ENERGY EVOLUTION:

OTTAWA'S COMMUNITY ENERGY TRANSITION STRATEGY

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Thank You to Our Partners

City staff benefited immensely from feedback and leadership provided by community stakeholders throughout the development of Energy Evolution: Ottawa's Community Energy Transition Strategy. The City extends its sincere thanks and appreciation to almost 200 public and private stakeholders representing more than 90 organizations who participated in high-level "Sounding Board" discussions as well as technical workshops.

- Arborus Consulting
- Association of Energy Engineers – Eastern Canada Conference
- Aspen Solar Management
- Atmospheric Energy Systems
- BGIS
- Building Owners and Managers Association
- Bullfrog Power
- Burritts Rapids Renewable Energy Association
- Canada Green Building Council
- Canadian Association for Renewable Energies
- Canadian Biogas Association
- Canadian Geoexchange Coalition
- Canada Science and Technology Museum Corporation
- Canadian Urban Transit Research and Innovation Consortium
- CanmetENERGY
- Carbon Impact Consultants
- Carleton University
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- Chamber of Commerce
- CH Four Biogas
- City of Ottawa (various departments and branches)
- City of Hamilton (Office of Energy Departments)
- City of Markham (Solid Waste)
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- Clean Air Partnership
- Clean Energy Canada
- Community Associations for Environmental Sustainability
- Communauto
- Domicile Development Inc.
- Eastern Ontario Landlords Organization
- EcoGen Energy Inc.
- Ecology Ottawa
- Econogics Inc.
- EDF Renewable Energies
- Electric Vehicle Council of Ottawa
- Enbridge Gas Distribution Inc.
- Energy Ottawa
- Envari
- Envirocentre
- Enwave
- Federation of Canadian Municipalities
- FVB Energy Inc.
- GHD Limited
- Gloucester Housing Corporation
- Greater Ottawa Home Builders' Association
- Green Communities Canada
- Healthy Transportation Coalition
- Hydraulic Energy and Renewable Energy Technologies
- Hydro One

- Hydro Ottawa
- Independent Electricity System Operator
- Innovative Hydro Controls
- Invest Ottawa
- iSolara Solar Power
- JAZZ Solar Solutions
- JJ McNeil Commercial Inc
- J. Michael Wiggin Consulting
- JL Richards
- Ken Church Consulting
- Leidos Canada
- Lumos Energy
- Master Group
- Minto Group
- National Capital Commission
- National Research Council
- Natural Resources Canada
- Norsun Energy
- Nova Bus
- Ontario Biogas Association
- Ontario Ministry of Agriculture, Food and Rural Affairs
- Ontario Energy Board
- Ottawa Carleton District School Board
- Ottawa Centre EcoDistrict
- Ottawa Climate Action Fund
- Ottawa Community Foundation
- Ottawa Community Housing
- Ottawa Gatineau Hotel Association
- Ottawa Macdonald Cartier International Airport
- Ottawa Renewable Energy Co-operative
- Ottawa Regional Society of Architects
- Ottawa Student Transportation Authority
- Passive House Canada
- Peak Power Energy
- Plug ‘N Drive
- Pollution Probe
- Public Services and Procurement Canada
- QUEST
- Regional Group
- RND Construction
- Rightwheel Inc
- Smarter Shift
- Sustainability Solutions Group
- Transport Canada
- Treasury Board of Canada
- Tucker House Treasury Board of Canada
- University of Ottawa
- VRTUCAR
- Wastewatch Ottawa
- whatIf? Technologies Inc
- Windmill Development Group Ltd
- WSP
- ZEBx
- Zibi

Additionally, sincere thanks and appreciation to the following City stakeholders for providing their subject matter expertise and continued feedback throughout the process.

- Climate Change Council Sponsors Group
- Mayor’s Office
- City Manager’s Office
- City Departments
    - Financial Services
    - Innovative Client Services

    - Planning, Infrastructure and Economic Development
    - Public Works and Environmental Services
    - Recreation, Cultural and Facility Services
    - Transportation Services
- Ottawa Public Health

Message from the Climate Change Council Sponsor's Group Chair

In 2020, Ottawa City Council took a bold step in unanimously approving our Climate Change Master Plan. Coupled with a declaration of a Climate Emergency, it was a strong commitment toward a better future for our city and beyond. Alone, though, the adoption and declaration are simply not enough.

To that end, Ottawa has committed to reducing community emissions by 100% by 2050 and reducing emissions from City operations by 100% by 2040. This puts us in lock step with the recommendations of the Intergovernmental Panel on Climate Change.

Energy Evolution will outline what it will take to achieve the ambitious targets mentioned above. These are achievements that will not be reached in isolation. There is not a single municipality or government who can achieve this alone. We all must work together and support each other to get there.

We all play a role in this process and toward these stated goals. Residents, business, utility companies, governments large and small. We are all in this together and together is how we will find success.

Councillor Scott Moffatt
Chair, Standing Committee on Environmental Protection, Water and Waste Management

Executive Summary

On January 29, 2020, Ottawa City Council approved short, mid, and long-term community and corporate GHG emission reduction targets that aligned with the Intergovernmental Panel on Climate Change target to limit global warming increases to 1.5ºC.

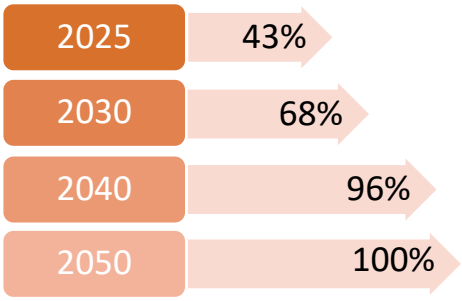

Figure 1: Short, Mid and Long-term Community Targets to Reach 100% by 2050 Target

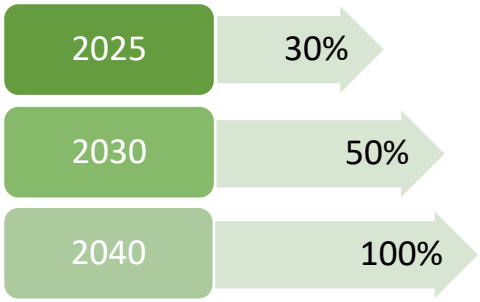

Figure 2: Short, Mid and Long-term Corporate Targets to Reach 100% by 2040 Target

Energy Evolution sets the framework for what it will take for Ottawa to achieve these GHG emission reduction targets. It is a community energy transition strategy designed to manage energy consumption, promote the use of renewable energy and advance local economic development opportunities in Ottawa. Developed in collaboration with more than 40 staff representing six departments, almost 200 public and private stakeholders representing more than 90 organizations, and the Climate Change Council Sponsors Group, Energy Evolution is a community-wide initiative with a vision to transform Ottawa into a thriving city powered by clean, renewable energy.

This strategy responds to Council's directive to identify the scale of change and investment required to achieve Council's long-term GHG reduction targets. It acknowledges that achieving these targets will require concerted efforts and collaboration across all sectors of society, and that the scope and scale required is unprecedented in both action and investment. Realizing this action and investment carries many risks including that the strategy is currently under resourced and unfunded and will rely on involvement and funding from all levels of government.

This strategy also advances the 2019-2022 Term of Council priority Environmental Stewardship by identifying projects to reduce the City's GHG emissions and embed climate change considerations across all operations. It aims to strengthen Council's commitment to naming, framing and deepening Ottawa's commitment to protecting our economy, our ecosystems, and our community from climate change and it helps implement the Climate Change Master Plan.

Energy and Emissions Model

At the core of Energy Evolution is a comprehensive, custom-built energy, emissions and finance model. The model incorporates growth, land use, buildings, transportation, and

waste data with energy conservation, efficiency, and renewable energy pathway studies and presents two GHG emission scenarios:

- A Business-As-Planned scenario (BAP scenario)
- A 100% by 2050 target scenario (100% scenario)

The model projects that Ottawa's emissions will remain relatively flat for the next 30 years under the BAP scenario, far from achieving the long-term target to reduce emissions by 100% by 2050. In order to achieve the 100% scenario, the model identifies the need to greatly reduce energy demand through conservation and efficiency and projects that:

- All fossil fuels will have to be phased out;
- Heating and transportation systems will have to be nearly fully electrified or transition to zero emission;
- Waste heat utilization and renewable natural gas production will have to be added;
- Sufficient renewable electricity (mostly wind and solar) generation and electricity storage will be required to meet demand and offset emissions on the provincial grid.

Benefits of a Community Energy Transition Strategy

There are many co-benefits that can be achieved through a community energy transition to low-carbon energy sources, including:

- Local Economic Development, including job creation, access to funding, and local energy dollar creation;
- Improvements to Public Health;
- Equity and Inclusion;
- Energy Resiliency and Security;
- Mitigating Future Risks.

Achieving the 100% Scenario

The model projects what outcomes are required to meet the 100% scenario in five key sectors: Land Use and Growth Management, Buildings (New and Existing), Transportation, Waste and Renewable Natural Gas, and Electricity. It will require implementation of the municipality's ongoing and planned actions, implementation of new actions that the municipality has not yet approved, and action and investment from all segments of society. Tables 1 through 7 and Figure 3 provide a summary of the projected GHG emission reductions and proposed projects by sector to achieve the 100% scenario.

Table 1 identifies the projected emissions reduction by sector to achieve the 100% scenario. According to the model, the buildings and transportation sectors are projected to account for roughly 75% of cumulative emission reductions from now until 2050. The remaining 25% is projected to come from the waste and renewable natural gas, and electricity sectors.

Table 1: Total projected community-wide GHG emission reductions required to achieve 100% scenario incremental to BAP scenario, 2030 and 2050 (non-cumulative)

Sector	Percentage (%) of Total Projected GHG Emission Reductions	
	2030	2050
Land Use and Growth Management	Embedded in other actions	Embedded in other actions
Buildings (New and Existing)	37.1%	38.0%
Transportation	29.9%	36.7%
Waste and Renewable Natural Gas	26.1%	16.9%
Electricity	6.5%	8.5%

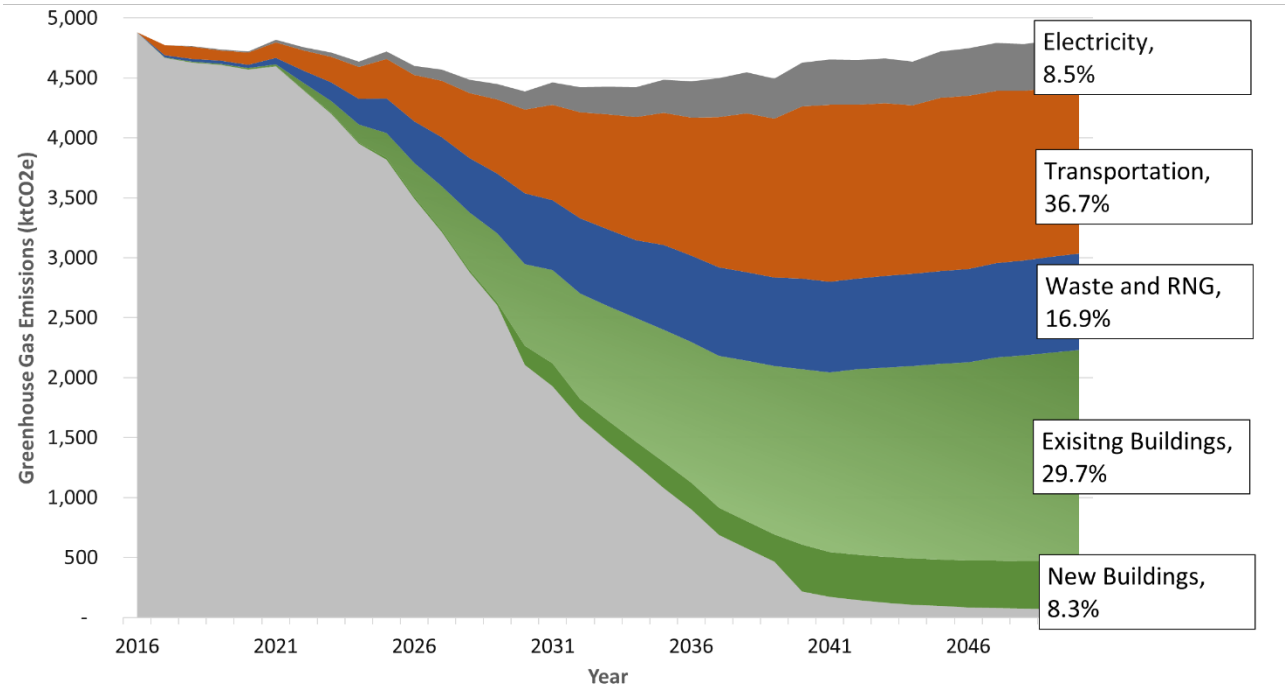

Figure 3: Total projected community-wide GHG emission reductions required to achieve 100% scenario incremental to BAP scenario by sector, 2016-2050. (percentages shown at 2050 are non-cumulative)

Within those sectors, 39 actions have been identified to achieve the 100% scenario. Table 2 identifies the top five actions from the model, which combine for roughly 80% of projected cumulative GHG emission reductions required.

Table 2: Projected top five actions from the energy and emissions model to achieve the 100% scenario by 2050

Actions	**Cumulative GHG Reductions by 2050 (%)**
1. Electrify personal vehicles	22.7%

Actions	Cumulative GHG Reductions by 2050 (%)
2. Retrofit residential buildings[1]	17.9%
3. Divert organics and create renewable natural gas[2]	17.2%
4. Retrofit commercial buildings[3]	15.1%
5. Transition to zero emission commercial fleets	8.3%

A total of 20 projects have been identified over the next five years to accelerate action and investment towards achieving the 100% scenario. Most of the projects are to be led by the municipality and are to be undertaken in collaboration with community partners. Proposed projects are contingent on future Standing Committee and Council approval as well as future staff and budget (capital and operating). To achieve the GHG reductions required in the 100% scenario, some projects may evaluate options beyond what's been identified prior to going to Standing Committee and Council.

Table 3: Projects to be undertaken in the land use and growth management sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Integration of energy and climate mitigation policies into the new Official Plan and supporting master plans to address multiple challenges being faced by the city over the next 25 years, climate change being one of the most critical. The Official Plan and supporting master plans will be guided by the Climate Change Master Plan with Council approved targets to reduce GHG's by 2050.	• Energy and climate mitigation policies embedded in new Official Plan and supporting master plans	Enabler

[1] Includes retrofitting pre and post-1980 homes, low rise residential and apartment building heat pumps
[22] Includes waste diversion and RNG production, rural biogas generation, waste heat, and power to gas
[3] Includes retrofitting commercial, offices, and residential buildings, and commercial building heat pumps

Table 4: Projects to be undertaken in the buildings sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Residential Building Retrofit Accelerator Program to accelerate residential, multi-unit residential, and commercial and institutional building retrofits through marketing, information and financial mechanisms	• 17% of existing residential buildings renovated or replaced • 20% of existing residential buildings transition to heat pumps • 10% of domestic hot water heating transitions to non-emitting sources	22% (222 kt CO2e)
Commercial Building Retrofit Accelerator Program to accelerate multi-unit residential, commercial, industrial, and institutional building retrofits through marketing, information and financial mechanisms	• 15% of existing commercial buildings renovated or replaced • 20% of existing commercial buildings transition to heat pumps • 10% of domestic hot water heating transition to non-emitting sources	18% (175 kt CO2e)
Building Retrofits through Local Improvement Charge Program to accelerate and finance deep energy retrofits of buildings through the local improvement charge mechanism	Embedded within the Residential and Commercial Retrofits Accelerator Programs	
Energy Community Improvement Plans to incentivize superior energy performance and deep energy retrofits using tax grants.	Embedded within the Residential and Commercial Retrofits Accelerator Programs	

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Community Building Heating Strategy to address infrastructure and utility requirements for new ways of heating buildings	30% drop in GHG intensity of federal district energy system	9% (92 kt CO2e)
Municipal Buildings Retrofit and Renewal Program to achieve higher building energy performance improvements in municipal owned buildings	Ramping towards having 27% of municipal buildings net zero by 2030	1% (12 kt CO2e)
Update Municipal Green Building Policy to align with corporate GHG reduction targets	Embedded within the Municipal Buildings Renovation and Retrofit Program	
High-Performance Development Standard to improve building design and construction across the community and support an industry-wide transition of new buildings to net zero emissions ready by 2030.	Ramping towards all new buildings being net zero energy by 2030	6% (59 kt CO2e)

Table 5: Projects to be undertaken in the transportation sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Personal Vehicles Electrification Strategy to enable and encourage personal electric vehicle adoption.	7% of personal vehicle sales are EVs in 2025	5% (49 kt CO2e)
Zero Emissions Commercial Vehicles Strategy to enable and encourage commercial electric vehicle adoption.	18% of commercial fleet is electric by 2025	6% (63 kt CO2e)
Municipal Green Fleet Plan Update to consider corporate greenhouse gas reduction targets.	Progress towards the 2030 target	<1% (<10kt CO2e)
Alternative Energy Sources for Transit Project to build a 100% zero emissions Concept Transit Network[4] by 2030.	48% of OC Transpo's passenger fleet is zero emission by 2025	6% (63 kt CO2e)
Transportation Mode Shift to reduce the reliance on personal vehicles in favour of sustainable modes including public transit, walking, cycling and carpooling.	Steady progress towards the 2030 mode share targets	3% (33 kt CO2e)

[4] The Concept Transit Network refers to the 2013 Transportation Master Plan rapid transit 2031 network concept.

Table 6: Projects to be undertaken in the waste and renewable natural gas sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Organics Resource Recovery Strategy to reduce emissions associated with managing waste and enable energy from waste.[5]	Significant increase in organics diversion starting in 2023	7% (73 kt CO2e)
Renewable Natural Gas Strategy to supply GHG neutral gas and other heating to the community.	Initial renewable natural gas production in the community starting in 2022	12% (122 kt CO2e)

Table 7: Projects to be undertaken in the electricity sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Electricity Resource Strategy to develop local or regional renewable electricity supplies and advocate for zero-emission generation at the provincial level.	Install: • 150 MW Solar • 20 MW Wind • 20 MW Hydro • 20 MW Electricity Storage	7% total, comprised of: • Solar: 57 kt CO2e • Wind: 4 kt CO2e • Hydro: 10 kt CO2e

Table 8: Enabling projects to support meeting the 100% scenario (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Climate Ambassadors Network to engage commercial and institutional champions to meet long term GHG reduction targets	• Reduced barriers to implementation • Increased funding to support implementation	Enabler
Climate Change Education and Outreach Program to engage the public in collective private action to meet long term GHG reduction targets	• Increased awareness and action	Enabler
Fund the Evolution to further assess potential sources of municipal funding, financing, and market enabling mechanisms	• Increased funding to support implementation	Enabler

[5] This will be considered for residential waste management through the municipal Solid Waste Master Plan (SWMP), expected to be complete by the end of Q2 2022. The SWMP will determine the direction and goals for residential solid waste management, diversion, and reduction over the next 30 years.

Financials

A community-wide financial analysis was undertaken to analyze those Energy Evolution actions that have financial impacts. The analysis represents investments required by and potential savings for everyone in Ottawa including the municipality, residents, businesses, institutions, and organizations.

All financial information presented represents high level estimates that are currently uncommitted and unfunded capital and operational needs. The analysis does not commit the municipality or any partners to any financial decision or provide direction on how to address funding gaps. The analysis is intended to:

- Identify the magnitude of funding required to implement Energy Evolution for the municipality and community partners, including senior levels of government
- Assess which potential funding sources, financial mechanisms or delivery mechanisms may be most appropriate for implementing Energy Evolution actions
- Inform strategic discussions, policy direction, annual budget cycles and the Long-Term Financial Plan.

It is not intended to provide sufficiently accurate financial information to make decisions. This level of detail will be brought forward to Standing Committee and Council when approval is sought on priority projects.

The financial analysis projects that in order to meet the 100% scenario cumulative community-wide investment from 2020 to 2050 totals $57.4 billion with a present value of $31.8 billion. All costs and net returns projected for the 100% scenario are incremental, above and beyond the BAP scenario. In the short term, annual community-wide capital costs are higher up-front as investments in public infrastructure, buildings, vehicles, energy-related equipment and renewables are made that will lead to long-term savings. Starting in 2032, there is a projected net financial benefit to society when the net annual savings and potential revenues exceed the annual investments. Investments made by 2050 will accrue a community-wide net return of $87.7 billion ($12.4 billion when discounted to 2020$). In the year 2050, the community will have accrued a potential net return of $28.4 billion, ($2.7 billion in 2020$). Table 9 shows how the net return could accumulate to 2050 and beyond based on the life expectancies of the investments made.

Table 9: Financial net value to society for achieving the 100% scenario

Capital Investments and Savings	Undiscounted ($Billion)	Present value (4.5% discount rate) ($Billion)
Capital investments	($57.4)	($31.8)
Operations and maintenance savings	$22.6	$9.0
Energy savings	$70.9	$18.1

Capital Investments and Savings	Undiscounted ($Billion)	Present value (4.5% discount rate) ($Billion)
Carbon price savings	$13.4	$4.0
Revenue from local generation	$38.2	$13.1
Community-Wide Net Return	**$87.7**	**$12.4**

Annual incremental community-wide investments of approximately $1.6 billion per year net present value would be required for the next decade (2020-2030) to achieve GHG reductions in line with the model and the 100% scenario. Of this, $581 million per year net present value would be required (2020-2030) for transit and active transportation infrastructure and an additional $41 million per year net present value would be required (2020-2030) for municipal building retrofits, zero emission non-transit municipal fleet, and renewable natural gas generation at wastewater, solid waste or agricultural facilities. Annual incremental community-wide investments drop to around $782 million per year from 2031-2050. During this period, net returns are expected to be much higher primarily due to saved energy costs and earned revenues from local energy generation. A breakdown of the actions bundled into each of the sectors is provided in Table 22.

Table 10: Breakdown of net costs and returns by sector (Net Present Value 2020$, in billions)

Sector	Estimated Net Costs ($Billions)	Estimated Net Returns by 2050 ($Billions)	Estimated Net Returns over Life of Investment ($Billions)
Land Use and Growth Management	$0	$0	$0
Buildings (New and Existing)	($17.7)	($6.0)	$0.4
Transportation	($7.9)	$3.9	$4.8
Waste and Renewable Natural Gas	($0.2)	$0.01	$0.02
Electricity	($6.0)	$4.8	$7.2
Total	**($31.8)**	**$2.7**	**$12.4**

It is recognized that the municipality alone will not be able to accomplish the scale of investment required. Future year funding commitments by the municipality, combined with revenue streams, private capital sources, and funding from senior levels of government will ultimately influence the City's success in achieving emissions reductions. Approval of future municipal annual incremental operating requests will be critical to expanding the staffing and resource capacity of departments who are leading projects to advance Energy Evolution. This funding would enable program optimization and improve the likelihood of leveraging capital from external sources, including federal grants and infrastructure monies.

Risks to Implementation

The scope and scale required to achieve the 100% scenario is unprecedented in both action and investment. Realizing this action and investment carries many risks. These risks may include:

- Insufficient financial support from different levels of government and the private sector to meet the budgetary and staffing needs of the 20 Energy Evolution projects and beyond;
- Higher capital and operating costs, as well as lower than expected saving and revenues, beyond what's currently estimated for project implementation and municipal operations;
- Regulatory barriers and compliance issues that impede the municipality from action and innovation, either by impeding the municipality directly through its own operations or impeding how the municipality can enact change in the community;
- Lack of uptake or buy-in from residents, businesses, industry or the municipality that impacts the viability of a new program or new standard;
- Diverging interpretations between stakeholders on how best to achieve the 100% scenario;
- Competing Council priorities or processes associated with other projects across the corporation;
- Competing departmental priorities including current operational mandates of impacted services, and how their mandates will need to change in order to work to achieve the emissions reductions in Energy Evolution;
- Lack of alignment between what the Energy Evolution model calls for and recommendations that come forward for plans and strategies that directly relate to Energy Evolution. Note that although it is expected that the range of options evaluated will include one or more scenarios that achieve the GHG reductions required in the 100% scenario, those scenario(s) may not ultimately be recommended;
- Aggressive implementation timelines which may not account for typical City processes including capital budget approval, Long-Range Financial Plan, planning, consultation, approvals, design, construction, and commissioning or account for provincial or federal approval processes that are out of the City's control.
- Changes in behavior, policy, and best practices related to COVID-19.

To mitigate these risks, the Energy Evolution project team will continue to work with City staff at all levels across the corporation, community partners, other levels of government, and the public to build out Energy Evolution projects and act as a resource or provide

technical advice on related projects**.** Information and recommendations to support project implementation will be shared with a Tiger Team comprised of all General Managers, the Chief Financial Officer, the City Manager's Office and Ottawa Health; the Climate Change Council Sponsors Group; the Environmental Stewardship Advisory Committee; a community-wide governance structure; and community partners to align and coordinate priorities, workplans, annual budgets, communications and advocacy efforts. The Energy Evolution project team will also continue to work with municipal colleagues across the country through organizations like the Canadian Urban Sustainability Practitioners network, Clean Air Partnership and Low Carbon Cities Canada to share information, best practices, and lessons learned.

Additionally, at the time of the writing of the strategy, multiple City plans and strategies were in the process of being developed that directly relate to Energy Evolution including the new Official Plan, the Transportation Master Plan Update, the Solid Waste Master Plan, Alternative Energy Sources for Transit Project, and the Municipal Green Fleet Plan. It is understood that these plans will complete their own options analysis to achieve each respective plan's goals and targets and that the outcomes may differ than what has been identified. It is expected that the range of options evaluated will include one or more scenarios that achieve the GHG reductions required in the 100% scenario, although those scenario(s) may not ultimately be recommended.

Next Steps and Reporting

- All 20 projects will be further developed with input from staff, stakeholders, and the public as required. Some projects may evaluate options beyond what's been identified prior to going to Standing Committee and Council. Once projects are fully developed projects will be brought to the appropriate future Standing Committee and Council for approval.

- Staff will develop a 10-year spending plan that can be considered in annual municipal budget processes and feed into the City's Long-Range Financial Plan. The next Long-Range Financial Plan will be updated at the beginning of the 2022-2026 term of Council. Budget and staffing requirements would be brought forward as part of the annual budget process.

- Staff will continue to engage with and provide training to staff and the public to embed climate considerations more broadly across the corporation and the community.

- Staff will prepare department specific presentations on Energy Evolution starting in 2021 to ensure that staff across the corporation are aware of, can align with, and continue to make use of relevant information. They will be delivered to Departmental Leadership Teams and offered to appropriate Service Area, Branch or Units teams to support ongoing alignment of priorities, workplans, and budgets.

- Staff intend to rerun the energy and emissions model every five years to assess how the City and the community are tracking towards achieving the 100% scenario and to determine what actions should be prioritized in the short-term.
- As part of the annual status update on the Climate Change Master Plan, staff will include annual corporate and community GHG inventories to help gauge Ottawa's progress towards GHG emission reduction targets, provide a status update on the Energy Evolution projects, and recommendations to advance the projects as required.
- A full review and update of the Climate Change Master Plan will be completed in 2025. Simultaneously, Energy Evolution and the future Climate Resiliency Strategy will be reviewed to see whether the three standalone documents can be merged into one.

Council Direction

In July 2015, development of a Renewable Energy Strategy (later renamed Energy Evolution) was identified as a strategic priority within the 2015-2018 City Strategic Plan.

In December 2017, Council received Energy Evolution Phase 1 and directed staff to initiate the recommendations in the report and complete Phase 2 of the Energy Evolution Strategy (ACS2017-PIE-EDP-0048).

In April 2019, City Council approved a motion to declare a climate emergency (ACS2019-CCS-ENV-0005) which included the following directions for the Energy Evolution final report:

- Status update of Energy Evolution Phase 1 actions
- New concrete actions and resource implications (staff and financial) to achieve GHG emission reduction targets
- Use an equity and inclusion lens in the prioritization of actions
- Funding and savings options for the City when implementing emission reductions

In January 2020, City Council unanimously approved the Climate Change Master Plan which included setting new short, mid and long-term targets to reduce community GHG emissions by 100% by 2050 and corporate GHG emissions by 100% by 2040. Energy Evolution is one of eight priority actions under the Climate Change Master Plan. Council also received an update on Energy Evolution and a draft energy and emissions model (ACS2019-PIE-EDP-0053).

1.0 Introduction

Worldwide, climate scientists agree that fast-rising global temperatures have created a climate emergency.[6] In 2018, the Intergovernmental Panel on Climate Change (IPCC) released The Special Report on Global Warming of 1.5°C providing the scientific evidence for the need to limit global warming increases to 1.5ºC. The IPCC states that limiting global warming to 1.5ºC is possible but "would require rapid, far-reaching and unprecedented changes in all aspects of society"[7].

While the current climate trends are alarming, the technological solutions, skills and knowledge exist to transition away from fossil fuels to clean, renewable energy sources. According to the IPCC and international scientific consensus, there are about 10 years to make significant change if average global temperature increase is to be limited to 1.5ºC[i] and it will take accelerated community-wide action and investment.

On April 24, 2019, Ottawa City Council declared a climate emergency, joining a global movement calling for urgent action to avert the climate crisis. In less than a year, City Council responded to the declaration, hiring additional staff in the Climate Change and Resiliency team and unanimously approving the Climate Change Master Plan. Energy Evolution is one of eight priorities approved in the Climate Change Master Plan.

Figure 1 provides an overview of Ottawa's climate change framework and describes work associated with both mitigation and adaption.

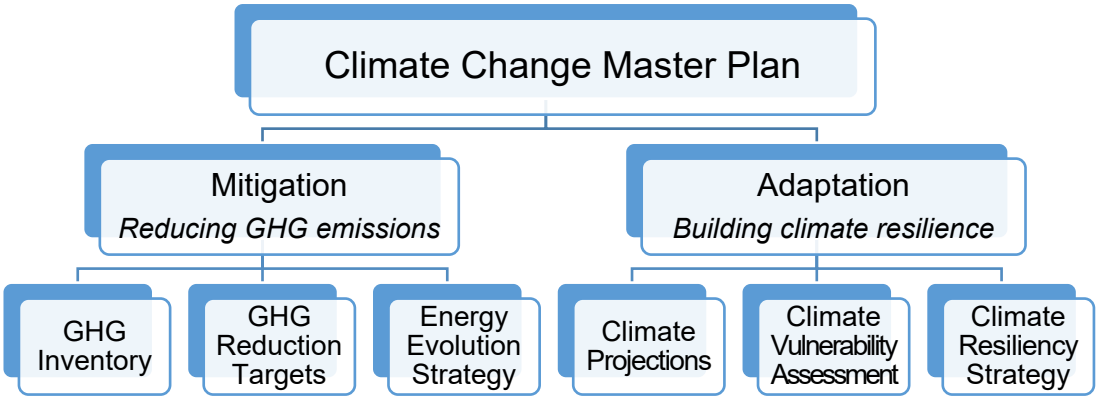

Figure 4: Climate Change Framework

[6] Carrington, D. (2019) Climate Crisis: 11,000 scientists warn of 'untold suffering', *The Guardian*, 5 Nov. https://www.theguardian.com/environment/2019/nov/05/climate-crisis-11000-scientists-warn-of-untold-suffering

[7] IPCC Press Release. Summary for Policymakers of IPCC Special Report on Global Warming of 1.5ºC approved by governments. October 8, 2018. https://www.ipcc.ch/site/assets/uploads/2018/11/pr_181008_P48_spm_en.pdf

2.0 What is Energy Evolution: Ottawa's Community Energy Transition Strategy?

On January 29, 2020, Ottawa City Council approved short, mid, and long-term community and corporate GHG emission reduction targets that aligned with the IPCC target to limit global warming increases to 1.5ºC.

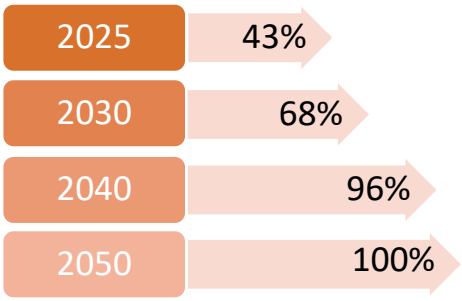

Figure 5: Short, Mid and Long-term Community Targets to Reach 100% by 2050 Target

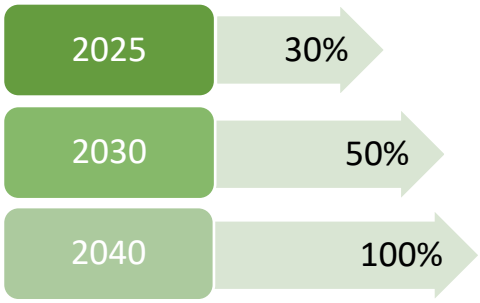

Figure 6: Short, Mid and Long-term Corporate Targets to Reach 100% by 2040 Target

Energy Evolution sets the framework for what it will take for Ottawa to achieve these GHG emission reduction targets. It is a community energy transition strategy designed to manage energy consumption, promote the use of renewable energy and advance local economic development opportunities in Ottawa. Developed in collaboration with more than 40 staff representing six departments, almost 200 public and private stakeholders representing more than 90 organizations, and the Climate Change Council Sponsors Group, Energy Evolution is a community-wide initiative with a vision to transform Ottawa into a thriving city powered by clean, renewable energy.

To achieve Energy Evolution's vision, residents, businesses, organizations and governments would be required to make a sustained transition away from a dependence on fossil fuels by:

- Reducing energy usage through conservation and efficiency
- Increasing the supply of renewable energy through local and regional production
- Prioritizing the procurement of clean, renewable energy.

At the core of Energy Evolution is a comprehensive, custom-built energy, emissions and finance model. The model incorporates growth, land use, buildings, transportation, and waste data with energy conservation, efficiency, and renewable energy pathway studies and presents two GHG emission scenarios:

- A Business-As-Planned scenario (BAP scenario)
- A 100% by 2050 target scenario (100% scenario)

The model projects what outcomes are required to meet these scenarios in five key sectors: Land Use and Growth Management, Buildings (New and Existing), Transportation, Waste and Renewable Natural Gas, and Electricity. To achieve the 100% scenario, rapid and far-reaching action and investment are required.

The model's financial analysis provides high-level cost estimates and preliminary estimates of savings and revenue. To help achieve the GHG emission reduction targets, Energy Evolution proposes 20 projects to initiate and further refine action within these five sectors over the next five years.

This strategy responds to Council's directive to identify the scale of change and investment required to achieve Council's long-term GHG reduction targets. It acknowledges that achieving these targets will require concerted efforts and collaboration across all sectors of society, and that the scope and scale required is unprecedented in both action and investment. Realizing this action and investment carries many risks including that the strategy is currently under resourced and unfunded and will rely on involvement and funding from all levels of government.

This strategy also advances the 2019-2022 Term of Council priority Environmental Stewardship by identifying projects to reduce the City's GHG emissions and embed climate change considerations across all operations. It aims to strengthen Council's commitment to naming, framing, and deepening Ottawa's commitment to protecting our economy, our ecosystems, and our community from climate change and it helps implement the Climate Change Master Plan.

2.1 Benefits of a Community Energy Transition Strategy

There are many co-benefits that can be achieved through a low carbon transition, including local economic development and job creation, improved public health, equity and inclusion, energy security and resiliency, and mitigating future risk.

2.1.1 Local Economic Development

If given the proper signals, markets can play a key role in responding to global challenges such as climate change. At the national level, one of the most powerful market signals entered into force is the federal government's commitment to require a price on carbon in all Canadian provinces and territories[8].

Supporting Ottawa's local businesses in the transition towards a low-carbon economy will help companies reduce operating costs and represents an opportunity to:

- Create good local jobs
- Attract investment and encourage innovation

[8] Prime Minister of Canada. (2016). Prime Minister Trudeau delivers a speech on pricing carbon pollution. Accessed electronically on September 6 from: http://www.pm.gc.ca/eng/news/2016/10/03/prime-minister-trudeau-delivers-speech-pricing-carbon-pollution8Government of Ontario. (2017).

- Keep a greater share of energy dollars (expenditures) within the local economy.

2.1.1.1 Job Creation

Reducing energy consumption and promoting the use of renewable energy is already credited with the creation of new green jobs in manufacturing, construction, and trades. According to the International Renewable Energy Agency, the global renewable energy sector employed 11 million people in 2018 and the number of people employed in solar power alone is estimated at 3.6 million.[9] Canada's clean energy sector is growing faster than the rest of the country's economy (4.8% versus 3.6% annually between 2010 and 2017), while also attracting tens of billions of dollars in investment every year. It's a large and growing employer, accounting for 298,000 jobs in Canada in 2017 which is equal to direct employment in the real estate sector.[10]

The job creation potential associated with energy efficiency is equally well established. Retrofitting existing homes and buildings increases the demand for various low-carbon and renewable energy technologies while also generating a demand for workers who can perform building upgrades, such as adding insulation, installing building automation systems, or replacing inefficient furnaces.

2.1.1.2 Attracting Investment and Encouraging Innovation

Ottawa has cultivated a reputation as a center for innovation and is home to dozens of federal research agencies and laboratories as well as several post-secondary institutions. In 2010, the city was named one of the top seven intelligent communities in the world by the Intelligent Community Forum.[11] According to the Ottawa Business Growth Survey, Ottawa's reputation as an innovation hub remains strong, with local business confidence highest among technology-sector companies and growing in the construction and hospitality sectors.[12]

In addition to advancing climate change and sustainability objectives, a community energy transition strategy can directly support efforts to promote innovation, entrepreneurship and technology development in Ottawa.

One direct connection is the contribution of energy efficiency and renewable energy technologies towards the development of Ottawa's clean technology sector. Ottawa is home to an estimated 240 clean technology companies, and the sector is one of six high-

[9] IRENA. (2018). Renewable Energy Jobs, Annual Review 2017. Accessed on Nov 18 2019 from http://resourceirena.irena.org/gateway/dashboard/?topic=7&subTopic=10 https://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Jobs_Annual_Review_2017.pdf
[10] Clean Energy Canada. (2019). Missing the Bigger Picture: Tracking the Energy Revolution 2019. Accessed on Nov 18, 2019 from https://cleanenergycanada.org/report/missing-the-bigger-picture/
[11] Intelligent Community Forum. (2017). The Top7 Intelligent Communities of the Year. Accessed electronically on September 14, 2017 from http://www.intelligentcommunity.org/top7
[12] Welch LLP and Ottawa Chamber of Commerce. (2019). Ottawa Business Growth Survey 2019.

growth “Knowledge-Based Industries” local economic development organization Invest Ottawa is currently working to support.[13]

Energy information and technology is also considered to be a key element of smart cities—the concept of using information and communication technology to deliver more effective municipal services and to grow the local knowledge-based economy. With potential applications ranging from smart grids and energy storage to automated electric vehicles and smart mobility systems, community energy planning will support the City as it looks for ongoing opportunities to advance the Smart City 2.0 strategy.

2.1.1.3 Local Energy Dollars

According to the Federation of Canadian Municipalities, medium to large cities spend an average of $2.7 billion per year on energy—large expenditures that typically leave the municipality.[14] Energy consumption data obtained from local utility providers in Ottawa yields a similar but more accurate estimate, with Ottawa residents spending $3.0 billion—or roughly $3,200 per capita—across all energy types in 2015.[15]

By examining the supply and the cost of energy consumed locally, there is an opportunity to keep millions of energy dollars circulating within the local or regional economy, with benefits ranging from business retention and attraction to housing affordability.[16] Hydro Ottawa is one example of a local energy company that aims to create long-term value for its shareholder, the City of Ottawa, and the communities it serves. In 2018, the company yielded a record $22.3 million dividend payment to the City—money that is directly invested into City programs and services.[17]

2.1.1.4 Low Carbon Cities Canada (LC3)

Through the 2019 federal budget and the Federation of Canadian Municipalities, a network of seven Low Carbon Cities Canada (LC3) were established across the country. The Ottawa LC3, called the Ottawa Climate Action Fund (OCAF), received a $20M endowment and close to $2M in initial operating funds to advance initiatives to significantly reduce carbon emissions by investing, providing grants, promoting understanding and influencing policies.

OCAF is hosted by the Ottawa Community Foundation. The Ottawa Community Foundation will support relationship building, program development, and the development

[13] Invest Ottawa. (2017). Clean Technologies. Accessed electronically on September 14, 2017 from https://www.investottawa.ca/clean-technologies/
[14] 19 Federation of Canadian Municipalities. (2016). Partners for Climate Protection National Measures Report 2015. Page 7. Accessed electronically on September 20, 2017 from https://fcm.ca/home/programs/partners-for-climate-protection/national-measures-report.htm
[15] Baseline Energy Study for Ottawa 2015: Including Supply Origin, Fuel Type, Use by Sector, GHG Impacts and Cost.
[16] QUEST – Quality Urban Energy Systems of Tomorrow. (2016). Community Energy Planning in Ontario: A Competitive Advantage for Your Community.
[17] Hydro Ottawa Holding Inc. (2019). Annual Report 2018.

of levers of influence and their advisory board will have a high level of independence in strategic direction, priority-setting, and decision-making.

Staff have joined the OCAF Advisory Board and signed a Memorandum of Understanding between the City of Ottawa and the Ottawa Community Foundation describing the intention and willingness to work together on reducing GHG emissions.

2.1.1.5 Access to Funding

Achieving energy and emissions targets will require significant resources and investments. Senior levels of government rely on cities to help achieve many of their energy and emissions commitments, whereas municipalities typically do not have the necessary revenues to sufficiently fund local climate action and rely on funding from senior levels of government. Provincial and federal government programs can spur change by incentivizing local action through funding programs. In some cases, these programs require municipalities to meet special requirements or apply a climate lens in order to be eligible to apply. Initiatives such as Energy Evolution are essential to enabling the City to apply and gain access to funding that would otherwise be unavailable. The most applicable funding for climate change solutions available today for both municipalities and private sector is from the Federation of Canadian Municipalities. It requires municipal approval for eligibility.

2.1.2 Public Health

To achieve the 100% GHG emissions reduction target, combustion of fossil fuels in furnaces, industrial activities, and vehicles would need to be nearly eliminated by 2050. As fossil fuel combustion declines, cardiovascular and respiratory health effects associated with their emissions will also decline.

An increased deployment of heat pumps for heating buildings would have the added benefit of increasing access to efficient air conditioning, thus reducing the health risk of extreme heat waves. Reducing noise levels from the source and using engineering measures are important ways to manage noise. For example, transitioning away from combustion engine vehicles to electric vehicles and better insulating buildings could improve the sleep quality and certain aspects of human health. Additionally, a healthy built environment encourages more active transportation and creates more opportunities for social connections which lead to better physical and mental health

2.1.3 Equity and Inclusion

Everyone has a role to play in meeting Ottawa's 100% GHG reduction target. Some, however, are better positioned to participate in the energy transition required to meet the target. Issues of poverty, affordable housing and climate change are complex, intractable and interrelated.

Experience in other municipalities suggests that when climate solutions include equity and inclusion considerations, multiple priorities can be addressed at the same time and more people can participate in the low-carbon transition.

To better understand equity and inclusion challenges, the Canadian Urban Sustainability Practitioners (CUSP) has developed an Energy Poverty and Equity Explorer tool[18] to access relevant data and develop equitable and inclusive clean energy programs to meet residents' needs.

2.1.4 Energy Security and Resiliency

Managing the uninterrupted availability of energy sources at an affordable price is fundamental to ensuring sustainable development, as well as protecting the well-being of residents and the bottom line for businesses. In addition to increasing demands from a steadily increasing population, extreme weather events such as high winds, freezing rain and ice storms can disrupt power supply. The challenge becomes how to manage that upward pressure and build resiliency against power disruptions from extreme weather events to provide residents the same uninterrupted level of service.

The City has a key role to play in ensuring energy security through land-use planning and policy development in order to identify local priorities, reduce energy demand, and ensure energy resources are available. Identifying local energy resource opportunities can help to ensure local energy security, increase diversity of energy sources, promote economic competitiveness, and improve reliability of energy systems and resiliency to extreme weather events. Renewable energy technologies play an increasingly important role in energy security. For example, converting vehicles from fossil fuels to renewable fuel sources such as biofuels, or introducing new technology such as electric vehicles, can reduce reliance on a volatile oil market. By diversifying local renewable energy sources, Ottawa decreases its reliance on the unpredictability of energy supply from outside the city boundary while boosting local economic growth.

2.1.5 Mitigating Future Risk

The magnitude of future climate impacts depends on the action taken to reduce emissions. Climate change is already impacting communities globally and locally. Canada is warming at twice the rate of global averages, and the rising occurrence of heat waves, flooding, tornadoes and wildfire is harming our communities, infrastructure, natural environment and economy[19]. Insurance claims for climate-related hazards across Canada have exceeded $1 billion per year since 2008, compared to average annual costs of $400 million in the previous 30 years. In 2018 alone, insured damage from severe weather reached $2 billion, and it is estimated that climate change could cost Canada $21 to $43 billion per year by 2050.[20] Of course, insured losses only account for a portion of the full costs attributed to catastrophic events. For every dollar of losses borne by

[18] The Energy Poverty and Equity Explorer tool (https://energypoverty.ca/).
[19] Environment and Climate Change Canada, 2019. Canada's Changing Climate Report https://www.nrcan.gc.ca/maps-tools-publications/publications/climate-change-publications/canada-changing-climate-reports/canadas-changing-climate-report/21177
[20] National Round Table on the Environment and the Economy. 2011. Climate Prosperity. Paying the Price: The Economic Impacts of Climate Change for Canada.

insurers in Canada, $3-4 are estimated to be borne by governments, households and businesses.[21]

Considerable investments are needed to make our communities less vulnerable to the impacts of climate change that are already being felt. The Federation of Canadian Municipalities and the Insurance Bureau of Canada released a report in February 2020 that estimates an average annual investment in municipal infrastructure and local adaptation measures of $5.3 billion is needed to minimize the worst impacts of extreme weather events. In national terms, this represents an annual expenditure of 0.26% of the national GDP.[22] Fortunately studies have shown a return on investment around 6:1, meaning that for every dollar invested in disaster mitigation measures, $6 is saved in future damages[23].

The rising occurrence of extreme weather events is also leading to higher insurance costs for both homeowners and municipalities. Climate change was cited as the reason for insurance companies across Canada increasing home insurance rates for 2019 by 5-10% on top of inflation, and premiums and deductibles for flood damage have also increased.[24] Municipalities such as Toronto and Calgary saw increased premiums, higher deductibles and changes to municipal insurance policies limiting liability following large flood events in 2013.[25] In Ontario municipal liability premiums increased by 22.2% between 2007 and 2016 to account for increased liability coverage.

These costs reflect the investments needed to reduce our vulnerability to the impacts of climate change that are already being felt – managing the unavoidable impacts of climate change. As noted by reports by the IPCC[26] and the Government of Canada[27], significant action is required to limit global warming to 1.5ºC to avoid the unmanageable impacts of climate change. Climate projections for the National Capital Region show the range in projected increases in temperature and precipitation in the region depending on future emission scenarios. Investments in Energy Evolution are therefore key in reducing the extent of future risks and costs from further climate change.

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[21] Moudrak, N., Feltmate, B., Venema, H., Osman, H. 2018. Combating Canada's Rising Flood Costs: Natural infrastructure is an underutilized option. Prepared for Insurance Bureau of Canada. Intact Centre on Climate Adaptation, University of Waterloo

[22] Insurance Bureau of Canada and FCM. Investing in Canada's Future: The Cost of Climate Adaptation at the Local Level, 2020 https://data.fcm.ca/documents/reports/investing-in-canadas-future-the-cost-of-climate-adaptation.pdf

[23] ibid

[24] Osental, D. 2019. Broker points to climate change as reason for rising home insurance rates. Insurance business industry magazine. 2019.

[25] Henstra, D., and Thistlewaite, J. 2017. Climate Change, Floods, and Municipal Risk Sharing in Canada. Munk School of Global Affairs (UoT). [online] Available at: https://munkschool.utoronto.ca/imfg/uploads/373/1917_imfg_no_30_online_final.pdf

[26] Intergovernmental Panel on Climate Change (IPCC), 2018 Special Report on Global Warming of 1.5°C https://www.ipcc.ch/sr15/

[27] Canada's Changing Climate Report (2019) Retrieved from: https://changingclimate.ca/CCCR2019

2.2 The Role of the Municipality

As a local authority with powers handed down by the Province, the City has direct control over a range of services that touch people's everyday lives and affect how energy is consumed, including housing, transportation systems, water and sewer infrastructure, and waste management. The City controls where and how growth will occur through the designation of land and in the development and enforcement of zoning by-laws. Building construction is also controlled through site plan control measures, urban design guidelines and building code enforcement. In carrying out its duties, the City partners with several associated agencies, including utility companies, the development industry, housing authorities, as well as other levels of government and the private sector throughout the National Capital region.

In addition to its regulatory powers, the City also plays a key role in bringing community stakeholders together to facilitate discussions and foster collaboration in planning and strategizing integrated approaches to achieve long-term energy sustainability goals. Through education and civic engagement, the City has a responsibility to communicate the basis for and the pathways to take towards a long-term sustainable energy future. Through municipal investment and delivery mechanisms, the City also has an opportunity to catalyze community action.

Despite the important role that the City plays in mobilizing forces toward a low carbon future, there are limitations on the extent of power that can be exerted by local government. This is due in part to the limit on financial resources available to the City to act on key initiatives and jurisdictional barriers and conflicts with regulatory requirements from other tiers of government. Ottawa's ability to meet GHG reduction targets is therefore contingent upon senior levels of government, stakeholders and partners to commit to action within their specific jurisdictions (i.e. utilities, housing, development industry, etc.).

2.2.1 Long-Term Municipal Plans

Coordination is needed amongst long-term municipal plans that directly relate to Energy Evolution to ensure a harmonized approach to achieving the long-term GHG emission reduction targets. Long-term municipal plans include but are not limited to:

- *New Official Plan* - The Official Plan provides a vision for the future growth of the city and a policy framework to guide the city's physical development. A new Official Plan for Ottawa is currently underway, to be completed by 2021. Changes to the Planning Act exempt new Official Plans from review for 10 years, which will provide the City with a stable monitoring period to evaluate the effectiveness of new land use policies. The planning horizon for the new Official Plan is to 2046, which is a 25-year horizon.
- *Transportation Master Plan Update* – The Transportation Master Plan (TMP) Update is guided by and being developed alongside the new Official Plan and is expected to be completed in fall 2023. The TMP and accompanying Ottawa Cycling Plan and Ottawa Pedestrian Plan provide the City's blueprint for planning, developing and

operating its walking, cycling, transit and road networks over the next several decades. The TMP Update model scenarios will include an analysis of greenhouse gas projections.

- *Solid Waste Master Plan* – The municipal Solid Waste Master Plan is intended to provide the overall framework, direction, and goals for solid waste management, diversion and reduction policy over the short, medium and longer-term horizon, primarily for residential waste. Its development is currently underway and is expected to be completed in 2022.

- *Energy Conservation and Demand Management* – The municipality is committed to improving energy management in the operations of its municipal facilities. The Energy Conservation and Demand Management Plan focuses on projects that reduce energy demand from electricity, natural gas, heating oil, propane and water as well as reduce GHG emissions.

- *Comprehensive Asset Management (CAM)* – Asset Management is an integrated business approach involving the different disciplines of planning, finance, engineering, maintenance, and operations to effectively manage existing and new infrastructure through their lifecycle. The City maintains nearly $42 billion (State of Asset Report, 2017) in existing infrastructure and works to ensure safe and sustainable services are delivered to our communities in a cost-effective way while committing to consider climate change resiliency.

- *Long Range Financial Plan* – Within each term of Council, the Long Range Financial Plan (LRFP) is updated to reflect any changes to the City's long term operating and capital requirements, ensuring consistency with recommendations of the Transportation Master Plan , Infrastructure Master Plan, the future Solid Waste Master Plan and the City's Fiscal Framework. The Long-Range Financial Plan provides a multiple-year outlook of the City's operating and capital requirements, focusing on the funding strategies that are required to provide for the renewal and maintenance of the City's assets in a state of good repair.

2.2.2 Notable Municipal and Community Initiatives

2.2.2.1 Land Use

a) *Ottawa Next: Beyond 2036* – The Ottawa Next: Beyond 2036 study explored policy implications and areas of potential disruption that Ottawa would need to address as it grows from a city of one million to a city of two million and its role as the center of a larger region of up to three million people by the end of the century. The study served as a basis for the review and development of the new Official Plan for the city. Policy implications were intended to trigger the critical evaluation of the resiliency of the City's growth management strategies.

b) *Five Big Moves* – The City is proposing to make a number of significant policy changes through the new Official Plan to make Ottawa the most liveable mid sized city in North

America. Referred to as the *Five Big Moves*, these high-level policy directions proposed shifts in how the City approaches five foundational planning issues: growth, mobility, urban design, resiliency and economy.

c) *Gladstone Station Secondary Plan* – In 2019, a Secondary Plan study was initiated for the Gladstone Station District. It is one of the first Secondary Plans undertaken by the City that has considered energy conservation and renewable energy technology as part of the planning process. The Gladstone Secondary Plan is expected to include opportunities to target net zero carbon emissions in new development using renewable energy solutions for heating and cooling, electrical energy generation and other initiatives such as low impact development designs.

2.2.2.2 Buildings

a) *Green Building Policy for the Construction of Corporate Buildings* – On-going since 2005, the policy dictates that all new municipal buildings greater than 500 m^2 will be designed and delivered in accordance with the Certified performance level of the Leadership in Energy and Environmental Design – Canada (LEED Canada) Green Building Rating System. Where possible, a LEED Gold performance level will be targeted.

b) *Deep Retrofits on Municipal Buildings* – Envari has provided the City a high-level estimate and scope of work for deep retrofits on three City buildings: a recreation centre, a community centre and a family shelter. The City is developing financial and environmental justification criteria and metrics. These criteria and metrics will support determining how to best develop a deep retrofit program and how it will align with the current life cycle renewal of existing municipal buildings.

c) Glebe Community Centre Innovative Window Technology Pilot – The Glebe Community Association and the City are replacing 12 existing windows within the Glebe Community Centre with an r-value of roughly 2 with new windows with an r-value of 11. This next generation technology uses suspended films between conventional panes of glass to provide multiple thermal barriers to heat loss. This trial is vital to improving building performance as windows are a huge source of heat loss from building envelopes, and ultimately GHG emissions, across the community.

d) *Tenant Engagement at Centretown Citizens Ottawa Corporation (CCOC) and Ottawa Community Housing (OCH)* – Both the CCOC and OCH have initiated successful tenant energy engagement programs in recent years. The CCOC has created the Green Commitments program to engage tenants and empower them with small, daily activities they can do to reduce their environmental impact. And OCH has created the Tenant Energy Engagement Pilot program to increase the energy literacy of tenants and initiate, support and sustain behavior change toward sustainability through active engagement, passive engagement, and conservation tools.

2.2.2.3 Transportation

a) *Light Rail Transit (LRT)* - The first phase of LRT opened in September 2019, replacing a 12.5 km stretch of bus rapid transit with low-carbon electric powered trains. The second phase of LRT is scheduled to be completed in 2025 and will introduce 44 km of new rail to the LRT system.

b) *Municipal Green Fleet Plan* – The City has kept well-informed of developments in the industry with regards to the municipal fleet. This includes trialing alternate fuels, implementing devices and technologies that reduce GHG emissions, and purchased low- and no-emission vehicles and equipment where they meet the operational needs of the client department and are available. An updated Municipal Green Fleet Plan will be brought forward in 2021.

c) *Public Electric Vehicle Charging Network* - The City is contributing to the expansion of the public electric vehicle (EV) charging network to help address charging access barriers to EV adoption. This network includes requirements for electric vehicle chargers at all new city facilities or facilities undergoing major renovations, twelve new stations in the right-of-way, and a new fast charger at Bob MacQuarrie Recreation Complex.

d) *Communauto* - Communauto has grown to be the largest carshare fleet in Canada and operates approximately 135 cars in Ottawa/Gatineau. Each car-sharing vehicle replaces 10 private cars, thus their contribution results in 1,215 fewer cars on the roads in Ottawa/Gatineau. Many of these cars are hybrids, which produce 33% less greenhouse gas emissions than their gas equivalent vehicle.

e) *Municipal Parking Management Strategy* – The City manages parking through a service-orientated approach. The program focusses on providing short-term parking in support of the local economy while also resolving issues in residential areas caused by sources of high parking demand. In addition, there is active support for programs and facilities that encourage sustainable mobility choices (e.g. funding for EV charging infrastructure, Park & Rides and bike parking).

2.2.2.4 Solid Waste and Wastewater

a) *Landfill Gas Improvements at City's Trail Waste Facility* – A Landfill Gas Perimeter Collection System was constructed at the Trail Waste Facility to augment the existing gas collection wells at the landfill and to reduce landfill gas migration offsite. This action had the co-benefit of reducing GHG emissions and the most significant reductions within the corporation as of 2018. However, it should be noted that starting in 2021 it is expected that an increase in emissions will be observed at the landfill as a result of provincial regulatory requirements to reduce the contaminating lifespan of the landfill in the future.

b) *Robert O. Pickard Environmental Centre (ROPEC) Electrical Reliability and Efficient Use of Digester Gas Project* – In 2019, Council approved funding to replace the three

existing end-of-life cogeneration engines at ROPEC and add a fourth cogeneration engine. These engines use digester gas produced through the wastewater treatment process to produce on-site electricity and heat used to offset electricity and natural gas imported from the utility grids. The project is expected to reduce GHG emissions by an additional 1,565 tonnes of CO2e per year in comparison with the use of three existing cogeneration units and is to be completed by the end of 2024.

c) *Biogas Optimization Study* – The City is currently undertaking a Biogas Optimization Study which seeks to identify options that effectively and efficiently optimize the production and benefits of the digester gas at ROPEC. The study will evaluate methods to increase the production of biogas through the addition of other feedstocks or biogas sources, as well as evaluate emerging processes and technologies, that could be used in conjunction with cogeneration.

d) *University of Ottawa's Waste Diversion Program* – Ottawa U has set out to try and create a zero-waste campus. In 2019 the campus was able to divert 65% of waste from landfill. This is achieved through increased access to recycling stations; low waste food service contracts; zero waste dining hall; and free store and reuse programs for staff and students.

e) *Queen Street Fare* – Since 2018, the food hall Queen Street Fare has been dedicated to reducing waste and cutting greenhouse gas emissions. The food hall is committed to sending no consumer waste to landfill and all packaging is compostable, stainless steel cutlery, cups and dishes are reused, and what limited material left is recycled.

2.2.2.5 Energy Generation

a) *Just Food, Bullfrog Power and Beau's Brewing Company Solar Energy Project* – In 2017, Bullfrog Power and Beau's Brewing Company partnered with Just Food to install a 10kW solar energy project at Just Food's community farm facility that provides power to the farm's greenhouse, cooler, and educational centre. The solar panel shed was designed to lower Just Food's operating costs and carbon footprint while also providing a demonstration of renewable energy use on a farm.

b) *Community Solar Net Metering on Canadian Museum of Science and Technology* – Hosted on-top of the Canadian Museum of Science and Technology, the solar rooftop project marks the first community-owned, net metered solar electricity installation in Ottawa. This 215kW project will produce a projected 230,000 kWh of clean energy, directly consumed by the Museum and is expected to keep energy bills lower and more predictable over the next 30 years.

3.0 Developing Energy Evolution: The Model

To understand the scope and scale of change required to achieve the GHG emission reduction targets, Sustainability Solutions Group and whatIf? Technologies Inc) was contracted to develop a comprehensive energy, emissions and finance model. The model, called CityInSight[28], was custom built to replicate Ottawa and includes data for population, dwellings, jobs, buildings, transportation, waste, industry, and land use. It enables bottom-up accounting for GHG and financial analysis, energy supply and demand including renewable resources, conventional fuels, energy consuming technology stocks (e.g. vehicles, appliances, dwellings, buildings) and all intermediate energy flows (e.g. electricity and heat).

The sections that follow provide an overview of how the energy and emissions model was developed and includes the following elements:

- Model Assumptions and Limitations
- Emissions Baseline
- Pathway Studies
- Business As Planned (BAP) Scenario
- 100% Scenario

3.1 Modelling Assumptions and Limitations

Typically, a time-based predictive model is based on a scenario which is a plausible prediction of how the future may unfold, but by no means a guarantee. The Energy Evolution models are no exception. Although actions proposed to achieve the GHG reduction targets were mainly drawn from a set of thoroughly vetted pathway studies and recent experience of best practices from other municipalities, it is acknowledged that actions proposed over the 30-year period may differ from what actually happens. This could be due to unexpected external factors that could influence the outcome such as the state of the economy or the need for social behaviour change, or the effectiveness of the action may differ than what was predicted.

Some GHG emissions are not accounted for in the modelling because limited data was available, or emissions were deemed to be outside of the scope of the Global Protocol for Community-Wide Greenhouse Gas Emission Inventories as outlined in Appendix A: Data, Methodologies, and Assumptions Manual. Emissions not included in the model include aviation, inter-city rail, small equipment, and agriculture. The model also does not factor in natural gas pipe leakage, embodied carbon in materials of buildings or equipment, or carbon sequestration activities.

Additionally, many City master plans were either being updated or in their infancy at the time that the models were being developed. These include the Official Plan, the

[28] CityInSight follows the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC Protocol) framework, an international standard for GHG emissions accounting.

Transportation Master Plan, and the Solid Waste Master Plan. The input data from City departments for areas such as land use, transportation, and solid waste was based on the best available data at the time and may not reflect current data being used to develop the master plans.

As these plans will come forward after Energy Evolution, it should be understood that:

- These plans will evaluate a range of options to achieve each respective plan's goals and targets and outcomes may differ than what has been identified in this strategy;
- It is expected that the range of options will include one or more scenarios that achieve the GHG reductions required to achieve the GHG emission reduction targets, but those scenario(s) may not ultimately be recommended;
- Data provided by City departments to inform the model was based on the best available data at the time and may differ from the data used to inform the plans and programs;
- Different models may be used to do a more detailed and sector specific assessment of the projected GHG implications, providing a level of granularity not available in Energy Evolution model.

Sector specific model assumptions for land use, buildings, transportation, waste and renewable natural gas and electricity are captured in Section 5.0. Details on the scope of the protocol and information used to populate the CityInSight model can be found in Appendix A: Data, Methodologies, and Assumptions Manual.

3.2 Emissions Baseline

A baseline energy and emissions profile was developed for 2016. Although the baseline year of the GHG emission reduction targets is 2012, 2016 was chosen as the baseline of the model in order to be calibrated to align with the 2016 Canadian Census.

In 2016, the emissions baseline in Ottawa was 5.09 megatonnes of carbon dioxide equivalent ($MtCO_2e$), or 5.07 tonnes of CO2e per capita, and includes emissions from buildings (residential and non-residential), in-boundary transportation, waste and fugitive emissions from landfills. Commercial buildings, residential buildings, and transportation sectors were responsible for the majority of Ottawa's emissions, contributing 18.8%, 28.9% and 40.4% of total emissions, respectively. The highest emitter by fuel type was natural gas (used in buildings), with 38.7% of total emissions, while gasoline and diesel (used in transportation) combined for 41.3%. Together, they constitute over three-quarters of total fuel emissions. Details on the baseline can be found in Appendix B: Business as Planned Scenario Report.

3.3 Pathway Studies

Pathway studies are focused technical reports describing how a specific energy technology or improvement in energy use may be developed over time in Ottawa and were used collectively as a basis to develop the 100% scenario model. They considered the overall technical potential for implementation and any constraints (economic, regulatory, etc.) that could influence uptake. To determine a given technology's potential to help achieve the long-term GHG target, each technology or improvement was estimated for a degree of uptake by the community as either conservative, moderate, or aggressive. For Ottawa to achieve its short, mid, and long-term GHG reduction targets, the model calls for implementation of the aggressive scenario in almost all cases and in some cases, the model demands actions that exceed the aggressive scenario or are new actions that the pathway studies didn't foresee.

The pathway studies were developed with technical experts from the municipality, senior levels of government, utilities, developers, consultants (Leidos, Sustainability Solutions Group, and whatIf? Technologies Inc) and subject matters experts through a series of technical workshops. The workshops were critical to better understanding the barriers, opportunities, and options for advancing specific energy technologies in Ottawa.

A total of 14 pathway studies were developed to inform Energy Evolution. Details on the pathways can be found in Appendix C: Pathway Studies. The pathway studies completed were:

- Solar Power
- Wind Power
- Biogas Energy
- Existing Residential Buildings
- New Residential Buildings
- Electrification of Transport – Light Vehicles
- Demand side management and energy storage
- Waterpower
- Heat Pumps
- District Energy
- Existing Non-Residential Buildings
- New Non-Residential Buildings
- Transportation
- Solid Waste, Wastewater, and Other Waste Sources

Additionally, the following actions beyond the pathways are explored:

- Additional renewable electricity and electricity storage
- Use of waste heat
- Power to gas
- Zero emission vehicle zones
- Gasification of leaf and yard waste.

3.4 Business-As-Planned (BAP) Scenario

The BAP scenario is a projection from today until 2050. It is designed to illustrate the anticipated energy use and emissions in Ottawa if no additional policies, actions, or strategies are implemented beyond those that are currently underway or planned. It accounts for population and demographic trends and uses energy and emissions information from all levels of government to inform assumptions about buildings, transportation, energy use, and waste. It also builds in the anticipated GHG emissions reductions that would result from the municipality's current and planned commitments including projects such as Stage 1 and Stage 2 of the light rail transit network.

It is expected that between 2016 and 2046 Ottawa's population will grow to almost 1.4 million people, a growth of about 402,000 people, correlating to roughly 195,000 new private households within the city. Employment is expected to scale with population, with 280,447 jobs added between 2016 and 2046. Typically, the upward trend in population and demographics would result in greater community emissions. However, the anticipated introduction of greater fuel efficiency standards, a decline in building heating requirements (a result of increasing average temperatures due to climate change and typical improvements to the building code), and a gradual uptake of electric vehicles provide a counterbalance.

Taking everything into account, the BAP scenario projects that community wide GHG emissions will increase by only 0.1 $MtCO_2e$, indicating that emissions would remain relatively flat through to 2050 despite population growth.

Figure 7 shows the GHG emissions projections by sector in the BAP scenario while Figure 8 depicts those same emissions by fuel source.

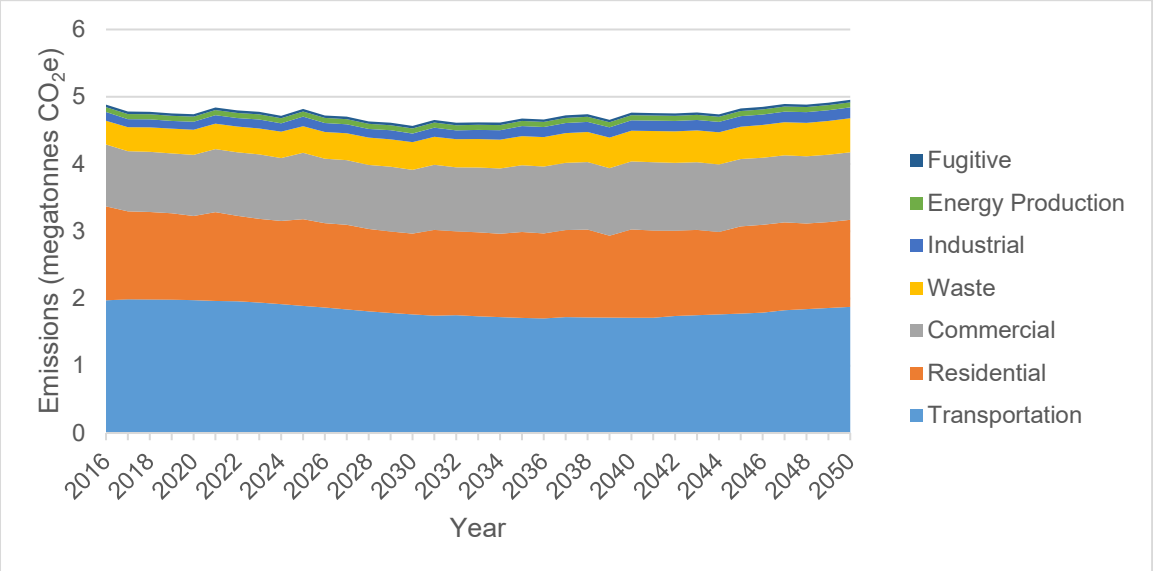

Figure 7 Projected emissions by sector for BAP scenario, 2016-2050

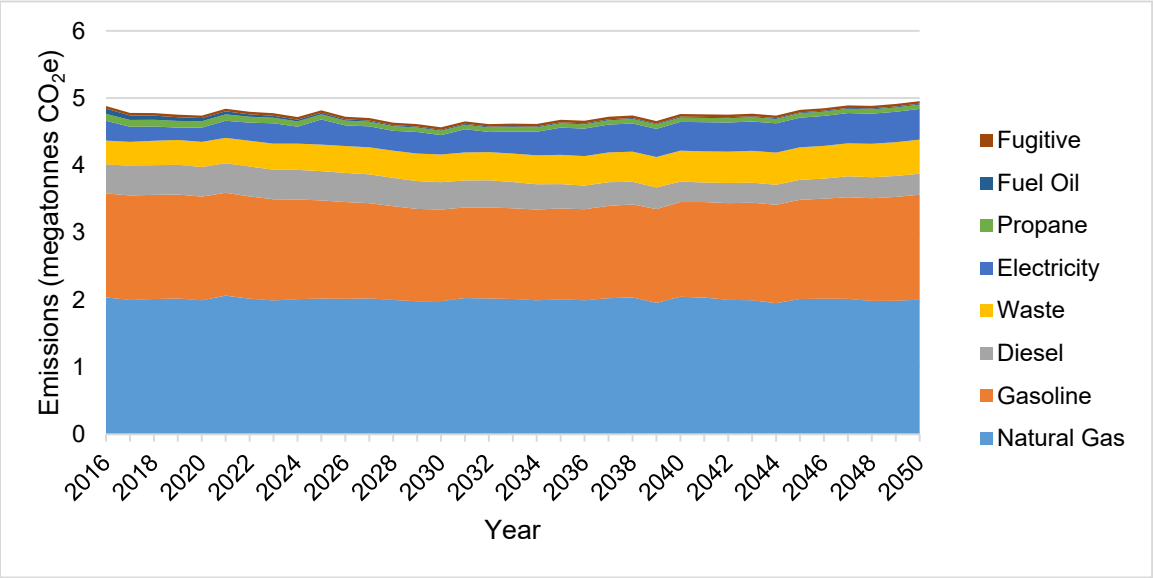

Figure 8 Projected emissions by fuel source for the BAP scenario, 2016-2050

3.5 100% Scenario

The 100% scenario explores the scope and scale of change required if Ottawa is to align with the IPCC target to limit global warming to 1.5ºC and reduce emissions by 100% by 2050 as approved by Council. To achieve this target, it requires reducing emissions by 4.82 $MtCO_2e$ over the next 30 years. The results indicate that in order to achieve the 100% scenario, rapid and far-reaching action and investment is required.

This means that almost all fossil fuels will have to be phased out, heating and transportation systems would have to be nearly fully electrified or transition to zero emission, waste heat utilization and renewable natural gas production would have to be added, and sufficient renewable electricity (mostly wind and solar) generation and electricity storage will be required to meet demand and offset emissions on the provincial grid. In the case of the buildings sector, energy conservation will typically need to occur before fuel switching. Since the timing of renewable energy production does not necessarily align with demand, the scenario relies on the storage proposed in the model and grid balancing to ensure that electrical demands are always met. For further details on the 100% scenario, refer to Appendix D: Technical Report.

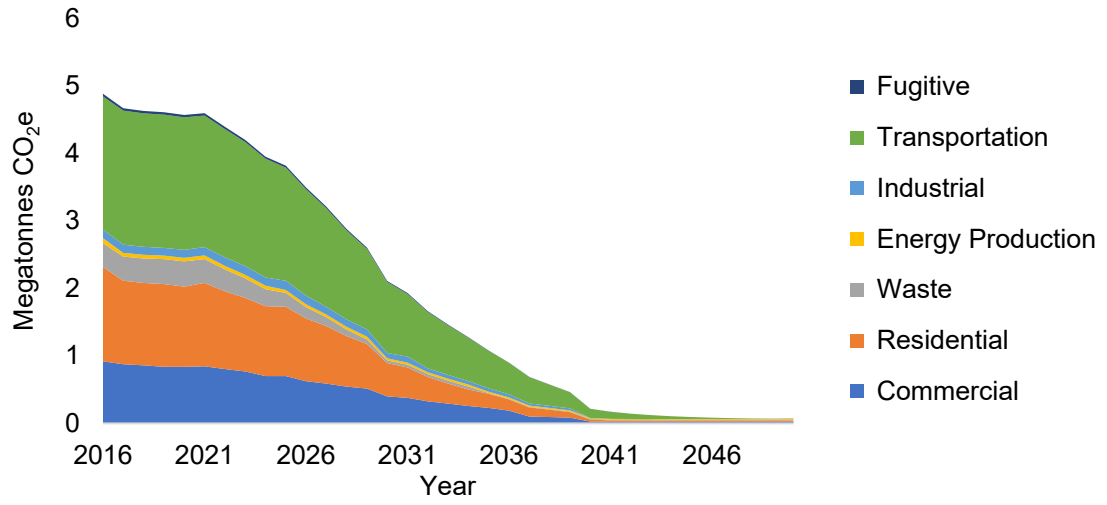

Figure 9: Projected emissions by sector for 100% scenario, 2016-2050

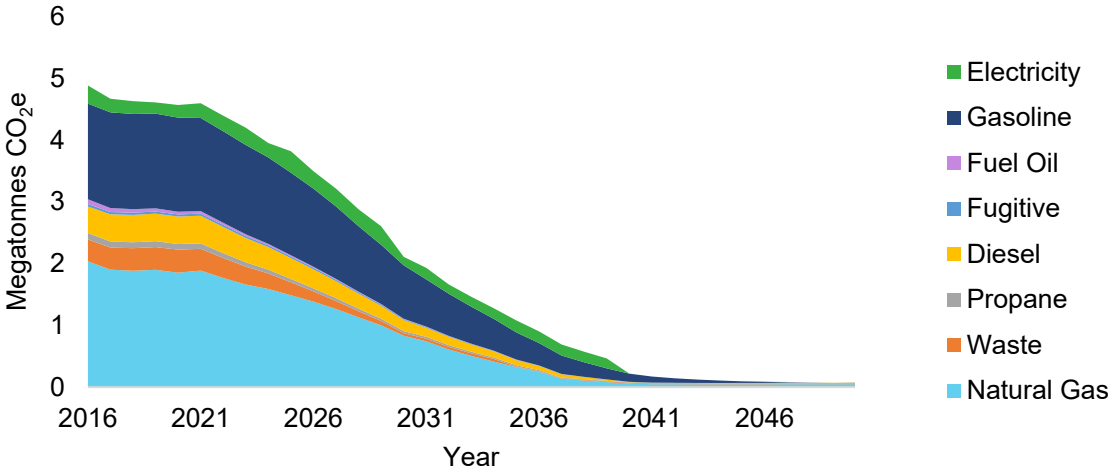

Figure 10: Projected emissions by fuel source for 100% scenario, 2016-2050

Table 11 compares the difference in total emissions between the BAP scenario and 100% scenario, relative to the 2016 baseline.

Table 11: Comparison of Total Emissions for BAP Scenario and 100% Scenario, 2016 and 2050

Scenario	Description	GHG Emissions ($MtCO_2e$)		
		2016	2050	Change
BAP Scenario	Aligns with current planned initiatives	4.88	4.98	0.1
100% Scenario	Aims to achieve a GHG reduction consistent with the IPCC recommendation of limiting global temperature increase to 1.5ºC.	4.88	0.07	-4.82

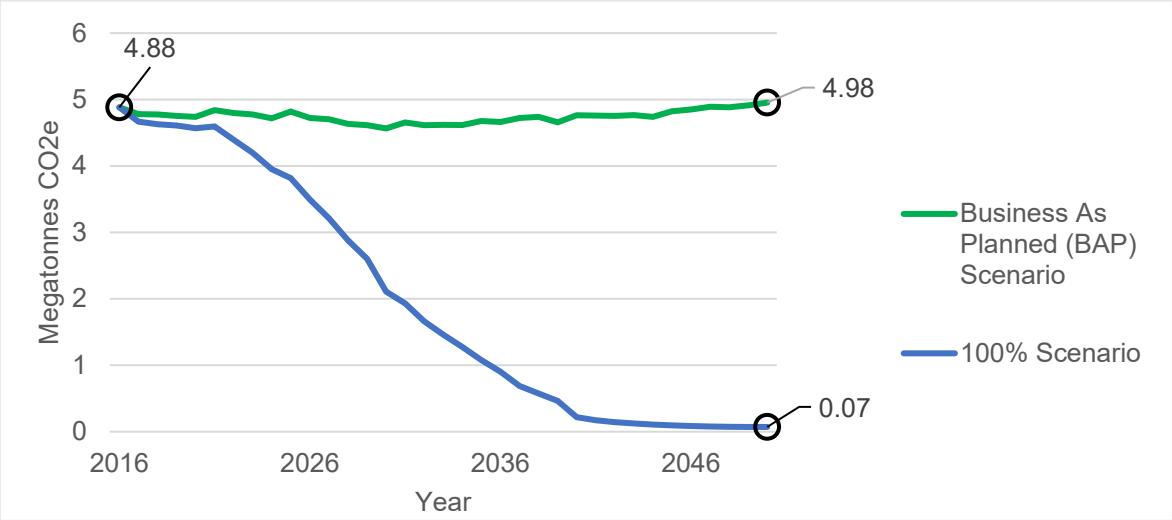

Figure 11: Comparison between BAP scenario and 100% scenario, 2016-2050

4.0 Achieving Ottawa's GHG Reduction Targets

Ottawa has made significant investments in recent years in projects that reduce the city's greenhouse gas emissions, notably light rail transit, landfill gas capture and municipal facility improvements. Yet, as indicated in the previous section, the model projects that Ottawa's emissions will remain relatively flat for the next 30 years under the BAP scenario, far from achieving the long-term GHG emission reduction targets.

Achieving Ottawa's GHG reduction targets will require implementation of the municipality's ongoing and planned actions, implementation of new actions that the municipality has not yet approved, and action and investment from all segments of society. Table 12 provides a summary of where community-wide GHG emission reductions are modelled to come from between now and 2050 in five key sectors:

- Land Use and Growth Management
- Buildings (New and Existing)
- Transportation
- Waste and Renewable Natural Gas
- Electricity

Table 12 identifies the projected emissions reduction by sector to achieve the 100% scenario. According to the model, the buildings and transportation sectors are projected to account for roughly 75% of cumulative emission reductions from now until 2050. The remaining 25% is projected to come from the waste and renewable natural gas, and electricity sectors.

Table 12: Total projected community-wide GHG emission reductions required to achieve 100% scenario incremental to BAP scenario, 2030 and 2050 (non-cumulative)

Sector	Percentage (%) of Total Projected GHG Emission Reductions	
	2030	2050
Land Use and Growth Management	Embedded in other actions	Embedded in other actions
Buildings (New and Existing)	37.1	38.0
Transportation	29.9	36.7
Waste and Renewable Natural Gas	26.1	16.9
Electricity	6.5	8.5

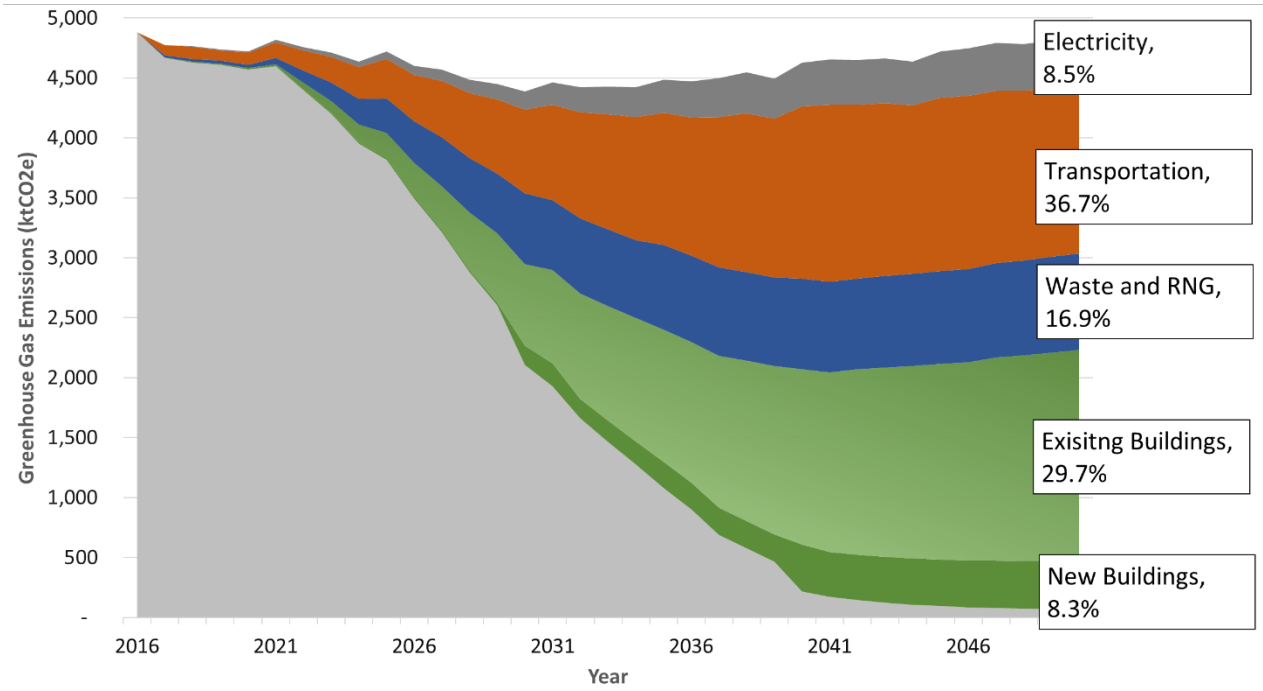

Figure 12: Total projected community-wide GHG emission reductions required to achieve 100% scenario incremental to BAP scenario by sector, 2016-2050. (percentages shown at 2050 are non-cumulative)

Within those sectors, 39 actions have been identified to achieve the 100% scenario. Table 13 identifies the top five actions from the model, which combine for roughly 80% of projected cumulative GHG emission reductions required.

Table 13: Projected top five actions from the energy and emissions model to achieve the 100% scenario by 2050

Actions	Cumulative GHG Reductions by 2050 (%)
1. Electrify personal vehicles	22.7%
2. Retrofit residential buildings[29]	17.9%
3. Divert organics and create renewable natural gas[30]	17.2%
4. Retrofit commercial buildings[31]	15.1%
5. Transition to zero emission commercial fleets	8.3%

Sections 4.1 through 4.5 provide an overview of each sector and are broken down as follows:

[29] Includes retrofitting pre and post-1980 homes, low rise residential and apartment building heat pumps
[30] Includes waste diversion and RNG production, rural biogas generation, waste heat, and power to gas
[31] Includes retrofitting commercial, offices, and residential buildings, and commercial building heat pumps

- A brief description of each sector
- An overview of jurisdictional considerations
- The assumptions that went into the model regarding each sector
- How each sector contributes to GHG emissions in the 2016 model baseline year and the BAP scenario
- The minimum results required to meet the 100% scenario and are based off the energy and emissions model outputs. Further options may be evaluated under this project to meet the scale of action required. For the full list of model metrics and their relative GHG emissions reductions, refer to Appendix E: Modelling Ottawa's Greenhouse Gas Emissions to 2050: Summary of Results.
- Proposed projects to catalyze action in Ottawa within the next five years (2020-2025). These projects are contingent on future Standing Committee and Council approval as well as future staff and budget (capital and operating) pressures. To achieve the GHG reductions required in the 100% scenario, some projects may evaluate options beyond what's been identified in the strategy prior to going to Standing Committee and Council. Where applicable, projects will go through the standard City project management process. For an overview of each project including the project description, co-benefits, risks, project metrics, key departments, key community partners, timelines, resources, and financial profile, refer to Appendix F: Project Overviews. For a summary of the projects, refer to Appendix G: Summary of Energy Evolution Projects (2020-2025).

4.1 Land Use and Growth Management

Ottawa's population reached 1 million people in 2019 and is projected to grow to approximately 1.4 million people by 2050. Household growth between 2018 and 2046 is anticipated to reach 195,000 units. For Ottawa to evolve in an era of climate change will require greater energy conservation and efficiency measures in shaping patterns of growth.

Municipal decisions affecting land use planning matters are to be consistent with the Provincial Policy Statements (PPS) set out in the Planning Act. The PPS directs that municipalities achieve a compact form of development that makes the most efficient use of infrastructure and land. PPS policies provide broad directions with respect to housing mix and choice, efficient use of infrastructure, and climate change. Council recently adopted the growth management strategy for the new Official Plan which considered each of these factors and established a direction that is consistent with the PPS. The Official Plan will maximize opportunities to achieve the targeted GHG emission reductions by directing that urban growth occur in a compact form, in locations with transportation

options that integrate active transportation and support the use of current and future transit, and to minimize the length and number of vehicle trips.

The Climate Change Master Plan, modeling work from Energy Evolution and climate projections from the National Capital Region Climate Projections study were also used to inform the policy directions on growth and development as part of the new Official Plan, which is expected in 2021.

Building on the key findings of Ottawa Next: Beyond 2036, embedding public health, environmental, climate and energy resiliency into the framework of our planning policies is one of the five Big Moves identified for the new Plan. Official Plan policies will guide reductions in greenhouse gas emissions through land use, transportation and energy planning consistent with Council approved targets.

4.1.1.1 Jurisdictional Considerations

Municipalities have primary responsibility for land use planning in Ontario working within the parameters of the Planning Act. *Bill 68, Modernizing Ontario's Municipal Legislation Act* included climate change as a matter of provincial interest for decision makers to address when carrying out their responsibilities under the *Planning Act*. This inclusion gave municipalities broad powers to pass by-laws respecting climate change and to participate in long-term planning for energy use. The Provincial Policy Statement (PPS) is issued under Section 3 of the *Planning Act* and all decisions affecting land use planning matters must be consistent with the PPS. The PPS encourages municipalities to provide opportunities for the development of energy supply including electricity generation facilities and transmission and distribution systems, district energy, and renewable energy systems and their supporting infrastructure to accommodate current and projected needs. In addition, as part of recent updates, the PPS requires municipalities to prepare for the local impacts of a changing climate and mitigate the risks to human health, safety, property and the environment.

The municipality's principal land use planning document is the Official Plan. The two greatest contributors to GHG emissions in Ottawa are buildings and transportation. The Official Plan through its growth management strategy intends to implement a model of urbanization that minimizes the need to travel, lessens the reliance on personal vehicles, and requires built forms that are less energy intensive.

4.1.2 Model Assumptions

The following assumptions were built into the energy and emissions model regarding land use that influenced the other sectors:

- Population of 1,500,664 people and 910,638 people employed by 2050[32]

[32] There are slight variations in population and employment data between the projections in the Official Plan and the Energy Evolution model. These variations do not have a significant impact and can be addressed in the next model update.

- 224,059 new dwelling units and 385,074 existing dwelling units by 2050
- The rate of intensification within the urban area increases to 60% by 2046[33]

4.1.3 Baseline and BAP Scenario

The current Official Plan has targets for the percentage of new dwelling units to be accommodated through intensification, being redevelopment that results in a net increase in the number of residential units. The intensification targets incrementally increase by 2% every five-year period, starting at 38% between 2012-2016, and ending at 46% by 2032-2036. However, an overall intensification rate of 51 per cent was achieved from 2012 to 2019, exceeding Official Plan targets.

The current Official Plan focuses intensification within the Central Area, Mixed-Use Centres, Town Centres, Transit-Oriented Development areas and along Arterial Mainstreets, collectively referred to as “intensification target areas”. The recommended intensification areas to 2046 will be identified as part of the new Official Plan.

The BAP Scenario assumes that a continuation of the current Official Plan policy framework of incremental intensification rate is maintained with suburban growth developed at a further distance from the rapid transit network, decreasing transportation mode options which lead to more automobile-centric development and consequently increased GHG emissions.

4.1.4 Achieving the 100% Scenario

a) Land Use and Growth Management

Population and employment projections for the new OP, as they stood at the time of modelling in Q3 2019 were incorporated into the models to inform the anticipated level of growth and development between 2018 and 2046 with an extrapolation made to 2050. Land use considerations were factored into the model including a housing mix that supports intensification, targeting greater densities in proximity to transit as well as built-in thresholds for new development to be built to higher efficiency standards.

The approved growth management strategy sets a target of 51 per cent of all urban growth to be accommodated in the built-up area through intensification, and 49 per cent through greenfield development over the course of the planning period to 2046. Intensification will absorb a share of the projected ground-oriented units, such as single-detached, semi-detached and rowhouses, or other built forms to support larger households. In so doing, the preliminary policy directions include recommendations for a built environment to achieve denser, 15-minute neighbourhoods to help reduce emissions from transportation by increasing viable options for walking and cycling and promote

[33] These numbers reflect planning assumptions at the time the modelling was done and will be updated after the Draft Official Plan is tabled. As we are targeting a 100% GHG reduction, the effect of changing input assumptions related to intensification will have only a small impact on the actions the model says we need to undertake.

social, mental and physical health and sustainable neighbourhoods. Policy guidance on new developing neighbourhoods will also promote opportunities for renewable energy supplies through Community Energy Plans.

Land use and transportation information were foundational geo-spatial inputs into the integrated model. The model was not explicitly designed to assess land use or growth management strategies. Regardless, the rate of intensification used in the model was used to compare the difference in required emissions between the Business As Planned scenario and the 100% Reduction scenario. The difference in cumulative GHG reductions under the 100% Reduction scenario was found to be 0.38 per cent of required emissions reductions to 2050. The slight variation is largely attributed to increased vehicle kilometres traveled (VKT). This increases emissions from fossil fuel powered vehicles in the period before they are phased out and from electric vehicles in the period before emissions from grid electricity are removed.

Any numerical differences that exist between the growth management strategy for the new Official Plan and the Energy Evolution model will be addressed in the next model update. These differences are modest and do not influence the necessary actions to be undertaken in the period up to 2025.

b) Buildings

Mitigating emissions from the building sector is also addressed through the Official Plan by giving direction for High-performance Development Standards for certain types of new construction with metrics for building energy efficiency and thermal performance based on criteria set out in the *Ontario Building Code* with progression towards net zero energy ready buildings with higher performance to be encouraged through incentives. Other tools exist under the Planning Act such as Community Improvement Plans allow the City to be used in support of improvements to existing building stock in order to conserve energy and reduce greenhouse gas emissions. The Energy Evolution model takes into account reduced dwelling sizes which are associated with reduced household energy costs, as their energy requirements for electricity and heating and cooling decline. The Official Plan is also expected to emphasize “building form” rather than “building type” which will enable a broader range of housing options to be built.

c) Transportation

The new Official Plan’s growth management strategy is in lockstep with the vision and guiding principles for the Transportation Master Plan Update, expected in 2022. The provision of higher-order transit in new and intensification growth areas is one of the key strategies that will help mitigate emissions from transportation by planning for the majority of trips to be made by sustainable modes by 2046. Increasing compact development also reduces overall transportation infrastructure costs and encourages active transportation.

d) Waste and Renewable Natural Gas

The Official Plan will bring into effect new high-performance development standards that will contain metrics for managing waste for certain types of development. Resource recovery and waste diversion practices will be applied to materials used by developers during construction. Development strategies to promote waste diversion among residents at multi-residential properties will be considered for inclusion.

It is also possible for the City to achieve emission reductions through the Solid Waste Master Plan. Opportunities for waste transfer stations will be considered if they are required to enable zero emission waste collection and optimal renewable natural gas production. All options to be considered through the Solid Waste Master Plan will be measured against an evaluation matrix that balances social, environmental and financial considerations, which will include analysis of net GHG impact of all potential initiatives and technologies.

e) Local Renewable Energy

Local energy generation and storage will ensure local energy security and reliability as well as promote economic competitiveness and resiliency. The PPS requires municipalities to seek opportunities for the development of energy supply including electrical generation facilities and transmission and distribution systems, district energy, including renewable and alternative energy systems, to accommodate current and projected needs. Given that less than 6% of the energy consumed in Ottawa is generated in Ottawa, it is evident that renewable energy technologies will play an increasingly important role to protect Ottawa's long-term energy security.

The Energy Evolution model actions include several renewable energy sources to capitalize for generation, including solar, water, and wind energy. Under the authority of the Planning Act, the new Official Plan intends to recognize and include renewable energy and energy storage facilities as generally permitted uses in some designations with accompanying compatibility criteria applicable to the built form context. Large facilities and buildings are also to be recognized as priority locations in support of their rooftop photovoltaic electricity potential to generate local renewable energy while reducing greenhouse gas emissions.

4.1.5 Priority Projects for the Next Five Years (2020-2025)

The new Official Plan, to be adopted in 2021 by Council, is a strategic document that describes the growth and physical development of the city over the next 25 years. It also sets the foundation upon which the reviews and updates of the Transportation Master Plan, Infrastructure Master Plan, Solid Waste Master Plan and the Greenspace Master Plan are to be built upon. Staff will update the Energy Evolution model as new information becomes available or when it would clarify the GHG implications of significant City plans and policies such as the Official Plan and master plans.

Table 14: Projects to be undertaken in the land use and growth management sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Integration of energy and climate mitigation policies into the new Official Plan and supporting master plans to address multiple challenges being faced by the city over the next 25 years, climate change being one of the most critical. The Official Plan and supporting master plans will be guided by the Climate Change Master Plan with Council approved targets to reduce GHG's by 2050.	• Energy and climate mitigation policies embedded in new Official Plan and supporting master plans	Enabler

4.2 Buildings (New and Existing)

The buildings sector is currently the largest contributing sector to emissions in Ottawa and the largest energy consumer. It accounts for emissions generated mostly through the combustion of fossil fuels (natural gas, some electricity, propane, heating oil, and diesel) for heating. Lower carbon electricity is employed for cooling, appliances, and lighting, which together form the balance of energy demands but a small contribution to emissions. Key opportunities identified for significant potential GHG reductions include deep energy retrofits, high-performance buildings, and the use of heat pumps and district energy for space for heating.

4.2.1 Jurisdictional Considerations

The provincial government is responsible for the regulation of building construction and renovations through Ontario Regulation (O. Reg.) 332/12: Building Code under the *Building Code Act,* but it is enforced at the municipal level. Ontario's Building Code is based on the National Building Code of Canada but remains solely within provincial jurisdiction. Additionally, owners of large buildings (i.e. buildings that are 50,000 feet squared or more) must report their energy use to the Province of Ontario under O. Reg. 506/18: Reporting of Energy Consumption and Water Use.

The National Energy Code of Canada for Buildings is reviewed on a five-year cycle. The next release is expected in 2020. This version will contain major revisions to advance energy performance and are expected to include guidance on retrofits and reduced window to wall ratios. In addition, the new code is expected to include stepped pathways to support provinces with more frequent progressive steps toward net zero energy buildings.

The federal government is responsible for setting standards for home heating under Canada's Energy Efficiency Regulations. At the provincial level, the government requires municipalities to commit to consider climate change – both mitigation and adaptation – in asset management planning.

4.2.2 Model Assumptions

The following assumptions were built into the BAP scenario for the buildings sector:

- 10% improvement in new buildings every five years based on the Ontario building code and new building energy performance standards
- Buildings area per person will increase from 77.3 m^2/person to 88.1 m^2/person. Building floorspace projections of new buildings are based on existing persons per unit (for residential) and floorspace (m^2) per employee/job (for non-residential space).
- Projected decrease in heating degree days and increase in cooling degree days.

4.2.3 Baseline and BAP Scenario

In 2016, 48.2% of GHG emissions in Ottawa came from buildings, with residential buildings contributing 27.5% and non-residential buildings contributing 20.7% respectively. Natural gas, employed for space and water heating was the highest emitting fuel type, responsible for 38.7% of community emissions. While electricity was responsible for the second highest share of energy consumed in buildings after natural gas, it equated to only 5.8% of total emissions due to the low-emission electrical grid in Ontario.

As Ottawa's population increases, the building stock is also expected to increase to accommodate people in homes, offices and commercial spaces. Under the BAP scenario, building emissions are expected to remain relatively constant despite this growth, primarily due to anticipated building upgrades, energy efficiency improvements, and the projected decrease in heating degree days (Figure 13).

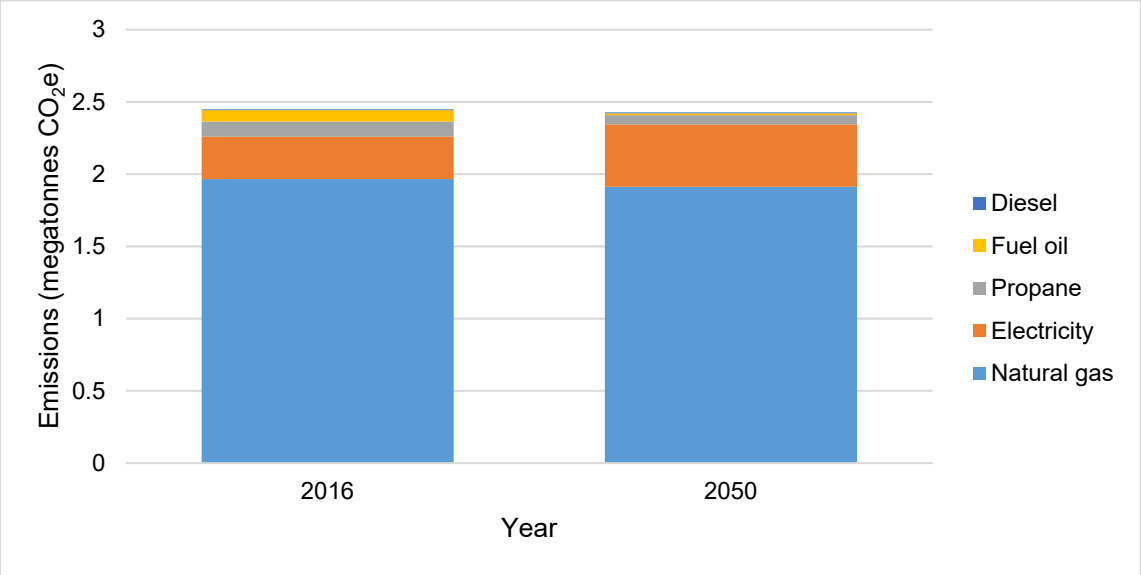

Figure 13: Building sector emissions by fuel type for BAP scenario, 2016 and 2050

4.2.4 Achieving the 100% Scenario

The model projects that the buildings sector could contribute roughly 38% of total GHG emission reductions required to achieve the 100% scenario. In order to realize these emission reductions, deep energy retrofits are required. As identified by the model, retrofitting residential buildings is projected to account for 17.9% of cumulative GHG emission reductions over the next 30 years, while retrofitting commercial buildings is projected to account for 15.1%. Electricity becomes the primary fuel for all building types and the switch to heat pumps for space heating and cooling is effective in reducing building emissions. Emissions from natural gas will decrease by 98% as a result of fuel switching and energy efficiency measures, while emissions from propane and fuel oil will decrease between 90% to 99%. By switching to electricity and reducing overall consumption, GHG emissions are projected to reduce by 99% in residential buildings, 97% in commercial buildings, and 97% in industrial buildings by 2050. Additionally, district energy use increases in the residential and industrial sectors due to the expansion of the existing federal district energy system and the addition of new district energy systems.

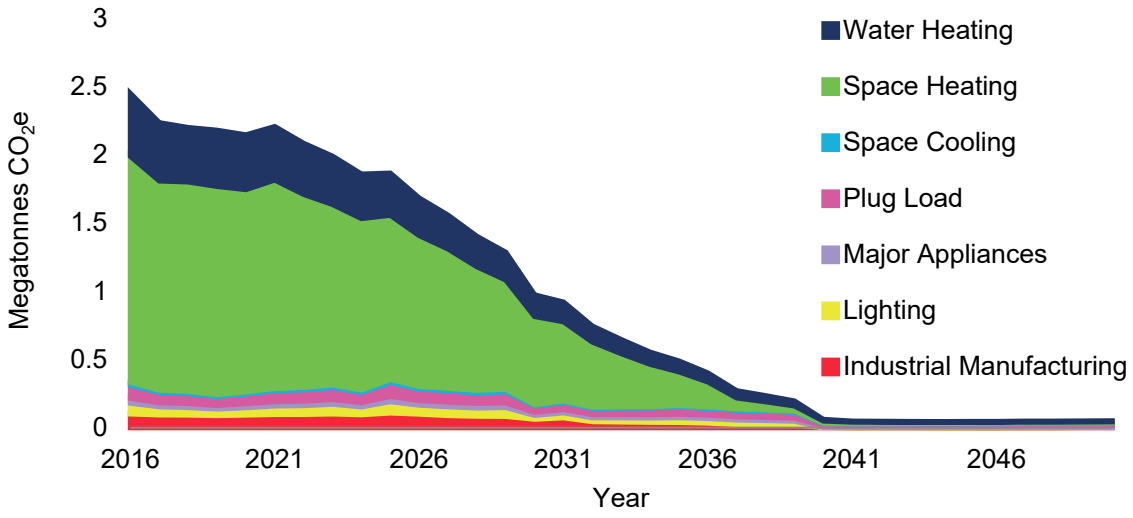

Figure 14: Building sector emissions by end use for 100% scenario, 2016-2050

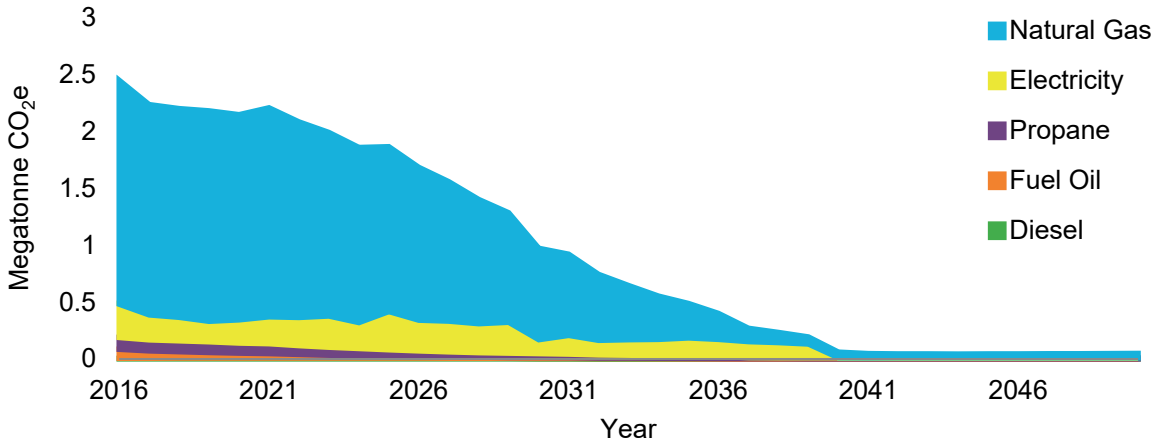

Figure 15: Building sector emissions by source for 100% scenario, 2016-2050

The model indicates that the minimum results required to meet the 100% scenario under the building sector are[34]:

- 98% of residential and small commercial existing buildings and 95% of large commercial and industrial existing buildings are retrofit for 70% heating savings and 30% electrical savings by 2040
- 16% of existing municipal buildings are retrofit to net zero emissions by 2030 and 99% by 2040
- 100% of new homes are net zero emissions by 2030
- 100% of new commercial buildings are near net zero emissions-ready after 2030
- 560,350 residential heat pumps installed and 73% of commercial building heat load served by heat pumps by 2050. (Buildings which must retain heating during prolonged power failures have back-up power generation for their heat pumps if required)
- 80% of existing commercial and apartment buildings and 15% of residential buildings served by district energy by 2050
- The federal district energy system to be converted to geothermal by 2040 and 100% of the district energy systems are to be geothermal by 2050.

[34] The minimum results are based off the energy and emissions model outputs. Further options may be evaluated under this project to meet the scale of action required.

4.2.5 Priority Projects for The Next Five Years (2020-2025)

Table 15 identifies projects to be initiated within the next five years to accelerate retrofits of existing buildings sector, the decarbonization of heating sources, and net zero emissions building construction:

Table 15: Projects to be undertaken in the buildings sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Residential Building Retrofit Accelerator Program to accelerate residential, multi-unit residential, and commercial and institutional building retrofits through marketing, information and financial mechanisms	• 17% of existing residential buildings renovated or replaced • 20% of existing residential buildings transition to heat pumps • 10% of domestic hot water heating transitions to non-emitting sources	22% (222 kt CO2e)
Commercial Building Retrofit Accelerator Program to accelerate multi-unit residential, commercial, industrial, and institutional building retrofits through marketing, information and financial mechanisms	• 15% of existing commercial buildings renovated or replaced • 20% of existing commercial buildings transition to heat pumps • 10% of domestic hot water heating transition to non-emitting sources	18% (175 kt CO2e)
Building Retrofits through Local Improvement Charge Program to accelerate and finance deep energy retrofits of buildings through the local improvement charge mechanism	Embedded within the residential and commercial retrofits accelerator programs	
Energy Community Improvement Plans to incentivize superior energy performance and deep energy retrofits using tax grants.	Embedded within the residential and commercial retrofits accelerator programs	
Community Building Heating Strategy to address infrastructure and utility requirements for new ways of heating buildings	30% drop in GHG intensity of federal district energy system	9% (92 kt CO2e)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Municipal Buildings Retrofit and Renewal Program to achieve higher building energy performance improvements in municipal owned buildings	Ramping towards having 27% of municipal buildings net zero by 2030	1% (12 kt CO2e)
Update Municipal Green Building Policy to align with corporate GHG reduction targets	Embedded within the Municipal Buildings Renovation and Retrofit Program	
High Performance Development Standard to improve building design and construction across the community and support an industry-wide transition of new buildings to net zero emissions ready by 2030.	Ramping towards all new buildings being net zero energy by 2030	6% (59 kt CO2e)

4.3 Transportation

The transportation sector is currently the second largest contributing sector to emissions in Ottawa and the second largest energy consumer. It includes five vehicle types (cars, light trucks, heavy trucks, urban buses, and light rail transit (LRT)) and accounts for emissions generated through the combustion of fossil fuels (diesel and gasoline) as well as alternative fuels (biodiesel, ethanol, and electricity).

Achieving significant GHG reductions hinges on transforming transportation in two ways: how people and goods move within the city and the National Capital Region and what fuels this movement. A flexible, integrated set of options will be required to allow seamless transition between transportation options to reduce reliance on vehicles, leading to a reduction in vehicle kilometres travelled and associated emissions. This would include a robust public transportation system with frequent service, increased active transportation options supported by safe walking and cycling facilities, shared mobility including shared commuting, auto-share and bike-share programs, and mobility hubs[35]. At the same time, transportation options need to be electrified (or other zero carbon solution) to drastically reduce GHG emissions.

4.3.1 Jurisdictional Considerations

The federal government is responsible for regulating the automotive industry and setting fuel standards, whereas the provincial government sets emission standards for all

[35] A Mobility Hub is a location that has several transportation options and is a concentrated point for a mix of uses such as transit, employment, housing, recreation and shopping.

vehicles in Ontario, renewable content for fuel, and has a regulatory role in the provision of measures such as road user fees.

At the local level, the municipality's Transportation Master Plan sets out the transportation growth management and travel demand policies along with the planning and implementation of its walking, cycling, transit, and road networks. The municipality also operates the traffic management system, has control over the allocation of municipal roadway space for different users, and sets parking fees for on-street parking and municipal lots. Spending of parking revenues is governed by the Municipal Act and the Municipal Parking Management Strategy. Additionally, it has control over the procurement and operation of its own fleet.

4.3.2 Model Assumptions

The following assumptions were built into the BAP scenario for the transportation sector:

- Electric vehicles are 5.5% of personal vehicle stock in 2050
- Total number of personal and commercial vehicles is proportional to households in the BAP scenario; personal vehicle stock share decreases and commercial stock remains the same between 2016 and 2050
- Annual vehicle kilometres travelled increase from 5.7 billion to 9.6 billion by 2050; this is driven by autonomous vehicles which increase transportation demand and contribute to vehicle movement because of deadheading
- Vehicle fuel consumption rates reflect the U.S. Corporate Average Fuel Economy (CAFE) fuel standard for light duty vehicles and Phase 1 and Phase 2 of Environmental Protection Agency (EPA) Heavy Duty Vehicles (HDV) fuel standards for medium and heavy-duty vehicles
- Mode share for transit, cycling, and walking based on 2013 Transportation Master Plan model data for 2011 and 2031 and held constant post 2031
- Transit fleet is electrified by 2050

4.3.3 Baseline and BAP Scenario

In 2016, 41.3% of GHG emissions in Ottawa came from transportation, with cars and light trucks accounting for roughly 85% of transportation emissions. Gasoline was the highest emitting fuel by type, responsible for 80% of emissions within the transportation sector and 33% of total emissions in Ottawa. Diesel accounted for the remaining 20% of transportation emissions.

Under the BAP scenario, transportation emissions are expected to slightly increase due to population growth and an increase in freight and associated diesel emissions. While there will be an increase in the electrification of personal vehicles, gasoline and diesel remain the dominant fuel types in 2050 accounting for 95% of transportation energy use.

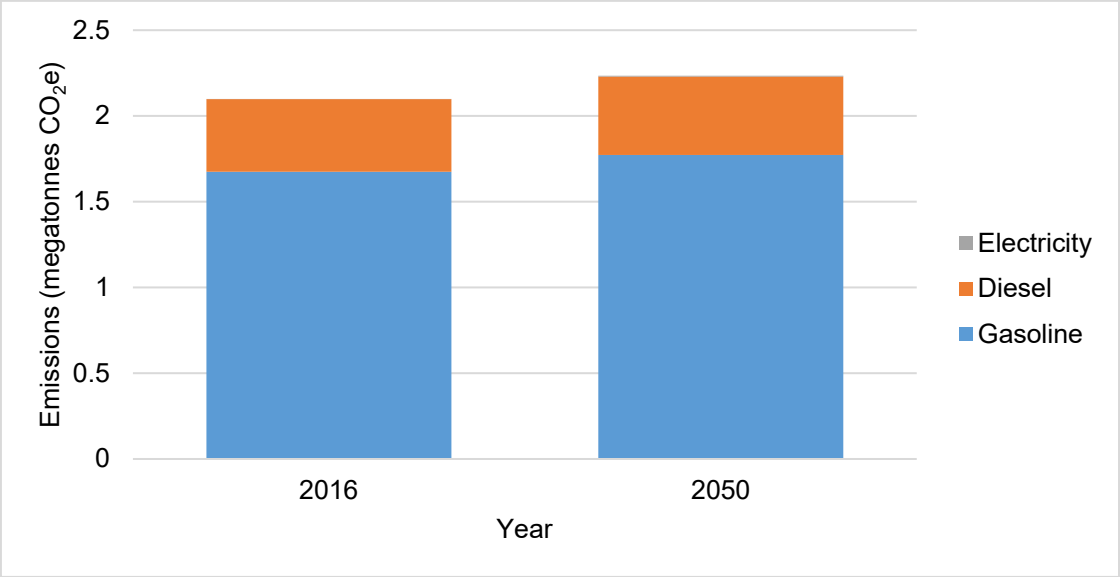

Figure 16: Transportation sector emissions by fuel type for BAP scenario, 2016 and 2050

4.3.4 Achieving the 100% Scenario

The model projects that the transportation sector could contribute roughly 37% of total GHG emission reductions to achieve the 100% scenario. In order to realize these emission reductions, electric vehicles must replace internal combustion engines and the use of diesel and gasoline as a fuel source for both personal and commercial vehicles. The model projects that the electrification of personal vehicles (cars and light trucks) is the single-most impactful action in Ottawa over the next 30 years, accounting for 22.7% of cumulative GHG emission reductions. Transitioning commercial fleets to zero emission vehicles is also in the top five actions accounting for 8.3% of cumulative GHG emission reductions. Over the course of transitioning to electric vehicles, emission reductions can be further accelerated by reducing overall vehicle kilometers travelled as a result of an increased share of transit use and active transport modes. All factors combined result in a 99% reduction in emissions in the transportation sector.

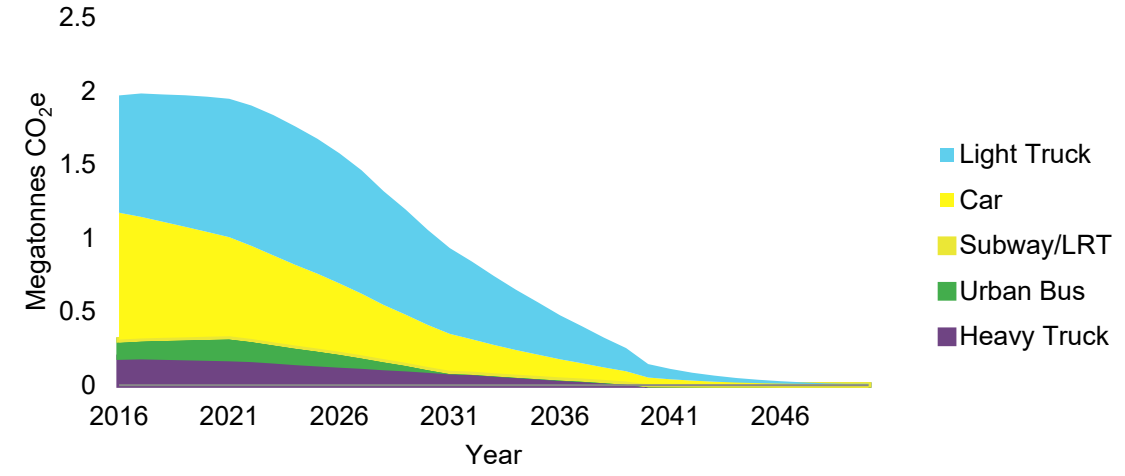

Figure 17: Transportation sector emissions by vehicle type for 100% scenario, 2016-2050

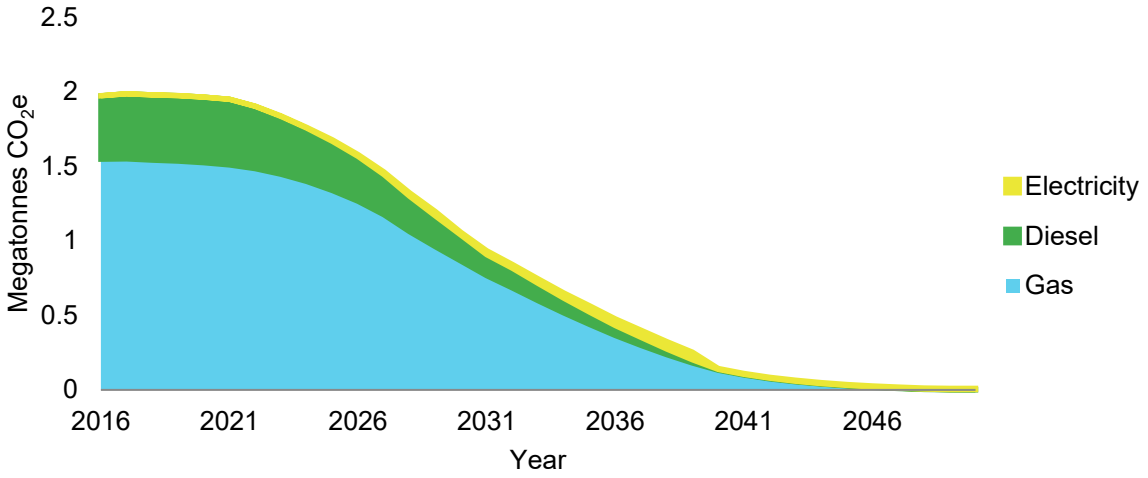

Figure 18: Transportation sector emissions by source for 100% scenario, 2016-2050

The model indicates that the minimum results required to meet the 100% scenario under the transportation sector are[36]:

- Electric vehicles (EVs) comprise 90% of new personal vehicle sales by 2030 and 100% by 2040
- 40% of heavy trucks are zero emission by 2030 and 100% by 2040
- 100% of transit fleet is zero emission by 2030

[36] The minimum results are based off the energy and emissions model outputs. Further options may be evaluated under this project to meet the scale of action required.

- Municipal fleet is 60% zero emission by 2030 and 100% by 2040
- Bus rapid transit and light rail transit increase in frequency by 2030
- Active transportation mode share is at 21% by 2030[37]
- Expanded transit to reflect "Concept Network" [38]
- ByWard Market and part of downtown Ottawa[39] are car free by 2030
- Congestion charges, EV only areas and increased parking fees

4.3.5 Priority Projects for The Next Five Years (2020-2025)

Table 16 identifies projects to be initiated within the next five years to accelerate the electrification of the transportation sector and the expansion of transit and active transportation infrastructure:

Table 16: Projects to be undertaken in the transportation sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Personal Vehicles Electrification Strategy to enable and encourage personal electric vehicle adoption.	7% of personal vehicle sales are EVs in 2025	5% (49 kt CO2e)
Zero Emissions Commercial Vehicles Strategy to enable and encourage commercial electric vehicle adoption.	18% of commercial fleet is electric by 2025	6% (63 kt CO2e)
Municipal Green Fleet Plan Update to consider corporate greenhouse gas reduction targets.	Progress towards the 2030 target	<1% (<10kt CO2e)
Alternative Energy Sources for Transit Project to build a 100% zero emissions Concept Transit Network by 2030.	48% of OC Transpo's passenger fleet is zero emission by 2025	6% (63 kt CO2e)
Transportation Mode Shift to reduce the reliance on personal vehicles in favour of sustainable modes including public transit, walking, cycling and carpooling.	Steady progress towards the 2030 mode share targets	3% (33 kt CO2e)

[37] The updated Transportation Master Plan (TMP) will recommend new mode share targets and establish the policies to support the vision that most trips will be made by sustainable transportation (i.e. walking, cycling, transit or other non-auto modes) by 2046.
[38] Concept Transit Network defined in the 2013 TMP refers only to the recommended infrastructure, not how it is operated. Through the updated TMP, additional transit network planning will be completed to 2046.
[39] Boundary defined as Wellington Street-Rideau Street, Sparks Street, Bank Street, and University of Ottawa campus.

4.4 Waste and Renewable Natural Gas

The waste and renewable natural gas sector is one of the smaller contributing sectors to emissions in Ottawa but presents a large opportunity to create net zero emission fuel. It is comprised of emissions from solid waste and wastewater and opportunities to displace conventional fossil fuels such as natural gas. The Energy Evolution model assumes that achieving additional GHG reductions within the waste sector hinges on two steps: eliminating organics from the landfill and converting all available waste organic material into usable energy using anerobic digestors or gasifiers to generate renewable natural gas (RNG)[40]. Additionally, smaller contributions from waste heat[41], power to gas and district energy are part of the overall emissions reduction opportunities in this sector. Solid waste includes residential and non-residential waste, recyclables, and source separated organics. Source separated organics are comprised of organic materials such as food scraps, paper waste, and leaf and yard waste. Most organic waste that ends up in a landfill does not breakdown. The portion that does decompose releases methane, a potent GHG emission that must be captured in Ontario to ensure it does not migrate to properties neighbouring the landfill. This captured gas can be used to generate electricity or can be recovered as a fuel source. The Province of Ontario has proposed banning organic waste from landfills by as early as 2022, however no formal strategy or plan for how this will roll-out has been released by the Province. The Solid Waste Master Plan will investigate policy options and programs that could achieve this provincial direction. Emissions from solid waste collection vehicles are accounted for in the transportation sector and emissions associated with energy used at waste facilities are accounted for in the buildings sector.

4.4.1 Jurisdictional Considerations

In Canada, all three levels of government have a role to play in waste management, with the federal and provincial government establishing:

- Waste reduction and diversion policies and programs
- Providing regulations and standards for waste management facilities and operations
- Approval and monitoring of waste management facilities and operations

The municipality is the operator and manager of the public waste management system which includes the municipal wastewater treatment plant, recycling and organic waste collection, as well as the disposal of solid non-hazardous waste at the Trail Road Waste Facility. The municipality also provides collection services for some parts of the industrial, commercial, and institutional (ICI) sector, although it is not required to do so by the provincial government. Within this sector, the municipality provides service to most of the

[40] Renewable natural gas refers to gas generated through electrolysis or gas generated through anaerobic digestion or gasification of organic waste.
[41] Waste heat refers to existing sources of unwanted heat, e.g., heat from existing industrial processes or sewers.

city's multi-residential buildings, municipally owned facilities, and small business through the Yellow Bag Program. ICI waste is regulated by the provincial government and is generally privately managed and operated.

4.4.2 Model Assumptions

The following assumptions were built into the BAP scenario for the waste sector:

- Emissions projections for waste are derived using projected population growth and existing rates of waste produced per capita and assumes no reduction in per capita waste[42]
- 2016 residential, multi-residential waste diversion rate of 47% was held constant to 2050; ICI sector diversion rates are unchanged from 2016 to 2050
- No new technology for carbon emission reductions in solid waste or wastewater treatment facilities assumed beyond 2016
- Landfill emissions include those from operating and retired landfills.

4.4.3 Baseline and BAP Scenario

In 2016, 7% of GHG emissions in Ottawa came from waste, the vast majority of which came from organic solid waste and a small amount from wastewater. Over 1 million tonnes of residential and ICI solid waste was produced in 2016, of which almost 70% was sent to landfills, 20% was recycled and 10% was biologically treated (through composting and anaerobic digestion). Additionally, over 100 million m^3 of wastewater was produced, the vast majority of which was treated at the Robert O. Pickard Environmental Centre. Emissions in solid waste and wastewater are built from actual site data comprised of direct emissions from biological material and energy (fuel, electricity) used to process materials.

Under the BAP scenario, both Ottawa's solid waste and wastewater production are expected to increase in step with population growth, by 40% and 35% respectively. As a result, emissions associated with solid waste and wastewater are expected to also increase under this scenario, rising over 37% by 2050. Notable increases in paper, wood waste, plastic and metal, and compost are expected also driven by population growth.

[42] Waste projections are being updated through the Solid Waste Master Plan and any changes will be considered in the next update of the model.

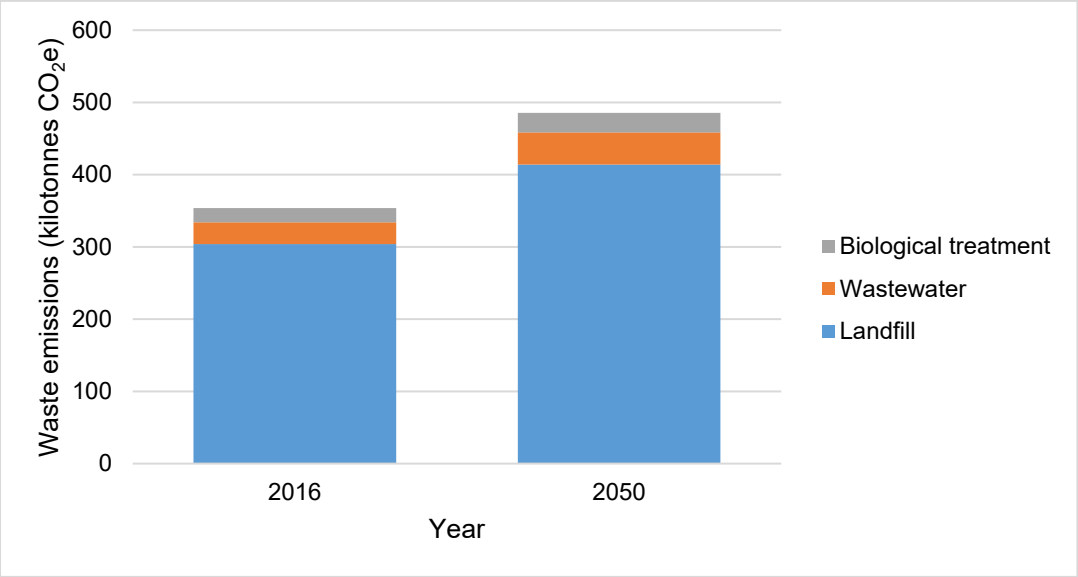

Figure 19: Solid and liquid waste emissions for BAP scenario, 2016 and 2050

4.4.4 Achieving the 100% Scenario

The model projects that the waste and RNG sector could contribute roughly 17% of total GHG emission reductions to achieve the 100% scenario. The diversion of organics from the landfill and using that organic material to make RNG is one of the most impactful actions to achieve the 100% scenario. The reduction in waste emissions could reach approximately 97% by 2050 by greatly reduced fugitive emissions (predominantly methane) and nearly perfect solid waste diversion rates. Additionally, biogas produced by capturing off-gassing from organic waste decomposition makes up the majority of emission reductions within this sector. Natural gas will need to be eliminated through conservation and switching to electrically powered heating and RNG.

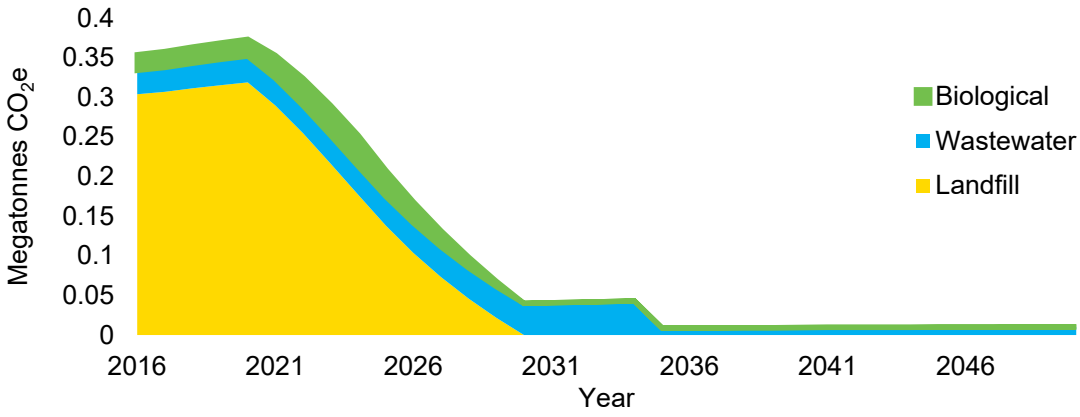

Figure 20: Solid waste and wastewater emissions for 100% scenario, 2016-2050

The model indicates that the minimum results required to meet the 100% scenario under the waste and renewable natural gas sector are[43]:

- All leaf and yard waste gasified after 2030 to displace natural gas
- Displace 1.5% of natural gas through power to gas[44] by 2030
- Anaerobic digester gas and landfill gas are predominantly used as renewable natural gas and displace natural gas use
- 98% of organics diverted by 2024
- 100% of paper waste diverted by 2042
- 3 MW of electricity from farm biogas until 2030; after 2030, farm biogas doubles and is used to produce RNG rather than electricity
- Use of waste heat displaces close to 4% of the emissions from building heating by 2050

4.4.5 Priority Projects for The Next Five Years (2020-2025)

Table 17 identifies projects to be initiated within the next five years to accelerate the emissions reductions from waste:

Table 17: Projects to be undertaken in the waste and renewable natural gas sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Organics Resource Recovery Strategy to reduce emissions associated with managing waste and enable energy from waste.[45]	Significant increase in organics diversion starting in 2023	7% (73 kt CO2e)
Renewable Natural Gas Strategy to supply GHG neutral gas and other heating to the community.	Initial RNG production in the community starting in 2022	12% (122 kt CO2e)

[43] The minimum results are based off the energy and emissions model outputs. Further options may be evaluated under this project to meet the scale of action required.
[44] Power to gas involves the hydrolysis of water using electricity to make hydrogen or methane for injection into the gas grid. Biogas and power to gas are collectively referred to as renewable natural gas
[45] Options to achieve this aggressive target along with all other considerations and implications will be explored through the development of the municipal Solid Waste Master Plan (SWMP), expected to be complete by Q1 2022. The SWMP will determine the direction and goals for residential solid waste management, diversion, and reduction over the next 30 years.

4.5 Electricity

Reducing emissions to 100% by 2050 will require an increase in electricity production and delivery. Ontario's current electricity supply has a low emissions profile; however, the model projects a doubling of electrical demand as electrification of transportation, heating and population growth drive demand. The additional requirements for renewable electricity generation will reflect both the need to meet new demand and to offset anticipated carbon intensity of the provincial grid as forecasted by the Ontario Ministry of Energy, Mines and Northern Development. Eliminating electricity generated from fossil fuel in Ontario's electrical supply will be a long-term activity and provincial commitments in this area could partially replace the need to install capacity in the community.

4.5.1 Jurisdictional Considerations

The Province is the regulator and a large owner of the bulk of the electricity generation in Ontario. A number of municipal and private energy generation operators do contribute power to the grid, but it is a highly regulated environment.

At the local level, Hydro Ottawa is fully owned by the municipality and Portage Power, a subsidiary of Hydro Ottawa, is the largest municipally owned producer of green power in Ontario. Portage Power currently has the following green energy operations in Ottawa and surrounding areas:

- Sixteen run-of-the-river hydroelectric facilities, including six stations in Ottawa's downtown core
- Hydroelectric generation capacity of 84.6 megawatts (MW) at Chaudière Falls
- Landfill gas-to-energy generation capacity of 10.2 MW, powering enough electricity for 10,000 homes
- Fourteen solar installations across Ottawa

Ten hydroelectric stations located in Eastern Ontario and nearby New York State that have a total combined output of 31 MW.

4.5.2 Model Assumptions

The following assumptions were built into the BAP scenario for the electricity sector:

- Applied the 2016 Independent Electricity Systems Operator's (IESO) Ontario Planning Outlook and National Energy Board's 2016 Ontario projected electricity generation capacity
- Slight increase in carbon intensity from 2016 onwards as nuclear loses some of its share. Post 2035, natural gas generation is maintained, effectively locking in a problematic GHG contribution

4.5.3 Baseline and BAP Scenario

In 2016, 5.8% of community emissions came from electricity consumption, predominantly from the buildings sector. Approximately 92% of electricity consumed in Ottawa comes from zero emission sources (primarily from the provincial grid), with local generation contributing 17.4% of the zero-emission electricity consumed via hydro and solar power.

Under the BAP scenario, electricity demand is on par with natural gas demand by 2050. Emissions associated with electricity production are expected to increase over the next 30 years due to population growth, energy demands being increasingly electrified, and a slight increase in the provincial bulk transmission grid emissions factor. Despite the growing demand for electricity, emissions associated with electricity are anticipated to account for only 8% of total emissions in Ottawa in 2050. This is in contrast to natural gas which is projected to have the same energy demands as electricity but would be responsible for 36% of emissions in Ottawa.

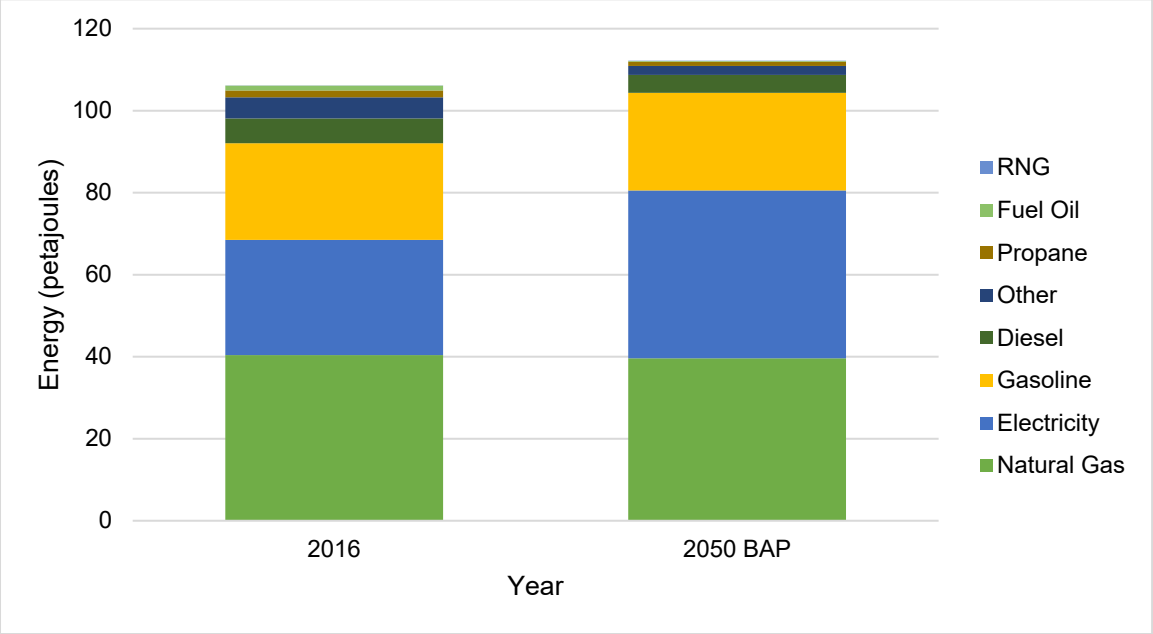

Figure 21: Energy use by fuel type for BAP, 2016 and 2050

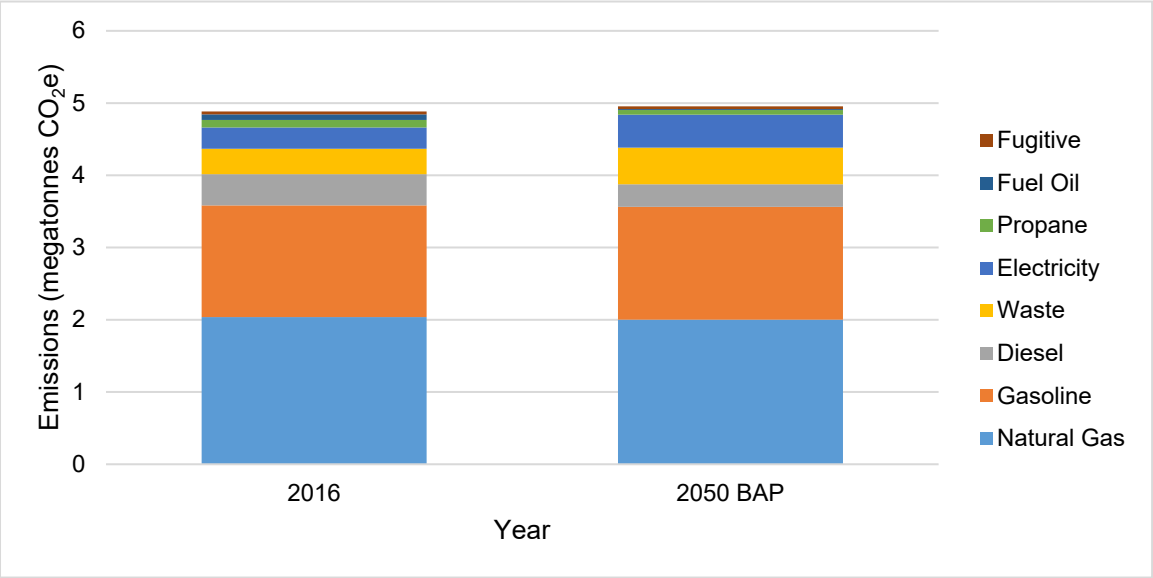

Figure 22: Emissions by fuel type for BAP scenario, 2016 and 2050

4.5.4 Achieving the 100% Scenario

The model projects that making the local electricity supply zero emission could contribute roughly 8.5% of total GHG emission reductions required to achieve the 100% scenario. To realize this target, electricity would need to become the dominant energy source, supplying 88% of the total energy required in Ottawa. As a result, electricity supply will need to increase by 127% and the local electricity supply will need to become entirely emission free, even with significant increases in electricity use for the electrification of transportation and heating. This kind of energy transition is only possible if conservation and efficiency in the building and transportation sectors greatly reduces energy demand in concert with a move to electrification. As electricity demand is expected to increase over the next 30 years, discussions with Ottawa's local distribution companies, the Independent Electricity System Operator and the Ontario Energy Board are already underway. Proactive demand forecasting and frameworks to allow more distributed energy resources are being explored.

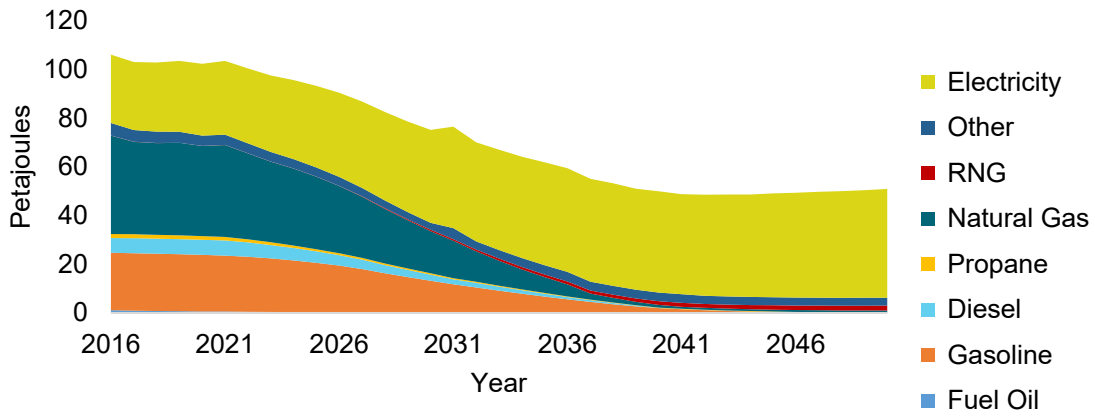

Figure 23: Energy consumption by fuel type for 100% scenario, 2016-2050

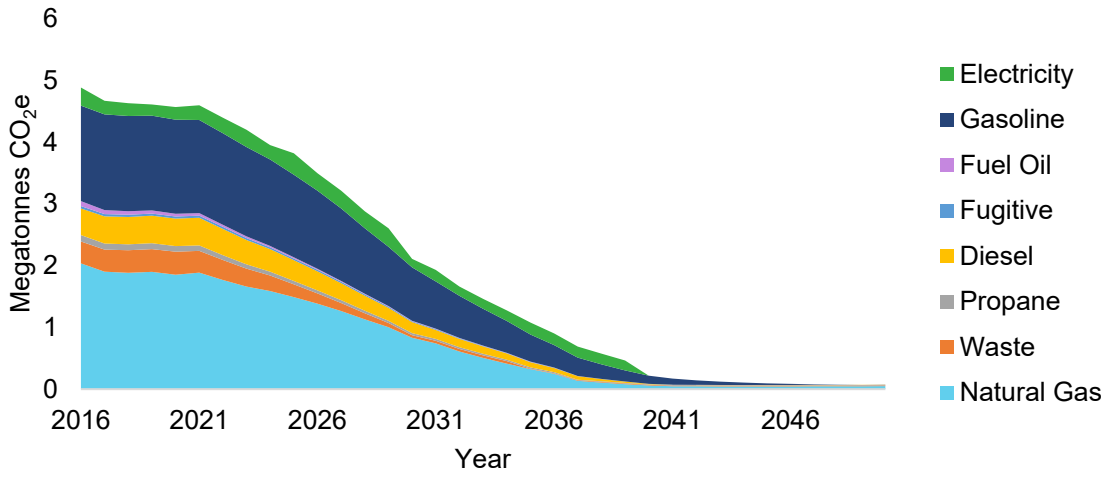

Figure 24: Emissions by fuel type for 100% scenario, 2016-2050

The model indicates that the minimum results required to meet the 100% scenario under the electricity sector are[46]:

- Solar photovoltaic (PV) reaches 1,060 MW by 2050 (approximately 36 km^2 of solar PV[47] mostly on rooftops)
- Wind generation reaches 3,218 MW by 2050 (approximately 710 large scale turbines)

[46] The minimum results are based off the energy and emissions model outputs. Further options may be evaluated under this project to meet the scale of action required.
[47] The required area could be less if the energy density of PV panels continues to increase.

- 310 MW of local energy storage by 2030 and 612 MW by 2050 [48](122 large shipping containers of lithium batteries) approximately

4.5.5 Priority Projects for the Next Five Years (2020-2025)

Table 18 identifies projects to be initiated within the next five years to increase renewable energy generation and energy storage:

Table 18: Projects to be undertaken in the electricity sector (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Electricity Resource Strategy to develop local or regional renewable electricity supplies and advocate for zero-emission generation at the provincial level.	Install: • 150 MW Solar • 20 MW Wind • 20 MW Hydro • 20 MW Electricity Storage	7% total comprised of: • Solar: 57 kt CO2e • Wind: 4 kt CO2e • Hydro: 10 kt CO2e

4.6 Enabling Projects and On-going Engagement

Reducing emissions to 100% by 2050 will require significant investment, policy alignment and regulatory changes amongst various levels of government, community partners including utilities, commercial and institutional champions, and the general public.

As directed by the Climate Emergency motion (ACS2019-CCS-ENV-0005), staff will work with senior levels of government to accelerate ambition and action to meet the urgency of climate change and provide additional resources for municipalities and the public to reduce their GHG emissions. This will be accomplished through an Advocacy Strategy to coordinate communications with senior levels of government, utilities, stakeholders, the broader community, and other Ontario and Canadian municipalities.

Community partners, including more than 200 key stakeholders representing approximately 90 organizations in Ottawa, have been critical in guiding and informing the development of the strategy and the supporting projects. Ongoing engagement with these community partners will be crucial to the successful implementation of Energy Evolution. Partners who have already committed to supporting projects are included in Appendix F: Project Overviews. Staff will continue to work with both these community partners and new ones as they emerge to identify opportunities, resourcing needs and financing to scale up community-wide efforts. The final modelling work done through Energy Evolution will be shared with stakeholders who have not yet been involved to facilitate an integrated approach across the community and to encourage collaboration amongst various levels of government, utilities, stakeholders, and the broader community.

[48] Assumes each MW of capacity stores 4 MWh of energy.

Staff will also seek to develop a new Climate Ambassadors Network to engage community partners to meet long term GHG reduction targets.

Expanding education and outreach with the broader public will be crucial to achieving community-wide GHG reduction targets. A Climate Change Education and Outreach Program will support broad communications and outreach to help all residents and stakeholders understand what the City is doing, and what they can do, to reduce greenhouse gas emissions and adapt to Ottawa's changing climate.

Table 19 identifies enabling projects to be initiated within the next five years to support private action.

Table 19: Enabling projects to support meeting the 100% scenario (2020-2025)

Project Description	Project Metrics	Cumulative GHG Reduction Requirements
Climate Ambassadors Network to engage commercial and institutional champions to meet long term GHG reduction targets	• Reduced barriers to implementation • Increased funding to support implementation	Enabler
Climate Change Education and Outreach program to engage the public in collective private action to meet long term GHG reduction targets	• Increased awareness and action	Enabler
Fund the Evolution to further assess potential sources of municipal funding.	• Increased funding to support implementation	Enabler

5.0 Financials

5.1 Analysis

Financial analysis was undertaken for Energy Evolution actions that have financial impacts. Analysis to meet Council's approved targets included:

- Capital investments
- Operating costs
- Savings
- Revenues
- Net present values
- Return on investment
- Cash flow impacts
- Annual GHG emissions reductions
- Employment impacts (It is estimated that 30 job-years of employment will be created for every $1M invested in energy efficiency[49])
- Economic development opportunities

The analysis was done at a community-wide level. As such, the analysis represents investments required by and potential savings for everyone in Ottawa including the City, residents, businesses, institutions, and organizations.

All financial information presented represents high level estimates that are currently uncommitted and unfunded capital and operational needs. The analysis does not commit the City or any partners to any financial decision or provide direction to staff how to address funding gaps. The analysis is intended to:

- Identify the magnitude of funding required to implement Energy Evolution for the City and partners, including senior levels of government
- Assess which funding sources, financial mechanisms or delivery mechanisms may be most appropriate for implementing Energy Evolution actions
- Inform strategic discussions, policy direction, annual budget cycles and the Long-Term Financial Plan.

It is not intended to provide sufficiently accurate financial information to make final decisions. This level of detail will be brought forward to Standing Committee and Council when approval is sought on priority projects.

[49] Dunsky Energy Consulting "The Economic Impact of Improved Energy Efficiency in Canada" 2018.

5.1.1 Methodology

To complete the financial analysis, Sustainability Solutions Group developed a "Cost Catalogue" based on research and consultation with internal and external experts. This research and consultation also informed the development of assumptions that went into determining the rate of uptake of the model metrics. The Cost Catalogue projects the capital and operating costs for all metrics in the Energy Evolution model that have financial implications and can be referenced in Appendix H: Cost Catalogue.

Data sources for capital costs included peer reviewed research, national and provincial projection documents, market trend statistics as well as City of Ottawa financial assumptions, past project costs, and future project estimates. Section 5.1 and 5.2 of Appendix D: Technical Report explain the data sources accessed.

Consultations included discussions with City staff from Finance Services, Transportation Services, Recreation, Cultural and Facilities Services, Public Works and Environmental Services and Planning, Infrastructure and Economic Development departments. External experts, including industry representatives from the sustainable building, renewable energy, and transportation sectors, were used to verify the capital cost assumptions and their relevancy in the Ottawa context.

All costs and profits projected for the 100% Scenario are incremental, above and beyond the BAP Scenario. A revolving loan tool was developed to project the capital needs and annual returns of each action in the Energy Evolution model independently or combined, to model how the returns from the early adopters can be rolled into the next actions to reduce the overall cost to society.

5.1.2 Assumptions and Limitations

Key inputs of the financial analysis are based on the Energy Evolution model assumptions, including:

- Discount rate of 4.5% as is the standard currently used by the City of Ottawa for long term financial projections
- Inflation is excluded in projections and net present value calculations
- Federal carbon price escalating to $50 per tonne by 2022, as stated by the Federal government, and increasing at approximately 3% annually thereafter
- Revenue streams from renewable heat and electricity sales
- Congestion charge revenues at $20/car entering downtown on weekdays
- Parking rate increases of 50%
- Amortization periods based on the shorter of life expectancies of equipment or 25 years
- Interest rates for borrowed funds at 4%
- Energy cost increases (Figure 25, Figure 26, and Figure 27).

It is recognized that these are based on modeled projections and will require further study and Committee and Council approval in many cases. See Appendix D: Technical Report for discussion about overall assumptions and limitations of the Energy Evolution model. Details about the assumptions and the methodology are available in Appendix A: Data, Methodologies, and Assumptions Manual and Appendix B: Business as Planned Scenario Report.

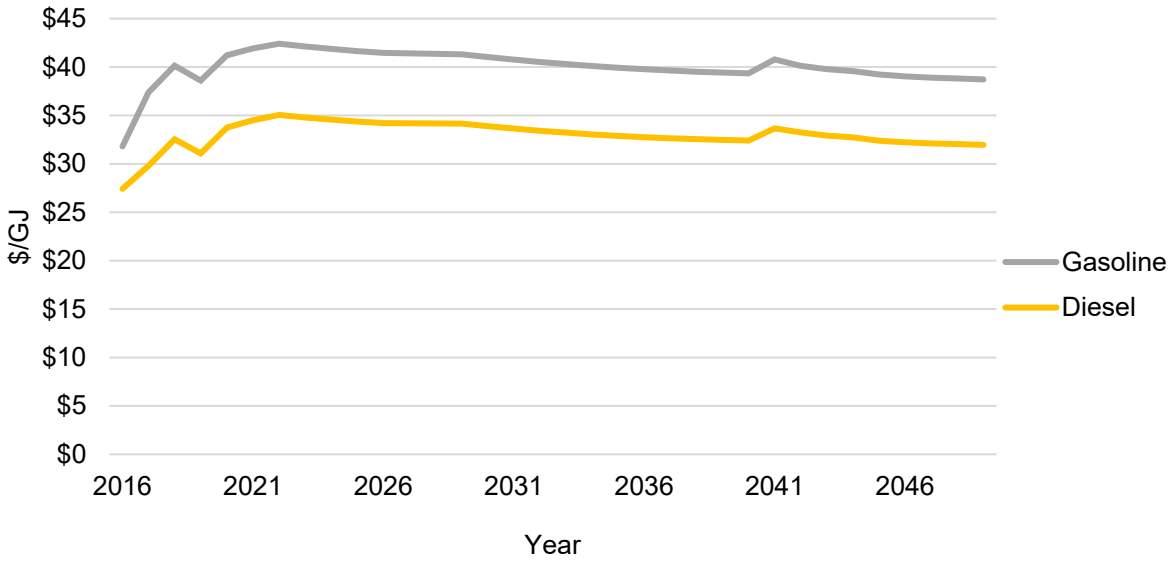

Figure 25: Transportation Fuels Cost Projections, 2016-2050

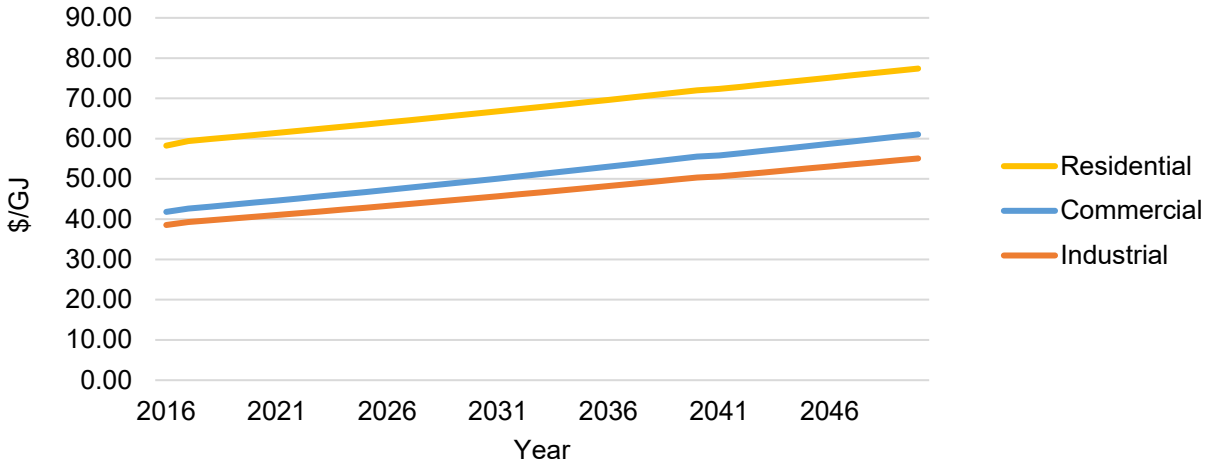

Figure 26: Electricity Cost Projections, 2016-2050

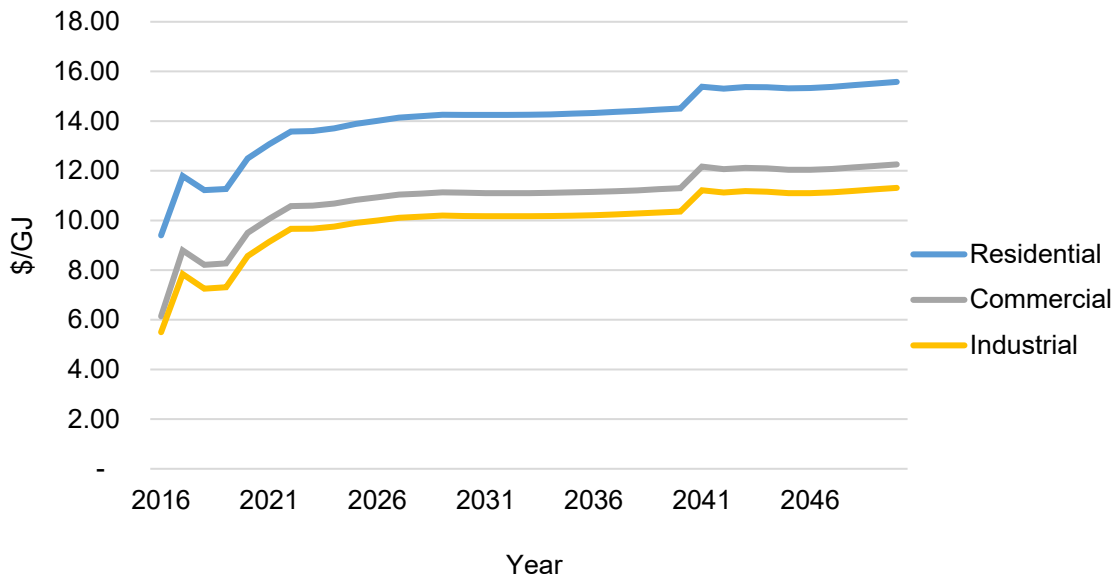

Figure 27: Natural Gas Cost Projections, 2016-2050

Financial analysis was based on the best data available at the time. Key limitations of the data include:

- Expansion of the transit network is based on the 2013 TMP. For the purposes of modeling the financial considerations of meeting Council's GHG reduction targets, the financial analysis uses the Concept Transit Network, and associated costing from the 2013 TMP. The City of Ottawa is at the beginning of the process to update the TMP and the proposed transit network may change. Council's approval of the updated TMP (including the recommended transit network) is expected in 2023. As part of the development of the TMP, both the Energy Evolution energy and emissions model and associated financial analysis can be updated to consider and evaluate all options from a climate impact lens and ensure alignment. This is significant because expansion of the transit network is the single biggest municipal cost included in the model.
- The Solid Waste Master Plan (SWMP) was under development at the time of the writing of this strategy. As such, this strategy is based on the known contracts and practices of the City's Solid Waste Services at that time. As part of the development of the SWMP, both the Energy Evolution energy and emissions model and associated financial analysis can be updated to consider and evaluate all options from a climate impact lens and ensure alignment. It is also recognized that the SWMP only deals with the residential component of the solid waste generated in the City. Waste management strategies and a financial model for the ICI sector currently fall outside of the scope of the SWMP.

This financial analysis is considered portfolio level analysis based on high level, or Class D, estimates. More detailed financial analysis will be required for specific projects as they move towards implementation. Estimates will require consideration within the City's annual budget cycle, the Long-Range Financial Plan, and the Asset Management Plan, since all financial requirements are currently unfunded.

The City recognizes that the municipality alone will not be able to accomplish the scale of investment required, but the City is in a position to play a role in visioning, planning for success, coordinating collective action amongst local entities, and collaborating with senior levels of government. A proposal for how the funds will be acquired as well as how the profits could benefit all residents is included as part of this analysis.

5.1.3 Cumulative Community-wide Investments by 2050

Financial analysis indicates that cumulative community-wide investments from 2020 to 2050 total $57.4 billion with a present value of $31.8 billion. The financial analysis considers total investment and savings for the community, not just the municipality of Ottawa.

In the short term, annual community-wide capital costs are higher than in the BAP scenario, as up-front investments in buildings, vehicles, energy-related equipment and renewables are made that will lead to long-term savings. Figure 28 shows that there is a net financial benefit to society starting in 2032 when the net annual savings and revenues exceed the annual investments. For all investments made to reach the 2050 target, the net return community-wide totals $87.7 billion which is $12.4 billion when discounted to 2020$. Table 20 shows how the net return accumulates to 2050 and beyond based on the life expectancies of the investments made. More details on the financial analysis are included in Appendix D: Technical Report. [50]

[50] The values in Table 8 differ slightly from the values in Table 5-2 of the Technical Report in Appendix D because of different assumption related to interest rates and loan terms. The consultants, Sustainable Solutions Group and whatIf? Technologies Inc used a 3% interest rate and 20-year loan terms expectancy for all assets. The City of Ottawa Finance department uses a 4% interest rate and the Energy Evolution project team adjusted loan terms based on the useful life of the asset.

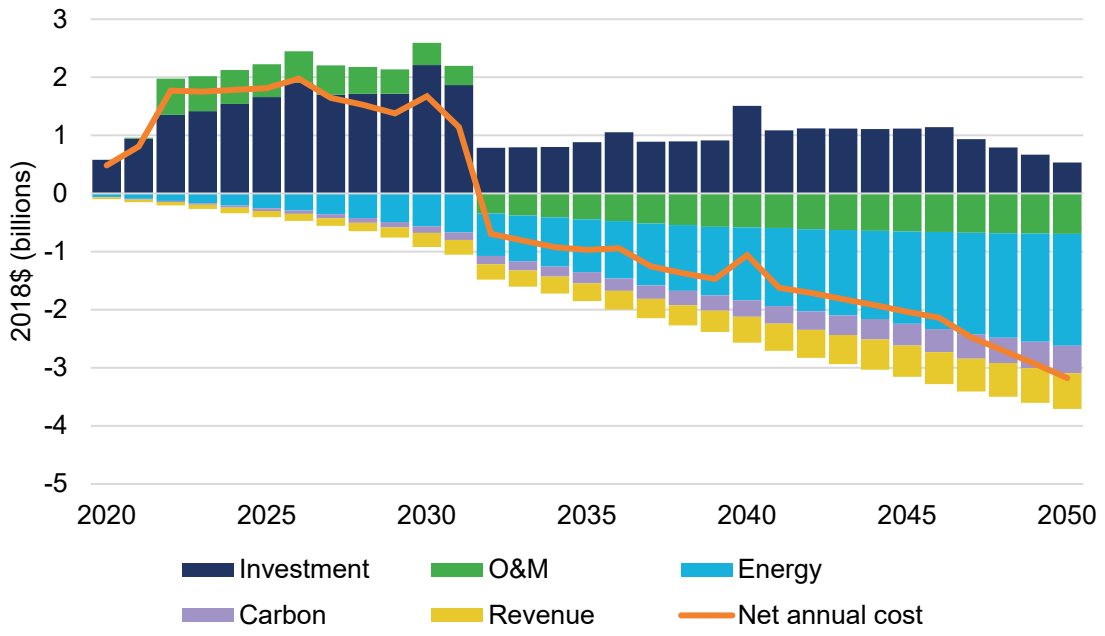

Figure 28: Annual incremental expenditures, savings, and revenues, 2020-2050

Table 20: Financial net value to society for achieving the 100% scenario

Capital Investments and Savings	Undiscounted ($Billion)	Present value (4.5% discount rate) ($Billion)
Capital investments	($57.4)	($31.8)
Operations and maintenance savings	$22.6	$9.0
Energy savings	$70.9	$18.1
Carbon price savings	$13.4	$4.0
Revenue from local generation	$38.2	$13.1
Community-Wide Net Return	**$87.7**	**$12.4**

5.1.4 Annual Incremental Community-wide Capital Investments by 2050

Achieving the 100% scenario will require unprecedented investments from the City, senior levels of government, and the community in the next 10 years. Compared to the BAP, annual incremental community-wide investments of approximately $1.6 billion per year net present value would be required for the next decade (2020-2030) to achieve GHG reductions in line with the model. Of this, $581 million per year net present value would be required (2020-2030) for transit and active transportation infrastructure. An additional $41 million per year net present value would be required (2020-2030) for municipal building retrofits, transitioning to a zero-emission municipal (non-transit) fleet, sewer heat capture, and renewable natural gas generation at wastewater and solid waste facilities.

Annual incremental community-wide investments drop to around $782 million per year from 2031-2050. During this period, net returns are much higher than in the BAP, primarily because of the saved energy costs and earned revenues from local energy generation.

Adding to the savings include saved carbon fees and lower operation and maintenance costs (for electric technologies including vehicles).

While the analysis indicates that there is a compelling economic argument for decarbonising the city, other barriers remain including coordination, capture and reinvestment of savings, lock-in of existing energy systems, education and capacity, access to capital, delivery mechanisms, and legal and policy barriers. For example, private vehicle financing, when they are debt financed (or leased), is often provided by the dealership who can offer more attractive terms due to their ability to lump the cost of financing into the cost of the car. Table 21 summarizes the annual incremental community-wide investments by 2050. Figure 29 shows where significant community-wide capital investments will be required between 2020 and 2050. The full analysis is included in Appendix D: Technical Report.

Table 21: Comparison of the present value of investments to meet the 100% scenario

Short term Annual Incremental Community Wide Investments (2020 – 2030)	Long term Annual Incremental Community Wide Investments (2031 – 2050)
$1.6 billion	$782 million

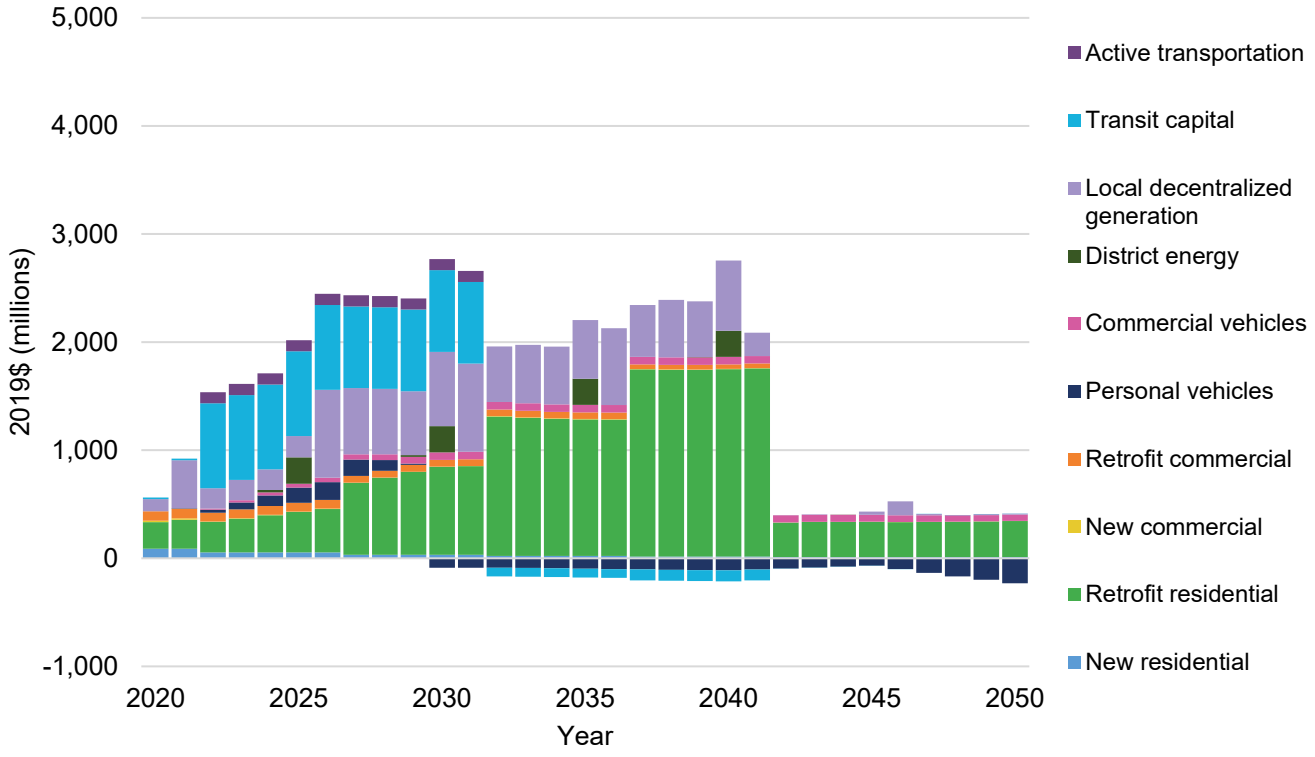

Figure 29: Community-wide capital investments by action, 2020-2050

5.1.5 Net Costs and Savings by Sector

Figure 30 depicts the annual breakdown of the capital investments, energy and operational savings, carbon fee savings, and generation revenue associated with implementing actions in Energy Evolution. The value of the cost savings increases dramatically as the time period progresses.

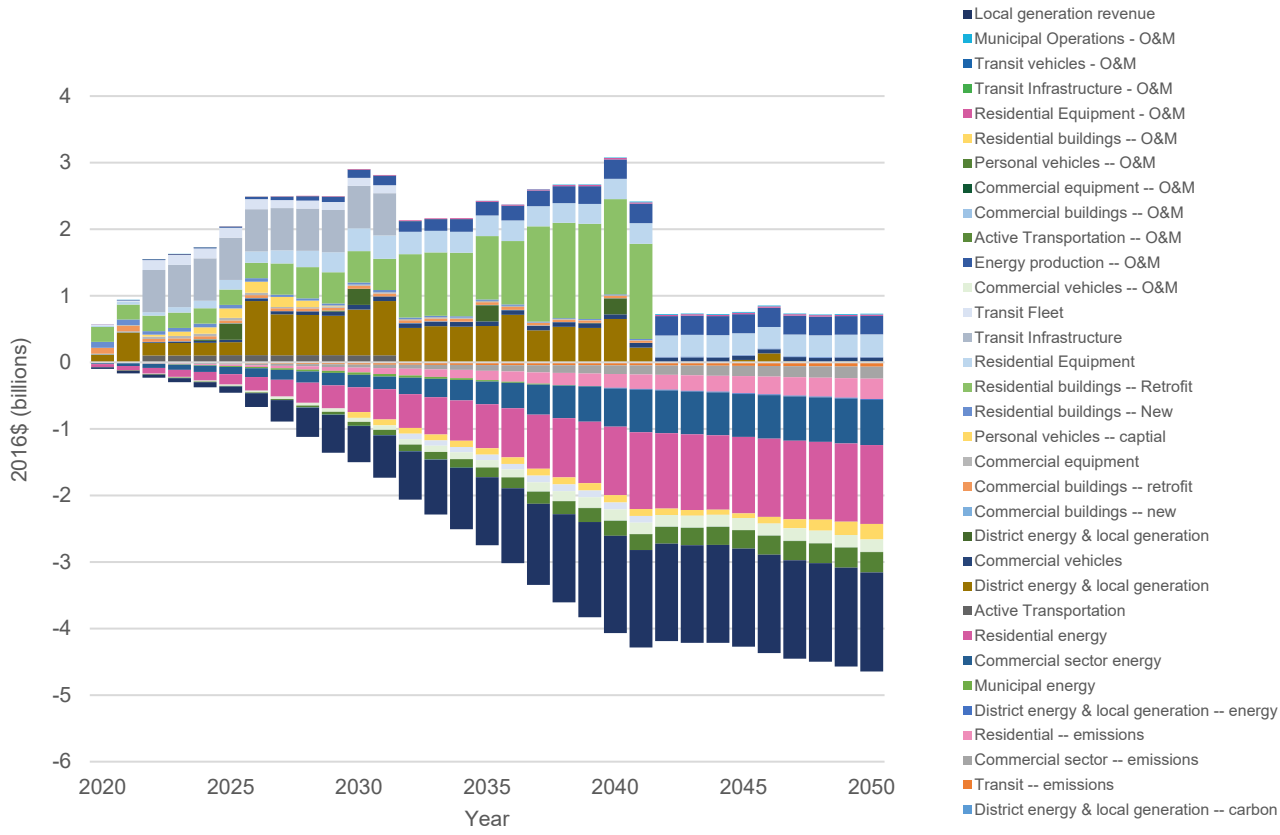

Figure 30: Breakdown of annual incremental net costs and savings, 2020-2050

A breakdown of the actions bundled into each of the sectors is provided in Table 22.

Table 22: Breakdown of net costs and returns by sector (Net Present Value 2020$, in billions)

Sector	Estimated Net Costs ($Billions)	Estimated Net Return by 2050 ($Billions)	Estimated Net Return over Life of Investment ($Billions)
Land Use and Growth Management	$0	$0	$0
Buildings (New and Existing)	($17.7)	($6.0)	$0.4
Transportation	($7.9)	$3.9	$4.8
Waste and Renewable Natural Gas	($0.2)	$0.01	$0.02
Electricity	($6.0)	$4.8	$7.2

5.1.6 Cost Estimates in Context

To comprehend the magnitude of these financial projections, it is helpful to compare the figures to other relevant Ottawa statistics as listed below:

- Annual GDP in 2016: $63 billion
- Annual City budget: $3.76 billion
- Annual spending on energy: $3 billion (for all end uses of energy)
- Annual spending on building improvements/renovations: $2.9 billion
- Annual spending on new motor vehicles: $5.8 billion
- Annual spending on cell phone plans: $480 million
- Insurance payouts in 2018 related to natural disasters exacerbated by climate change: $53 million
- City spending on road resurfacing in 2019: $51 million

5.1.7 Impacts on Vulnerable Populations in Ottawa

Although a portion of the population has access to funds and leveraging, a significant portion of Ottawa's population experiences energy poverty[51] and has fewer resources to take the recommended carbon reduction actions. 18% of all Ottawa households, or nearly 56,000 Ottawa households, experience high energy cost burdens. This is disproportionately higher in lower income households. As the proposed projects, programs and policies are developed, these segments of the population will be considered to ensure equity and inclusion of the most vulnerable.

5.2 Financing

5.2.1 Municipal Action

Compared to the BAP, annual incremental municipal investments of approximately $621 million per year present value would be required for the next decade (2020–2030) to achieve GHG reductions in line with the model and the targets. Nine municipal actions have been identified that would require financing to achieve Council's GHG reduction targets:

1. Expand transit

[51] Energy Poverty is defined by Canadian Urban Sustainability Practitioners as homes that spend more than 6% of their after-tax income (two times the national average) on home energy bills, primarily electricity and natural gas (https://energypoverty.ca/).

2. Alternative Energy Sources for Transit
3. Transportation mode shift
4. Transitioning to a zero-emission municipal (non-transit) fleet
5. Municipal building retrofits
6. Organic waste diversion
7. Renewable natural gas generation
8. Power to gas
9. Car free zones

Table 23 provides an overview of projected financing for municipal GHG reduction actions associated with the nine municipal actions above.

Table 23: Overview of projected financial returns for municipal GHG reduction actions (Net Present Value, Life expectancy of assets, in billions)

Municipal Actions Requiring Financing Based on Model	Associated Project	Projected Initial Capital Investments	Projected Net Return by 2050	Projected Net Return over Life of Asset	Potential Sources of Capital Funding	Potential Financial Mechanisms	Potential Delivery Mechanisms
Expand transit	Zero Emissions Transit Project	($5.0)	($2.0)	($1.6)	• Grants from senior levels of government (e.g., FCM) • Development Charges • Gas tax • Debt financing	• Congestion charge. Parking lot licensing.	• City to build the Concept Network
Zero Emissions Transit	Zero Emissions Transit Project	($0.7)	$0.3	$0.3	• Grants from senior levels of government (e.g., FCM) • Gas tax • Debt financing	• Possibly leases for the first few years until the technology risk is overcome	• OC Transpo, possibly through bus or battery leases. Chargers and rail infrastructure through P3.
Road Infrastructure Costs	Transportation Mode Shift	$0	$0.2	$0.2	• Expenditure savings	• Expenditure savings	• Reduced road expansion costs from reduced vehicle use

Municipal Actions Requiring Financing Based on Model	Associated Project	Projected Initial Capital Investments	Projected Net Return by 2050	Projected Net Return over Life of Asset	Potential Sources of Capital Funding	Potential Financial Mechanisms	Potential Delivery Mechanisms
Congestion Charge	Transportation Mode Shift	$0 (TBD)[52]	$1.7	$1.7	• User fee	• Daily charge to enter downtown	• Technology, equipment and cost to collect
Increase Public Parking Revenues	Transportation Mode Shift	$0	$0.1	$0.1	• User fee	• Street and public lot parking fees, public lot rates	• City for on street parking and City lots.
Increase/improve cycling & walking infrastructure	Transportation Mode Shift	($0.7)	($0.5)	($0.5)	• Grants from senior levels of government (e.g., FCM) • Development Charges • Debt financing	• Repaid through road infrastructure savings	• City investment and cost to maintain
Car free zone	Transportation Mode Shift	$0 (TBD)	$0.001	$0.001	• Grants from senior levels of government (e.g., FCM) • Debt financing	• Some road infrastructure savings	• City investment and cost of enforcement
EV Zones	Personal Vehicle	($0.0004)	$0.1	$0.1	• Grants from senior levels of	• Offset through EV	• City investment

[52] Transportation Master Plan will assess the cost to implement various road user fee mechanisms

Municipal Actions Requiring Financing Based on Model	Associated Project	Projected Initial Capital Investments	Projected Net Return by 2050	Projected Net Return over Life of Asset	Potential Sources of Capital Funding	Potential Financial Mechanisms	Potential Delivery Mechanisms
	Electrification Strategy				• government (e.g., FCM) • Debt financing	charger revenue	and cost of enforcement
Zero Emissions Municipal Fleet	Municipal Green Fleet Plan Update	($0.002)	$0.03	$0.03	• Grants from senior levels of government (e.g., FCM) • Annual contribution to capital	• Replace fleet over time as part of fleet long range plan	• Owned or leased
Municipal buildings retrofits	Municipal Buildings Renewal and Retrofit Program	($0.8)	$0.9	$1.7	• Private service providers, Envari, City capital funds	• City investments or leases • Energy cost savings	• Energy service contracts, fee for service, equipment leases
Waste diversion	Organics Resource Recovery Strategy	($0.07)	$0.3	$0.3	• Recycling to be paid for through producer pays fees. • Residential organics and waste may be paid by City service and/or tax fees (under	• Service fees. Tax base. Private contracts for ICI	• City to deliver residential waste services. Province regulates ICI waste services which are provided

Municipal Actions Requiring Financing Based on Model	Associated Project	Projected Initial Capital Investments	Projected Net Return by 2050	Projected Net Return over Life of Asset	Potential Sources of Capital Funding	Potential Financial Mechanisms	Potential Delivery Mechanisms
					review in the SWMP). • ICI waste services paid by private sector.		and managed by the private sector.
Expand wastewater treatment plant biogas generation	Renewable Natural Gas Strategy	($0.03)	($0.05)	($0.03)	• Private capital. • Grants from senior levels of government (e.g., FCM) • Debt financing	• Repaid through sale of biogas.	• P3 or City owned.
Power to gas	Renewable Natural Gas Strategy	($0.1)	($0.05)	($0.05)	• Private capital, Canada Infrastructure Bank, FCM, Grants from senior levels of government • Debt financing	• Repaid through sale of biogas.	• P3 or City owned.
Total		**($7.5)**	**$1.3**	**$2.4**			

5.2.2 Community Action

5.2.2.1 Rationale for Municipal Involvement

Municipalities are uniquely positioned to catalyze community emissions reductions. Most significant emissions reductions achieved around the world are expedited through municipal, provincial and federal governments creating enabling conditions that have a market transformation influence. The role for municipalities can be lumped into two categories: enabling policies and effective financing tools.

Municipalities are also uniquely positioned to operate with an equity and inclusion lens, ensuring vulnerable populations are not left behind. Private financiers do not have this mandate.

The municipality stands to benefit from playing this catalyst role, as a low-carbon economy is economically stable, more attractive to businesses, more cost effective to operate, healthier for residents, and equitable for all.

5.2.2.2 Enabling Policies

The finance-related enabling policies uniquely available to municipalities that have been effectively employed in emissions reductions from buildings strategies include:

- Community improvement plans
- Property tax rates and associated grants based on carbon emissions
- Licensing exemptions for achieving low carbon goals
- Green procurement standards
- Green leases
- Bylaws and fines
- Service fees

These tools present effective ways of overcoming barriers to GHG emissions reduction solutions.

5.2.2.3 Effective Financing Tools

Each of the actions identified in the Energy Evolution model can be delivered in various ways. Some of these can be delivered in such a way that the savings are captured for reinvestment, while others will be harder to do so. Some of the measures will have quick paybacks while others are longer or have no payback at all. Bundling the quick payback measures with the longer payback measures will help all of them become successful.

A coordinated financing strategy can ensure the savings are used to capitalize deeper GHG reduction projects. Modeling shows that, if a low carbon revolving loan fund were set up to finance a significant portion of the actions (all those considered reasonably financed by a public bank), the net return from the carbon reduction actions could be captured and reinvested into the next action. This would decrease the total cost to the Ottawa economy to meet the climate goals by up to 60%. This was modeled for Ottawa using a revolving loan tool.

All levels of government are well positioned to play a role in the financing and revolving of capital in the community for a few reasons. They can borrow funds at low interest rates, which can make all the actions requiring upfront investment more financially attractive. P3 arrangements are also well positioned because they de-risk projects, making it easier to access low cost private capital.

Typically, the public sector provides services that have no return on investment while the private sector manages only profitable services. There is an opportunity for the public sector to participate in carbon-reduction programs and services and benefit from the associated cashflows.

Financing mechanisms that the municipal public sector could be involved in are listed below and associated with specific actions in Table 24:

- Local improvement charges
- On-bill financing
- Public-private partnership (P3)
- Equipment leases
- Energy service agreements
- Credit enhancements

Table 24: Key Opportunities for government financing to catalyze community action (Net Present Value, 2020-2050, in billions)

Community Actions Based on Model	**Associated Project**	**Projected Initial Capital Investments**	**Projected Net Return by 2050**	**Projected Net Return over Life of Asset**	**Potential Sources of Capital**	**Potential Financial Mechanisms**	**Potential Delivery Mechanisms**
Net zero new homes	High-Performance Development Standard	($3.1)	$1.1	$2.5	• Private capital • LC3 • Canada Mortgage and Housing Corporation (CMHC)	• Financing of incremental efficiency measures at construction	• Low interest financing
New commercial buildings	High-Performance Development Standard	($0.07)	$0.3	$0.6	• Private capital • LC3 • CMHC	• Green mortgages	• Low interest financing
Retrofit houses	Residential Building Retrofit Accelerator Program	($8.0)	($0.2)	$1.8	• Private capital • Green Bonds • FCM • Canada Infrastructure Bank • CMHC • Utility efficiency programs	• LIC • On-bill financing • Green mortgages • CMHC loans	• ESCO or Efficiency Utility. Mechanisms involve bulk buys, PEER, and community-scale retrofits.
Retrofit apartments	Commercial Building Retrofit Accelerator Program	($0.3)	$0.2	$0.4			
Retrofits for small commercial and office buildings	Commercial Building Retrofit Accelerator Program	($0.1)	$0.3	$0.6	• Private capital • Green Bonds • FCM	• LIC • MEETS • On-bill financing	• ESCO, efficiency utility.

Community Actions Based on Model	**Associated Project**	**Projected Initial Capital Investments**	**Projected Net Return by 2050**	**Projected Net Return over Life of Asset**	**Potential Sources of Capital**	**Potential Financial Mechanisms**	**Potential Delivery Mechanisms**
Retrofits for commercial, office and industrial buildings	Commercial Building Retrofit Accelerator Program	($0.5)	$1.3	$2.4	• Canada Infrastructure Bank • Natural Resources Canada • Utility efficiency programs	• ESAs	
District energy system	Community Building Heating Strategy	($0.3)	$0.1	$0.1	• Canada Infrastructure Bank • FCM	• P3	• ESAP and/or thermal utility
Electrify commercial vehicles	Zero Emissions Commercial Vehicles	($0.8)	$1.9	$1.8	• Private capital, dealership financing	• Dealership financing • Private lenders	• Dealership financing • Carshare fleets
Electrify personal vehicles	Personal Vehicle Electrification Strategy	($0.6)	$4.1	$4.7	• Private capital • Dealership financing • Envari for public charging infrastructure	• Dealership financing • Green mortgages • On-bill financing	• Dealership financing • Carshare fleets
Low-rise residential heat pumps in existing buildings	Residential Building Retrofit Accelerator Program	($2.4)	($0.9)	($1.0)	• Green bonds • Envari and energy service providers capital	• LIC • On-bill financing • Green mortgages • CMHC loans	• Leased by Envari or other energy service providers

Community Actions Based on Model	Associated Project	Projected Initial Capital Investments	Projected Net Return by 2050	Projected Net Return over Life of Asset	Potential Sources of Capital	Potential Financial Mechanisms	Potential Delivery Mechanisms
Apartments heat pumps in existing buildings	Residential and Commercial Building Retrofit Accelerator Program	($0.8)	($0.3)	($0.4)	• Green bonds • Envari and energy service providers capital	• LIC • On-bill financing • Green mortgages • CMHC loans	• Leased by Envari or other energy service providers
Commercial heat pumps in existing buildings	Commercial Building Retrofit Accelerator Program	($0.2)	($0.03)	($0.03)	• Green bonds • Envari and energy service providers capital	• LIC • On-bill financing • Green mortgages • CMHC loans	• Leased by Envari or other energy service providers
Residential PV	Electricity Resource Strategy	($0.4)	$0.7	$0.9	• Green Bonds, private capital	• LIC • On-bill financing • Green mortgages	• Bulk installations through efficiency utility or renewable energy co-op, leasing
Commercial PV	Electricity Resource Strategy	($1.1)	$0.9	$1.2	• Canada Infrastructure Bank • Private capital • Portage Power and generators • Community bonds	• Net metering, virtual net metering or opportunities from distributed energy	• Portage Power • Private generators • Renewable energy co-op

Community Actions Based on Model	Associated Project	Projected Initial Capital Investments	Projected Net Return by 2050	Projected Net Return over Life of Asset	Potential Sources of Capital	Potential Financial Mechanisms	Potential Delivery Mechanisms
						resource planning	
Waste heat	Community Building Heating Strategy	($0.0006)	$0.1	$0.1	• Canada Infrastructure Bank • FCM	• Repaid through sale of thermal units	• City to enable capture of heat for public and/or private consumption
Electric water heaters in residential and commercial buildings	Residential and Commercial Building Retrofit Accelerator Programs	($0.06)	($0.1)	($0.1)	• Private capital • Envari and energy service providers capital	• LIC • On-bill financing • Green mortgages • CMHC loans	• Leased by Envari or other energy service providers
Hydropower	Electricity Resource Strategy	($0.1)	$0.1	$0.1	• Canada Infrastructure Bank • Private capital • Portage Power • Community bonds	• Virtual net metering or opportunities from distributed energy resource planning	• Portage Power or other renewable energy generators
Wind	Electricity Resource Strategy	($4.4)	$8.0	$9.8	• Canada Infrastructure Bank	• Virtual net metering or opportunities from	• Portage Power

Community Actions Based on Model	**Associated Project**	**Projected Initial Capital Investments**	**Projected Net Return by 2050**	**Projected Net Return over Life of Asset**	**Potential Sources of Capital**	**Potential Financial Mechanisms**	**Potential Delivery Mechanisms**
					• Private capital • Portage Power • Community bonds	distributed energy resource planning	• Private generators • Renewable energy co-op
Federal district energy systems	Community Building Heating Strategy	($1.0)	($0.5)	($0.5)	• Federal funds and/or private capital through thermal utility	• Repaid through sale of thermal units.	• PSPC and third-party providers

5.2.3 Potential Municipal Sources of Funding

Given the unprecedented capital investments required to fund Energy Evolution, different sources of funding should be explored. Potential municipal sources of funding will be further explored and assessed for viability as part of the Fund the Evolution project identified in Section 4.6 and through concurrent city strategies and plans.

For investments that have a positive financial return, borrowing funds may be a strategic option to take advantage of current low interest rates. Financing opportunities for municipal investments that will be explored as part of the strategy include:

- Debt limit adjustments
- Bonds / Loans (such as green bonds)
- Reserve funds

For projects that do not offer a return on investment, other revenue streams will be required. Revenue opportunities generally within municipal authority fall into five main categories:

- Parking and road-based fees
- Property-related taxes
- Development-related charges
- User/Service fees
- Environmental fines

All potential sources of municipal revenue require further analysis and Standing Committee and Council approval would be required prior to implementation. Analysis will consider additional factors such as the ability to leverage other public and private sources of funding, public acceptance, ease of implementation, limitations on revenue use, authority to implement, economic impacts, and equality and inclusion.

5.2.4 Future Municipal Budget Implications

Future year funding commitments by the City, combined with revenue streams, private capital sources, and funding from senior levels of government will significantly increase the City's success in achieving emissions reductions. Also, the City’s ability to debt finance projects that have a positive return on investment, for which debt servicing exemptions may be required.

Approval of future municipal annual incremental operating requests will be critical to expanding the staffing and resource capacity of departments who are leading projects to advance Energy Evolution. This funding would enable program optimization and improve the likelihood of leveraging capital from external sources, including federal grants and infrastructure monies.

Staff are monitoring relevant provincial and federal programs for municipalities, businesses, and/or residents to support GHG emission reductions. Although, it is

unknown at this time what level of financial support and timing of investment is to be expected by other levels of government, Ottawa should proactively position itself to take advantage of these new funding resources. Staff will be bringing forward budget requests in subsequent years as informed by this model.

5.2.4.1 Priority Projects for The Next Five Years (2020-2025)

Out of the estimated $7.4B investment required by the municipality, $3.2B is required over the next five years to undertake the priority projects identified in Section 4. Of that, $2.6B is required for the transit network alone. This investment should be considered in the affordability analysis for the next Long-Range Financial Plans for Tax Supported Capital, Rate Supported Capital, Transit and Solid Waste and as part of the update of the TMP and the development of the SWMP.

It is recognized that the City alone will not accomplish the scale of investment required. Funding from senior levels of government and private capital sources is a crucial part of the financial strategy to address the expected funding gap that will be created by the investments required for Energy Evolution. As part of the Long-Range Financial Plan updates, many of the financial strategies or mechanisms described throughout Section 5 should be further assessed to identify other potential sources of revenue, savings and financing to affordably fund the municipality's portion of the Energy Evolution priority projects.

6.0 Implementation

6.1.1 Summary of Energy Evolution Projects

Section 4 identifies 20 projects over the next five years (2020-2025) to accelerate action and investment towards achieving the 100% scenario. The action and investment required is summarized in Appendix G: Summary of Energy Evolution Projects (2020-2025). These projects were selected based on their direct GHG reduction potential or ability to enable GHG reductions in order to meet the requirements under the energy and emissions model. Most of the projects are to be led by the municipality and to be undertaken in collaboration with community partners. Proposed projects are contingent on future Standing Committee and Council approval as well as future staff and budget (capital and operating) pressures. To achieve the GHG reductions required in the 100% scenario, some projects may evaluate options beyond what's been identified prior to going to Standing Committee and Council. Where applicable, projects will go through the standard City project management process.

Appendix G: Summary of Energy Evolution Projects (2020-2025) should be read in conjunction with Appendix F: Project Overviews. The project overviews provide further details for each project including a project description, co-benefits, risks, project metrics, key departments, key community partners, timelines, resources, and financial profile.

6.1.2 Risks to Implementation

Section 4 and Section 5 identified the scope and scale required to achieve the 100% scenario both in action and investment. Realizing this action and investment carries many risks. These risks may include:

- Insufficient financial support from different levels of government and the private sector to meet the budgetary and staffing needs of the 20 Energy Evolution projects and beyond;
- Higher capital and operating costs, as well as lower than expected saving and revenues, beyond what's currently estimated for project implementation and municipal operations;
- Regulatory barriers and compliance issues that impede the municipality from action and innovation, either by impeding the municipality directly through its own operations or impeding how the municipality can enact change in the community;
- Lack of uptake or buy-in from residents, businesses, industry or the municipality that impacts the viability of a new program or new standard;
- Diverging interpretations between stakeholders on how best to achieve the 100% scenario;

- Competing Council priorities or processes associated with other projects across the corporation;
- Competing departmental priorities including current operational mandates of impacted services, and how their mandates will need to change in order to work to achieve the emissions reductions in Energy Evolution;
- Lack of alignment between what the Energy Evolution model calls for and recommendations that come forward for plans and strategies that directly relate to Energy Evolution. Note that although it is expected that the range of options evaluated will include one or more scenarios that achieve the GHG reductions required in the 100% scenario, those scenario(s) may not ultimately be recommended;
- Aggressive implementation timelines which may not account for typical City processes including capital budget approval, Long-Range Financial Plan, planning, consultation, approvals, design, construction, and commissioning or account for provincial or federal approval processes that are out of the City's control.
- Changes in behavior, policy, and best practices related to COVID-19.

To mitigate these risks, the Energy Evolution project team will continue to work with City staff at all levels across the corporation, community partners, other levels of government, and the public to build out Energy Evolution projects and act as a resource or provide technical advice on related projects**.** Information and recommendations to support project implementation will be shared with a Tiger Team comprised of all General Managers, the Chief Financial Officer, the City Manager's Office and Ottawa Health; the Climate Change Council Sponsors Group; the Environmental Stewardship Advisory Committee; a community-wide governance structure: and community partners to align and coordinate priorities, workplans, annual budgets, communications and advocacy efforts. The Energy Evolution project team will also continue to work with municipal colleagues across the country through organizations like the Canadian Urban Sustainability Practitioners network, Clean Air Partnership and Low Carbon Cities Canada to share information, best practices, and lessons learned.

Additionally, at the time of the writing of the strategy, multiple City plans and strategies were in the process of being developed that directly relate to Energy Evolution, including the new Official Plan, the Transportation Master Plan Update, the Solid Waste Master Plan, the Alternative Energy Sources for Transit Project, and the Municipal Green Fleet Plan. Recommendations that come out of these plans and programs will have direct impacts on Ottawa's GHG emissions and affect Ottawa's ability to meet Council's approved GHG emission reduction targets. Given their significance, each of these plans and programs have been captured within the 20 projects identified in Section 4. The results of the Energy Evolution modelling exercise have been shared with City staff and

consultants working on these plans to facilitate knowledge and data sharing and align workplans and consultation activities where possible.

As these plans will come forward after Energy Evolution, it should be understood that:

- These plans will evaluate a range of options to achieve each respective plan's goals and targets, and outcomes may differ than what has been identified in this report and Document 1;
- It is expected that the range of options will include one or more scenarios that achieve the GHG reductions required in the 100% scenario, but those scenario(s) may not ultimately be recommended;
- Data provided by City departments to inform the model was based on the best available data at the time and may differ from the data used to inform the plans and programs;
- Different models may be used to do a more detailed and sector specific assessment of the projected GHG implications, providing a level of granularity not available in Energy Evolution model;
- The model includes aggressive implementation timelines which may not account for City processes that typically take several years prior to project implementation, including Council direction, capital budget approval, planning, consultation, approvals, design, construction, and commissioning. It also may not account for provincial or federal approval processes that are out of the City's control.
- All plans are contingent on future Standing Committee and Council approval as well as future staff and budget (capital and operating) pressures.

As the strategy is implemented, new City plans and policies may also be proposed and others will be updated including the Asset Management Plans, the Long-Range Financial Plan and other plans as appropriate. The results of the Energy Evolution modelling exercise can provide detailed information, assumptions and projections on energy, fuel, emissions, and financials that should be considered to achieve Council's GHG emission reduction targets.

6.1.3 Governance

Transforming Ottawa into a thriving city powered by clean, renewable energy. will require broad and deep participation in mitigation efforts. Responsibility for energy conservation and renewable energy planning is shared amongst a variety of city departments as well as external agencies and community partners. Because of the complexity of the problem and the short timelines for action, a governance structure is required to build corporate

and community capacity, align priorities, and share accountability in tackling climate change.

Energy Evolution will contribute to and leverage the governance framework established in the Climate Change Master Plan to:

- Establish common vision, goals, and priorities
- Coordinate implementation of climate mitigation and adaptation research and action
- Scale up community wide projects, programs, or policies
- Access funding and resources
- Influence organizations and residents to take action

7.0 Next Steps and Reporting

7.1 Next Steps

All 20 projects will be further developed with input from staff, stakeholders, and the public as required. In some cases, working groups comprised of staff and community partners will be established to help advance projects. Once projects are fully developed, staff will bring projects to the appropriate Standing Committee and Council for approval, where required.

To aid with the success of the projects, staff will:

- Develop a 10-year spending plan that can be considered in annual municipal budget processes and feed into the City's Long-Range Financial Plan. The next Long-Range Financial Plan will be updated at the beginning of the 2022-2026 term of Council. Budget and staffing requirements would be brought forward as part of the annual budget process.
- Continue to engage with and provide training to staff and the public to embed climate considerations more broadly across the corporation and the community. As the City's centre of expertise for climate change and resiliency, the Climate Change and Resiliency team will also continue to provide technical expertise on corporate projects and support community initiatives.
- Prepare department specific presentations on Energy Evolution starting in 2021 to ensure that staff across the corporation are aware of, can align with, and continue to make use of relevant information. Presentations will include an overview of Council's approved GHG emission reduction targets, relevant aspects of the energy and emissions model, priority projects, departmental implications, and next steps. They will be delivered to Departmental Leadership Teams and offered to appropriate Service Area, Branch or Units teams to support ongoing alignment of priorities, workplans, and budgets.

To ensure that staff across the corporation are aware of, can align with, and continue to make use of relevant information, presentations will be given to City departments starting in 2021. They will include an overview of Council's approved GHG emission reduction targets, relevant aspects of the energy and emissions model, priority projects, departmental implications, and next steps. These presentations will be delivered to Departmental Leadership Teams and offered to appropriate Service Area, Branch or Units teams to support ongoing alignment of priorities, workplans, and budgets.

To keep the model relevant, staff on the Energy Evolution project team are planning to be trained by the consultants on how to use the model in-house. This is expected to reduce costs and increase the value of the model over the long-term. Training will be explored for staff in other teams as well as external stakeholders who may also be interested in being trained on how to use the model so it can be used to support the

development of plans, policies, projects and programs to meet the long-term GHG emission reduction targets.

Staff intend to rerun the energy and emissions model every five years to assess how the City and the community are tracking towards achieving the 100% scenario and to determine what actions should be prioritized in the short-term. Subject to capacity and budget, staff may run parts of the Energy Evolution model before five years if it is helpful to evaluate the GHG implications of significant City plans such as the new Official Plan, Transportation Master Plan Update and Solid Waste Master Plan.

7.2 Reporting

A status update on the Climate Change Master Plan will be provided on an annual basis. As part of the annual status update, staff will:

- Include annual corporate and community GHG inventories to help gauge Ottawa's progress towards GHG emission reduction targets,
- Provide a status update on the Energy Evolution projects, and
- Provide recommendations to advance the projects as required.

A full review and update of the Climate Change Master Plan will be completed in 2025. Simultaneously, Energy Evolution and the future Climate Resiliency Strategy will be reviewed to see whether the three standalone documents can be merged into one.

8.0 Conclusion

Ottawa has made significant investments in recent years in projects that reduce the city's greenhouse gas emissions. Yet, the energy and emissions model projects that Ottawa's emissions will remain relatively flat for the next 30 years under the BAP scenario, far from achieving the long-term GHG emission reduction targets.

Energy Evolution sets the framework for what it will take to achieve Ottawa's long-term target to reduce community GHG emissions by 100% by 2050. Achieving this target will require accelerated and significant investment, policy alignment and regulatory changes to make a sustained transition away from a dependence on fossil fuels. Collaboration amongst all levels of government, utilities, commercial and institutional champions, and the general public will be critical to its success.

Achieving Ottawa's GHG reduction targets will require implementation of the municipality's ongoing and planned actions, implementation of new actions that the municipality has not yet approved, and action and investment from all segments of society. 20 priority projects have been identified to accelerate action and investment over the next five years if Ottawa is to stay on track to achieve the 100% scenario. These projects are contingent on future Standing Committee and Council approval as well as future staff and budget (capital and operating) pressures.

Let's work together to transform Ottawa into a city powered by clean, renewable energy.

Appendices

Appendix A: Data, Methodologies, and Assumptions Manual

Appendix B: Business as Planned Scenario Report

Appendix C: Pathway Studies

Appendix D: Technical Report

Appendix E: Modelling Ottawa's Greenhouse Gas Emissions to 2050: Summary of Results

Appendix F: Project Overviews

Appendix G: Summary of Energy Evolution Projects (2020-2025)

Appendix H: Cost Catalogue