kerr, N., Sakai, P., … Kuylenstierna, J. (2014). The economic case for low carbon cities. A New Climate Economy. Retrieved from http://eprints.whiterose.ac.uk/82868/

38 International Energy Agency. (2014). Capturing the multiple benefits of energy efficiency. Paris, France. Retrieved from http://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEficiency.pdf

years per million dollars of program spending.[39]
Low carbon technologies tend to be more labour intensive than high carbon activities, at least in the short term (Table 9). In the long term, as the cost of renewable energy decreases, the ratios may decline.

Table 71. Average employment over the life of a facility (jobs/MW).[40]

	Construction, manufacturing, installation	O&M and fuel processing	Total employment
Solar PV	5.76–6.21	1.2–4.8	7.41–10.56
Wind	0.43–2.51	0.27	0.71–2.79
Biomass	0.40	0.38–2.44	0.78–2.84
Coal	0.27	0.74	1.01
Gas	0.25	0.70	0.95

Note: Ranges refer to the results of different studies. Employment is shown relative to the average installed capacity, correcting for differences in capacity factor. (Because renewable installations operate only 20% of the time, compared with 80% for fossil fuel plants, 4 MW of renewable capacity is needed to produce the same output as 1 MW of fossil fuel capacity).

Innovation Co-benefits

Actions that reduce emissions will stimulate innovation as enterprises reposition themselves and invest in research and development to provide new services, business models and markets. This process will trigger a process of technology diffusion, adaptation and experimentation.

Technological and social innovations are occurring rapidly and the community energy and emissions plan is an opportunity to identify and plan for innovation, ensuring that benefits are maximized for those who need it the most.

Table 72. Innovation examples.

Technological innovation	Techno-social innovation	Social innovation
Autonomous electric vehicles	Autonomous shared electric vehicles	Car-sharing

39 ENE. (2014). *Energy efficiency: Engine of economic growth in Canada*. Retrieved from http://acadiacenter.org/wp-content/uploads/2014/11/ENEAcadiaCenter_EnergyEfficiencyEngineofEconomicGrowthinCanada_EN_FINAL_2014_1114.pdf

40 Fankhaeser, S., Sehlleier, F., & Stern, N. (2008). Climate change, innovation and jobs. *Climate Policy*, *8*(4), 421–429. https://doi.org/10.3763/cpol.2008.0513

Decentralized energy generation (solar PV, renewable natural gas)	Energy co-operatives	Co-operative model
Energy storage	Heating and electricity district energy	Municipal utility (provides energy services)
Building energy monitoring	Energy services contract utility	Energy efficiency as a service

EXAMPLE:

Toronto Renewable Energy Co-operative: http://www.trec.on.ca/about

Southeast False Creek Neighbourhood Energy Utility: http://vancouver.ca/home-property-development/southeast-false-creek-

Co-Benefits to Municipal Finances

Low carbon development policies also benefit municipal finances. Compact, complete communities have lower emissions compared to their suburban sprawling counterparts and result in lower municipal capital and operation costs. An analysis in the US estimated direct cost savings for building road and utility infrastructure in smart growth developments relative to dispersed, car-dependent developments at between US$5,000 and US$75,000 per household unit.[41] [42]

Health and Social Co-benefits

The World Health Organization defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."[43] Research indicates that climate change is leading to adverse physical and mental health effects.[44] The under-privileged, in particular, are at elevated climate change-induced health risks. Poor living conditions increase vulnerability to climate change and cause poor health status—further increasing climate vulnerability. Climate change mitigation actions will benefit overall population health, and will be especially beneficial to vulnerable populations.

RESOURCE:

IndEco Strategic Consulting. (2016). Health benefits of a low-carbon future.

Retrieved from http://www.c40.org/researches/c40-lse-cobenefits

RESOURCE:
Provincial Health Services Authority. (2014, March). BC healthy built environment linkages toolkit.

http://www.phsa.ca/Documents/linkagestoolkitrevisedoct16_2014_full.pdf

EXAMPLE:

City of Seattle. (2016). Seattle 2035- Growth and equity: Analyzing impacts on displacement and opportunity related to Seattle's Growth Strategy.

http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2427615.pdfneighbourhood-energy-utility.aspx

Air Quality

Air quality can be improved by changing the technologies that produce and consume energy. Reducing emissions and airborne toxins such as nitrogen oxides (NOx), sulfur dioxide (SO2), particulate matter, and mercury lowers air pollution-related disease rates.[45] Several studies have concluded that substantive morbidity and mortality benefits would result from improved air quality, especially from the reduction of micro-particulates resulting from burning fossil fuels and firewood.[46] In outdoor environments, improved fuel-efficiency, increased use of public transit, and reduced numbers of combustion engine vehicles contribute to improved air quality and better health outcomes. It has been found that traffic-related air pollution even at relatively low concentrations in Ontario is associated with increased mortality from cardiovascular disease.[47] In indoor environments, improvements to ventilation systems and the use of less toxic building materials (e.g. insulation, wall panelling) improves air quality while reducing energy use.
Active Transportation

Studies in Copenhagen[48] and Shanghai[49] have shown that the relative risk of all-cause mortality was 30–40% less among those who cycled compared to those

45 Nemet, G.F.; Holloway, T.; Meier, P. Implications of incorporating air-quality co-benefits into climate change policymaking. Environ. Res. Lett. 2010, 5, 1–9.

46 Barrett, Bruce, Maggie Grabow, Cathy Middlecamp, Margaret Mooney, Mary Checovich, Alexander Converse, Bob Gillespie, and Julia Yates. "Mindful Climate Action: Health and Environmental Co-Benefits from Mindfulness-Based Behavioral Training." *Sustainability* 8, no. 10 (October 17, 2016): 1040. doi:10.3390/su8101040.

47 Chen, H., Goldberg, M. S., Burnett, R. T., Jerrett, M., Wheeler, A. J., & Villeneuve, P. J. (2013). Long-term exposure to traffic-related air pollution and cardiovascular mortality. Epidemiology, 24(1), 35–43.

48 Andersen LB, Schnohr P, Schroll M, Hein HO. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Arch Intern Med2000;160:1621-8.

49 Matthews CE, Jurj AL, Shu XO, Li HL, Yang G, Li Q, et al. Influence of exercise, walking, cycling, and overall nonexercise physical activity on mortality in Chinese women. Am J Epidemiol2007;165:1343-50.

who did not use active transportation or get equivalent amounts of leisure time exercise. A 19% reduction in all-cause mortality risk has been shown to occur with 30 minutes of daily moderate-intensity activity, 5 days per week. When populations engaged in 7 hours of moderate activity weekly, the all-cause mortality risk dropped by 24% compared to those with no activity.[50] All-cause mortality rates in moderately and highly active people have been found to be 50% lower than those with no activity. The same studies have found that cycling to work would also reduce all-cause mortality rates by 40%.[51]

Active transportation may increase exposure to air pollution, leading to negative health consequences; however, a recent study has shown that the benefits of physical activity by far outweigh risks from air pollution.[52]

Studies have shown that children who walk or bike to school are fitter than those who travel by car or bus, with 30% higher vigour in boys, and seven times higher in girls.[53] It is estimated that the doubling of people walking would reduce the risk to each individual walker by approximately one-third.[54] A review reported that public transport usage could increase physical activity by 8–33 minutes per day.[55]

The Elderly

Increased access to public transportation can overcome mobility barriers experienced by those who do not drive.[56] For the elderly, the physical health implications of sprawl include less active lifestyles, respiratory issues and increased use of medication due to higher ozone levels and increased air pollution, and fatalities due to automobile accidents.[57] The isolation and weakened community networks resulting from sprawl can result in negative mental and social capital impacts.

A built environment designed for walking encourages physical fitness and exercise, increasing overall health among elderly people. Oxygen uptake and flexibility both increase with physical activity.[58] According to one author, "physical activity in

50 Woodcock, J., Franco, O. H., Orsini, N., & Roberts, I. (2011). Non-vigorous physical activity and all-cause mortality: systematic review and meta-analysis of cohort studies. International Journal of Epidemiology, 40(1), 121–138.

51 Andersen LB, Schnohr P, Schroll M, Hein HO. All-Cause Mortality Associated With Physical Activity During Leisure Time, Work, Sports, and Cycling to Work. *Arch Intern Med.* 2000;160(11):1621-1628.

52 Tainio, Marko, Audrey J. de Nazelle, Thomas Götschi, Sonja Kahlmeier, David Rojas-Rueda, Mark J. Nieuwenhuijsen, Thiago Hérick de Sá, Paul Kelly, and James Woodcock. "Can Air Pollution Negate the Health Benefits of Cycling and Walking?" Preventive Medicine 87 (June 2016): 233–36. doi:10.1016/j.ypmed.2016.02.002.

53 Voss C, Sandercock G. (2010). Aerobic fitness and mode of travel to school in English schoolchildren. Med Sci Sports Exerc. 2010 Feb;42(2):281-7.

54 Jacobsen, P. L. (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. Injury Prevention, 9(3), 205–209.

55 Rissel, C., Curac, N., Greenaway, M., & Bauman, A. (2012). Physical Activity Associated with Public Transport Use—A Review and Modelling of Potential Benefits. International Journal of Environmental Research and Public Health, 9(7), 2454–2478.

56 Jackson, R. and C. Kochtitzky. (2010). Creating a Healthy Environment: The Impact of the Environment on Public Health. Centers for Disease Control and Prevention. Sprawl Watch Clearinghouse Monograph Series.

57 Frumkin, H. (2002). Urban Sprawl and Public Health. Public Health Reports, 117, 201-217

58 Morris, N. (2003). Health, Well-being and Open Space. OPENspace: the Research Centre for Inclusive Access to Outdoor Environments. Edinburgh College of Art and Heriot-Watt University

the natural environment not only aids an increased life-span, greater well-being, fewer symptoms of depression, lower rates of smoking and substance misuse, but also increases the ability to function better at work and home".[59]

Retrofitting buildings for energy efficiency can improve indoor temperature regulation, reducing the impact of summer heat on the elderly, a high-risk population in terms of developing severe heat stroke, heat exhaustion, fainting, swelling or heat cramps during a heat wave.[60]

Children and Youth

Although they will bear the burden of climate change impacts, children and youth and the rights of future generations currently have little say in climate change-related policy. Empowerment and inclusion of children and youth in climate action decision-making processes encourages a sense of contribution, ownership and pride that in turn encourages sustained civic and community engagement. Taking action on climate change now will lessen the climate impacts burden on children and youth throughout their lives. Leaving climate change unaddressed would likely lead to shorter lifespans, increased risk of disease, increased risk of poverty, and increased risk of orphanhood for children.

Environmental Co-benefits

Environmental or natural capital typically includes three aspects:[61]

- Land: provides space for human and natural activities.
- Subsoil resources: underground stocks of minerals, fossil fuels and water that provide flows of raw materials and energy.
- Ecosystems: self-maintaining natural systems that provide ongoing flows of a wide variety of ecosystem goods and services (e.g. timber and carbon sequestration).

Energy sprawl is the potential habitat effect of different energy fuels and technologies. The land-use intensity of different energy sources varies significantly, from nuclear (1.9–2.8 km2 /TWh/yr) to biofuels (320–375 km2/TWh/yr); in other words, nuclear energy generates significantly more energy per unit of area than biofuel energy. Emissions reduction actions that reduce energy consumption or generate renewable energy locally will reduce energy sprawl and habitat impacts. Emissions reduction actions that increase energy requirements—such as biofuel substitution—may increase energy sprawl. Following an emphasis on conservation, balanced energy production decision-making is required to ensure limited environmental impacts.

Developing low carbon, compact, complete communities—as opposed to sprawling ones—preserves natural areas and their ecosystems. These areas

59 Morris, 2003, p.17.

60 Frumkin, 2002.

61 Smith, Robert. (2016). Comprehensive wealth in Canada- Measuring what matters in the long run. International Institute for Sustainable Development. Retrieved from http://www.iisd.org/sites/default/files/publications/comprehensive-wealth-full-report-web.pdf

provide myriad services such as carbon sequestration, air pollution mitigation, human enjoyment, and enhanced human physical and mental well-being.[62] Additional services include more efficient land-use and resource management, protection of biodiversity and habitat, protection of soil health, water purification and retention, enhanced connectivity of fragmented landscapes and buffers against natural hazards.

62 Stott, I., Soga, M., Inger, R., & Gaston, K. J. (2015). Land sparing is crucial for urban ecosystem services. *Frontiers in Ecology and the Environment*, *13*(7), 387–393.

Appendix 7: GHG inventory assumptions

1. Electricity GHG intensity (g CO2eq/kWh)

2010	*2011*	*2012*	*2013*	*2014*	*2015*
140	100	100	80	40	43

Source: Environment Canada, 2016.National Inventory Report

2. Energy use intensity, residential buildings, Ontario, 2012 (GJ/m2)

Dwelling type	*Space heating*	*Water heating*	*Appliances*	*Lighting*	*Space cooling*	*Total*
Single detached	0.46	0.14	0.06	0.02	0.03	0.71
Singled attached	0.37	0.15	0.07	0.02	0.02	0.63
Apartment	0.3	0.19	0.09	0.01	0.01	0.6
Mobile home	0.74	0.11	0.07	0.02	0.03	0.96

Source: Natural Resources Canada, Comprehensive Energy Use Database. Retrieved from: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_res_on.cfm

3. Energy use intensity, commercial buildings, Ontario, 2012 (GJ/m2)

Building type	*Space heating*	*Water heating*	*Auxiliary Equipment*	*Auxiliary Motors*	*Lighting*	*Space cooling*	*Total*
Wholesale Trade	0.629	0.139	0.36	0.109	0.142	0.131	1.509
Retail Trade	0.641	0.139	0.353	0.111	0.145	0.144	1.532
Transportation and Warehousing	0.702	0.05	0.154	0.117	0.155	0.096	1.273
Information and Cultural Industries	0.62	0.133	0.345	0.104	0.136	0.135	1.474
Offices	0.57	0.106	0.263	0.09	0.121	0.107	1.257
Educational Services	0.631	0.135	0.351	0.106	0.139	0.129	1.491
Health Care and Social Assistance	0.941	0.263	0.524	0.16	0.209	0.207	2.303
Arts, Entertainment and Recreation	0.702	0.151	0.391	0.118	0.154	0.135	1.651
Accommodation and Food Services	0.899	0.254	0.505	0.153	0.2	0.194	2.205
Other Services	0.611	0.131	0.34	0.103	0.134	0.122	1.442

Source: Natural Resources Canada, Comprehensive Energy Use Database. Retrieved from: http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_com_on.cfm

4. Vehicle data

Cars On-Road Average Fuel Consumption (L/100 km)

	2011	*2012*	*2013*	*2014*
Motor Gasoline	8.5	8.4	8.4	8.3
Diesel Fuel Oil	6.7	6.7	6.8	6.8

Passenger Light Truck On-Road Average Fuel Consumption (L/100 km)

	2011	*2012*	*2013*	*2014*
Motor Gasoline	11.5	11.4	11.3	11.3
Diesel Fuel Oil	9.9	9.4	9.1	8.8

Medium Truck On-Road Average Fuel Consumption (L/100 km)

	2011	*2012*	*2013*	*2014*
Motor Gasoline	23	22.8	22.4	22.1
Diesel Fuel Oil	22.8	22.4	22.1	21.7

Heavy Truck On-Road Average Fuel Consumption (L/100 km)

	2011	*2012*	*2013*	*2014*
Diesel Fuel Oil	33.2	32.8	32.5	32.1

Average Distance Travelled per Year (km)

	2011	*2012*	*2013*	*2014*
Cars	16,580	16,364	15,951	14,938
Passenger Light Trucks	16,707	16,667	16,434	15,563
Freight Light Trucks	18,966	19,193	18,913	17,930
Medium Trucks	25,481	25,332	25,826	24,838
Heavy Trucks	92,773	90,602	91,988	91,279

Source: Natural Resources Canada, Nationa Energy Use Database. Retrieved from: https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=tran&juris=ca&rn=60&page=0

5. Mobile fuel emissions factors (kg/L)

	CO2	*CH4*	*N2O*
Gasoline	2.2	0.00023	0.00047
Diesel	2.582	0.000068	0.00022
Natural gas	2.738	0.013	0.000086
Propane	1.515	0.00064	0.000028

Source: Government of BC (2016). 2016/2017 BC Best Practices Method for Quantifying Greenhouse Gas Emissions

6. Stationary fuel combustion

Fuel	*Energy conversion factor*	*Energy conversion factor unit*	*CO2 (kg/GJ)*	*CH4 (kg/GJ)*	*N2O (kg/GJ)*
Natural gas	0.3885	GJ/m3	49.58	0.001	0.0009
Propane	0.02531	GJ/L	59.86	0.0009	0.0043
Light fuel oil	0.0388	GJ/L	68.12	0.0007	0.0008
Heavy fuel oil	0.0425	GJ/L	74.26	0.0013	0.0015
Kerosene	0.03768	GJ/L	67.94	0.0007	0.0008
Diesel fuel	0.0383	GJ/L	67.43	0.0035	0.0104
Wood fuel- industrial (50% moisture)	0.009	GJ/kg		0.01	0.0067
Wood fuel- residential (0% moisture)	0.018	GJ/kg		0.8333	0.0089
Renewable natural gas	0.03885	GJ/m3		0.001	0.0009

Source: Government of BC (2016). 2016/2017 BC Best Practices Method for Quantifying Greenhouse Gas Emissions

7. Global warming potential of major GHG gases

Gas	*GWP-20 year*	*GWP- 100 year*
CO2	1	1
CH4	84	28
N2O	264	265
HCF-134a	3,710	1,300

Source: Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Appendix 8: Spheres of Influence Method

Determining the spheres of influence of the local government is crucial to establishing the areas in which the government can take action to reduce GHG emissions. Local governments will have more power to achieve emissions reductions in some areas over others. The following diagrams summarize an approach to establishing the local government spheres of influence.

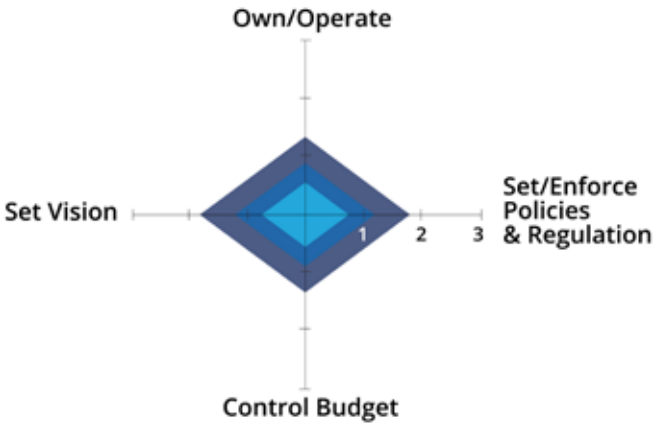

Figure 31. Assessment of municipal influence chart.

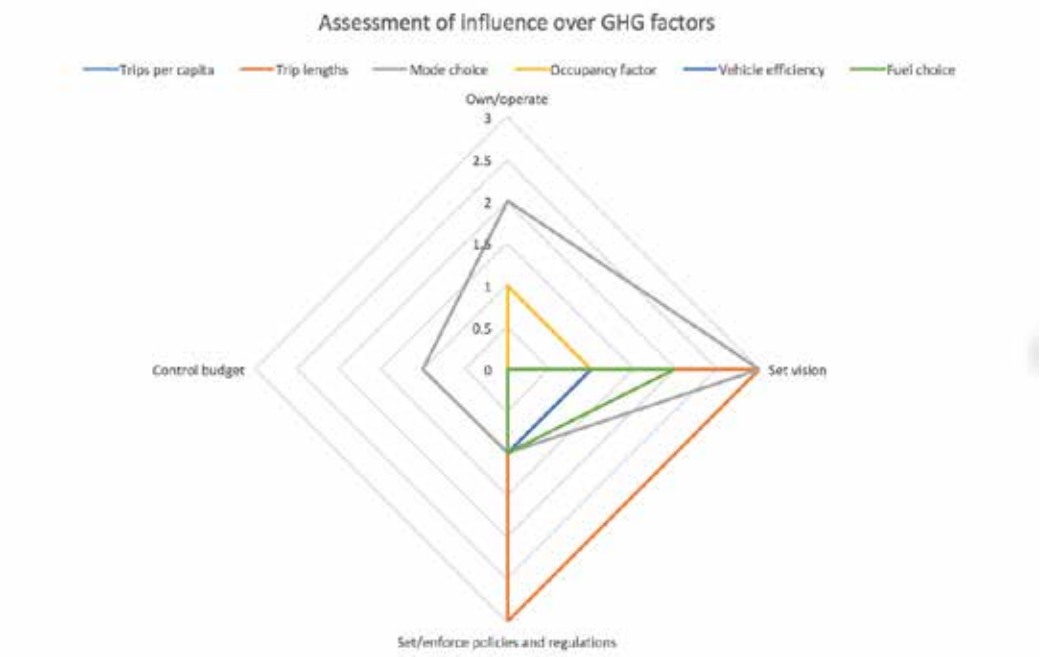

Figure 32. Influence assessment scoring criteria.

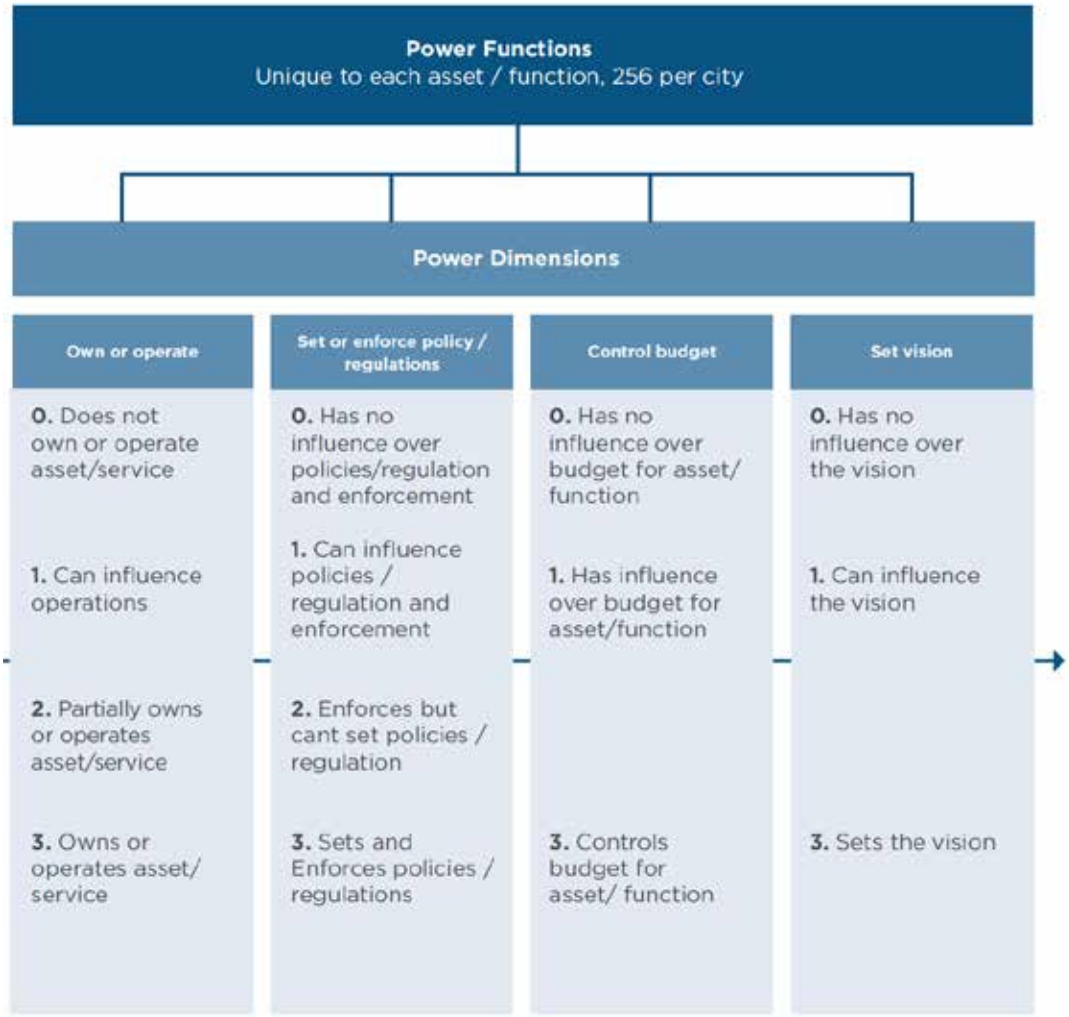

Figure 33. Sample assessment of municipal influence on transportation factors.

For example, Figure 34 illustrates the analysis of transportation factors using this framework, highlighting the fact that the primary areas of influence are trip length and mode choice, which the local government can influence through land-use planning and transit services. In contrast, it is challenging for the local government to influence trips per capita, fuel choice and occupancy factor. To influence these aspects, the local government needs to partner with other stakeholders and other levels of government.

Appendix 9: Energy and Emissions Models, Assumptions and Calibration

Table 73. Sample energy and emissions models.

Title	Creator	Description	Applicability	Co-benefits	Considerations
CityInSight	Sustainability Solutions Group and whatIf? Technologies	An energy, emissions, land-use systems-dynamics model used for generating scenarios.	Evaluate future land-use and technology scenarios.	Financial, transportation.	Open source, spatial analysis, GPC accounting framework, complex to apply.
Climate action for URBan sustainability (CURB)	C40 and World Bank	Tool for developing energy and emissions scenarios and evaluating actions.	Evaluate future technology scenarios.	Simple financial analysis.	Excel-based, not open source. Does not include spatial analysis.
Urban Footprint	Calthorpe Associates	Tool for developing future land-use scenarios.	Evaluate future land-use scenarios.	Financial analysis, public health, transportation, water use.	Open source, spatial. Does not include a detailed energy and emissions analysis, complex to deploy.
Envision Tomorrow	Fregonese Associates	Web-based scenario planning tool for evaluating growth patterns and future land-use decisions.	Evaluate future land-use scenarios.	Financial analysis, public health, transportation.	Open source, spatial, web-based platform. Does not include a detailed energy and emissions analysis.

Modelling Assumptions

Relevant streams: Intermediate, Advanced

There is a significant lack of data for performing accurate energy and emissions modelling. For example, energy utility data is available spatially aggregated, and not normally available at the level of individual dwellings or by end-use. For transportation, there is limited information on the frequency and length of trips by walking, cycling or driving. These and other data limitations require the use of assumptions. Additionally, assumptions are required to project the impact of technological development, behaviour patterns, development patterns, and financial outcomes.

Data assumptions can be derived from scientific papers or other research endeavours (such as the outputs of other models), are measured in another context than the one to which the model is being applied (*ex-situ*), or describe

future conditions.

There are four methodologies that can be used to identify assumptions:

- *Literature reviews.* Studies published in peer-reviewed journals and reports by recognized institutions can provide useful sources of assumptions. They must be contextualized and clearly cited.
- *Regression analysis* is a statistical technique for estimating the relationship between variables, for example between density and VKT. The analysis will assess the statistical significance of the estimated relationships—a measure of the degree of confidence between the true relationship and the estimated relationship.
- *Population surveys* are used to collect information in an organized and methodical manner using well-defined concepts, methods and procedures.
- *Modelled assumptions.* The outputs of other models which have been validated can be used as assumptions and should be clearly sourced with information regarding the scenario in which the assumption was generated.
-

Extensive use of assumptions is required in this type of modelling, which implies a high level of uncertainty. This necessitates care in communicating the results appropriately.

Model Calibration

Relevant streams: Intermediate, Advanced

To be as accurate as possible, an energy and emissions model must be calibrated. This involves ensuring that the model outputs reflect observed data. For example, in the case of residential buildings, the calibration process involves:

1. Determining the number of dwellings by type from the census and MPAC.
2. Identifying the floor area of each dwelling type from MPAC data.
3. Assuming an energy use intensity for each dwelling type.
4. Calculating total energy consumption.
5. Comparing total energy consumption against total energy consumption reported by the utility.
6. Adjusting the energy use intensity until the outcome from the model matches the total reported by the utility.

Different modelling approaches use different techniques to align the modelled outcome with the observed data. Calibration should be applied to all outcomes for which there is observed data. In Ontario, this is primarily electricity and natural gas consumption, which is available from utilities. Observed data is not typically available for transportation energy consumption or other energy sources or fuels.

Appendix 10: Multi-criteria Analysis for Prioritization and Decision-making

MCA is a simple process that involves four key steps:

1. Identifying and characterizing the option(s);
2. Identifying relevant criteria (e.g. effectiveness, cost, carbon emissions);
3. Weighing criteria (where we ask "which criteria are more important, which are less important?");
4. Scoring options against the criteria (on a scale, for example, 1–10, or "pass or fail" binary scores).

Table 74. Sample MCA calculation

Options		Criteria 1	Criteria 2	Criteria 3	Results
	Weight (0–1)	0.5	0.25	0.25	
Low carbon option A	Score (1–5)	1	2	3	
Low carbon option B		2	4	4	
Low carbon option C		4	5	5	

At each stage, value judgements are made about relevant criteria, about how we define what is 'better" or "worse", and about the degree to which we can trade off performance on one criteria in favour of performance on another. Recognizing that this is a process that involves value judgements is important: assessments are often presented as a purely technical matter, but this is inaccurate and misleading. On its own, MCA does not provide a clear answer to questions about "which option is best?", or "is a project acceptable?". Such questions involve value judgements, and no method can provide a clear answer without being based on these subjective values. Instead, these methods are best thought of as a framework for ordering preferences and judgements in a consistent and clear way. MCA is particularly relevant when there are multiple values to consider (social, environmental and economic values, for example). It facilitates the respect for, and acknowledgement of, different value systems by incorporating a range of perspectives. It also bridges the gap between technical knowledge and social values by permitting both quantitative and qualitative aspects.

Policy decisions result in winners and losers, thus it is important to check if a policy option seems preferable because some dimensions (e.g. the environmental) or some social groups (e.g. lower income groups or future generations) are not taken into account in the MCA.[63] There are three principles to ensure the integrity of the MCA process: be honest, be modest, and be cautious. Doing so will help balance the interests and rights of human beings and other species, of present and future generations, and of different social groups.

Application of MCA

Relevance: Low, medium, high

» Step 1: Characterizing the actions

Each of the actions will be described precisely and unambiguously, so that their intentions are easily understood.

» Step 2: Identifying relevant criteria

Criteria are developed in consultation with stakeholders and can be developed either prior to or during an MCA workshop. Criteria should reflect the performance of the options from different aspects, should be able to be clearly evaluated either qualitatively or quantitatively, and should reflect the essential characteristic of the objectives. If the MCA is being completed in a workshop setting, no more than 8 criteria should be used.

Table 75. Sample MCA criteria.

Criteria	Impact on GHG emissions	Impact on public health	Impact on employment	Impact on on marginalized groups in the community	Impact on the economy	Difficulty of implementation
Method of assessment	Quantitative	Quantitative/ qualitative	Quantitative	Qualitative	Quantitative/ qualitative	Qualitative

Data will be available for some of the criteria as a result of the modelling activities; for other criteria, a qualitative assessment must be undertaken, which is based on the judgement of the participants.

» Step 3: Weighting criteria and aggregating scores

Each of the criteria will be weighted on a scale of 1 to 5, where 1 is least important and 5 is most important. The weighting process is dependent on the priorities of the municipality. If there is a significant focus on GHG emissions, this category would be weighted higher than considerations of implementation.

» Step 4: Scoring options against the criteria

The options are scored against the criteria in two ways:

1. The quantitative performance of the options derived from the modelling

63 Kiker, G. A., Bridges, T. S., Varghese, A., Seager, T. P., & Linkov, I. (2005). Application of multicriteria decision analysis in environmental decision making. *Integrated Environmental Assessment and Management*, *1*(2), 95–108.

work and other analysis. These results can be directly entered into the MCA and weighted on a scale of 1 to 5. In other words, for the category of GHG reductions, the action which achieves the greatest reductions is given a 5. The GHG reductions of other actions are divided by the one with the highest score and then multiplied by 5 to generate their score, a process of weighting.

2. The options will then be evaluated qualitatively against the chosen set of criteria in a workshop setting or in another form of collaboration, again using a score of 1 to 5.

» Step 5: Initial results

The results for all options will be calculated by multiplying the criteria weightings with the scores (see Table 74).

» Step 6: Sensitivity analysis

Finally, the results are analyzed to ensure they reflect common sense. In the case that there are results which appear unusual, the scores are reviewed to ensure that they still make sense. A sensitivity analysis involves adjusting the scores of the options and the weighting of the criteria to evaluate how this impacts the order of priority.

Using the results of the MCA

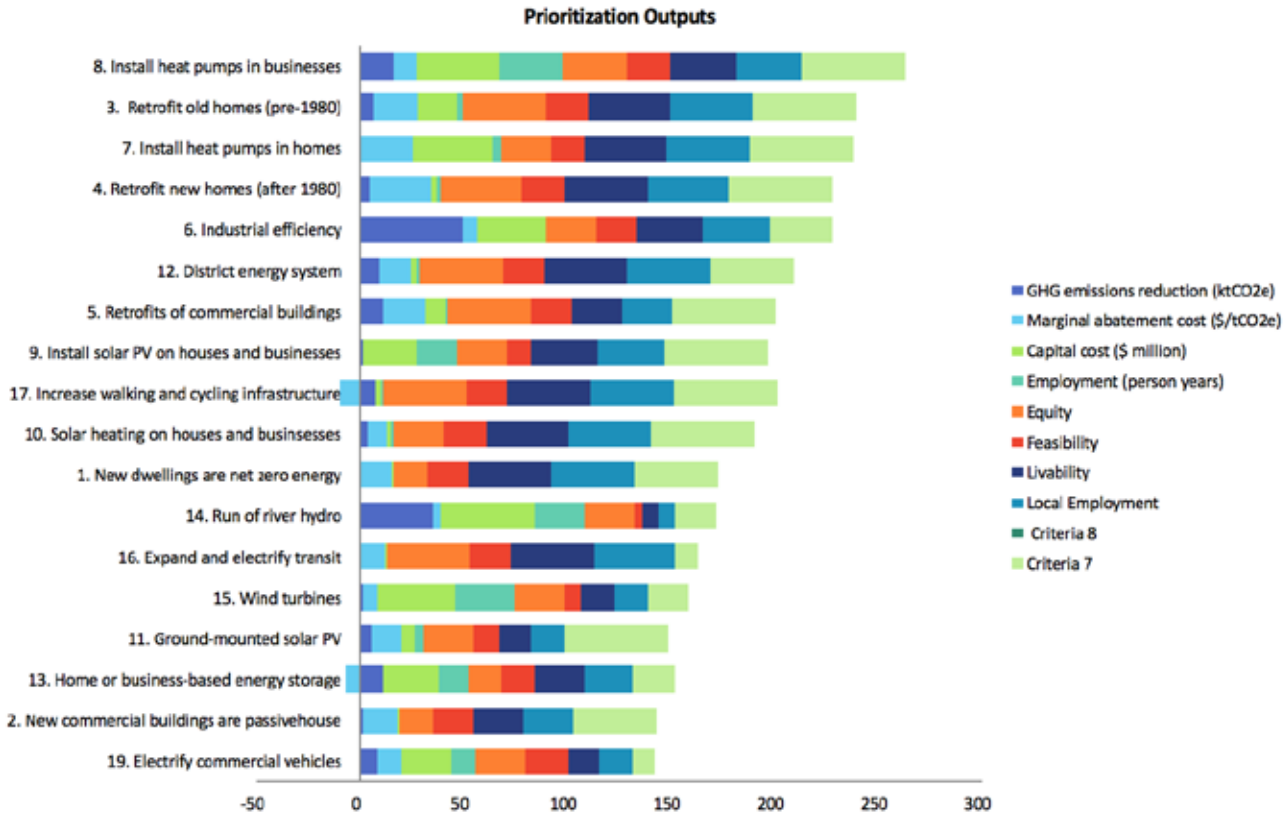

Figure 34. Sample results from an MCA

MCA sheds new light on the costs and benefits of the actions, including which actions may require greater implementation considerations, to ensure co-benefits are maximized. The MCA provides insight on which actions will be of most benefit to specific stakeholders, which can then be involved in the implementation process.

Appendix 11: Municipal Land-use Policies to Support GHG Mitigation in Ontario

Planning Act	Description	Potential Approaches to Addressing Climate Change
Provincial Plans (Section 1)	» Provincial plans defined in the Planning Act include a number of provincial plans established through respective legislation.	» A planning decision including a decision by an appeal body in respect of the exercise of any authority that affects a planning matter shall conform with the provincial plans that are in effect on that date, or shall not conflict with them, as the case may be. » Comments, submissions or advice affecting a planning matter that are provided by the council of a municipality, a local board, a planning board, a minister or ministry, board, commission or agency of the government shall conform with the provincial plans that are in effect on that date, or shall not conflict with them, as the case may be. » All defined provincial plans include a range of policies from different perspectives and for different geographical areas addressing climate change.
Official Plans (Section 16)	» Official plans describe municipal council's policies on how land should be used. An official plan deals mainly with issues such as: » where new housing, industry, offices and shops will be located » what services like roads, watermains, sewers, parks and schools will be needed » when, and in what order, parts of the community will grow » community improvement initiatives.	» Many Ontario municipalities have incorporated climate change related policies into their official plans. » » On December 12, 2017, the Building Better Communities and Conserving Watershed Act, 2017 (Bill 139) received Royal Assent. It will require that all municipal official plans shall contain climate change policies that identify goals, objectives and actions to mitigate greenhouse gas emissions and to provide for adaption to a changing climate, including through increasing resiliency.

Planning Act	Description	Potential Approaches to Addressing Climate Change
Community Improvement Plans (Section 28)	» Community improvement plans (CIP) focus on the maintenance, rehabilitation, development and redevelopment of targeted areas. » Municipal councils must adopt official plan policies and a by-law to designate a community improvement project area; and official plan policies must specify municipal programs and incentives and their eligible works, improvements, buildings or facilities. » Prescribed upper-tier municipalities may adopt CIPs dealing with prescribed matters to support higher density mixed-use development and redevelopment along existing or planned transit corridors, and infrastructure improvement and development (e.g. alternative energy systems and renewable energy systems, waste management systems, and water works, wastewater works, stormwater works and associated facilities). » Municipalities can make grants or loans within CIP project areas to help pay for certain costs, and can establish Tax-Increment-Equivalent Financing programs (TIEF).	» Promote neighbourhood revitalization by incorporating a range of energy conservation approaches (e.g. community energy, green roofs and walls, solar panels, landscaping, etc.) » Help improve and develop new stormwater facilities to make communities more resilient to extreme weather events. » Support the building of bike lanes and related facilities.
Zoning By-Laws (Section 34)	» Municipal zoning by-laws regulate land-uses and physical characteristics of land-use (e.g. building height, density, location and parking). » Zoning by-laws implement the objectives and policies of a municipal official plan. » Require council/approval authority to pass zoning by-laws and zoning by-law amendments. » Can be used on a municipal-wide or site-specific basis.	» Can ensure mixed-use and compact development, thus reducing greenhouse gas emissions; » Can place buildings and arrange building mass in a way that frames the public realm and promotes the use of renewable energy and energy conservation; » Can set a minimum building height which can contribute to safer, more compact, well-designed, walkable and vibrant streetscapes; » Can reduce development pressures on agricultural and resource areas; » May create shorter trip distances to employment and nearby services, and improve the viability of walking and cycling through mixed-use, compact form and reduced parking.

Planning Act	Description	Potential Approaches to Addressing Climate Change
Minimum / Maximum Standards in Zoning (Subsection 34 (3) and the City of Toronto Act (Section 113)	» Clarifies that zoning by-laws can regulate minimum as well as maximum standards for height and density and minimum lot area » Does not require official plan policies in place	» Can promote safe, compact, well-designed, walkable and vibrant streetscapes and communities, thus reducing greenhouse gas emissions; » Can establish an urban design standard to ensure compatibility with adjacent buildings and the surrounding neighbourhood; » Can support intensification and transit supportive goals, thus reducing development pressure on green and open spaces and promoting active transportation.
Site Plan Control (Section 41 and the City of Toronto Act Section 114)	» Site Plan control is a technical design refinement process that builds upon zoning for the proper design and functioning of a site, and requires official plan policies for set up. » A site plan control by-law must be passed by the municipality designating all or any part of the area shown in the official plan as a site plan control area » Can regulate certain external building, site and boulevard design matters (character, scale, appearance, sustainable streetscape design) » Allows for limited conditions related to design matters	» Can help implement municipal urban design objectives; » Can improve design quality of sites, buildings, streetscapes and places; » May require sustainable design features to support energy efficiency, sustainable transportation options, water conservation, and improved air and water quality; » May enable strategic tree planting to provide shelter from cold winter winds and provide shade in the summer.
Height and Density Bonusing (Section 37)	» A process allowing buildings to exceed the height and density of development otherwise permitted by zoning by-laws in exchange for community benefits » A municipality must have approved official plan policies related to bonusing in place. » A municipal council must pass a zoning by-law to authorize increases in height and density of a development in return for the provision of facilities, services, or matters of community benefit. » Often negotiated between a developer and a municipality	» Many Ontario municipalities have considered a range of community benefits such as: » Local improvements to transit facilities, » Provision of pedestrian and cycling facilities, » Provision of parkland and/or park improvements, » Conservation of greenspace and urban forests, » Energy conservation and environmental performance measures, » Enhancement of the natural heritage system.

Planning Act	Description	Potential Approaches to Addressing Climate Change
Plan of Subdivision (Section 51)	» Plan of subdivision is a process of creating multiple lots. It requires plan approval from the approval authority. » The approval authority may impose conditions to the approval of a plan of subdivision, including requirements for land dedication or other requirements.	» Planning approval authorities may assess subdivision design and layout having regard to matters such as street connectivity to support transit, cycling and walking, the conservation of natural resources, and the size, shape and orientation of lots to facilitate the efficient use and conservation of energy. » Can play a central role in creating compact, integrated neighbourhoods.
Community Planning Permit System (Section 70.2,	» Community Planning Permit System (formerly Development Permit System) combines zoning, site plan control and minor variance into one streamlined application and approval process. » It requires official plan policies and a community planning permit by-law in place, and may apply to all or part of a municipality defined as Community Planning Permit Area. » Allows municipalities to impose conditions which shall be outlined in permit by-laws and may be set out in agreements and registered on title.	» Municipalities have the ability to impose a range of conditions on the issuance of a permit, provided that these conditions meet prescribed criteria. For example: » Conditions could include those related to vegetation removal and site alteration, as well as ongoing monitoring requirements to ensure public health and safety and protection of the natural environment; » Conditions could include the provision of specified facilities, services or matters for specified density or height, including increases in these, provided that prescribed criteria are met.
Zoning with Conditions (Subsection 34 (16) and the City of Toronto Act Subsection 113 (2))	» Municipalities could impose zoning with conditions, provided a regulation was put into place prescribing conditions that could be applied, along with limitations. » Can be 'as-of-right' conditions in area-wide zoning by-law and 'conditions per site' under zoning by-law amendment. » Require official plan policies relating to zoning with conditions in place » Provincial regulation has not been in place.	» Provides an opportunity to increase development potential that might not otherwise be permitted without conditions. » The tool is not yet in effect as in order to do so, there needs to be a provincial regulation. The previous regulation consultation has indicated that a number of potential conditions relate to climate change, such as conditions related to: » Adequate provision of permitted hard services (e.g. water, waste, energy), » Provision for energy conservation and alternative energy provisions (e.g. district energy), » Promoting the maintenance, restoration or improvement of the diversity and connectivity of natural features and long-term ecological function and biodiversity of natural heritage systems, » Restrictions on impervious surface coverage.

Appendix 12: Sample Energy and Emissions Plan Contents

Figure 4: Typical contents of a stand-alone, city-level climate action plan

- A long-term **vision statement**, supported by clear objectives and targets, set in short, medium and long-term timescale and grouped into several strategic areas, sectors, or 'pillars'.
- An **introduction**, describing how the plan was developed, including public participation processes.
- A **description** of how the climate action plan links with other existing/statutory plans in the city, and other local socio-economic and environmental goals.
- A **description** of how climate action planning links to other national, regional goals, regulations, plans and processes.
- A **technical and scientific summary** including a statement on the science behind climate change and projections of climate impacts, and baseline assessments such as a greenhouse gas emissions inventory, a vulnerability assessment and health implications, or a local renewable energy potential assessment.
- An **overview** of existing adaptation or mitigation related initiatives.
- A **summary** of how actions were prioritized and other decisions were made, including the criteria used.
- **Sets of actions**, organized according to several **strategic areas** with corresponding goals, selected in accordance with criteria, and ensuring co-ordinated action.
- A **strategy for outreach, education, communication and dissemination**.
- A **framework for reporting** results and ensuring accountability.
- A **monitoring and evaluation framework,** along with key performance indicators, for measuring progress, updating actions.
- A **glossary** to explain unavoidable technical terms.

Table 76. Appendix 13: Sample Policies and Mechanisms for Implementing Low Carbon Actions

Action		Local Government Spheres of Influence			
		Own or operate	Control budget	Set or enforce regulations or policies	Set vision
		Sample Policies or Mechanisms			
LAND-USE					
1	Concentrate development in areas appropriate for district energy and amenity and transit accessibility	Location of municipal amenities (recreation centres, libraries, etc)		Bylaws, bonusing, settlement area boundaries, development permits	Official Plan, supporting planning documents
2	Sustainable community design and development	Location, design and operation of municipal amenities		Secondary plans	Official Plan, supporting planning documents
TRANSPORTATION					
2	Enhanced transit	Transit authority		Bylaws, bonusing	Official Plan, Transportation Plan
3	Transportation demand management	Transit authority programs	Personal transportation planning		
4	Enhanced walking and cycling infrastructure	Bike share programs	Physically separated bike lanes	Community Improvement Plan	
5	Increased adoption of electric vehicles	Municipal fleet; public charging stations	Electric vehicle incentives	Construction and major renos. charger requirements; parking policy	Transportation Plan
BUILDINGS					
6	Required advanced energy performance	Municipally owned building performance requirements		Energy performance requirements using site plan approvals	Official Plan
7	Retrofit homes	Municipally owned utility	Local improvement charges		Partnership with utilities or private sector
8	Retrofit commercial buildings				
9	Re-commission buildings				
ENERGY SYSTEM					

Action		Local Government Spheres of Influence			
		Own or operate	Control budget	Set or enforce regulations or policies	Set vision
		Sample Policies or Mechanisms			
10	Solar PV in new buildings	Municipally owned utility	Local improvement charges	Zoning by-law, site control plans	Official Plan, Community energy and emissions plan
11	Solar PV retrofits				
12	Introduce zero carbon district energy systems		Local improvement charges, Community Improvement Plans		
13	Install electric heat pumps		Incentives		
14	Install distributed energy storage				
15	Increase renewable natural gas use		Community choice aggregation		
INDUSTRY					
16	Increase industrial process efficiency	Municipally owned utility		Site control plans	Official plan
FREIGHT					
17	Transition to zero emissions vehicles	Municipal fleet requirements	Incentives, charging stations	Congestion zone, parking policies	Official Plan, Transportation Plan
WASTE					
18	Increase waste diversion rates	Waste management program			Waste management plan
19	Generate biogas from wastewater	Municipal utility			
AGRICULTURE, FORESTRY & LAND-USE					
20	Increase carbon sequestration areas		Urban forestry & wetland restoration programs	Green belt, parks, urban forest	Official Plan