

TransformTO: Climate Action for a Healthy, Equitable and Prosperous Toronto - Report #2 - The Pathway to a Low Carbon Future

Date: April 20, 2017
To: Parks and Environment Committee
From: Chief Corporate Officer
Wards: All

SUMMARY

In July 2007, Toronto City Council recognized the far reaching impacts of climate change and unanimously made a commitment to see community-wide greenhouse gas emissions reduced by 80% against 1990 levels by the year 2050. The City's innovation and leadership is why Toronto has seen its greenhouse gas emissions drop by 24%, exceeding our 2012 goal of a 6% reduction. However, our current pace of change is insufficient to achieve the emission reduction goal for 2050.

Analysis shows that the 2050 goal is achievable with existing technologies, but it means bold action is required to transform Toronto's urban systems - buildings, energy, transportation and waste. Where Toronto is already on the correct trajectory, we need to stay the course. In other areas, we need to increase the scale and pace of change.

The path to the 2050 goal is one where many of the low-carbon actions will pay for themselves over the long term. It is also a path that can facilitate achievement of a city that is more healthy, equitable and prosperous. The TransformTO Modelling Advisory Group, consisting of 35 community leaders and City staff have identified how low-carbon actions can drive significant co-benefits. Their report, *Attachment A: TransformTO Modelling Advisory Group Summary Report*, outlines ways to realize these co-benefits.

Initiated in 2015, TransformTO involved the engagement of over 2,000 residents, the input of an inter-divisional steering team and the Modelling Advisory Group, in combination with detailed technical modelling. Getting to Toronto's 2050 goal requires:

- A. Maintaining & Implementing Toronto's Planned Climate Actions
- B. Committing to the Vision - A Low-Carbon, Healthy, Equitable and Prosperous Toronto
- C. Maximizing Community Benefit from Climate Action
- D. Leadership through City Action

- E. Urban System Transformation
 - i. Mobilizing Low-Carbon Neighbourhoods
 - ii. Expanding Mobility Options and Embracing Electrification
 - iii. Building Energy Performance
 - iv. Renewable and Community Energy Approaches
 - v. Towards Virtual Waste Elimination
- F. Monitoring & Reporting

In December 2016, City Council approved a package of TransformTO strategies to initiate transformation in Toronto's urban systems that must be funded and implemented to put Toronto on the needed long-term trajectory. In addition to full implementation of these strategies, this report identifies three Acceleration Campaigns to ensure that efforts to reduce greenhouse gas (GHG) emissions also maximize potential community benefits:

- 1) Mobilize Low-Carbon Neighbourhoods;
- 2) Exploring the Implications and Opportunities of Electric Mobility; and
- 3) Workforce Development for High-Performance Buildings

RECOMMENDATIONS

The Chief Corporate Officer recommends that:

1. City Council approve the following long-term goals and pursue necessary measures to realize a low-carbon Toronto in 2050 that achieves an 80% reduction in greenhouse gas (GHG) emissions against 1990 levels:
 - a) 65% reduction in community-wide GHG emissions by 2030 from 1990 levels as an interim target;
 - b) 100% of new buildings are designed and built to be near zero GHG emissions by 2030;
 - c) 100% of existing buildings are retrofitted to the highest emission reduction technically feasible, on average achieving a 40% energy performance improvement over 2017 levels, while limiting affordability impacts to residents, by 2050;
 - d) 75% of community-wide energy use is derived from renewable or low-carbon sources by 2050;
 - e) 30% of total floor space community-wide – residential and commercial – will be connected to low-carbon thermal energy by 2050;
 - f) 100% of transportation options - including public transit and personal vehicles - use low or zero-carbon energy sources, and active transportation accounts for 75% of trips under 5 km city-wide by 2050; and

g) 95% of waste is diverted in all sectors – residential, institutional, commercial and industrial - by 2050.

2. City Council direct the Chief Corporate Officer to lead cross-corporate implementation of City Council's approved "Leading by Example" TransformTO Report #1 Strategies, for which business cases will be brought through the annual budget process, towards achievement of the following low-carbon leadership goals:

a) Design and build all new City-owned facilities to be near zero GHG emissions by 2026;

b) Retrofit all City-owned buildings, including social housing, to the highest emission reduction technically feasible, on average achieving a 40% energy savings over 2017 building energy performance by 2040;

c) Install 24MW capacity of renewable energy on City-owned facilities and lands by 2020;

d) Establish a green fleet plan to transition 45% of City-owned fleet to low-carbon vehicles by 2030;

e) Achieve a net zero waste status at all City-owned facilities by 2030;

f) Generate and utilize 1.5 Million Giga-joules of energy from biogas by 2030; and

g) Earn designation as one of Canada's Top 100 Green Employers by 2020.

3. City Council approve the long-term goal of transitioning to a low-carbon Toronto by 2050 in a way that maximizes public benefit and minimizes harms by using the following guiding principles when designing and delivering climate actions:

a) advance social equity;

b) improve affordability particularly for vulnerable populations;

c) protect low-income residents

d) contribute to poverty reduction

e) enhance and strengthen the local economy;

f) maintain and create good quality local jobs;

g) improve public health; and

h) create resilient communities and infrastructure.

4. City Council direct that the TransformTO low-carbon, long-term goals and implementation plans be integrated:

a) by the Chief Resilience Officer into the development and implementation of Toronto's Resilience Strategy; and

b) into all relevant City of Toronto strategies, policies and programs.

5. City Council request the Chief Corporate Officer to continue working and partnering with the City's Agencies and Corporations to advance the TransformTO low-carbon, long-term goals and implementation plans.
6. City Council direct the Chief Corporate Officer to initiate three TransformTO Acceleration Campaigns, as described in this report, to maximize the community benefit potential of low-carbon action, namely:
 - a) Mobilizing Low-Carbon Neighbourhoods;
 - b) Workforce Development for High-performance Buildings; and
 - c) Exploring the Implications and Opportunities of Electric Mobility.
7. City Council direct the Chief Corporate Officer to prepare and provide to City Council in the second quarter of each new term of Council, a report that identifies:
 - a) Updates on TransformTO key performance indicators including:
 - i) City-wide GHG emissions as measured by the City of Toronto GHG Inventory;
 - ii) Co-benefits of low-carbon actions (indicators to be presented in first four year implementation plan update);
 - iii) Public engagement (number of organizations/individuals engaged and their level of engagement); and
 - iv) Amount of financial and other resources mobilized in support of low carbon action in Toronto;
 - b) progress towards City of Toronto low-carbon leadership goals; and
 - c) revisions and additions to the short-term strategies, and the implementation plan for that term of Council.
8. City Council direct the Chief Corporate Officer to prepare and provide to Council a status update on the TransformTO key performance indicators in the third year of each Council term.
9. City Council direct the City Manager to advocate to the Provincial and Federal Governments for program funding or financing, co-delivery opportunities, and related policies and regulatory supports necessary to achieve the TransformTO long-term, low-carbon goals.
10. City Council direct the City Clerk to forward Council's decision in this report to the following Provincial and Federal ministries for information: Minister of the Environment and Climate Change (Ontario), Minister of Municipal Affairs (Ontario), Minister of Energy (Ontario), Minister of Infrastructure (Ontario), Minister of the Environment and Climate Change (Canada), and the Minister of Infrastructure and Communities (Canada).
11. City Council direct the Chief Corporate Officer to report back on the relevance of consumption-based GHG emissions accounting in the Toronto context as part of the 2019 status update and renewed TransformTO implementation plan.

FINANCIAL IMPACT

As directed by City Council in December 2016, business cases for the approved TransformTO Report #1 Strategies will be brought forward through the 2018, 2019, and 2020 budget processes.

Incremental operating investments would be required for 2018 and future years to implement the TransformTO Report #1 strategies. This funding would enable program optimization and improve the likelihood of leveraging capital from external sources, including provincial cap and trade proceeds and federal infrastructure monies. These operating dollars will also help determine the requirement for municipal capital dollars to support GHG emissions reduction action.

Table 1: Annual operating cost forecast 2018-2020 and the total community-wide capital forecast

TransformTO Short-term Strategy		Operating Budget Estimate by Year (\$000)				Projected Community-Wide Capital Requirements to 2020 (\$000)
		2018	2019	2020	TOTAL	
1.2	Innovative financing mechanisms	\$130	\$130	--	\$260	--
4.4	Improve fleet fuel efficiency	\$230	\$350	\$360	\$940	\$650 to \$900
4.5	Promote Smart Commute to Toronto Public Service	\$80	\$90	\$90	\$260	--
1.1	Enhance the Better Buildings Partnership	\$1,850	\$2,110	\$1,890	\$5,850	\$85,000 to \$156,000

TransformTO Short-term Strategy		Operating Budget Estimate by Year (\$000)				Projected Community-Wide Capital Requirements to 2020 (\$000)
		2018	2019	2020	TOTAL	
1.5	Continue support for residential property owners	\$550	\$790	\$950	\$2,290	\$18,000 to \$208,000
2.3	Advance low-carbon/renewable thermal energy networks	\$350	\$380	\$400	\$1,130	\$1,000 to \$10,000
2.2	Advance community energy planning	\$430	\$460	\$500	\$1,390	--
2.1	Advance leading edge new construction standard	\$260	\$280	\$300	\$840	--
5.2	Use building energy disclosure as an engagement tool	\$140	\$140	\$140	\$420	--
5.1	TransformTO community engagement	\$670	\$510	\$380	\$1,560	--

TransformTO Short-term Strategy		Operating Budget Estimate by Year (\$000)				Projected Community-Wide Capital Requirements to 2020 (\$000)
		2018	2019	2020	TOTAL	
5.3	Leverage Live Green Toronto	\$600	\$750	\$780	\$2,130	--
1.3	Dedicate funding for community-based climate action	\$120	\$130	--	\$250	\$20,000
5.4	Collaborate with utilities on local programming	No business case / refer to Attachment A of TransformTO Report #1. http://www.toronto.ca/legdocs/mmis/2016/pe/bgrd/backgroundfile-98040.pdf				
4.3	Utilize landfill gas & biogas	--	--	--	--	\$30,800
4.1	Expand energy retrofits in City facilities	\$180	\$570	\$1,150	\$1,900	\$84,000 to \$147,000
1.4	Improve energy efficiency in social housing	\$350	\$370	\$380	\$1,100	\$55,000 to \$240,000

TransformTO Short-term Strategy		Operating Budget Estimate by Year (\$000)				Projected Community-Wide Capital Requirements to 2020 (\$000)
		2018	2019	2020	TOTAL	
4.2	Scale-up renewable energy installations	\$350	\$370	\$380	\$1,100	\$26,000 to \$53,000
3.5	Enable electric vehicles	\$110	\$120	--	\$230	--
3.4	Develop a freight strategy	\$130	\$140	--	\$270	--
2.4	Create a renewable energy strategy	\$170	\$140	--	\$310	--
3.1	Explore road pricing	Refer to status update in Attachment A of TransformTO Report #1. (http://www.toronto.ca/legdocs/mmis/2016/pe/bgrd/backgroundfile-98040.pdf)				
3.2	Support safe cycling & walking					
3.3	Enhance transit					
TOTAL		\$6,700	\$7,830	\$7,700	\$22,230	\$320,450 to \$865,700

On February 15, Toronto City Council approved the allocation of \$330,000 in operating budget for 2017 to:

- help secure additional financing to support climate action (Strategy 1.2);
- support the delivery of the City's Better Buildings Partnership programming to promote energy efficiency in buildings (Strategy 1.1); and
- support the delivery of Smart Commute initiatives to City of Toronto staff (Strategy 4.5).

Report #1 Strategy 1.2 - Innovative financing mechanisms, creates a full-time staff position dedicated to developing a holistic sustainable finance strategy for the City designed to maximize access to cap and trade proceeds and infrastructure funding aligned with the TransformTO strategies, including the Acceleration Campaigns identified in Report #2.

An estimated \$320-\$866 million of capital investment is required community-wide to implement the TransformTO Report #1 strategies. In this context and given the significant funding identified, "community-wide investment" means potential financial contributions from all orders of government (i.e. Federal, Provincial and City), plus the private sector and individual property owners. Two scenarios for investment in climate action are described below:

- Low scenario: A community-wide investment of \$320 million represents a moderate scale-up and enhancement of existing City programs and new programs, which could achieve an additional 455,000 tonnes of emissions reductions by 2020.
- High scenario: A community-wide investment of \$866 million represents an aggressive scale-up and enhancement of existing City programs and new programs, which could achieve an additional 857,000 tonnes of emissions reductions by 2020.

All building energy-efficiency retrofit related capital costs for City-owned facilities will be funded through recoverable debt, and building retrofit programs will be aligned with existing state of good repair capital projects.

With respect to the funding strategy, staff are monitoring and engaging with provincial and federal counterparts in pursuit of available funding that is aligned with the City's climate change priorities. It is unknown at this time what level of financial support and timing of investment is to be expected by other levels of government, external parties, and the portion to be City funded.

Since December 2016, progress has already been made in mobilizing capital for low-carbon action. Toronto Community Housing Corporation (TCHC) has been allocated \$28.3 million in grant funding through the Social Housing Apartment Retrofit Program (SHARP) to reduce GHG emissions from their buildings. The City is providing TCHC with a low-interest repayable loan of \$35.2 million to fund the remaining 55% of a deep energy retrofit project at nine of their buildings. By leveraging provincial grant funding, the City can optimize the environmental and economic benefits realized by this

project and future projects. This combined funding package represents 20% of the community-wide capital required in the low-cost scenario to 2020.

The additional Acceleration Campaigns presented in this report will be initiated within the resources requested through the TransformTO Short-Term Strategies business cases. Future funding needs beyond 2018 for the Acceleration Campaigns will be presented through the annual budget process if required.

The Deputy City Manager & Chief Financial Officer has reviewed this report and agrees with the financial impact information.

DECISION HISTORY

In July 2007, Toronto City Council unanimously adopted the 64 consolidated actions proposed in the Climate Change and Clean Air Action Plan (item 2007.EX10.3) and the following community-wide greenhouse gas reduction targets:

- 6% reduction against 1990 levels by 2012;
- 30% reduction against 1990 levels by 2020; and
- 80% reduction against 1990 levels by 2050.

To further advance Toronto's efforts towards a low-carbon future, in November 2009, Toronto City Council adopted the Power to Live Green: Toronto's Sustainable Energy Strategy (item 2009.EX36.9).

In July 2014, City Council requested the preparation of a program for accelerating the actions being taken to address climate change (item 2014.PE28.4). In response to this direction, City Council approved in May 2015 (item 2015.PE3.6) the terms of reference for Transformation Toronto 2050 (now called TransformTO: Climate Action for a Healthy, Equitable and Prosperous Toronto), which outlined the steps to be taken towards the renewal of Toronto's 2007 Climate Change and Clean Air Action Plan and the 2009 Sustainable Energy Strategy.

Approved by City Council in December 2016, TransformTO: Climate Action for a Healthy, Equitable and Prosperous Toronto: Report #1 (Item 2016.PE15.1) outlined 23 strategies for moving Toronto towards the trajectory needed to achieve the 2050 goal. In addition, the Parks & Environment Committee provided direction for staff to investigate the potential to include a number initiatives in the May 2017 report. *Attachment C: Evaluation of potential additions to TransformTO Report #1 Strategies*, provides response to the direction to investigate the following:

- A ban or restrictions on gas powered lawn and garden equipment;
- By-law changes to encourage urban agriculture in new development;
- Move to zero carbon district energy option;
- Policies to reduce construction waste;
- Feasibility of installing renewable energy on parking facilities;
- Requiring climate change warning labels at gas stations in Toronto, under the City of Toronto Act.

Presented to City Council in December 2016 TransformTO: Short-term Strategies Business Case (Item 2016.PE15.1b) provided a summary of the scale of investment and resource requirements needed to implement the strategies presented in the first report. This report was received for information.

Budget Committee on January 12, 2017 considered the TransformTO Short-term Strategies Financial Estimates (Item 2017.BU29.1v) which provided an estimate of the operating funding required in 2017 to initiate the short-term strategies.

On February 15, Toronto City Council approved the allocation of \$330,000 in operating budget for 2017 to:

- help secure additional financing to support climate action (Strategy 1.1);
- support the delivery of the City's Better Buildings Partnership programming to promote energy efficiency in buildings (Strategy 1.2); and
- support the delivery of Smart Commute initiatives to City of Toronto staff (Strategy 4.5).

COMMENTS

1. Introduction

Initiated by City Council in May 2015, TransformTO was established to engage people in a process of re-imagining our city: a city that has achieved a low-carbon future while enhancing our local economy, reducing inequalities, and improving public health. Through engagement of residents, community leaders, and experts, TransformTO has identified the changes required to achieve the long-term goal of reducing greenhouse gas emissions by 80% by 2050.

The imperative for action is urgent. Municipal investments and policy decisions in the next five years have the potential to lock-in high or low levels of carbon emissions for up to a century. Worldwide, cities are already grappling with the impacts of climate change, including disproportionate burdens on their most vulnerable residents, and heavy costs to their budgets to recover from infrastructure damage caused by extreme weather events. At the same time, cities are also awakening to the opportunities to re-shape themselves in ways that will slow the worst impacts of climate change, build resilience to shocks and stresses, improve business productivity, create local employment, safeguard the vulnerable, and contribute to better public health.

Based on an international report undertaken for C40 Cities, *Potential for Climate Action*, the cities in the world that are having most success in responding to climate change and driving positive benefits are those that take a collaborative approach, co-ordinating efforts across City divisions, and in partnership with their communities, local business and institutions, bringing together the necessary expertise and resources to create positive change.

TransformTO embodies the premise that we cannot address climate issues in Toronto without understanding how low-carbon solutions connect with multiple city goals, and that we must proactively consider the needs of all Toronto communities in long-term low-carbon planning. TransformTO has been informed by cross-divisional work including over 10 City divisions and agencies, and supported by a multi-sectoral community advisory group charged with examining the potential to leverage carbon reduction efforts to drive broad community benefits.

2. Developing TransformTO

The low-carbon pathway presented in this report is the result of extensive community engagement and analysis over the last two years and answers two central questions:

- What are the relative impacts and optimal sequencing of various low-carbon actions within the 2050 timeframe?
- Which low-carbon actions have the most potential to drive community benefit and how can this be achieved?

While the City of Toronto Environment & Energy Division and The Atmospheric Fund co-led TransformTO, it is an initiative that reflects the input of residents, staff from relevant City divisions and agencies, and technical experts.

Community Consultation.

Over 2,000 members of the public were engaged early in the process to contribute to the understanding of which actions should be included in the scenario modelling exercises, and identify priority areas of action and ways in which the community would like to participate in Toronto's low-carbon transformation. The summary of community advice on how to achieve Toronto's low-carbon future was presented to City Council in December 2016 and is available online here: [TransformTO: Climate Action for a Healthy, Equitable, and Prosperous Toronto, Community Engagement Report, 2015-2016](#)

Stakeholder Engagement

Staff Project Steering Team: 20 staff from City Divisions and Agencies were regularly convened to draw on their professional experience in designing and implementing existing climate initiatives; to make use of their existing knowledge and data sets; and to align the proposed TransformTO actions with existing strategic plans.

Modelling Advisory Group (MAG): The MAG included 10 City staff and 25 community members from multiple sectors representing knowledge of public health, local economy, and equity issues. The MAG oversaw the modelling research, reviewed and refined draft results, undertook multi-criteria analysis of the low-carbon actions modelled and provided advice. *Attachment A: TransformTO Modelling Advisory Group Summary Report* is a summary of the advice from the MAG on achieving Toronto's low-carbon future while maximizing community benefit.

Toronto Public Health: Toronto Public Health produced a report available online: [Health Benefits of a Low-Carbon Future](#) (HL 13.4), which identifies synergies between carbon reduction and public health benefit and has informed the TransformTO project.

Technical Modelling & Community Benefit Research

Technical GHG Analysis: TransformTO retained through a competitive process the Sustainability Solutions Group (SSG) as technical consultants to develop two scenarios:

- The Business-As-Planned (BAP) Scenario – shows the results of all currently planned low-carbon actions to 2050. It reflects existing City Planning projections of population, employment and construction of GO's Regional Express Rail, Eglinton Crosstown Rail Transit, Finch West Rail Transit, Sheppard East Rail Transit and Toronto-York Spadina Subway Extension.
- The TransformTO Low-Carbon Scenario – modelled the potential of 36 actions to reduce GHG emissions across Toronto community-wide and shows the extent to which current action would need to be enhanced to achieve the City's 2050 GHG reduction target. It incorporates ideas expressed during the TransformTO community conversations and the Modelling Advisory Group, and was validated in conversation with cross-divisional staff.

Both scenarios provide a comparison of the relative impact – and interdependencies and optimal sequence – of the modelled actions.

Community Benefits Research. Analysis of the potential community benefit of reducing GHG emissions are identified in the TransformTO Low-Carbon Scenario. This research is based on a cross-jurisdictional literature review and is informed by recommendations from the Modelling Advisory Group. The MAG participated in a multi-criteria analysis process on how best to maximize community benefits, such as lowering energy costs for residents, protecting vulnerable residents, producing "green jobs", improving housing quality, and improving public health outcomes, while maintaining equity for marginalized and future populations.

SSG's final technical report, *Attachment B: Modelling Toronto's Low Carbon Future: Results of Modelling Greenhouse Gas Emissions to 2050* documents a scenario to achieve an 80% GHG emissions reductions from 1990 by 2050 using current technologies, and discusses the community benefits that could be derived from dramatically reducing GHG emissions in Toronto.

3. Getting on the Low-Carbon Pathway

A. Maintaining and Implementing Toronto's Planned Climate Actions

Toronto is a leader in taking climate action. Creating the Toronto Atmospheric Fund in 1991 to catalyze innovations in climate action set the stage for a long-term commitment to reducing GHGs in Toronto, which contributed to a 24% reduction in city-wide GHG emissions since 1990 during a period of both significant population and economic growth.

Toronto has a strong policy and program foundation supporting low-carbon action. To achieve the forecasted five million tonne GHG reduction in the Business-As-Planned Scenario by 2050, Toronto must follow through on planned low-carbon actions by:

- Continuing to implement the Official Plan and its many objectives including managing growth in Downtown, Centres and along Avenues;
- Fully implementing the planned and funded transit and active transportation infrastructure under SmartTrack, the Walking Strategy, Toronto's Complete Streets Policy, and the 10-year Cycle Network Update;
- Continuing to increase diversion of solid waste through implementation of the Long Term Waste Management Strategy;
- Continuing to implement the Toronto Green Standard and update it with continuously improving energy efficiency requirements; and
- Continuing to implement existing City policies and programs to improve energy efficiency in existing buildings through the Better Building Partnership, the Home Energy Loan Program, the High-rise Retrofit Improvement Support Program, and the broader Tower Renewal Program.

B. Commit to the Vision - A Low-Carbon, Healthy, Equitable and Prosperous Toronto in 2050

Even with continued commitment to ensure the delivery of Toronto's currently planned climate actions, the Business-As-Planned (BAP) scenario projects Toronto will not reach its 2050 GHG reduction target - there will be an 8.7 million tonne (Mt) gap.

The TransformTO Low-Carbon Scenario prepared by the SSG consulting team presents one possible future for Toronto, and demonstrates that it is possible to reach Toronto's 80% emission reduction goal with existing technologies. However, reaching City Council's GHG reduction goals requires bold and immediate action coupled with significant investment. The actions modelled transform Toronto's urban systems - transportation, buildings, energy and waste.

Details on the 36 actions modelled in the TransformTO Low-Carbon Scenario and their relative impact are provided in *Attachment B: Modelling Toronto's Low Carbon Future: Results of Modelling Greenhouse Gas Emissions to 2050*. The actions combined fill the 8.7 million tonne gap between the business as planned and our targeted emission reductions by 2050. Throughout this report the GHG emission reduction potential of specific actions is identified within Toronto urban systems.

Based on the assumptions inherent in achieving Toronto's 80% reduction goal, and the necessary transformation of the city's urban systems, TransformTO presents a vision of a low-carbon Toronto in 2050 where the following long-term goals have been achieved:

- 100% of new buildings are designed and built to be near zero GHG emissions by 2030;
- 100% of existing buildings are retrofitted to the highest emission reduction technically feasible, on average achieving a 40% energy performance improvement over 2017 levels by 2050;

- 75% of community-wide energy use is derived from renewable or low-carbon sources by 2050;
- 30% of total floor space community-wide – residential and commercial – will be connected to low-carbon thermal energy by 2050;
- 100% of transportation options - including public transit and personal vehicles - use low or zero-carbon energy sources, and active transportation accounts for 75% of trips under 5 km city-wide by 2050;and
- 95% of waste is diverted in all sectors – residential, institutional, commercial and industrial - by 2050.

The result of this level of action is a low-carbon city that uses significantly less energy than today and looks dramatically different:

Buildings in 2050

Many people live in apartments in mixed-use areas that have a wide range of daily services. All new dwellings built after 2030 are within walking distance of transit or are built at transit-supportive densities. Homes use just 20% of the energy they used in 2015 and produce nearly zero GHG emissions. Space heating and cooling is sourced from neighbourhood-scale low-carbon district energy systems utilizing waste heat. Workplaces will incorporate more efficient shared office spaces and be designed to high energy efficiency standards if new, and retrofitted if not. Indoor air quality and worker productivity will be improved. Commercial buildings will generate energy with solar photovoltaic panels on roofs and facades, and will likely be connected to a low-carbon district energy system for heating and cooling.

Moving around in 2050

In most neighbourhoods in the city, it is easy to walk to a school, park, grocery store, restaurant and other key destinations. Safe and pleasant bike lanes and sidewalks will make it easy for people of all ages to walk or bike. And you'll be in good company with most of your neighbours walking or cycling for trips under 5 km. Affordable, shared electric vehicles are easily accessible for all ages for trips that are too complex for transit and too far for walking or cycling. Transit is much more extensive than in 2016 with new subway lines and enhanced bus and train systems. Many more people will walk, cycle, and take transit (23%) to work and fewer will drive. Some people travel to work only four days a week as part of a compressed work week or telework arrangement.

The Circular Economy in 2050

Waste generated per capita has diminished significantly though reuse enabled by the sharing economy and food waste is dramatically less. Services create lending libraries for tools not needed frequently, and people consume less disposable products. Local hubs will take back and re-use or re-purpose daily items, generating local employment. Goods producers will take more responsibility for the waste their products create. 95% of the waste that is created is diverted from landfill through recycling and reuse programs.

Greenhouse Gas Reduction Targets

Toronto's GHG reduction targets were determined to support the level of emission reduction necessary to maintain global climate stabilization. The need for this level of ambition was reinforced at the Paris Summit in 2015 and is reflected in jurisdictions worldwide as summarized in Table 2 below.

Table 2: GHG Reduction Targets in other jurisdictions

Jurisdiction	Baseline Year	Interim Target(s)	Long-term Target
Berlin, Germany	1990	40 by 2020	95% by 2050
San Francisco CA, USA	1990	40% by 2025	80% by 2050
Portland OR, USA	1990	40% by 2030	80% by 2050
Washington DC, USA	1990	50% by 2035	70% by 2050
London, United Kingdom	1990	34% by 2020	80% by 2050
Vancouver, Canada	2007	33% by 2020	80% by 2050
Toronto, ON, Canada	1990	30% by 2020 65% by 2030*	80% by 2050
Ontario	1990	15% by 2020 37% by 2030	80% by 2050
Canada	Varies	30% by 2030 (2005 base year)	50% by 2050 (1990 base year)

* TransformTO is recommending an aggressive interim target, based on the modelled Low-Carbon Scenario of 65% reductions in community-wide emissions of GHGs by 2030 from a 1990 base year.

C. Maximizing Community Benefit from Climate Action

The proposed guiding principles for TransformTO's implementation are to maximize public benefit and minimize harm by designing and delivering climate actions that:

- advance social equity;
- improve affordability particularly for vulnerable residents;
- protect low-income residents;
- contribute to poverty reduction;
- enhance and strengthen the local economy;
- maintain and create good quality local jobs;
- improve public health; and
- create resilient communities and infrastructure.

A finding of the TransformTO research is that the climate actions proposed have significant potential to deliver on other city goals. A literature review provided insights about areas where urban low-carbon action and community benefit coincide and informs the final technical paper *Attachment B: Modelling Toronto's Low Carbon Future: Results of Modelling Greenhouse Gas Emissions to 2050*.

The TransformTO Modelling Advisory Group concluded that while many low-carbon actions have the potential to drive multiple benefits, they may not do so - and may even create harms, if attention to the benefits potential is not specifically addressed when low-carbon programs are designed. Responding to this finding, the three proposed Acceleration Campaigns seek to take a collaborative approach to designing low-carbon actions that drive multiple community benefits.

If delivered with community benefit in mind the transition to Toronto's low-carbon future can deliver significant advances in public health, local economic development, and social equity. For example based on the modelled Low-Carbon Scenario:

Public Health in 2050

Toronto's air will be cleaner as one of the highest-impact pollution sources - combustion of fossil fuels for transportation - will be virtually eliminated, reducing premature deaths and hospitalizations, which according to the Toronto Public Health Report in 2014, *Path to Healthier Air* were estimated at 280 and 1,090 per year respectively. Walking and cycling rates increase dramatically and total kilometres walked or cycled increases to 2.4 billion kilometres. The benefits of the additional exercise are wide ranging and studies in other cities have indicated that the relative risk of all-cause mortality was 30-40% less among those who cycled. Almost all of the pre-2016 building stock is retrofit improving the indoor environmental quality, providing more comfortable indoor air temperatures and improved circulation of fresh intake air. With health services and food shopping in closer proximity - thanks to improved transit and complete neighbourhood design - more people will have easier access to the support they need to keep themselves and their families healthy.

Social Equity in 2050

Dense, well-managed urban development and the provision of accessible, affordable public transport increases the ability of equity-seeking groups to access goods, services, and economic opportunities. An emphasis on social housing retrofits will see vulnerable residents in Toronto experience improved quality of housing. Building retrofit measures to reduce greenhouse gas emissions result in reduced household energy costs, households in over 50% of neighbourhoods will save between \$375 and \$500 per year for heating, cooling and electricity. Almost all neighbourhoods will see household savings on utility bills addressing issues of energy poverty. Due to extensive district energy and the use of renewable energy, these costs savings hedge against fluctuations in global energy prices. Community benefits agreements will enable the growth in local employment, driven by a wide-scale energy retrofit campaign, to provide training and job opportunities for youth and people with difficulty accessing employment.

Economy in 2050

There are many new types of employment opportunities in 2050 and the low-carbon transition is estimated to directly result in 327,000 new person years of employment. A major new industry is focused on upgrading the energy efficiency of buildings. Retrofitting includes businesses with expertise in finance, law, construction and engineering. The outflow of local dollars to pay for imported energy sources is drastically reduced, and redirected towards local spending. Other sectors that grow significantly include renewable energy, particularly solar PV, energy storage and district energy. While a shift towards electric vehicles has a negative impact on employment in auto maintenance and repairs, it opens new opportunities in smart grid applications that integrate electric mobility with new types of consumer services.

D. Leadership through City Action

While corporate emissions from City operations are a small percentage of overall GHG emissions in Toronto (6%), leading by example is critical to set the pace, demonstrate commitment, spur innovation, and catalyze community action. As part of the long-term strategy, TransformTO recommends that City Council demonstrate corporate leadership across its real estate and fleet by committing to:

- Design and build all new City-owned facilities to be near zero GHG emissions by 2026;
- Retrofit all City-owned buildings, including social housing, to the highest emission reduction technically feasible, on average achieving a 40% energy savings over 2016 building energy performance by 2040;
- Install 24MW capacity of renewable energy on City-owned facilities and lands by 2020;
- Establish a green fleet plan to transition 45% of City-owned fleet to low-carbon vehicles by 2030;
- Achieve zero waste status at all City-owned facilities by 2030;
- Generate and utilize 1.5 Million Giga joules of biogas by 2030; and
- Earn designation as one of Canada's Top 100 Green Employers by 2020.

All building energy efficiency related capital costs associated with City-owned facilities will be financed through recoverable debt, and retrofits will be coordinated with scheduled state of good repair projects. Alignment with the current City-wide Real Estate Review presents an opportunity to integrate low-carbon leadership goals with the increasingly strategic management of cross-corporate facilities and real estate assets.

In December 2016, City Council approved five TransformTO Short-term Strategies focused on leading by example. Business cases to fund these strategies will be presented through the 2018 budget process and these strategies will need to be implemented to achieve the recommended corporate leadership goals presented above. Table 3, below, provides a summary of these actions.

Table 3: TransformTO Report #1 Leading by Example Strategies

TransformTO Report #1 Strategy	Description	2018 Operating Expenditure (\$000)	GHG Reduction to 2020 (tonnes CO2e)	Planned Action
1.4 Improving energy efficiency of social housing	Improve the energy efficiency and quality of social housing to drive deep carbon and utility cost reductions, while improving the living conditions for low-income households.	\$350	5,000 - 25,000	Leverage the \$42 million in Provincial SHARP funding, coupled with financing from the Sustainable Energy Plan Financing program.
4.1 Expand energy retrofits at City facilities	Accelerate the implementation of the Energy Conservation and Demand Management (ECDM) Plan to drive energy consumption savings of 30% or greater across its real estate portfolio.	\$180	15,000 - 40,000	Ongoing City-facility energy efficiency retrofits focused on GHG savings as well as energy cost savings.

TransformTO Report #1 Strategy	Description	2018 Operating Expenditure (\$000)	GHG Reduction to 2020 (tonnes CO2e)	Planned Action
4.2 Scale-up renewable energy installations	Dramatically expand renewable energy generation capacity at City-owned facilities and double capacity by 2020 to 24 MW.	\$350	450 - 900	Plan to complete 56 solar photovoltaic installations at City facilities by the end of 2017.
4.4 Improve fleet fuel efficiency	Renew Green Fleet Plan to reduce carbon emissions and tail-pipe pollutants that cause smog by implementing strategies including anti-idling devices, alternative fuel plans, fleet resizing and eco-driving programs.	\$230	N/A	Updated Green Fleet Plan to be presented by the end of 2017
4.5 Promote Smart Commute to Toronto Public Service	Smart Commute Program will encourage City staff to shift towards sustainable commuting options, such as transit, active transportation, carpooling, and alternative work arrangements.	\$80	1,500	Funded for 2017 a City of Toronto Smart Commute program may include a formalized telework policy, car-bike-ride sharing services, and improved end-of-trip facilities for cyclists and walkers.

TransformTO Report #1 Strategy	Description	2018 Operating Expenditure (\$000)	GHG Reduction to 2020 (tonnes CO2e)	Planned Action
4.3 Utilize landfill gas and biogas	Explore opportunities to produce and utilize Renewable Natural Gas (RNG). RNG is produced by upgrading biogas or landfill gas to natural gas quality, at which point it can be injected directly into the natural gas grid.	N/A	95,000	City is investigating how landfill gas could be used to power Solid Waste vehicles.

E. Urban System Transformation

Getting Toronto on the path to a low-carbon future requires coordination on three fronts:

- 1) implementation of the planned suite of climate actions the City has already approved;
- 2) funding of the approved Report #1 Strategies; and
- 3) adoption of proposed acceleration actions to create community benefits by reducing greenhouse gas emissions.

The following sections presents how these three elements converge to catalyze urban system transformation.

i. Mobilizing Low-Carbon Neighbourhoods

Toronto's existing planning framework is working. The majority of growth is happening in areas identified for growth by the Official Plan and along Avenues well served by transit. Toronto's Official Plan envisions a city with:

- vibrant neighbourhoods that are part of complete communities;
- a healthy natural environment including clean air, soil, energy and water;
- infrastructure and socio-economic systems that are resilient to disruptions and climate change.

Toronto's Official Plan is implementing the Province's Growth Plan goal to provide complete communities as places that " meet people's needs for daily living throughout an entire lifetime by providing convenient access to an appropriate mix of jobs, local services, a full range of housing, and community infrastructure including affordable housing, schools, recreation and open space for their residents. Convenient access to public transportation and options for safe, non-motorized travel is also provided."

Toronto's Planned Action

The TransformTO Low-Carbon Scenario identified that were a city-wide rapid transit line system implemented (as outlined in the City's Feeling Congested Strategy) all neighbourhoods with a sufficient residential and employment density to support rapid transit service would be serviced. Similarly, almost all future development is projected to happen within 500m of rapid transit service. No significant additional GHG emissions reductions could be gained by further shifting planned development.

The Opportunity

TransformTO's community engagement and Modelling Advisory Group called for ways for residents to participate in the City's low-carbon plan within their own neighbourhoods. TransformTO community engagement indicated that at the neighbourhood scale, residents feel they have familiarity and agency to suggest, support and advance actions in alignment with city-wide low-carbon goals. Leveraging the low-carbon neighbourhoods' frame into an Acceleration Campaign can capture the significant resources represented within Toronto's diverse neighbourhoods to support residents in developing and advancing flexible, innovative low-carbon solutions that help people live better lives. Best practices in global cities seeking deep carbon reduction action emphasize the critical need to fully engage all residents, leveraging co-benefits relevant to them. Applying a neighbourhood lens can also support the development of local relationships and networks that are critical to Toronto's resilience. This approach aligns with the Toronto Strong Neighbourhoods Strategy, offering an opportunity to gain synergies with Toronto's neighbourhood equity goals.

Many low-carbon actions can be considered at the neighbourhood scale. For example, community energy planning looks at efficient use of energy through highly localized shared energy services. As Toronto undertakes public and rapid transit infrastructure build-outs there is an opportunity to work with communities to maximize the utility and utilization of these investments through programming, outreach and engagement. The approach also offers the opportunity to acknowledge that broad-based behaviour change will be necessary to achieve the full benefits of the TransformTO strategy, and to gain community input regarding the best way to support this behaviour change.

Council-Approved Report #1 Strategies

TransformTO Report #1 presented two strategies that were approved by City Council and will need to be implemented to maximize the opportunity for neighbourhood mobilization:

Table 4: TransformTO Report #1 Engagement Strategies

TransformTO Report #1 Strategy	Description	2018 Operating Expenditure (\$000)	GHG Reduction to 2020 (tonnes CO2e)
5.1 Continue TransformTO Community Engagement	Engage and collaborate with residents, businesses and stakeholders, especially those whose views are traditionally under-represented to achieve Toronto's low-carbon goals. Use scenario modelling results and visualizations of a low-carbon, healthy equitable and prosperous Toronto to stimulate community dialogue and action.	\$670	Enabler
5.3 Leverage Live Green Toronto	Expand engagement with community stakeholders and private sector partners to drive climate action delivery through the multifaceted Live Green Toronto program that includes information, programs, volunteer network and events.	\$600	Enabler

Accelerated Actions

Residents can benefit from support to maximize the opportunities of Toronto's urban form, active transportation infrastructure, and public transit. TransformTO recommends that an Acceleration Campaign "Mobilize Low-Carbon Neighbourhoods" be initiated to achieve the following objectives:

- Leverage existing community networks to collaborate and partner on broad engagement efforts based on best practices in neighbourhood-based engagement that enable active participation and leadership by communities and residents in strategy and actions;

- Co-develop, with community partners and stakeholders, a process to help translate city-level low-carbon goals to the neighbourhood context to help engage Toronto citizens in leading and supporting climate action in ways that benefit them;
- Work with City of Toronto Social Development Finance and Administration to explore how neighbourhood-scale TransformTO initiatives could address affordability of services and programs for Toronto residents and support the City's social development strategies such as Toronto Strong Neighbourhoods 2020, TO Prosperity, the City's Poverty Reduction Strategy and the Seniors Strategy;
- Work with the Chief Resilience Officer to develop neighbourhood-scale TransformTO initiatives that could enhance local networks and resources to respond constructively to shocks and stresses; and
- Develop criteria for selecting neighbourhoods that could serve as hosts for neighbourhood-scale TransformTO initiatives and start by selecting and funding three to five projects.

ii. Expanding Mobility Options and Embracing Electrification

Achieving our low-carbon goals hinges on transforming transportation in two ways: how we move around our city and between our city and the rest of our region; and what fuels our movement. What is required is a flexible, integrated set of options including robust public transportation with frequent service, increased active transportation options supported by well-planned infrastructure to ensure public safety, shared mobility including shared commuting, auto-share and bike-share programs, and mobility hubs to allow seamless transition among different transportation options. At the same time, transportation options need to be electrified to drastically reduce GHG emissions.

Toronto's Planned Action

Currently when people in Toronto travel to work 66% go by car, 22% take public transit, and 12% walk or cycle. In a low-carbon Toronto the transportation system will be transformed and there is the potential for 17% of people to walk, 28% to cycle, 23% to take transit, and only 32% to drive to work.

Our existing emphasis on transit-supportive development in Toronto's Official Plan is critical to achieving the projected Business-As-Planned (BAP) GHG emissions reductions. The BAP Scenario reflects the build out of GO's Regional Express Rail, Eglinton Crosstown Rail Transit, Finch West Rail Transit, Sheppard East Rail Transit and Toronto-York Spadina Subway Extension.

In addition to transit investments Toronto is committed to supporting active transportation. Toronto adopted the Walking Strategy in 2009 that seeks to build a physical and cultural environment that supports and encourages walking, including vibrant streets, parks, public squares, and neighbourhoods where people will choose to walk more often. In 2016, City Council adopted the 10-year Cycle Network Update dedicating \$16 million annually to its implementation. The Complete Streets policy presented in 2017 requires streets be designed to be safe for all users, such as people who walk, bicycle, take transit or drive, and people of varying ages and levels of ability. Vision Zero Toronto's Road Safety Strategy adopted in 2016 also prioritizes active transportation in Toronto. All of these strategies will need to be realized to achieve Toronto's low-carbon goals.

The Opportunity

The TransformTO Low-Carbon Scenario demonstrates a significant potential for GHG reductions in the transportation sector of over 3000 kilotonnes from transit and active transportation infrastructure expansion and the electrification of transportation.

Transit & Active Transportation Infrastructure Expansion (150 kt - Annual GHG reduction potential in 2050):

- Build 25 lines of rapid transit across Toronto by 2050 including the Relief line, Regional Express Rail (RER+) including stops at Richmond Hill and Milton (CP freight line), and the development of an express bus network across the city.
- Reach 800,000 residents with personal transportation planning efforts.
- Support active transportation for 75% of trips less than 5 km through significant active transportation infrastructure investment.

Electrification of Transportation (3000 kt - Annual GHG reduction potential in 2050):

- All electric buses by 2040
- All new vehicles are electric by 2030
- All City-owned vehicles are electric by 2042

Converting passenger, freight and transit vehicles from gasoline to electric or low-carbon renewable fuels is a central element of the TransformTO Low-Carbon scenario. Not only would this conversion, which would amount to near elimination of gasoline by 2050, provide significant GHG emission reduction, it would also reduce critical air pollutants affecting Toronto residents. It represents a major shift with respect to transportation technology and local electricity grid management. New social innovations such as car sharing could bring forward more affordable transportation options in ways that allow more seamless access to public transit offerings, especially in lower density areas with less access to transit.

Council-Approved Report #1 Strategies

TransformTO Report #1 presented the following strategies to advance sustainable transportation that will need to be implemented to achieve the GHG reductions possible in the transportation sector.

Table 5: TransformTO Report #1 Transportation Strategies

TransformTO Report #1 Strategy	Description	2018 Operating Expenditure (\$000)	GHG Reduction to 2020 (tonnes CO ₂ e)
3.4 Develop a low-carbon freight strategy	Develop a city-wide low-carbon freight strategy, and related interdivisional policies, regarding urban goods movement/urban freight in alignment with Metrolinx's Regional Transportation Plan (RTP).	\$130	Enabler
3.5 Enable electric vehicles (EVs)	Work with the Province to develop a city-wide policy and to support the anticipated adoption of EVs by developing policies and program to expand EV use in Toronto, particularly with respect to vehicle charging stations and parking.	\$110	50,000

Accelerated Actions

TransformTO identified a number of additional areas for further investigation including congestion charges, car-free zones and dedicated individual travel planning. Electric vehicle technology has the potential to serve as mobile electricity storage, and to enable management of electricity services at the household and neighbourhood level, including integration with distributed renewable electricity generation. Cities and electric utilities must carefully consider the implications of a potential acceleration of electric vehicle adoption, and position themselves to ensure that the pathway is well managed in order to maximize benefits to the community and minimize potential harms. Vehicle purchase incentives and other supports such as deployment of public charging infrastructure must be carefully considered in light of providing equitable access to electric mobility among Toronto's diverse population and neighbourhoods. Finally, the potential of electric mobility to enhance or detract from other low-carbon transportation actions and systems including shared transportation options, public transportation and active transportation needs to be explored.

TransformTO recommends that an Acceleration Campaign "Exploring the Implications and Opportunities of Electric Mobility" be initiated to achieve the following objectives:

- Co-develop, with Toronto Hydro, relevant City Divisions, community partners and other stakeholders, a process to support the development of an electric vehicle transition strategy for Toronto, including:
 - Research to identify best practices in electric vehicle preparedness planning in major North American cities to ensure equitable outcomes for all residents.
 - Demonstration projects to better understand how to maximize the potential for electric vehicle use to drive broad community benefits.
 - An electric vehicle charging infrastructure strategy.
 - Criteria for selecting projects to understand the implications of electric vehicle use for the local grid, developed with Toronto Hydro.
- Work with the Chief Resilience Officer to explore how electric vehicles could play a role in improving Toronto's resilience to shocks such as power disruptions.

iii. Building Energy Performance and Comfort

Over half of GHG emissions in Toronto come from operating residential and commercial buildings, primarily from natural-gas fired space and water heating. Increasing the energy performance of existing buildings - and ensuring new ones are built to high standards - is a primary focus of the TransformTO Low-Carbon scenario. Energy efficiency retrofits also drive significant long-term energy cost savings and support increased local economic spending. The level of activity required to retrofit Toronto's existing buildings will drive a major new local employment sector. Retrofit activity is also synergistic with social housing renewal, and can offer important health benefits to social housing residents.

Toronto's Planned Action

The City of Toronto has been investing in high-efficiency, high-performance buildings for over 20 years. The Better Buildings Partnership celebrated its 20 year anniversary in 2017 and has retrofitted 566 Million ft², created over 60,000 years of person employment, and avoided 690kt of GHG emissions in a 20 year timespan. The Home Energy Loan Program (HELP) and High-rise Retrofit Improvement Support (HI-RIS) Program pilots offered residential property owners a low-interest financing mechanism for deep energy efficiency retrofits, to date 125 single family homes and over 1,000 apartment units have been retrofitted through these programs.

Since 2010, the Toronto Green Standard (TGS) has required new buildings to meet higher levels of energy performance than the Ontario Building Code. The TGS is administered by the City Planning Division and is implemented through the development approvals process. The TGS offers a significant development charge refund incentive for developments certified as having met Tier 2, the City's highest performance standard. Tier 2 projects are profiled on the City's green development website (www.toronto.ca/greendevlopment). The TGS energy performance requirements have resulted in 115,000 annual tonnes of avoided GHG emissions between 2010 and 2016. The TGS is the process of being updated to version 3.0 for 2018.

The City Planning Division in partnership with The Atmospheric Fund and the Environment and Energy Division has recently developed a new Zero Emissions Buildings Framework. The details will be provided to Council in the fall of 2017. The study includes a global best practices review of leading energy codes and standards and sets out an energy performance and GHG reduction pathway to 2030 zero emissions for five building archetypes typically built in Toronto. Implementation of the proposed targets for new construction alone would result in a cumulative total reduction of 30 Megatonnes of carbon to 2050. The Planning Division is in the process of consultation with the building industry and devising the implementation and incentive strategy to support higher tiers of performance and zero emissions buildings.

The Opportunity

Toronto is one of the most rapidly growing cities in North America. The forecasts supporting the Provincial Growth Plan anticipate that the City will grow by almost 400,000 households between 2001 and 2041. The majority of this development will occur in areas identified for growth by Official Plan policies. It is critical that the new housing created be low-carbon and energy efficient. Over 80% of floor space that will exist in 2050 has already been built, making retrofitting existing buildings of equal importance.

There are almost 4000 kilotonnes of GHG reduction potential in the buildings sector. The TransformTO Low-Carbon Scenario demonstrates that efficiency gains in existing buildings, and high-performance for new construction present opportunities for significant GHG emission reduction.

Existing Buildings (2500 kt of potential GHG reductions annually in 2050):

- Multi-unit residential buildings (MURBs) – (5 storeys or more). Retrofit MURBs built between 1945 and 1984 to achieve 50% savings of thermal energy and 40% of electricity and fuel switch to geothermal energy; retrofit all MURBs built after 1984 to achieve thermal savings of 40% and electrical savings of 30% and fuel switch to geothermal energy.
- Single family homes - Retrofit all to achieve thermal savings of 40% and electrical savings of 30%.
- Commercial and office buildings - Retrofit to achieve thermal savings of 40% and electrical savings of 30%.
- Electric heat pumps - Used in 50% of residential building stock and 60% of the commercial building stock.

New Buildings (1300 kt of potential GHG reductions annually in 2050):

- Require all new buildings designed and built to near zero emissions performance levels by 2030, as modelled based on the proposed Zero Emissions Buildings Framework.

To achieve this scale and pace of deep retrofits will require a significant workforce mobilization. TransformTO analysis estimates that between now and 2050, high-performance new construction and energy retrofits in residential, commercial and institutional buildings could result in over 80,000 person years of employment.

Council-Approved Report #1 Strategies

TransformTO Report #1 presented the following strategies to advance energy efficiency and emission reduction in building construction and retrofitting that will need to be implemented to achieve the identified potential GHG reductions:

Table 6: TransformTO Report #1 Building Energy Strategies

TransformTO Report #1 Strategy	Description	2018 Operating Cost(\$000)	GHG Reduction to 2020 (tonnes CO2e)
1.1 Enhancing the Better Buildings Partnership (BBP)	Increase technical resources, financial assistance, and coordination of incentives for property owners, so that the BBP will deliver energy efficiency and resilience improvements in new and existing public and private buildings.	\$1,850	185,000 - 415,000
1.3 Dedicated funding for community-based climate action	Expand Sustainable Energy Plan financing for community based groups, including not-for-profits, interested in undertaking energy conservation and greenhouse gas emission reduction projects to ensure benefits are shared across all neighbourhoods.	\$120	Enabler

TransformTO Report #1 Strategy	Description	2018 Operating Cost(\$000)	GHG Reduction to 2020 (tonnes CO2e)
1.5 Continued support for residential property owners	The City will support residential buildings by providing a streamlined pathway of resources, incentives, and financing for property owners to undertake energy works. Expand the Home Energy Loan Program and High-rise-Retrofit Improvement Support Program to include a broader scope of eligible properties, renewable energy and resilience improvements, without passing costs on to more vulnerable populations including tenants	\$550	3,000 - 4,000
2.1 Leading-edge new construction standard	In consultation with green building leaders, the City will elevate energy efficiency standards for new construction with Version 3.0 of the Toronto Green Standard (TGS). The TGS will progressively raise-the-bar for better building energy performance and lower environmental impact, by setting out long-term energy and emission reduction targets by building type, thereby offsetting emissions from population growth.	\$260	10,000
5.2 Use building energy disclosure as an engagement tool	The City will publish annual reports on city-wide building energy use as a means of understanding market trends and opportunities for enhanced policy and program development	\$140	Enabler

TransformTO Report #1 Strategy	Description	2018 Operating Cost(\$000)	GHG Reduction to 2020 (tonnes CO2e)
5.4 Collaborate with utilities on local programming	The City will work alongside Toronto Hydro and Enbridge Gas to support urban renewable energy development, to expand customer access to utility data, and to manage issues related to city-wide energy growth, such as reducing demand in high-growth, energy constrained areas.	N/A	Enabler

Accelerated Actions

TransformTO has identified a significant opportunity to align workforce development programs with low-carbon building initiatives. TransformTO is recommending the initiation of an Acceleration Campaign "Workforce Development for High-Performance Buildings" with the objectives to:

- Create a high-performance existing buildings performance acceleration strategy that includes retrofits, building operations enhancement, and that sets specific targets to progressively improve building energy performance between 2020 and 2050;
- Identify priority approaches to drive community benefits, including an early focus social housing renewal;
- Develop a high-performance building workforce strategy in consultation with local employers, employee groups, trade unions and training facilities, to create a highly skilled workforce to support high-performance new building construction, retrofits, and distributed renewable energy deployment. The workforce strategy should give special consideration to people who face barriers to employment and consider ways to implement the retrofits; and
- Improve Toronto’s building stock resilience to extreme weather events and power disruptions.

iv. Renewable and Community Energy Approaches

Toronto has undergone multiple energy system transformations in the past - from a wood fired settlement in the late 1700s, to a coal-powered small city in the mid to late - 1880s, with natural gas arriving by the late 1800s and an electrical grid emerging by the early 1900s. In 1900 there were less than 200 cars on Toronto's streets, by 1920 27,000. As quickly as our energy system has changed in the past, it must change now to avoid the worst impacts of climate change. In 2004, Toronto began a major shift to low-carbon district energy by enabling the creation of downtown Toronto's deep lake

water cooling system that offsets the equivalent of 61 megawatts (MW) of energy demand and avoids 79,000 tonnes of GHGs annually. By phasing out coal from Ontario's electricity generation mix in 2014, the Province dramatically reduced the GHG emissions associated with electricity consumption in Toronto.

Toronto's Planned Actions

The 2014 update of the Official Plan requires an Energy Strategy be submitted for large development proposals or for development proposals within a Community Energy Plan area. The policies also support and encourage energy conservation and processes that contribute to an energy neutral built environment and require planning frameworks for new neighbourhoods to have a strategy for energy conservation. The policies require that Mixed Use Areas provide for energy conservation and integrated energy solutions; that Secondary Plans, campus plans and studies identify opportunities for energy conservation and local integrated energy solutions; that a Community Energy Plan (CEP) be undertaken to guide revitalization of Regeneration Areas; and encourages the completion of a CEP for areas targeted for growth. There are currently four planning studies underway where the City is investigating the potential to be net-zero communities under the updated CEP criteria.

The Opportunity

Toronto is a leader in low-carbon energy system innovation, has a strong policy foundation to build upon, and is engaging communities in net-zero community energy planning. By continuing to support distributed renewable energy generation capacity, development of low-carbon district energy systems, and advancing policy and regulations for low-carbon energy planning Toronto can reach its 2050 target.

The TransformTO Low-Carbon Scenario demonstrates that renewable energy, district energy, and energy storage have the potential to realize over 1000 kilotonnes of GHG emissions reduction from Toronto's energy system.

Solar (200 kt GHG reduction potential annually by 2050):

- Net-metered solar photovoltaics (PV) systems are installed on all new construction by 2050 and 75% of buildings constructed before 2016 to provide between 10 - 30% of electrical load depending on building type and age.
- Integrated solar PV and solar thermal systems are applied to all building facades that have PV.

District Energy (800 kt GHG reduction potential annually by 2050):

- Zero carbon district energy systems - powered by deep lake water cooling, renewable natural gas, industrial and wastewater waste heat - provide power to over 10,000 non-residential buildings, and over 625,000 residential houses, apartments and condos.

Energy Storage (50 kt GHG reduction potential annually by 2050):

- Distributed energy storage across the city enables time shifting of demand to off-peak periods with a capacity of 1,000MW by 2050.

Council-Approved Report #1 Strategies

TransformTO Report #1 presented the following strategies to catalyze energy system transformation and will need to be implemented to achieve the GHG reductions necessary to reach the 2050 target:

Table 7: TransformTO Report #1 Renewable and Community Energy Strategies

TransformTO Report #1 Strategy	Description	2018 Operating Cost (\$000)	GHG Reduction Potential by 2020
2.2 Advance Community Energy Planning	The City will maximize the potential for Community Energy Planning (CEP) preparation and implementation for all new major developments and revitalization areas, exploring net-zero CEPs whenever possible.	\$430	Enabler
2.3 Advance low-carbon/Renewable Thermal Energy Networks (District Energy)	In partnership with stakeholders significantly scale-up the development of thermal energy networks and map low-carbon/renewable energy sources across Toronto.	\$350	10,000 - 100,000
2.4 Create Renewable Energy Strategy	Advance the city-wide adoption of clean, renewable energy technologies such as solar PV, wind and geo-exchange through a comprehensive long-term strategy developed with industry stakeholders.	\$170	Enabler

Accelerated Actions

Toronto continues to advance significant district energy projects, mobilizing private capital to invest in low/zero-carbon thermal energy networks. There is an opportunity to leverage investments in net-zero community energy plans to mobilize residents, as discussed in the section on low-carbon neighbourhoods. Similarly, efforts towards energy system transformation advancement will be aligned with the "Workforce Development for High-Performance Buildings" Acceleration Campaign. In Q3 2017 a report will be presented to Parks & Environment Committee with recommended next steps in the development of an energy storage strategy for the City of Toronto. In 2017 Q2 a report will also be brought forward to update Council on the development of a partnership to design, build and deliver a large-scale low-carbon thermal district energy system in downtown Toronto.

v. Towards Virtual Waste Elimination

The management and disposal of waste has the potential to produce significant greenhouse gas emissions, particularly the production of methane associated with the decomposition of organic waste.

Toronto's Planned Action

City Council adopted a new Long Term Waste Management Strategy in July 2016 that puts priority on reducing waste and minimizing the amount sent to landfill. It emphasizes the importance of community engagement and encourages prevention of waste, maximizing its value before disposal and supporting the move towards a circular economy. The strategy will guide waste management for the next 30-50 years and adopts an aspirational goal of zero waste generation by 2050 in line with the transformation required to achieve Toronto's GHG reduction targets.

The Opportunity

The Draft Strategy for a Waste Free Ontario includes two goals:

- zero waste in the province; and
- zero greenhouse gas emissions from the waste sector.

Toronto's Long Term Waste Management Strategy sets similarly transformational goals - 70% diversion by 2026, an aspirational zero waste goal, and tracking of a new performance measure, waste generation per capita. The TransformTO Low-Carbon Scenario identifies that 350 kilotonnes of GHG emissions reductions, beyond the savings achieved in the Business-As-Planned scenario by achieving a 95% diversion rate by 2050.

The TransformTO Low-Carbon Scenario follows the international Global Protocol for Community-Scale GHG Emission Inventories, and therefore uses the 100-year Global Warming Potential (GWP) of methane, the GHG most associated with landfilled waste. A sensitivity analysis demonstrates that if the 25-year GWP of methane is used an additional 630 kt of GHG emissions could be avoided by reaching the zero waste goal.

Council-approved Strategy

The Long Term Waste Management Strategy lays out a 10 year roadmap for implementation that must be fully implemented to realize the 2050 GHG reduction targets.

Accelerated Action

City of Toronto Solid Waste Management Services manages an estimated one third of the total waste generated in Toronto. Additional research into the commercial and industrial waste streams will enable more targeted programming to focus on diversion and minimization in these sectors. Live Green Toronto in partnership with Solid Waste Management is developing a new, *Waste Diversion Community Investment Program* that will be brought to Council in 2017 to support the Long Term Waste Management Strategy. The "Mobilize Low-Carbon Neighbourhoods" Acceleration Campaign will include a waste diversion element.

F. Monitoring and Reporting

TransformTO has presented the long-term low-carbon pathway to 2050, based on the implementation of Toronto's planned low-carbon actions, funding and implementation of a set of Council-approved TransformTO Report #1 Strategies, and implementation of the Acceleration Campaigns proposed in this report. Monitoring and evaluation activities will need to assess progress against goals in all three of these areas.

With each new term of City Council a progress report and updated implementation plan will be presented that identifies:

- 1) updates on TransformTO key performance indicators including:
 - a) City-wide GHG emissions as measured by the City of Toronto GHG Inventory study;
 - b) Co-benefits of low-carbon actions (indicators to be presented in first four year implementation plan update);
 - c) Public engagement (number of organizations/individuals engaged and their level of engagement); and
 - d) Amount of financial and other resources mobilized in support of low-carbon action in Toronto;
- 2) progress towards City of Toronto low-carbon leadership goals; and
- 3) revisions and additions to the short term strategies, and the implementation plan for that term of Council.

Every second year a status update will be prepared for Council to report on the key performance indicators for TransformTO.

4. Exploring Consumption Based GHG Emissions Accounting

The analysis completed in this report is guided by the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories, using a geographic approach. This approach accounts for emissions that result from the various sectors within the geographic limits of the city and some GHG emissions, resulting from electricity production outside of the city's boundaries, are also tracked. Toronto focuses on monitoring and reporting its production emissions because the City has some control over these emissions through policy and programs such as conservation programs or green building standards.

A consumption-based approach seeks to track all GHG emissions associated with the goods and services consumed by individuals living in the City of Toronto, while excluding goods and services which are exported. This approach typically uses an input-output model, which links consumption patterns and trade flows to energy use and GHG emissions.

Consumption-based inventories typically result in higher emissions on a per capita basis than sector-based inventories in 'consumer cities' like Toronto, and the opposite is true for cities in the Global South which are producing goods for consumers in the North. The results, which focus on patterns of consumption, can provide additional insights into sources of emission and create opportunities for new municipal policies.

Cities around the world are starting to track "consumption-based" emissions and C40 Cities has a new initiative focused on this. Toronto is currently researching how it might define and design a consumption-based inventory approach to better understand the full range of emissions sources for the City while at the same time understanding how this information could be used to inform future greenhouse gas mitigation policy and programming.

5. Conclusion

TransformTO presents a feasible pathway to a healthy, equitable and prosperous low-carbon city by the year 2050. The key findings of the project presented in support of the report recommendations are:

- City Council's community-wide GHG reduction goals can be met with existing technology;
- Toronto, its residents and businesses along with action by Provincial and Federal Governments are reducing GHG emissions in the context of population and economic growth;
- Existing policies and programs provide a foundation for success and have helped create the business case for new and additional actions;
- The scale and pace of change in Toronto's urban systems must be accelerated to reach the long-term goal of an 80% reduction in GHG emissions by 2050;
- Additional community benefits that align with City of Toronto city-building strategies and objectives can be derived by taking action towards a low-carbon future;
- A sustained, integrated, community-wide approach is required to achieve the long term goal; and

- The TransformTO Report #1 Strategies approved by City Council in December 2016, if fully funded, are the first step towards increasing the scale and pace of change required to achieve the long-term goal.

The initial investments in the TransformTO Report #1 strategies approved by City Council in December 2016 requires both city budget resources, and the mobilization of resources from other orders of government, private partners, and the community. The City of Toronto's ability to implement the Report #1 strategies, and operating budget requirements, will be subject to funding received from external sources. The operating budget forecasts provided in this report are in part to develop a better understanding of the City capital cost requirements of implementing these strategies, along with how best to access other resources. Toronto can achieve its long-term low-carbon goals, but bold action is required today to both maximize the effectiveness, and minimize the cost of reducing GHG emissions at the transformational scale required.

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ATTACHMENTS

Attachment A: TransformTO Modelling Advisory Group Summary Report
Attachment B: Modelling Toronto's Low Carbon Future: Results of Modelling Greenhouse Gas Emissions to 2050
Attachment C: Evaluation of potential additions to TransformTO Report #1 Strategies