The City of Toronto's

# Net Zero Existing Buildings Strategy

Final Report

March 2021

Prepared for:

Environment and Energy Division

Prepared by:

# Acknowledgements


Ana Maria Medina, City of Toronto

Andrew Penner, BGIS

Andrew Pride, Andrew Pride Consulting

Bala Gnanam, BOMA

Bryan Purcell, The Atmospheric Fund

Charles Marshall, Dialog

Chetan Mistry, Ontario Ministry of Municipal Affairs and Housing

Chris Magwood, Endeavor Centre

Dylan Aster, City of Toronto

Eric Stein, City of Toronto

Glenn Hultzer and team, A.W. Hooker & Associates

Jeff Ranson, Canada Green Building Council

Jenn McArthur, Ryerson University

Jim Bolger, Waterloo Energy Products

Jim Lord, Ecovert

Joe Bile, Toronto Hydro

John Cartwright, Toronto & York Region Labour Council

Jonathan Frank, VanCity Community Investment Bank

Keir Brownstone, Toronto Community Housing Corporation

Kristopher Kolenc, REALPAC

Linda Swanston, City of Toronto

Lisa King, City of Toronto

Matt Carlsson, Morrison Hershfield

Morgan McDonald, Ledcor

Peter Washer, HTS Engineering

Rae-Anne Miller, City of Toronto

Sarah Van Der Paelt, Enbridge Gas Distribution

Stephen Teeple, Teeple Architects

Steve Kemp, RDH Building Science Inc.

Stewart Dutfield, City of Toronto

Will Gonell, Gonell Homes

# Contents


TORONTO
#HostCity2015

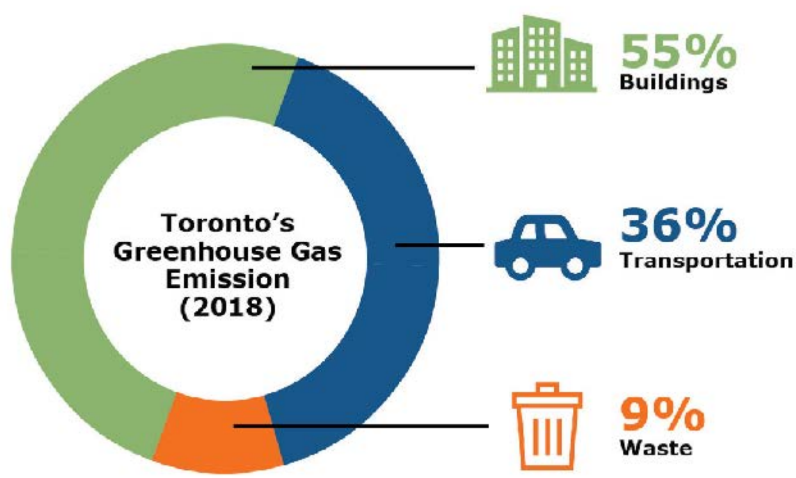
# Executive Summary

## The Need for Net Zero Emissions Buildings

The City of Toronto has set a goal of reducing city-wide emissions to **net zero emissions by 2050 or sooner**, relative to 1990 levels. Achieving this goal requires a significant reduction in the emissions derived from energy use in buildings, as they represent over half (55%) of Toronto's GHG emissions. While the Toronto Green standard already represents a policy designed to substantially reduce emissions in new building projects, the bigger challenge of achieving the same goal across the sector lies with the large number of existing buildings across the city. The necessary action to achieve this goal represents a significant shift in the market that will take a concerted and coordinated effort involving multiple actors, including federal, provincial and municipal governments, as well as industry associations, financial institutions, trade unions, the real estate sector, and of course – home and building owners.

## A Strategy for the City of Toronto

Building on the city-wide work embodied in TransformTO, the City has developed a comprehensive Net Zero Existing Buildings Strategy that will chart a path to a decarbonized and net zero emissions building sector. The Strategy, as summarized in this report, presents the background information and set of recommended building-scale actions and city-wide policies necessary for the City of Toronto to transform its existing building sector.




Toronto's greenhouse gas emissions in 2018 (Transform TO)

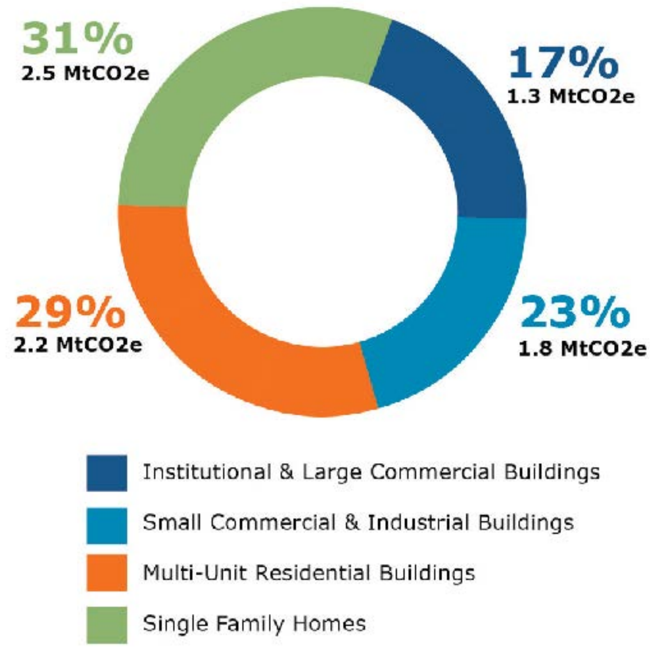
The Strategy represents a set of recommendations for the City to consider in reducing emissions from its building stock. The proposed actions and policies are drawn from a combination of best practices in other leading jurisdictions, citywide and sector-specific modelling and costing analysis, impact assessment, as well as extensive input from key industry members, broader stakeholder engagement, and City of Toronto staff. It provides an overview of the challenges of decarbonizing Toronto's existing buildings and identifies key policies and actions necessary to achieve the City's climate targets while maximizing potential co-benefits and minimizing potential harms to owners and tenants.

## How Can We Get to Zero Emissions in Our Existing Buildings?

Toronto's building sector can be broken down into different types of buildings, each with their own emissions profile, or collective contribution to sector-wide emissions. Modelling shows that 29% of building emissions can be attributed to multi-unit residential buildings, 31% to single family homes, 17% to large commercial and institutional buildings, and 23% to smaller commercial and industrial buildings.

To understand how best to reduce emissions from these different building types, 82 distinct building-level retrofit measures that could be implemented in Toronto's buildings were explored, classified under five key systems:

1. User-driven loads and occupancy-based controls
2. Enclosure
3. HVAC Delivery
4. HVAC Plant
5. Renewable Electricity




**GHG emissions breakdown by building sector**

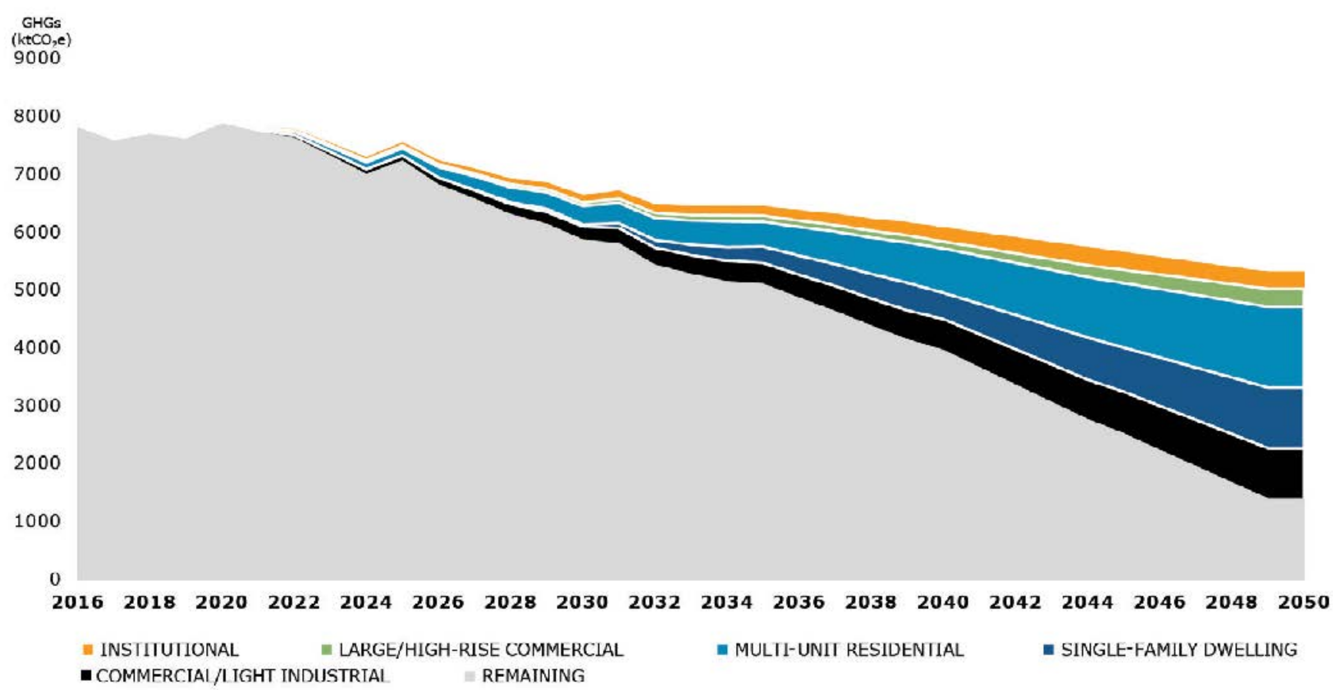
These were then grouped into six primary packages of measures and applied to Toronto's major building sectors to understand the potential operational emissions reductions, capital and energy cost implications as well as other important co-benefits, such as embodied emissions reduction and passive survivability. Key insights derived from this analysis include the following key insights related to building systems:

- User-driven loads (e.g. lighting, plugged equipment) represent a likely starting-point from which most facilities would engage in further upgrades
- Considering embodied impacts in deep retrofit design will be an important feature of projects that invest significantly in enclosure upgrades and fuel switching
- All suitable packages include fuel switching to electric heat pumps (except where a low carbon district energy system may be available).
- Load reduction and near-temp system design reduces the electricity demand and overall capacity of fuel switching equipment
- Facilities in downtown or high-intensity areas should explore low/zero emission co-generation and district energy node opportunities before deciding on their fuel switching and renewable energy strategies
- Solar PV improves the business case for all retrofit packages while potentially supporting grid stewardship, and therefore should be promoted for all suitable buildings.

In addition to these insights, this analysis also showed that modeling-supported life-cycle cost analysis is the best way to compare complex HVAC configurations and the trade-offs between load reduction, fuel switching and grid-conscious improvement packages. Further, a site-specific assessment is the best (and perhaps only) way to reveal the most appropriate combination of decarbonization measures.

## A City-Wide Transformation

Packages of measures applied to Toronto's entire building stock were then combined into a city-wide pathway to show how the City can effect a transformation to zero emissions by 2050. Overall, the sector-specific retrofit packages explored for this Strategy show **that it is possible to reduce existing building emissions by over 80% by 2050 (relative to a baseline year of 2016)**. By comparison, business as planned will only reduce existing building emissions by 34% by 2050. The prototype recommended (i.e. preferred) emissions reduction scenario seeks to balance an ambitious scope and scale of GHG savings with a pace that considers the complexities of renovating almost every building in the city over the next 30 years.




**GHG reduction by sector compared to business-as-planned to 2050**

Key insights from this city-wide analysis include the following:

- There is no mix of packages that results in a zero emissions building sector, as a result of the remaining emissions associated with Ontario's electricity. As such, additional measures such as the installation or procurement of renewable energy, carbon offsets, or grid-scale decarbonization will be necessary to achieve the City's net-zero emissions target.
- While the pace of change proposed in the recommended scenario above has sought to strike a balance between speed and feasibility, it is nevertheless still swift, representing a 3% average change in floor area per year. The key to such a high pace of change will rely on an open-minded, flexible, consolidated, and harmonized effort by all interested parties (i.e. utilities, other levels of government, non-profit actors, the City and building owners).
- Deep emissions retrofits at the level and scale necessary to affect market transformation do not pay back in the traditional sense and represent a net investment on the part of building owners, even based on the current planned cost of carbon This is due largely to the scale of capital required and the very low cost of natural gas relative to electricity. Retrofit measures with a reasonable short-term payback are also likely already being undertaken by many building owners, but do not achieve the emissions savings necessary to hit the City's targets.
- Making the switch to lower-carbon sources of energy is both necessary and, if implemented carefully, can be the lowest cost way to achieve deep emissions reductions. That said, the importance of grid decarbonization – and the co-benefit of grid resilience – cannot be overstated. Wherever possible, fuel switching should be aligned with load reduction and with renewable generation to keep capital and cost savings in the city and support cost-effective decarbonization of the grid, all while improving the quality of space and managing the impacts of a changing climate.
- Relative to a business-as-planned scenario, the prototypical proposed pathway is estimated to increase local building retrofit economic activity by 87%, from $162 billion to $302 billion, and nearly double annual investment in existing buildings, from $5.4 billion per year to $10 billion per year. This investment will create an estimated additional 8,500 direct, full-time jobs in local construction, energy services and supportive work over 25 years.

## Key Policies and Actions for Reducing Existing Building Emissions

To effect a city-wide market transformation towards zero emissions existing buildings will require significant action on the part of the City of Toronto, as well as many other industry members. To enable and accelerate the uptake of retrofit measures needed to meet the City's targets, the Strategy recommends nine key policies that comprise 47 specific actions:

**Actions to set requirements** to assess performance and create a path to net zero

**1**

**Require annual performance reporting and public disclosure** to improve building owners' and the City's understanding of the performance of Toronto's homes and buildings

**2**

**Establish emissions performance requirements** to gradually require performance improvements in a way that allows flexibility and acknowledges sector-specific challenges

**3**

**Require energy audits and retro-commissioning** to support building owners in understanding how to improve their energy and emissions performance, prepare to meet upcoming requirements and achieve/ maintain performance targets year-over-year.

**Actions to provide support and resources** to make retrofits easier and more affordable

**4**

**Provide and support financing and funding** to ramp up the amount of capital available to home and building owners for deep emissions retrofits

**5**

**Provide integrated retrofit support** to reduce the complexity, cost and time associated with retrofits, and support building owners with lower capacity in navigating the many processes and decisions they face when exploring retrofit options

**6**

**Support permitting and approvals process** to support building owners in navigating the permitting processes for deep emissions retrofits

**Actions to lay the groundwork** for market transformation

**7**

**Build awareness and capacity of home and building owners** to provide them with the information they need to make wise retrofit investments

**8**

**Support workforce development and training** to ensure a strong and sufficiently numbered workforce is ready to meet the new demand for deep emissions retrofits

**9**

**Advocate for action at other levels of government** to enable the necessary changes to make retrofits a smart, dependable investment

These actions have been recommended to not only achieve deep emissions reductions, but also to realize several additional benefits to building occupants and the larger community. When done right, home and building retrofits can foster additional outcomes that benefit owners, tenants, and occupants and that, when factored into the total cost of retrofits, can help to improve return on investments. As already indicated briefly above, some of these co-benefits include:

- ✓ Improved comfort via improved airtightness and insulation to retain heat in winter, and mechanical systems that provide spaces with cooling in the summer
- ✓ Improved occupant health through the provision of enhanced ventilation control and filtration
- ✓ Improved resilience by extending building habitability during power outages and extreme weather events (i.e. passive survivability)
- ✓ Lowering (or at least maintaining) energy costs to tenants even when fuel switching
- ✓ Increasing numbers of local jobs in a green retrofit economy
- ✓ Lowering the utility-scale cost of grid decarbonization

## Sectoral Actions and Performance Targets

The nine recommended policies and the sector-specific actions described above are intended to be taken as a complete strategy, as the success of any one component will rest on the earnest implementation of the others. For example, expecting building owners to comply with requirements for performance improvement relies on the existence of a trained and growing workforce to deliver the necessary upgrades. Similarly, supporting home and building owners in making the transition to zero emissions must necessarily leverage support and funding from other actors (e.g. utilities) and scales (e.g. federal and provincial governments). Taken together, these nine recommendations have the potential to elicit a market transformation in Toronto's building sector and achieve the goal of net zero emissions by 2050 or sooner.

As conditions and markets change, the City will need to review and revise the nature and timing of these recommended actions to ensure they meet the City's goals and its emission reduction targets. This will necessarily include ensuring alignment with other citywide plans and strategies, including the forthcoming city-wide Net Zero strategy update to TransformTO, *the Corporate Real Estate Management Portfolio Energy Plan*, future updates to the Toronto Green Standard (including TGS v4), as well as the expansion of low-carbon district energy systems across the city.

There are a few key issues of note that bear emphasizing in order to ensure the success of the Strategy as it has been proposed:

- Among the most important steps to take in this Strategy is ensuring that the building industry, from homeowners to large commercial property owners, labour unions to industry associations, energy modellers to energy advisors, architects to contractors, are all aware of the end goal the City has set, and the ways it plans to get there. Further engagement with key groups and stakeholders will be important to note only raise awareness, but garner support and identify and potential pitfalls or issues that may have been overlooked in the creation of this Strategy.

- The Strategy includes a set of draft targets, created based on the prototype recommended pathway discussed above and using the best available data. The City will need to continue to collect home and building performance data to calibrate and adjust performance requirements over the next several years prior to the first set of formal targets becoming requirements. The success of voluntary programs (e.g. the Green Will Initiative) will also be critical to understanding the challenges and sector-specific importance of the various measures, packages and pathways currently included in the Strategy.
- While all of the actions and policies proposed here are important to effect the necessary market transformation to achieve zero emissions existing buildings, none of them will be successful in meeting the City's targets without clear authority on the part of the City of Toronto to require performance improvements in existing buildings. On their own, building industry capacity, educating homeowners, or even providing financing and incentives are not enough to shift the market to a state where zero emissions buildings are the norm by 2050. This means working with the Province of Ontario to clarify what, if any, regulatory adjustments may be necessary for the City to move forward with mandatory building performance requirements

## The Path Forward

This Strategy is intended to provide City staff, industry members, and home and building owners with context and information necessary to understand the many dimensions of achieving deep emissions reductions in the existing building sector.

While the measures and policies presented in this Strategy represent a significant effort and achievement, they nevertheless do not achieve zero emissions, as targeted across all sectors based on the City of Toronto's Climate Emergency Declaration in October 2019. Much work will still need to be done to effect the necessary change, including significant shifts by federal and provincial governments and the building industry at large.

The changes that are necessary to transform the building sector also represents considerable effort on the part of home and building owners, that will in turn require significant support from all scales of government, as well as a number of other organizations. Ingenuity, financial resources, partnerships and other support will need to come from utilities and governments, financial institutions, industry associations, educational bodies, trades unions, real estate agents, consultants, as well as from the capacity and desire of home and building owners/managers themselves. The City of Toronto will need to work together with community members and other partners to ensure a path forward that harnesses the benefits of zero emissions buildings, reduces costs, and achieves the goals of a healthy, resilient and zero emissions city.

# List of Acronyms

| | |
|---|---|
| **ASHP** | Air source heat pump |
| **BAP** | Business as planned |
| **CDM** | Conservation and Demand Management |
| **CEDI** | Cooling Energy Demand Intensity |
| **CIB** | Canada Infrastructure Bank |
| **DOAS** | Dedicated Outdoor Air System |
| **ERL** | Energy Retrofit Loan |
| **EWRB** | Energy and Water Reporting and Benchmarking |
| **FS2** | Fuel Switch Level 2 |
| **GHG** | Greenhouse gas |
| **GPC** | Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories |
| **GSHP** | Ground source heat pump |
| **GWP** | Global Warming Potential |
| **HRAI** | Heating, Refrigeration and Air Conditioning Institute of Canada |
| **HVAC** | Heating, Ventilation and Air Conditioning |
| **ICI** | Institutional, Commercial and Industrial |
| **IESO** | Independent Electricity System Operator |
| **ILCC** | Incremental life-cycle cost |
| **LEED** | Leadership in Energy and Environmental Design |
| **LFS** | Like-For-Similar |
| **MACC** | Marginal Abatement Cost Curve |
| **MENDM** | Ministry of Energy, Northern Development and Mines |
| **MURB** | Multi-Unit Residential Building |
| **NAIMA** | North American Insulation Manufacturers Association |
| **OEB** | Ontario Energy Board |
| **OGA** | Ontario Geothermal Association |
| **RCx** | Retro-commissioning |
| **REC** | Renewable Energy Certificate |
| **SAWDAC** | Siding and Window Dealers Association of Canada |
| **SFH** | Single-family home |
| **STEP** | Sustainable Towers Empowering People |
| **TAF** | The Atmospheric Fund |
| **TCO** | Total Cost of Ownership |
| **TEDI** | Total Energy Demand Intensity |
| **TEUI** | Total Energy Use Intensity |
| **TGS** | Toronto Green Standard |
| **SHGC** | Solar Heat Gain Coefficient |
| **ZCR** | Zero Carbon Ready |

# 1. Introduction

## 1.1 Toronto's Climate Leadership

The City of Toronto is one of a growing number of global cities that has committed to demonstrating leadership in the reduction of greenhouse gas (GHG) emissions. Originally adopted in 2017, TransformTO, the City's climate action strategy, established GHG emissions reduction targets of 65% by 2030 and 80% by 2050 (relative to 1990 levels). As awareness of the growing climate crisis grew, the declaration of a Climate Emergency in October 2019 saw a revision of *TransformTO*'s GHG emissions reduction targets from an 80% reduction relative to 1990 levels by 2050 to **net -zero emissions by 2050 or sooner.**

## 1.2 Reducing Building Emissions

The emissions derived from energy use in buildings represented over half (55%) of Toronto's GHG emissions in 2018, making it one of the most important areas of focus.[i] This means that to meet Toronto's climate targets, significant emissions reductions from both new and existing buildings have to be achieved. With respect to new buildings, the 2018 update to the Toronto Green Standard (TGS) included a new set of energy and emissions targets for new Part 9 and Part 3 building construction (low-/high-rise residential, commercial office, large format retail). The TGS v3 included four tiers of new construction targets that will be incrementally increased over time to eventually require all new construction projects to achieve near-zero emissions by 2030. As a show of leadership and to help spur on the rest of the building sector, the City of Toronto has committed to achieving Tier 2 TGS as the minimum performance level and striving for net zero for all new City-owned buildings. [ii]

While it is important to reduce emissions in new projects, the bigger challenge in reducing emissions from the building sector lies with the large number of existing buildings across the city. Retrofitting the thousands of homes and buildings across the city and shifting them to cleaner, renewable sources of energy will take a concerted and coordinated effort involving multiple actors, including federal, provincial and municipal governments, as well as industry associations, financial institutions, trade unions, the real estate sector, and of course – home and building owners. To meet this challenge, the City has developed a comprehensive **Net Zero Existing Buildings Strategy** that will chart a path to a decarbonized and net zero emissions building sector by 2050, or sooner.

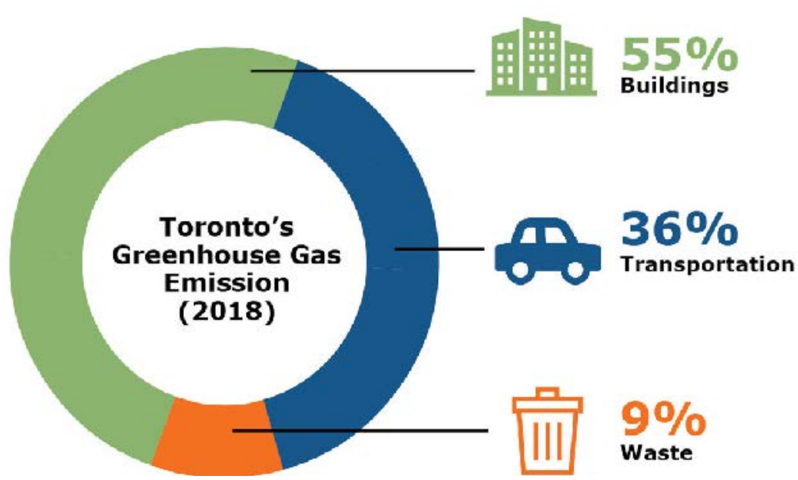



**Figure 1: Toronto's greenhouse gas emissions in 2018 (Transform TO)**

> ***Net zero** emissions refers to reducing GHG emissions from building operations to as close to zero as possible, and balancing out any remaining emissions with an equivalent amount of carbon removals (e.g. offsets)*

### 1.2.1 Building On Past Successes

The development of an Existing Building Emissions Reduction Strategy for Toronto must necessarily build on the City of Toronto's strengths and successes, including its two major building support platforms. Notably, the City's Better Buildings Partnership already provides funding, expertise and support to improve energy efficiency and reduce emissions in Toronto's residential, commercial, industrial and institutional buildings. It provides building owners with a centralized resource to support them in understanding and accessing the various supports available to them in benchmarking and improving their assets' performance. Similarly, Better HomesTO provides Toronto's residents with a one-stop platform to help improve their home's energy efficiency and reduce associated emissions.

Together, these two platforms already provide services and financial support for reducing emissions, including via the following programs:

- The City's ***Tower Renewal Program***[iii] provides site improvement guidance and financing to support property owners and managers of apartment buildings to reduce operating costs, increase building efficiency and improve the quality of life for residents.
- Offered via the Tower Renewal Program, the ***High-Rise Retrofit Improvement Support Program*** (Hi-RIS)[iv] helps multi-unit residential building (MURB) owners to introduce building improvements that reduce energy and water consumption. This program provides Local Improvement Charge (LIC) financing with up to 20-year terms at competitive fixed rates to residential apartment buildings in Toronto at or above three storeys[1].
- The ***Sustainable Towers Empowering People*** (STEP)[v] program provides direct support to owners and managers in benchmarking and reporting their energy, water and waste performance.
- The ***Home Energy Loan Program*** (HELP) is similar to Hi-RIS but is targeted at homeowners of all income levels, providing financing of up to $75,000 and flexible terms up to 20 years to cover the cost of home energy improvements such as air sealing, insulation, heat pumps, and renewable energy and energy storage technologies[vi].
- The ***Energy Retrofit Loan***[vii] program offers low-interest loans to help owners of commercial, institutional and multi-unit residential properties to improve energy efficiency and reduce emissions in their buildings. The City provides financing for up to 100% of project costs, at a rate equal to the City's cost of borrowing, with repayment terms up to 20 years.

---

1 Local Improvement Charges (LIC) are levies made by municipalities to support building and infrastructure projects that are paid off as part of the property assessment. As such, the repayment obligation transfers to the new owner when the property is sold. While often used to support municipal infrastructure, they can also be used to provide a building owner with financing for improvements.

### 1.2.2 A Larger Movement to Decarbonized Buildings

Toronto's efforts in existing building decarbonization will be supported at action at other scales as well. In 2016, the Government of Canada committed to greenhouse gas (GHG) emissions reduction targets of 30% by 2030 and 80% by 2050 (relative to 2005 levels). The Pan-Canadian Framework on Clean Growth and Climate Change prioritized the support of existing building retrofits through strategies including:

- Developing a model code for existing buildings by 2022 to be adopted by the provinces and territories
- Requiring benchmarking and labelling of building energy use
- Setting new standards for heating equipment and other key technologies to the highest level of efficiency that is economically and technically achievable, and
- Supporting the continuation and expansion of provincial and territorial efforts to retrofit existing buildings.[viii]

In Fall 2020, this commitment was strengthened via the introduction of legislation outlining the need to achieve a nationwide net zero emissions target by 2050[ix], followed by a commitment to supporting home energy retrofits as a part of its 2021 budget.[x] Federal government commitments now include $2 billion in investment in building energy retrofits via the Canada Infrastructure Bank (CIB) Growth Plan, as well as $2.6 billion to Natural Resources Canada to subsidize energy efficiency improvements, energy assessments, and energy auditor training. The Federation of Canadian Municipalities has also earmarked $300 million for Community Efficiency Financing to support municipalities in supporting home energy efficiency upgrades.

At the provincial scale, the Energy and Water Reporting and Benchmarking (EWRB) initiative sets a strong foundation for existing building energy and emission reductions by requiring large commercial, residential and institutional buildings over 100,000ft$^2$ to annually report their energy and water consumption. Scheduled to scale down to buildings 50,000 ft$^2$ and above in 2023, the EWRB helps to support owners in understanding their building's performance, as well as water and energy saving opportunities.

## 1.3 Why Do We Need a Strategy?

While the actions and commitments by all three levels of government will certainly help to support the uptake of energy and emissions reductions in existing buildings, a broader transformation of the existing building market will still require significant and coordinated action and investment. A true market transformation in which net zero emissions buildings become the norm requires a process of bringing in and supporting new technologies, products, practices and services that dramatically improve building energy efficiency and reduce emissions. This can be only achieved by removing barriers to the widespread adoption of low-emissions and energy efficient technologies and products, as well as identifying opportunities to support or accelerate their adoption[xixii].

Meeting the GHG targets and associated co-benefits laid out in TransformTO process requires not only a direct and strategic effort to transform the retrofit market, but to elicit that transformation at an accelerated pace. In essence, this means that the typical "S-curve" associated with the phases of adoption of new technologies or practices (see Figure 2) has to become much steeper, by fostering the conditions necessary to achieve mass market adoption of low-emissions practices sooner and as widely as possible.

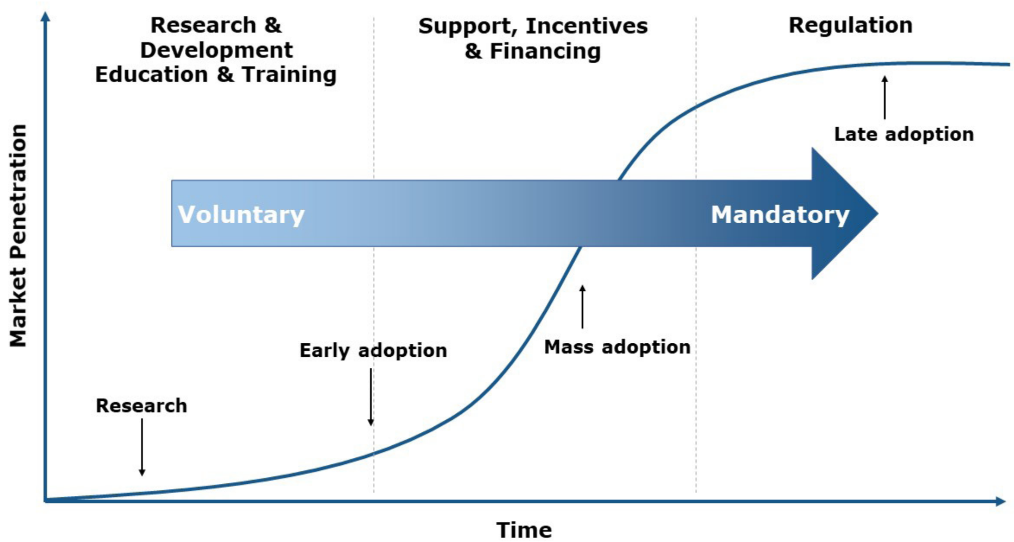



**Figure 2: S-curve of technology adoption and market transformation**

Eliciting this scale and pace of transformation has a number of associated challenges, not least of which is the considerable potential cost associated with replacing or upgrading major components of a home or building to achieve deep emissions reductions. While the required measures (and their associated costs) to achieve deep emissions reductions vary by building, many homes and buildings will need to make the shift from using higher emissions energy sources to lower carbon electricity and renewables.

However, home and building retrofits can fortunately serve to foster a number of additional outcomes that benefit owners, tenants, and occupants and that, when factored into the total cost of retrofits, can help to improve return on investments. Some of these include:

- ✓ Improved comfort via improved airtightness and insulation to retain heat in winter, and mechanical systems that provide spaces with cooling in the summer
- ✓ Improved occupant health through the provision of increased ventilation and filtration rates
- ✓ Improved resilience by extending building habitability during power outages and extreme weather events (i.e. passive survivability)

- ✓ Lowering (or at least maintaining) energy costs to tenants even when fuel switching Better air quality, quieter spaces, and increased thermal comfort for occupants
- ✓ Increasing numbers of local jobs in a green retrofit economy
- ✓ Lowering the utility-scale cost of grid decarbonization

At the same time, it will be important to provide owners with the tools and knowledge necessary to ensure that the potential harms associated with retrofits when done at the wrong time or in the wrong way can be avoided (i.e. co-harms). Some examples of potential co-harms associated with poorly executed deep retrofits include the following:

- × Increased energy insecurity for low-income households via higher energy bills
- × Increased risk of "renovictions" that price lower-income households out of affordable housing
- × Increasing stress on the electricity grid

This Strategy and its recommendations have been developed to directly address these and other potential issues and opportunities associated with a market transformation to zero emissions buildings.

## 1.4 Reading the Strategy

This Strategy presents the background information and set of recommended strategies necessary for the City of Toronto to transform its existing building sector. The recommendations presented here are drawn from a combination of best practices in other leading jurisdictions, citywide and sector-specific modelling and costing analysis, impact assessment, as well as extensive input from key industry members, broader stakeholder engagement, and City of Toronto staff. It provides an overview of the challenges of decarbonizing Toronto's existing buildings and identifies key policies and actions necessary to achieve the City's climate targets while maximizing potential benefits and minimizing potential harms to owners and tenants. It is intended to provide City staff, industry members, and home and building owners with context and information necessary to understand the many dimensions of achieving deep emissions reductions in the existing building sector. Following this introduction, the Strategy is organized into four additional sections:

- **Section 2** reviews the major sources of emissions in Toronto's building sector, as well as the major emissions reduction measures available to different sectors at the system, facility and city-wide scale, as well as their associated impacts, including both potential benefits and harms
- **Section 3** outlines the guiding principles driving the strategy, as well as the proposed policies and actions necessary to reduce emissions across the sector
- **Section 4** outlines proposed actions and policies by sector, including institutional portfolios, large and small commercial buildings, multi-unit residential buildings, and single-family homes.
- **Section 5** reviews details pertinent to the Strategy's implementation

*This Strategy focuses primarily on **operational emissions** – i.e. the emissions associated with the energy needed to operate a building, including heating, cooling, ventilation, and plug loads. All modelling and analysis presented here includes operational emissions only. Other emissions associated with buildings, including embodied emissions, upstream methane, and refrigerant leakage are discussed as potential co-harms throughout the document, but especially in Section 2.4.3.*


1849 Medical & Dental Centre
RT-86

# 2. Toronto's Existing Building Emissions

## 2.1 GHG Emissions And Toronto's Building Stock

Cities like Toronto quantify emissions coming from different sectors using established protocols for determining what should and shouldn't be counted towards a city's GHG emissions inventory. The Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC) is the protocol used by the City of Toronto, which has defined three scopes to distinguish emissions based on where they occur:[xiii]

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

The primary source of emissions in Toronto's building sector are the Scope 1 and Scope 2 emissions associated with its buildings' annual energy demand, or the sector-wide operational energy loads for heating, cooling, ventilation, and plug loads. These activities make use of two primary sources of energy – electricity and natural gas – which have different emissions intensities. In Ontario, the average grid emissions intensity in 2016 was 40g $CO_2e$ per kWh[2]; in comparison, the combustion of marketable natural gas generated approximately 181g $CO_2e$ per kWh[xv,xvi,3] or nearly four and a half times the emissions of electricity. Renewable energy (e.g. from on-site solar photovoltaics or renewable natural gas) have no emissions (or net zero emission) associated with energy consumption (Figure 3). Figure 3 also shows emission factors for 2017 and 2018 (the most recent National Inventory Report available at the time of this report). It is important to note that grid emissions increased between 2017 and 2018, and are projected to increase in the future based on projections of Ontario's provincial grid generation mix[4]. Natural gas emission intensity is constant between 2016 and 2018 and is nine times higher than 2017 grid emissions intensity and six times higher than the 2018 grid emissions intensity. While the federal Clean Fuel Standard is not yet in place, the modelling included consideration for the projected clean fuel standard starting in 2023 (i.e. decrease of natural gas emissions intensity over time). For more information, see **Appendix A.**

---

2 Average emission factor for grid emissions for consumption intensity in Ontario taken from Table A13–7 Electricity Generation and GHG Emission Details for Ontario of Canada's National Inventory Report

3 Emissions factors for natural gas combustion in Ontario (CH4, and N20) taken from Annex 6 of Canada's National Inventory Report; Global warming potentials for CH4 (28) and N20 (265) from IPCC 5th Assessment Report.

4 Canada Energy Regulator. Canada's Energy Future Data Appendices.

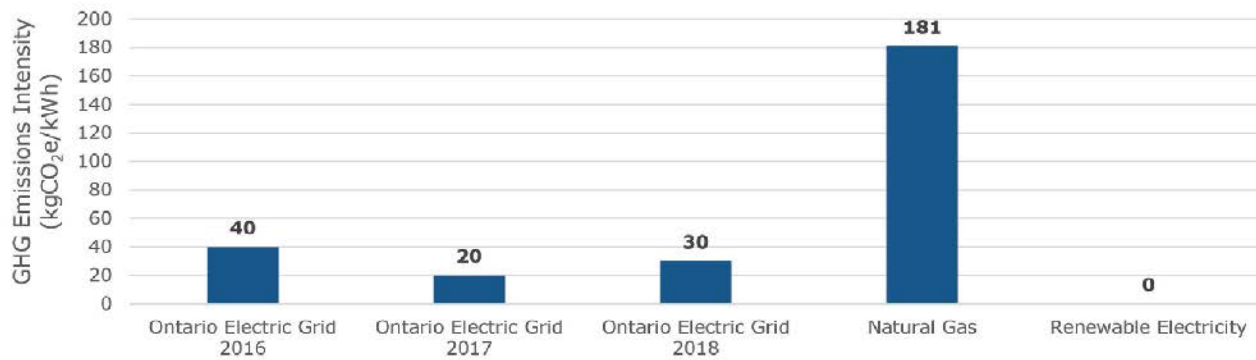



**Figure 3: GHG Emissions Intensity by energy source**

Understanding this difference in emissions intensity from different energy sources is key to understanding how emissions can be reduced throughout Toronto's building stock. For the most part, in the discussion and results presented below, the emissions factors above (or similar) have been used. However, there are also important factors which, depending on the future changes in fuel mix for the Ontario grid and best practices in accounting for (especially Scope 3) emissions, can impact the recommended scenario and the needed action at both the facility and grid scale to achieve net zero emissions. More discussion of these broader emission factor implications is included in Section 2.3 below.

## 2.2 Breaking It Down

As noted in the Introduction, Toronto's building sector accounts for approximately 55% of the city's total emissions, making it a crucial sector to address in emissions reduction efforts (see Figure 1). However, as the way emissions are generated across Toronto's many buildings is not uniform, it is important to explore how each key building type differs in terms of its relative contribution to the sector's overall emissions profile, as well as the measures necessary to reduce them.

### 2.2.1 By Sector and Energy Source

The first level way to break down emissions into increased detail is by sector and by energy source (or fuel type), As shown in Figure 4, 60% of building sector emissions come from the residential sector, and are roughly equally divided between multi-unit residential buildings (MURB) (29%) and single family homes (31%). The remaining 40% is derived from the institutional, commercial, and industrial (ICI) sector, which is divided here into large commercial and institutional buildings (17%) and smaller commercial and industrial buildings (23%).

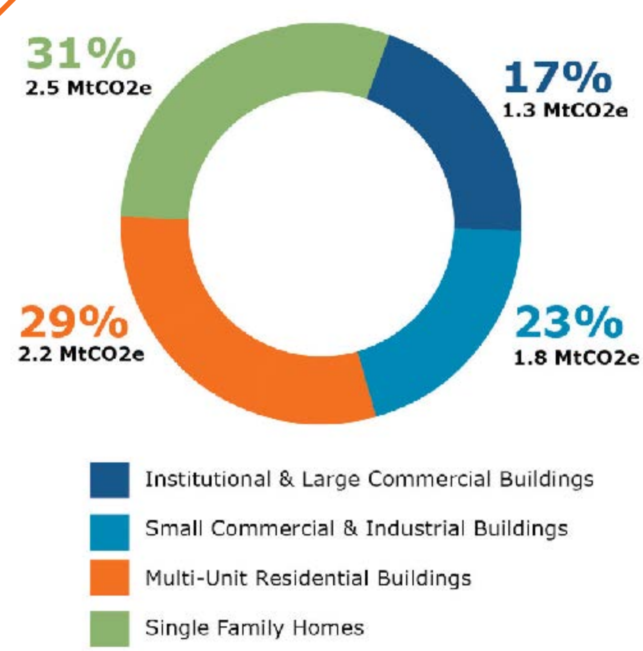



**Figure 4: GHG emissions breakdown by building sector**

ICI, MURB and single-family homes each represent three distinct markets, both in terms of property ownership and in terms of the overall design and construction sector. The ICI sector is broken down into these two groups to represent two major differences between them: first, each group shares a similar approach to key energy and emissions-related features, such as wall construction techniques, window-to-wall ratio, and the approach to HVAC delivery. Second, each group typically exhibits different ownership models: while larger commercial and institutional buildings tend to be held in portfolio, smaller commercial office, retail and light industrial (e.g. warehouse) buildings tend to be held by a larger number of owners or as single holdings.

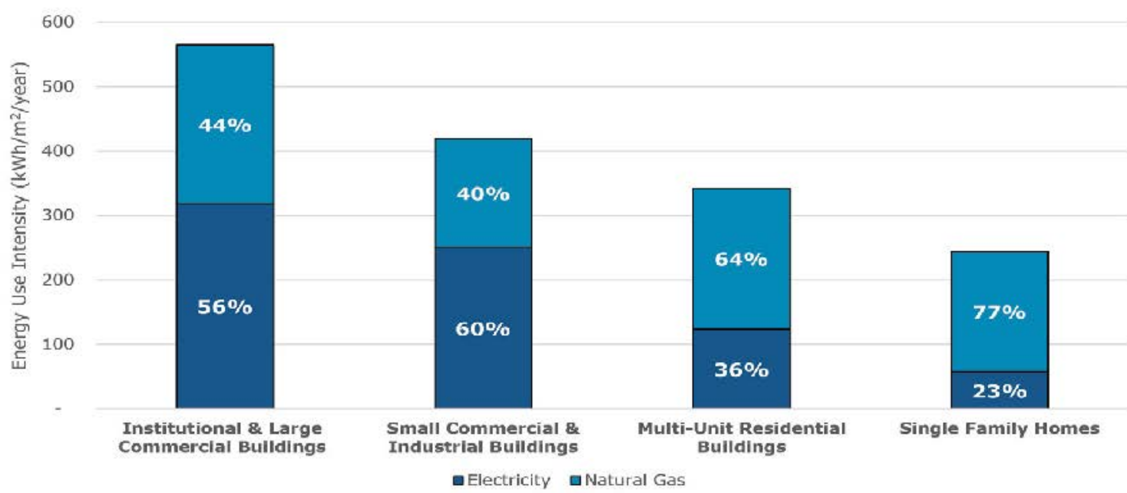



**Figure 5: Annual energy use intensity by building sector**

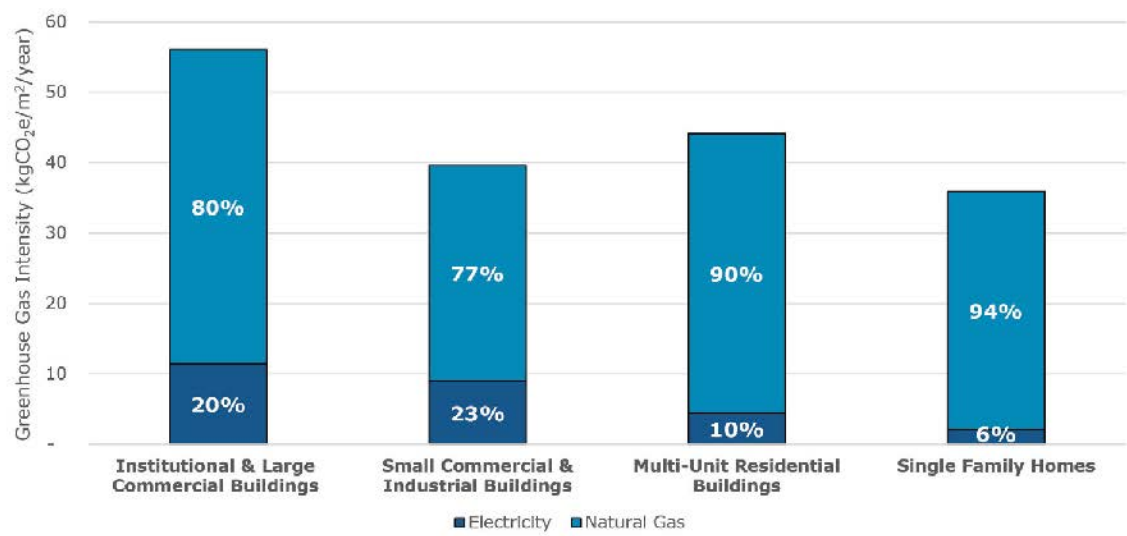



**Figure 6: Annual greenhouse gas intensity by building sector**

As can be seen in Figure 5 and Figure 6, the lower emissions intensity of electricity means that building sector emissions are largely derived from the use of natural gas. However, electricity emissions still represent a significant proportion of emissions overall, especially for the large commercial and institutional sector. The majority of emissions in the MURB and single-family home sectors are representative of the significant consumption of natural gas for heat and domestic hot water uses. In all sectors, energy use intensity of existing buildings vastly exceeds the energy targets for new buildings in the TGS (see Figure 7).

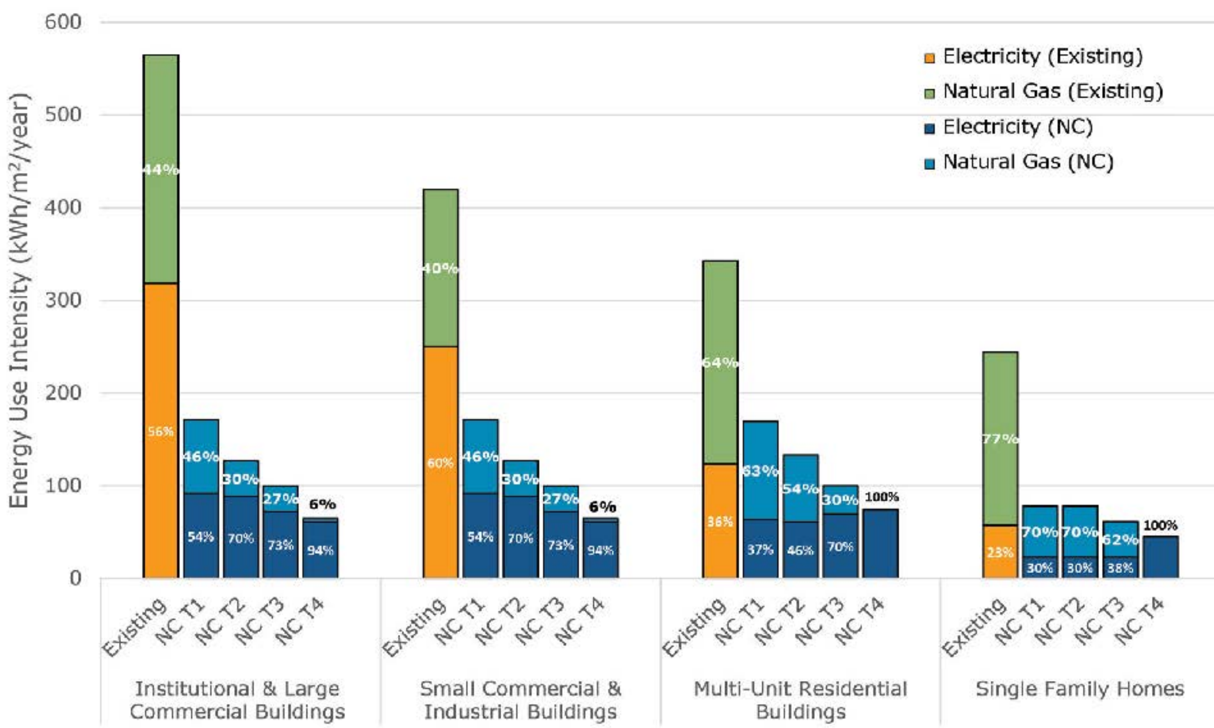



**Figure 7: Annual energy use intensity by building sector and new construction (NC) targets as per the Toronto Green Standard**

## 2.2.2 By Energy Profile

Beyond energy and emissions trends by sector and fuel type, it is important to further subdivide the building stock into groupings around common themes to understand how different features of their make-up (e.g. technologies, processes or systems) or operations may play a role in building emissions. Factors that can play a role in shaping building emissions profiles include:

- Facility principal operation type (e.g. school vs. classroom, MURB vs. hotel, office vs. retail)
- Facility usage patterns (e.g. operating hours, occupancy patterns)
- Size (e.g. larger buildings vs. smaller buildings)
- Vintage (e.g. older v. newer buildings), and
- Ownership model (e.g. condo vs. rental)

In the United States, Energy Star offers a significant pool of data that has begun to identify the factors that most affect differences in energy and emissions, starting with building archetype as the main organizing principal, representing the standard construction approach for each broad vintage and type of facility.[xvii] However, the Energy Star data set in Canada is still growing and fairly limited to date.[xviii]

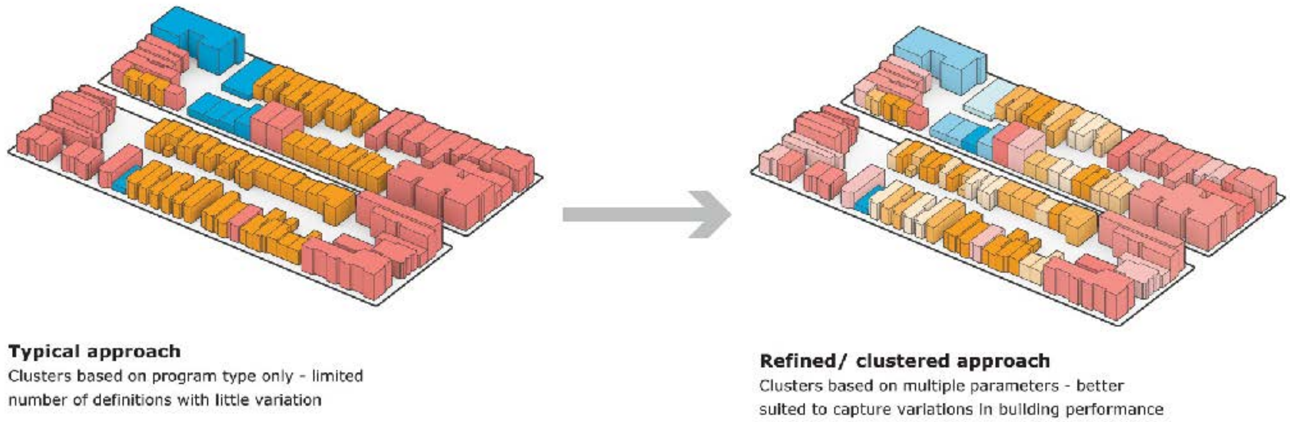



**Figure 8: A comparison of the clustering method used to analyze Toronto's building stock vs. a more conventional approach**

As a result, a statistical clustering technique was used to group Toronto’s buildings by their energy profile. This clustering methodology is designed to capture statistically significant variations in energy use (i.e. electricity and natural gas usage) across the existing building stock by grouping buildings by their energy use characteristics, in addition to common parameters such as program type or vintage. Energy use benchmarking data was used to identify important clusters of buildings, after which each building was assigned to a representative cluster based on known attributes, including area, program, vintage, and others (see Figure 8). This process requires reliable sources of facility-level data, with as many key features as possible to develop the most representative groupings. Data sets that included the necessary building details (i.e. actual energy use by fuel, building type, area, vintage, etc.) that were used include the following:

- ***Large buildings.*** One year of EWRB data (under O.Reg. 506/18 Reporting of Energy Consumption and Water Use) is available for the City of Toronto, providing one year of facility-level data for all buildings greater than 100,000 $ft^2$. This regulation requires large buildings over 100,000ft2 to report their energy and water use once a year to the Ministry of Energy, Northern Development and Mines. EWRB data was anonymized and stripped of location detail.
- Energy use results were extrapolated to smaller buildings below the EWRB threshold.
- ***Part 9 buildings.*** EnerGuide rating data was used to help identify and model retrofit pathways for single family home archetypes and to validate output from city-wide modelling. Though EnerGuide data is not a prediction of energy use, it helped determine appropriate building classifications within the data set and identify expected end-use breakdowns.
- ***Public sector buildings.*** Broader public sector properties are among the highest-intensity groupings of buildings in the city, but also have the best dataset available for validation through requirements to report set out in O.Reg 507/18 Broader Public Sector: Energy Reporting and Conservation and Demand Management Plans). This data was cross-referenced against the EWRB data for validation and confirmation of floor area and overall performance of the sub-sector.

With energy use profiles prepared from the data sets above, statistical analysis was then used to cluster all buildings into distinct typologies. For Toronto’s existing building stock, the statistical analysis identified **32 individual clusters:** some with a homogenous building program type (e.g. all single-family homes), and others with a variety of program types linked through other characteristics. For a full summary of the details of the clusters, please see **Appendix A**.

Figure 9 shows the breakdown of emissions across the 32 archetypes. **Of particular note is that the first two clusters are MURB, which together represent 25% of Toronto's building emissions, and as such will require specific focus in emission reduction efforts.** Approximately 50% of all building sector emissions are derived from the first six clusters (which represent a mix of all four primary building types), with 80% of all emissions derived from half of the clusters identified.

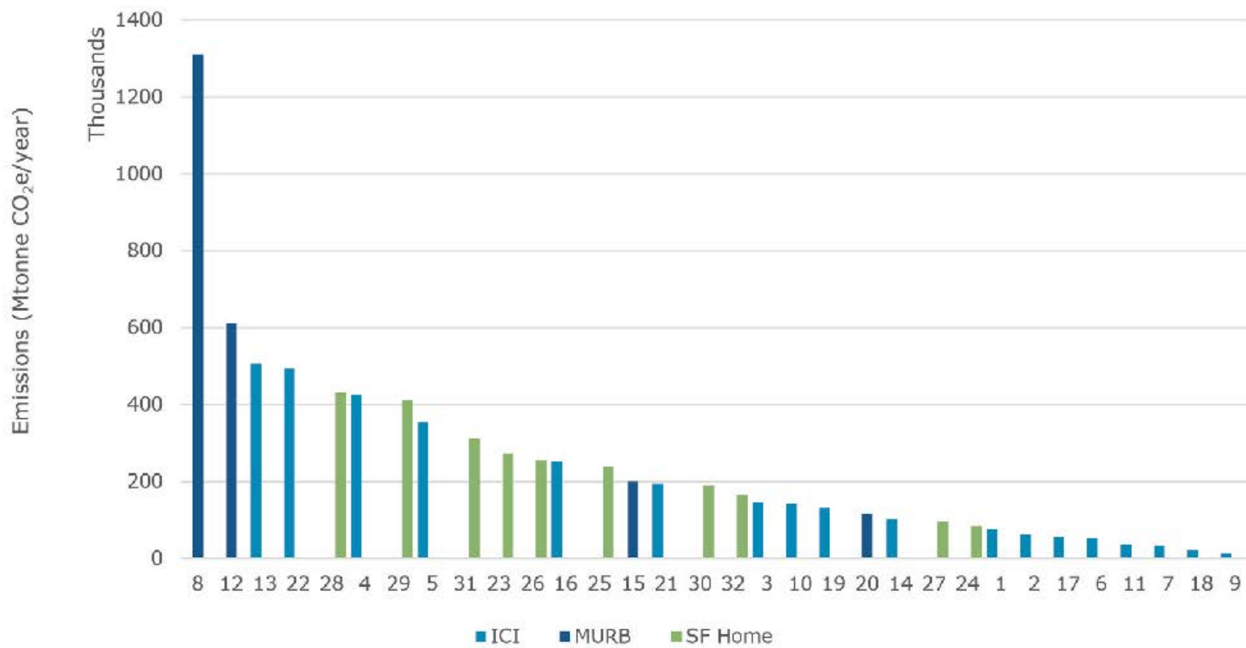



**Figure 9: Annual GHG emissions by cluster and associated building sector**

### 2.2.3 By Energy End Use and System Details

Finally, a third way to break down Toronto's building stock is by different end-use breakdowns, or the fuel-specific energy use for different purposes. For each cluster, a simple, planning-level energy model was developed to create more detailed breakdowns of energy use and to create the foundation for an evaluation of the impact of various energy efficiency strategies. In creating these energy models, the key challenge was to match the modeled energy use with the expected energy use of the cluster. Statistical surrogate models – a class of machine learning algorithms – were used to find the appropriate set of model input assumptions (for a full description of this process, see **Appendix A**).

To facilitate pricing of improvement measures, system level details were developed for nine of the 32 clusters, including the six clusters responsible for 50% of emissions, with those derived from Cluster 12 (MURB, constructed circa 1990) for the first and third quartiles shown as an example in Table 1. The table summarizes the variation in performance across the cluster by system, with details on range of effective performance, exemplar systems, and their typical service lives.

**Table 1: Cluster 12 Input Parameters - 1st and 3rd Quartile Values**

| Example Summary of Appendix Information (Cluster 12 - MURB circa 1990, 5,000 - 20,000 m²) | | | | | |
|---|---|---|---|---|---|
| **Energy System Group** | **Calibrated Parameter** | **Range of effective performance** | | **Examplar System** | **Typical Service Life (years)** |
| | | **Q1** | **Q3** | | |
| **Enclosure** | Window to Wall Ratio | 60% | 25% building | Generally punched windows with some curtain-wall | — |
| | Window R-value | 1.1 | 1.7 | Double glazed, air-filled IGU with aluminum frames | 25-35 |
| | Wall R-value | 2.3 | 9.7 | 1-2" of board insulation or batt insulation to interior | 25-50 |
| | Roof R-value | 4.5 | 9.7 | 1-2" of mostly continuous, rigid insulation | 25-30 |
| **Ventilation Systems** | Ventilation Heat Recovery | 38% | 60% | Central pressurized cooridors with suit-level exhaust. No heat recovery assumed in base case. | 15-20 |
| **Heat / Cool Systems** | Delivery system | See discussion | | 4-pipe fan-coil system with constant volume pumps and fans | 20-30** |
| | Cooling COP | 2 | 2 | Central centrifugal or scroll chiller with cooling towers on roof | 20-30 |
| | Heating COP | 0.70 | 0.93 | Central, standard efficiency gas-tired boiler | 20-30 |
| **User-driven Energy Use** | DHW flow rates & appliances | See discussion | | Typically upgraded fixtures & appliances, but to older standards | 10-15 |
| | Plugs & Lighting | 15 W/m² | | Some facilities have undergone lighting upgrades*** | 10-20 |

* *Heat recovery is not very common in MURBs that fit into Cluster 12, however, it is common to turn off ventilation systems, mimicking the effects of heat recovery.*

** *Active equipment (e.g. fans and pumps) losts 15-20 years, but ductwork and pipes can last 40-60 years*

*** *See discussion in the next section (i.e. 2.3) about occupant-driven energy and its importance to achieving cost-effective emissions reductions.*

This information helps to identify what, when and how systems may be upgraded or replaced over the next several decades. While these opportunities will be crucial for the achievement of significant emissions reductions, it is important to note here that MURB and larger commercial building capital plans tend to focus primarily on minimizing lifecycle costs of system maintenance, and not on emissions reductions. Longer term capital planning and regular maintenance is not at all common in smaller commercial buildings or single-family homes, meaning that replacement often takes the form of emergency “like-for-like” or only slight improvements in efficiency. In all building types, investment in large capital expenditures such as recladding or major HVAC upgrades is typically avoided unless absolutely necessary and occur at a small number of major milestones throughout the building’s overall service life (i.e. at 15 to 40-year intervals, depending on the facility and sub-systems in question).

**Meaningful integration of GHG reduction measures into capital planning is therefore a challenging but critical feature of successful decarbonization projects, in order to maximize synergies, reduce disruption, and lower the cost of upgrades to building owners, operators and occupants.**

## 2.3 Reducing Toronto's Emissions

With the building sector broken down and its broad emissions profile understood, this section now turns to an exploration of the measures that can be used to reduce those emissions and achieve the City of Toronto’s target of net zero emissions by 2050. With 32 clusters mapped on to nine prototypical facilities for capital cost analysis, enough detail exists in the baseline data to analyze the energy savings by fuel and associated GHG, capital and energy cost implications of important decarbonization measures for Toronto’s building stock. This approach also allows an exploration of the *systemic* (i.e. interconnected and interactive) effects of combinations (or *packages*) of measures on overall GHG emissions reductions, as well as implications for cost and capital planning.

### 2.3.1 System-level Actions

Key categories of retrofit measures that can (and likely will need to be) implemented in Toronto’s buildings can be classified under five key systems:

1. User-driven loads and occupancy-based controls
2. Enclosure
3. HVAC Delivery
4. HVAC Plant
5. Renewable Electricity

Within each of these five categories, specific actions can be taken that align with varying degrees of effort and resultant impact on reducing emissions:

- **Level 1** represents a minimum level of investment
- **Level 2** represents a level of improvement equivalent to typical new construction
- **Level 3** represents a “best in class” and most aggressive investment in performance that can be made for a given system based on market-ready technology and know-how

Each of the five systems and the three associated levels of effort are described below, including their broad implications for both cost and emission reductions.

#### User-driven loads and occupancy-based controls

This category refers to the equipment and processes primarily under the operation and control of facility occupants/users, and includes lighting, appliances, computer equipment, process ventilation, and other similar functions. It also includes measures that relate to users’ ability to control the comfort and energy service requirements of their spaces (i.e. ventilation, thermal comfort and humidity). Levels of effort for these kinds of upgrades for each major building type are presented in Table 2.

Overall, these user-driven measures are easy to install and implement while the facility is occupied. Most of the savings are related to electricity use in a facility, which often places them high on the list of “low-hanging fruit” in energy audits. Re-commissioning in particular is broadly understood to be a best practice across the MURB and ICI sectors, and offers very good value for money, especially in large ICI facilities with complex HVAC distribution and central plant systems. However, lighting and zonal appliance/equipment improvements do not always translate into reduced emissions, since more efficient lighting produces less waste heat, increasing the overall heating load.

**Table 2: Levels of effort for user-drive loads and occupancy-based controls**

| Sub-System | Effort | SFH | MURB | Low-rise ICI | High-rise ICI |
|---|---|---|---|---|---|
| **Lighting** | 1 | Re-lamp with equivalent LEDs | | | |
| | 2 | LED fixtures and occupancy-based controls | | | |
| | 3 | — | — | Daylighting controls, where relevant | |
| **Appliances & Equipement** | 1 | Energy Star appliances | | Sector-specific, but Energy Star equivalent equipment selection (e.g. low-flow fume hoods, office equipment, etc) | |
| | 2 | Top 10% of Energy Star appliances | | Energy recovery from equipment where common (e.g. refrigerated casework in grocery stores, pool dehumidification & heating integration, etc.) | |
| | 3 | Select appliances that reduce need for penetrations and supplementary ventilation (high-spin front load washers + heat pumps dryers, etc.) | | Maximym energy recovery from equiprment where feasible (e.g. process exhaust in laboratories and kitchens, etc.) | |
| **Occupancy-based Controls** | 1 | Smart thermostats including remote sensors | | Upgrade BAS to include, integrate and use occupancy information | |
| | 2 | Variable-speed furnace with ultra-low fan speed | | Variable-speed pumps and fans and Commissioning/ Re-commissioning of equipment and distribution systems | |
| | 3 | — | — | — | Dynamic reset of HVAC systems based on facility-wide occupancy tracking |

### System-Level Best Practices

The most important systemic benefit of investing in user-driven loads and occupancy-based optimization is that they are the most cost-effective way to improve energy use, making it prudent to include these measures in any package of upgrades (where possible and practical). Indeed, because of their practicality and cost-effectiveness, the minimum level of investment in these measures is likely to be included into the capital plans of most facilities. **As such, user-driven and occupancy-based measures have not been directly considered in this study, as they represent a likely starting point from which most facilities would engage in further upgrades.**

Engagement with occupants to accept, properly use and enable the full potential of these measures is very important to their success and such engagement can realize broader systemic benefits, including enhanced awareness on the part of occupants about how their activities can affect energy use in other venues in their lives (e.g. at home, at the office, etc.).

## Case Study: Benefits/ drawbacks of LED lighting with and without heat pumps

The implications of user-driven measures can be illustrated by considering the interplay between LED lighting upgrades and fuel switching. This example shows the annual emissions associated with a deep retrofit project in Ontario where all parameters were fixed – except the presence of an LED lighting retrofit (Low lighting power density (LPD) vs. High LPD) and ground source heat pump retrofit (GSHP vs. Boiler).

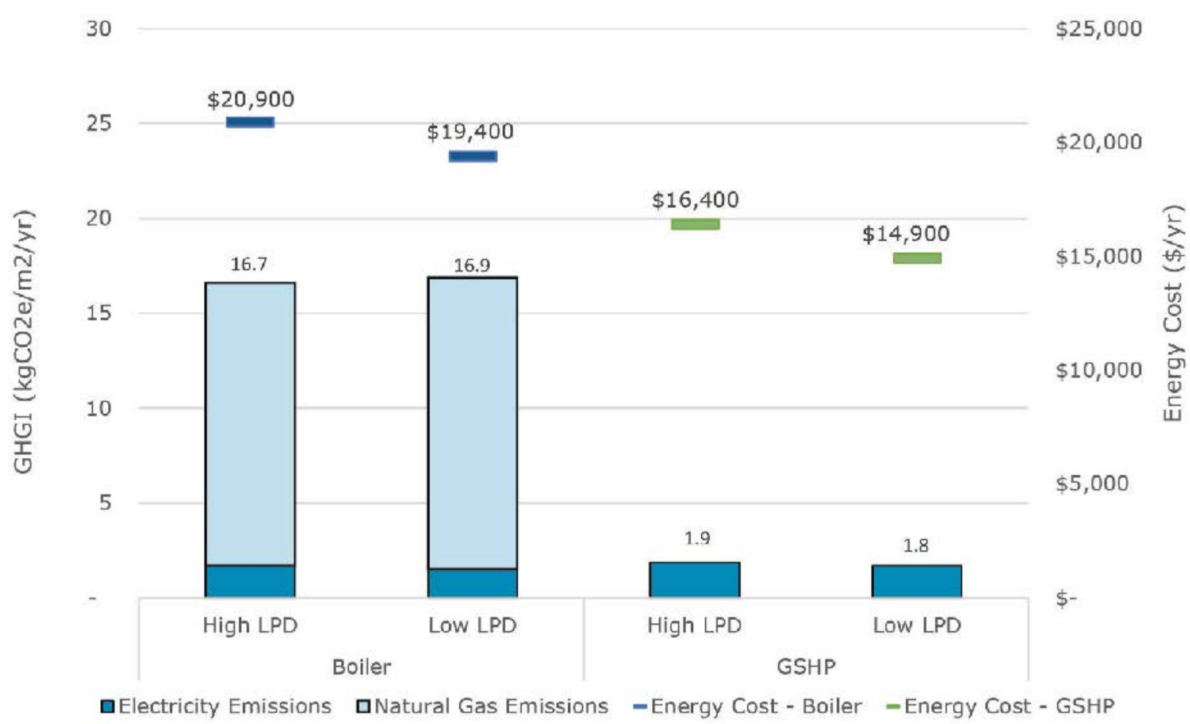



**Figure 10: Comparison of annual GHG emission intensity and energy cost savings for LED and GSHP retrofit**

In addition to demonstrating the importance of heat pumps at reducing emissions, the figure above shows that despite contributing to a similar cost savings, a decrease of lighting energy marginally increases emissions when a boiler is present. This result is a bit confusing, since a reduction in lighting energy would suggest a savings in electrical energy and therefore a reduction in emissions from electricity.

The explanation lies in the impact of lighting energy on zone heating loads. Heating loads go up in the low-LPD case because the higher efficiency lights contribute less heat to the space. When that higher load is met by a boiler burning high-emissions natural gas, net emissions go up. When the same load is met by the GSHP, emissions go down, since the GSHP is much more carbon-efficient at meeting the heating load.

## Enclosure

The enclosure refers to the systems that separate the occupied space from the outdoors, notably the opaque walls and exposed floors, roofs and windows/skylights. Below-grade systems are also important, but not specifically addressed in this study with the exception of single-family homes (see Appendix A for single-family home foundation recommendations). Levels of effort for enclosure upgrades for each major building types are presented in Table 3.

**Table 3: Levels of effort for enclosure upgrades**

| Sub-System | Effort | SFH | MURB | Low-rise ICI | High-rise ICI |
|---|---|---|---|---|---|
| **Walls** | 1 (R-10) | Fill cavities and air-seal without disrupting finish | Upgrade walls from the inside, avoiding condensation risk | New insulation in interior walls with air sealing | |
| | 2 (R-10) | Replace interior OR exterior wall finish, new framing | Reclad or over-clad building with additional insulation | Re-clad exterior walls + additional insulation and sealing | |
| | 3 (R-10) | Replace interior AND exterior wall finish, new framing | Reclad building with significant additional insulation | — | |
| **Roof** | 1 | Blow-in/insulate cavity (R-20 to 40) | Maximum insulation without change to parapets (R-15 to 20) | | |
| | 2 | Blow-in/insulate more + air sealing (R-30 to 50) | Maximum feasible roof insulation, affecting parapets (R-30 to 40) | | |
| | 3 | Blow-in/insulate most + best air sealing (R-40 to 60) | — | | |
| **Windows** | 1 | Best double glazed, low-e t+ argon gas Improved vinyl frames | Best double glazed, low-e + argon Improved aluminum frames (e.g. >13 mm thermal break) | | |
| | 2 | Best triple glazed, low-e + argon gas Improved vinyl frames | Best triple glazed, low-e + argon Best aluminum frames (e.g. >19 mm thermal break) or fiberglass frames | | |

One critical feature of all enclosure upgrades is their impact on infiltration. In most enclosure types, reductions in air leakage can be achieved both through replacement of various components (e.g. during window replacement) or as a stand-alone activity (e.g. when windows are sealed from the inside using caulking). This study does not explore the cost/benefit of separate air sealing activities; instead, all air sealing is included proportionately in other enclosure upgrades. However, it should be noted that air sealing and airtightness testing are both low-cost but effective means of reducing building emissions. Both Part 3 and Part 9 buildings have air sealing targets to strive for based on the best practice performance from the new construction industry.

Another important consideration borrowed from the new construction sector is properly accounting for thermal bridging in overall enclosure performance. The effect of point and linear thermal bridges is much more severe in commercial high-rise construction and in projects with significant curtain wall or storefront glass areas. While single-family and low-rise commercial facilities generally tend to fair better, all deep retrofits that include wall upgrades should consider thermal bridging impacts, following best practice guidelines offered by Passive House standards (e.g. EnerPHit)[xix] and consistent with the TGS v3.[xx]



### System-Level Best Practices

As enclosures improve (in commercial buildings especially), cooling loads can become dominant, motivating action to reduce Cooling Energy Demand Intensity (CEDI) in a commensurate manner to heating (i.e. Thermal Energy Demand Intensity, or TEDI). While a significant portion of cooling loads come from internal gains, the majority come from solar gains through windows. Many existing buildings offer more modest window to wall ratios than their newer counterparts, making it easier to address cooling energy through TEDI-aligned actions, such as selecting the right solar heat gain coefficient (SHGC) in new, high-performance windows and connecting 24/7 cooling equipment to heat pump systems that also serve ventilation and domestic hot water preheat. Other ways to reduce incoming solar gains include appropriately shading windows using overhangs, louvers, balconies, or other external shading devices.

As part of this study, analysis was completed to evaluate the benefit of considering embodied emissions reductions in enclosure retrofits by including thermodynamically and building science equivalent carbon-storing, bio-based materials instead of traditional construction materials (e.g. cellulose insulation instead of mineral fibre or fibre glass). **As evident already in the growing literature from the new construction sector, this materials-conscious approach to deep retrofit design will be an important feature of projects that invest significantly in enclosure upgrades and fuel switching.**[xxi] Further discussion on this feature of the analysis is included in Section 2.4.3 as well as in **Appendix A.**

**Case Study: Comparing the benefits of new construction (NC) vs. existing building (EB) embodied carbon materials**

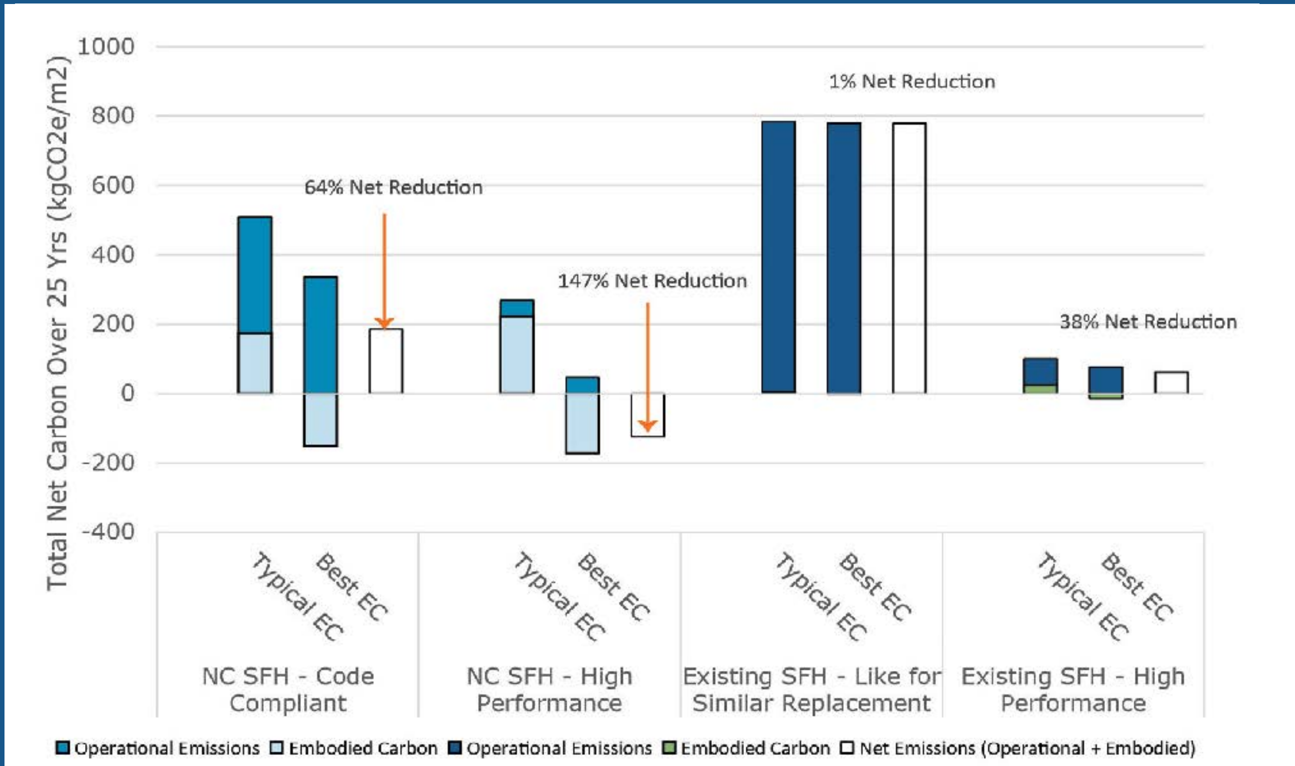



**Figure 11: Comparison of operational and embodied emissions in new construction and existing building**

Work in the new construction sector that examined the potential for embodied carbon storage opportunities of building materials for residential new construction shows two cases for embodied carbon improvement potential (as shown in the left two sets of bars above in grey): 1) a code compliant case that uses a gas furnace and 2) one with efficiency improvements and an electric heat pump.[xxii] Because of the importance of embodied carbon to new construction, the improved cases show a 64% and 147% (i.e. net storage potential) reduction over a 25-year period of operation.

A similar comparison was completed for existing residential retrofits for this Strategy (see the two sets of blue bars to the right of the graph). Retrofit projects do not include as significant an investment in new materials, resulting in only a 1% improvement for a “Like For Similar” upgrade, and up to a 38% reduction for a case with significant investment in enclosure upgrades and electric heat pump. A similar comparison could be made for the MURB sector, but with an even more prominent difference in benefit between new construction and existing building cases.

Despite the reduced benefit of low embodied carbon material choices for existing buildings when compared to new construction, significant benefit still exists – especially in deep retrofits that include fuel switching. The implications city-wide for such action is discussed further in Section 2.4.3 and in **Appendix A**. Policy recommendations related to low embodied choices, in the residential sector especially, are included in Section 4.

### HVAC Delivery

HVAC delivery systems connect a building's space (and its users) to the energy transformation systems that are typically stored either centrally or outside. These systems benefit from occupant-sensitive controls (as discussed above), but can also be designed to consider opportunities for energy/heat recovery and reduced work by central equipment. The concept of near-temp system design is discussed further below, but can be simply interpreted as heating systems that permit cooler delivery temperatures – i.e. those that allow for heat pumps to be more effective at their job in the winter months. Levels of effort for HVAC upgrades for each major building type are presented in Table 4.

While HVAC delivery approaches are arranged by "effort" in Table 4, it is actually more appropriate to recommend: (a) adding heat recovery, (b) achieving low fan and pump power, and (c) enabling near-temp heating/cooling with the least impact to existing piping and ductwork (unless a significant retrofit of these systems are already needed). The concepts of Dedicated Outdoor Air Systems (DOAS) and zonal delivery are prominent, since they often allow for this result with few drawbacks. These configurations also reduce roof-mounted equipment, improving equipment service life, enhancing

**Table 4: Levels of effort for HVAC upgrades**

| Sub-System | Effort | SFH | MURB | Low-rise ICI | High-rise ICI |
|---|---|---|---|---|---|
| **Heat (HRV) and Energy (ERV) Recovery from Ventilation** | 1 | HRV added when facility airtightness is increased | Add HRVs/ERVs to suites when recladding and air-sealing suites | Improved RTUs with built-in HRV (>50% effective) | Add variable-flow energy recovery to existing HVAC delivery |
| | 2 | Replace bathroom fans with ERVs | Partially centralized ERVs with staged flow and occupancy control | Dedicated Outdoor Air System (DOAS) with HRV (>60% effective) | DOAS with HRV as part of like-for-similar delivery upgrade per below |
| | 3 | — | Fully ducted, centralized ERVs with variable flow | Variable air volume (VAV) Dedicated Outdoor Air System (DOAS) with ERV (>75% effective) | Oversized, VAV DOAS with ERV with new distributed delivery system per Level 3 below |
| **Variable-speed, Near-temp System Configurations** | 1 | Single, centrally-ducted system with zonal controls | One variable-speed 4-pipe fan-coil or heat pump per suite | Improved Roof-top Units (RTU) with true variable-flow | Smart upgrade of existing delivery systems to maximize variable flow |
| | 2 | Multiple, interconnected units serving upper and lower floors | Separate heating and cooling systems with variable flow and large radiative surfaces | Separate DOAS and/or larger radiative surface perimeter heating system | Transform existing systems to zonal or near-zonal delivery with VAV DOAS |
| | 3 | — | Reconfigure HVAC systems to have DOAS and zonal delivery systems | VAV DOAS + Variable refrigerant flow (VRF) or similar allowing for interconnection between zones and systems | VAV DOAS + fully zonal delivery with large radiative surfaces |

resilience to extreme weather, and offering more roof real estate for renewable energy from PV. That said, DOAS/zonal approaches can involve significant (and potentially costly) changes to existing systems (i.e. ease of installation) and can negatively impact the free cooling benefits of larger central and roof-mounted equipment. **Combined with modeling-supported life-cycle cost analysis, ensuring an excellent understanding of existing equipment service life is the best way to evaluate the nuances of different HVAC configurations in a deep retrofit, especially for more complex buildings (i.e. large MURBs and ICI facilities).**

### System-Level Best Practices

As noted above, variable-speed, near-temp delivery allows the HVAC systems to take full advantage of the benefits of occupant-based controls and heat pump systems. The biggest challenge of implementing these approaches in larger buildings with high-temp heating systems is the cost of retrofitting existing piping and ductwork systems to achieve the lower temperature delivery required. Load reductions can help to avoid the need for these costly changes and should be investigated for this purpose. There are also new heat pump technologies nearing market readiness in Canada that will enable higher temperature delivery, adding flexibility to this challenging part of deep retrofit design.[xxiii]

The most important systemic consideration associated with upgrading HVAC delivery systems is overlapping them with other planned facility renewal, including enclosure upgrades (see the case study in Section 4.3). The following are examples of how this overlap can play out in different sectors:

- **SFH:** Air sealing can necessitate the installation of ERVs/HRVs for ventilation
- **MURB:** in-suite ERVs align well with recladding projects
- **Low-Rise ICI:** New HVAC configurations overlap with roof replacement
- **High-Rise ICI:** Zonal system refurbishments (including enclosure upgrades) align with tenant turn-over (or night activities) can result in reclaimed space from HVAC.

### HVAC Plant

The purpose of the HVAC plant is to transform energy from utilities (i.e. electricity and natural gas) into forms useful for heating and cooling. This work is typically done by separate pieces of equipment in larger buildings (i.e. boilers and chillers) and distributed to delivery devices. In smaller low-rise buildings, roof spaces and back yards are used to store packaged equipment or split systems (i.e. furnaces with remote A/C or rooftop-units). In large buildings, the opportunity for energy recovery at the plant is also important to explore, since simultaneous needs for heating and cooling can be more easily centralized and served by a common heat pump plant, improving the system's effectiveness at delivering both services. Levels of effort for HVAC plant upgrades for each major building type are presented in Table 5

**Table 5: Levels of effort for HVAC plant upgrades**

<table>
<tr><th>Sub-System</th><th>Effort</th><th>SFH</th><th>MURB</th><th>Low-rise ICI</th><th>High-rise ICI</th></tr>
<tr><td rowspan="3">Fuel Switching</td><td>1</td><td>Switch AC or add heat pump with condensing gas-fired back-up furnace</td><td>Add balcony-mounted heat pumps or replace central chiller with heat pump</td><td>Heat pump roof-top with gas-fired back-up or maintain perimeter heat</td><td>Heat recovery chiller system serves 20-40% of heat needs</td></tr>
<tr><td>2</td><td>Cold climate air-source heat pump for all heating, cooling and domestic hot water (DHW)</td><td>Distributed low-ambient heat pumps or full central heat pump replacing boilers, chillers and DHW</td><td>Cold climate ASHP system (e.g. VRF)</td><td>Full central, cold climate ASHP system that minimizes need for natural gas back-up</td></tr>
<tr><td>3</td><td>Ground-source heat pump</td><td>Distributed or centralized ground-source heat pumps</td><td>Ground-source heat pump System (e.g. VRF + ground heat exchanger)</td><td>Full, central ground source heat pump system OR central biomass heating</td></tr>
<tr><td rowspan="3">Energy Recovery</td><td>1</td><td colspan="2">—</td><td colspan="2">IT cooling loads collected together and connected to centralized equipment</td></tr>
<tr><td>2</td><td colspan="2">Drain water heat recovery as preheat to centralized heating or domestic hot water</td><td colspan="2">Special heat recovery systems especially for large, distributed cooling loads (e.g. dehumidification in food stores or museums)</td></tr>
<tr><td>3</td><td colspan="4">Solar hot water as pre-heat, especially for highly glazed buildings with larger than normal heating loads or large domestic hot water loads.</td></tr>
</table>

Given the site-specific nature of energy recovery options, none have been studied in detail in the quantitative analysis prepared for this study. That said, these approaches can yield important cost saving benefits when the goal is to fully decarbonize heating on site.

In many downtown facilities, fuel switching can be more challenging due to limited site and roof areas for the installation of geo-exchange or additional fluid coolers. Fortunately, opportunities do exist for many of these facilities to connect to low emissions central plants or energy sharing nodes. The City has begun to support and promote activities of this type through a variety of programs[5].

An additional challenge with fuel switching to heat pumps is their inability to generate high temperature hot water, as discussed above. This can be a challenge for process heating requirements in large industrial facilities, but a mixed/series-connected system involving heat pump pre-heat and top up with either gas-fired or electric resistance heating is common in most buildings. For this reason, the analysis has left a residual amount of heating from natural gas in the overall inventory (discussed below) reflective of the likely need for high-temperature heating, especially in the short and medium term.

#### System-Level Best Practices

**The discussion on load reduction and near-temp system design above contributes to the critical goal of reducing the electricity demand and overall capacity of fuel switching equipment.** A few important motivations for focusing on load reductions include the following:

- Beyond the cost savings associated with reusing piping and ductwork, the best place to save money in holistic, building-wide deep retrofits is by reducing the number of pieces of HVAC plant equipment required
- Removing the need for a full stage/piece of large equipment can also save space, which can then be used to enhance equipment modularity, enhance resilience with back-up systems, or be converted to occupied space
- Likewise, when fuel-switching is site-constrained, greater load reductions enable a larger share of on-site systems to serve decarbonization goals or make it easier for other facilities to share the same (likely more expensive) decarbonized central energy being generated at an adjacent facility
- Peak electricity demand from heating (and cooling) equipment can be significantly reduced (see further discussion in Section 2.4.7).

5 https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/district-energy/

## Case Study: An example of load reductions with heat pumps

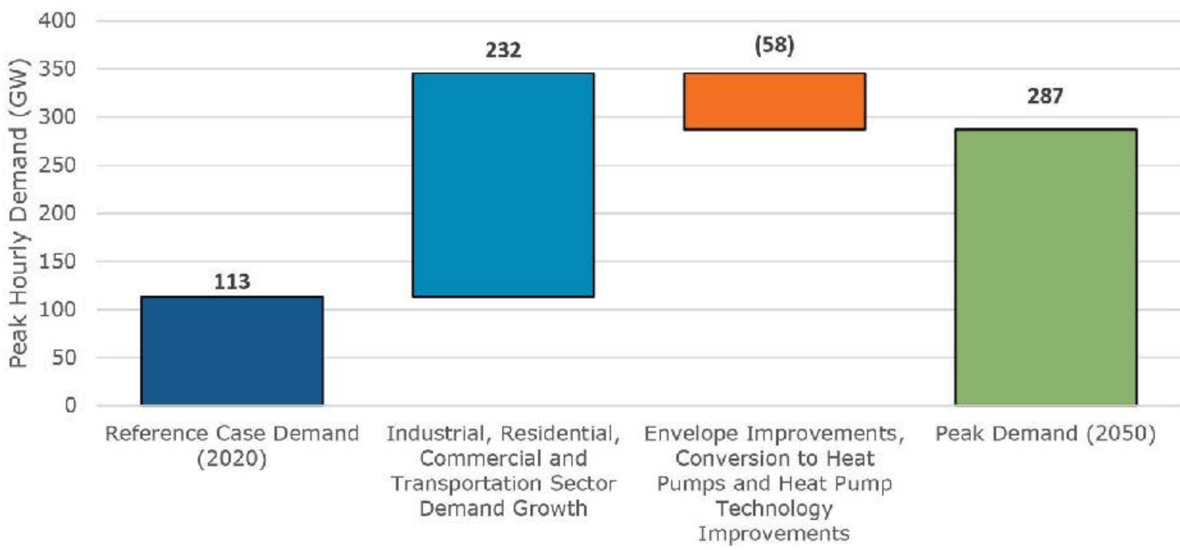



**Figure 12: Impact of total electrification to peak hourly demand of Canadian electricity grid**

The broad implications of fuel-switching on electricity grids in Canada has been examined in two recent studies. A 2019 study commissioned by the Canadian Gas Association (CGA) and ICF on electrification in Canada estimated a significant peak hourly demand impact for a total electrification scenario (peak hourly demand estimated to more than double). However, the report estimated that by using building envelope improvements, electric resistance heating conversion to ASHPs, and improvements in ASHP performance over time, this peak demand growth could be mitigated by approximately 25% (58 GW/232 GW).

In the analysis conducted for this Strategy, load reductions could support even further reductions (e.g. up to 50% sector-wide, per discussion in Section 2.4.7), indicating the need for more site-specific study of the potential of load reductions to benefit peak demand.

Furthermore, as GSHPs were not considered in the CGA/ICF study, a follow-up 2020 study completed by the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) and Dunsky concluded that GSHPs can have a significant peak load reduction benefit compared to ASHPs. As an example, for the City of Toronto the study estimated that GSHP peak load benefits would range from >10% less peak load compared to an ASHP (for MURB/large commercial buildings), up to >50% for single family homes and small commercial buildings, respectively.

### Renewable Electricity

On-site generation of renewable electricity, heating energy and cooling energy can significantly benefit the broader grid and neighbourhood-scale need for zero emissions energy sources. Demand response technologies allow for the peak loads/demand to be managed or smoothed out so that renewable resources can be stored and more effectively dispatched when needed. Levels of effort for adding on-site renewable energy generation and storage for each major building type are presented in Table 6.

**Table 6: Levels of effort for on-site generation of renewable electricity**

<table>
<tr><th>Sub-System</th><th>Effort</th><th>SFH</th><th>MURB</th><th>Low-rise ICI</th><th>High-rise ICI</th></tr>
<tr><td rowspan="3">Photovoltaics (PV)</td><td>1</td><td colspan="4">Roof-mounted -fixed PV systems, racked or ballasted, angle not optimized (~50% of roof area covered)</td></tr>
<tr><td>2</td><td>—</td><td colspan="2">Maximum roof-mounted design, including additional racking and/or minimizing roof-mounted HVAC systems</td><td>—</td></tr>
<tr><td>3</td><td>Roofing-integrated PV systems</td><td colspan="2">Parking shelter/awning systems</td><td>Façade-integrated PV systems</td></tr>
<tr><td rowspan="3">Zero / Low Emissions Co-generation</td><td>1</td><td rowspan="3">—</td><td colspan="3">Where appropriate, consider a connection to central energy nodes instead of installing on-site zero-emission plant equipment</td></tr>
<tr><td>2</td><td colspan="2" rowspan="2">—</td><td>Zero-emission co-gen should be investigated to overlap high-temp heating and back-up requirements</td></tr>
<tr><td>3</td><td>Where prudent for on-site reasons, consider expanding the size of zero-emission co-gen to support adjacent facilities.</td></tr>
<tr><td rowspan="3">Demand Response (DR) & Thermal Storage</td><td>1</td><td colspan="3">Thermostats that allow for remote control and DR setback</td><td>BAS with DR-ready capability</td></tr>
<tr><td>2</td><td colspan="4">Battery storage and DR systems that align with smart charging technologies for electric vehicles (see below)</td></tr>
<tr><td>3</td><td>—</td><td colspan="3">Thermal storage to balance heating and cooling diurnally and seasonally and improve efficiency and peak demand of both heating and cooling energy services</td></tr>
</table>

Renewable energy (especially PV) can reduce operating costs and is low maintenance. As with user-driven loads, adding PV to projects can help to significantly improve the business case of long-term energy investments. That said, given the site-specific nature and limited scope of the analysis, this study does not analyze renewable generation or demand response options other than Level 1 roof-mounted solar PV.

As mentioned above, there are many central plant development projects on-going across the City and zero/low emissions co-generation options fit directly in that class of development as well. **Facilities investing in significant redevelopment located in the city's downtown or other high-intensity areas should fully explore zero / low-emissions co-generation and district energy node opportunities before implementing fuel switching and renewable energy strategies.**



**System-Level Best Practices**

Renewable electricity generation coupled with demand response is generally accepted as being a required pairing in the long-term planning of zero emissions electricity grids, including in Ontario. Facility-level action will be needed, especially in large facilities already subject to demand-based pricing (i.e. Class A customers). Further discussion on this topic is included in Section 2.4.3.

In the context of broader decarbonization goals for the City of Toronto, it is important to note that fuel switching is not only required for buildings, but vehicles as well. Though charging infrastructure for vehicles is not yet readily available, when it is, the cost-effectiveness of fuel switching in that sector will be much better than the case for buildings under current energy pricing (i.e. electric vehicles are much cheaper to operate than gas vehicles as compared to same situation in buildings, which typically cost more to operate when fuel switched). This tension sets up an important systemic opportunity for many buildings to capitalize on. Installing smart charging infrastructure can overlap with the desire for demand management that comes from building system improvements (e.g. PV, fuel switching, battery storage, etc.). Where these changes are planned together, some of the business case for electrification of vehicles can be tied into the business case for building improvements, creating a stronger overall case for both. If incentives are also flowing to vehicle charging infrastructure projects in the near term, the case becomes even more attractive.

### 2.3.2 Facility-level Actions

Many of the system-level actions (and associated levels of improvement) described above were customized and analyzed for the nine focal and 32 overall facility clusters. The individual measures were then combined into six upgrade packages of measures designed to highlight and study different approaches to achieving deep emissions reductions and associated co-benefits. The high-level description of the six packages is provided in Figure 13. A modified package was also later developed, which applies a full fuel switch of heating and domestic hot water only (without any enclosure or other load improvements). This package is used for newer facilities and to understand the relative cost and importance of fuel switching on its own as compared to packaged upgrades.

| | |
|---|---|
| Like-for-Similar (LFS) | • Aligning targeted measure-level improvements with systems and equipment that are expected to require replacement in a 30-year window of service life (windows and roof)<br>• Captured in typical 30-year capital plans (where applicable) |
| LFS + Easy Fuel Switch (LFS+FS1) | • Start with Like-for-similar, add 1 or 2 (max) other measures/improvements (approx. Level 1 enclosure)<br>• Implement level 1 fuel switch (with gas support/backup) |
| LFS + Full Fuel Switch (LFS+FS2) | • Start with Like-for-similar, add 1 or 2 (max) other measures/improvements (approx. Level 1 enclosure)<br>• Level 2 Fuel Switch (i.e. cold climate ASHP, minimal gas backup required)<br>• DHW fuel switch (ASHP) |
| Fuel Switch Ready (FSR) | • Enclosure improvements and upgrades needed to ready the facility for future fuel switching<br>• Level 2 HVAC delivery upgrades, including heat recovery |
| Zero Carbon Ready (ZCR) | • Start with Fuel Switch Ready<br>• Implement level 2 fuel switch (cold climate, minimal gas back up required) including DHW fuel switch |
| Max Site Potential (MAX | • Level 3 enclosure upgrades (maximum)<br>• Best HVAC upgrades<br>• Fuel switch with geo-exchange, including DHW fuel switch |

**Figure 13: Description of six primary packages of measures**

**Package Performance: GHG Reduction Potential**

These different packages of measures were used to explore and identify the possible pathways to achieving the City's target of net zero emissions by 2050. **It should be noted here that none of the packages can achieve zero emissions on site, given the emissions intensity of Ontario's electricity (see Section 2.4.2 for a sensitivity analysis of city-wide emissions reduction pathways)**. The motivations for these specific package definitions are presented below, with more details on the package exploration and definition process in **Appendix A**:

- Some packages were designed to represent a baseline of performance (*Like-for-Similar, or LFS*), to set bounds for maximum performance (*Max Site Potential*) or for specific facility types (e.g. full fuel-switch only). Though it is intended as a baseline, LFS represents not just a simple replacement with same, but a better level of performance (e.g. replacing single pane windows with double pane).
- The *Fuel Switch Ready* package is appropriate for those facilities that want to invest more significantly in their facility in general, but have recently upgraded central plant equipment, or are already connected to (or considering a connection to) a central plant that is planning to decarbonize.
- Progressive investment in fuel switching is likely to occur over time as the market matures and as regulations tighten. This may require building owners to consider a less costly fuel switch for immediate equipment change-over, while still planning for a longer-term transition to a full fuel switch.
- Regardless of the market, the *Level 1 fuel switch* is a reasonable level of achievement for building owners unable to afford more space or to invest in decarbonizing their entire heating system, but who are nevertheless seeking significant reductions aligned with planned replacement of existing cooling equipment.
- Not all buildings can achieve a Level 2 fuel switch with LFS levels of investment in enclosure (and other) upgrades. These will require more extensive investment in enclosure upgrades.
- The *Level 1 PV* (i.e. least-cost rooftop system) is shown as both included and excluded from packages at various points during the results summary to allow for PV to be understood on its own and as part of a package of upgrades.

The packages beyond LFS were also selected to meet or exceed two high-level reduction thresholds within each sector:

1. A minimum upgrade package performance of 50% reduction in GHG emissions, reflecting established best practice in retrofit activities, and
2. A near-net zero[6] pathway of at least an 80% reduction in GHG emissions, including a complete or near-complete fuel switch to electricity or other low-carbon fuel source for all but the highest-temperature heating requirements (e.g. high-pressure steam generation for industrial processes)

Package performance across the entire building stock using 2016 emission factors for electricity are shown in Figure 14, with details on variation across the major sectors shown in **Appendix A**.

6 See Section 3.3 and 3.4 for a discussion on going beyond 80% to net zero emissions in the building stock.

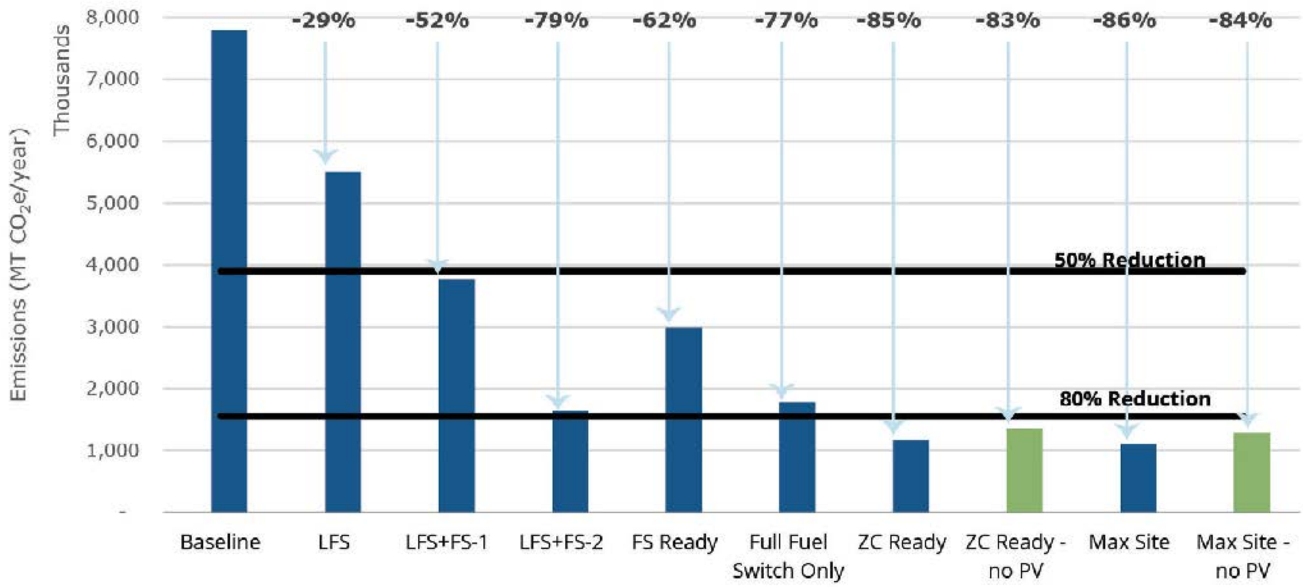



**Figure 14: Citywide emissions reductions by package**

Important performance insights derived from the packages include the following:

- ***Like-for-Similar is not enough.*** On average, LFS is a significant reduction, especially in the residential sector, but does not cross the 50% threshold.
- ***Fuel switching required for 80%.*** Though HVAC and enclosure upgrades can achieve significant improvements on their own, fuel switching is required to achieve the 80% threshold.
- ***Full Fuel Switch Only is almost at 80%.*** Full fuel switching on its own (without any enclosure upgrades) almost achieves an 80% reduction under current grid emission factors[7].
- ***Packages with a minimum "Like-for-Similar" enclosure upgrade can achieve 80%.*** All other packages that include at least a LFS level of upgrade and a full fuel switch result in an average of 80% reduction (i.e. LSF+FS-2, ZC Ready, Max Site).
- ***PV is material, but not significant.*** In a regime where grid emissions stay at or below current levels; however, this is not the current trajectory as discussed further in Section 2.4.2.
- ***Zero Carbon Ready and Max Site are very similar.*** The difference between the maximum site improvements and the ZC Ready package is not material. That said, some features of the max site (e.g. geo-exchange, enhanced heat recovery, triple glazed windows) may be appropriate in a large number of projects with suitable conditions.

7 As discussed above, note that some facilities cannot engage in a full fuel switch without some investment in load reduction. For these facilities, either a the LFS+FS2 or ZCR packages would be required to approach or exceed the 80% target.

**Package Intensity Performance: TEDI, TEUI, GHGI**

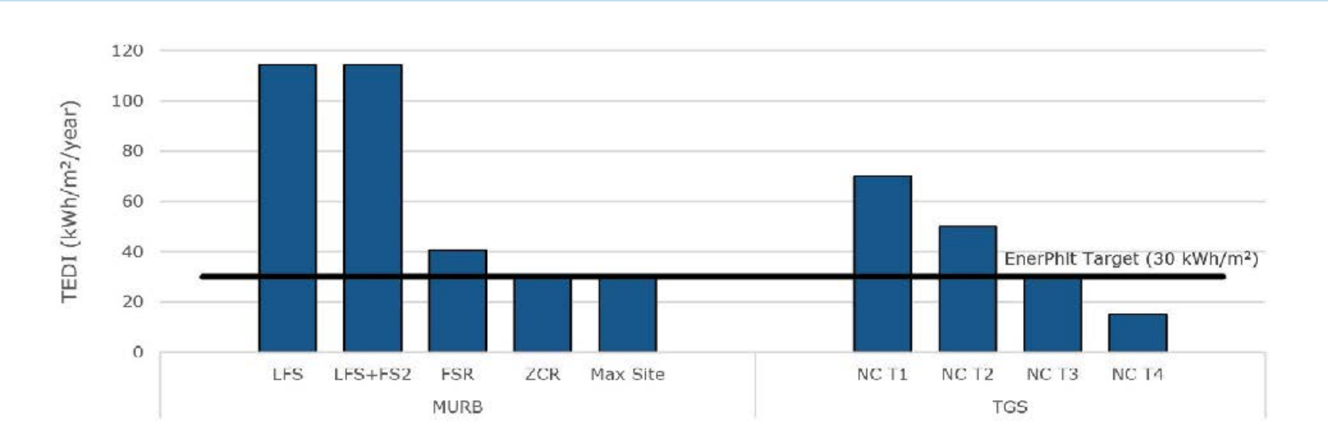



**Figure 15: Package TEDI Performance vs. TGS for MURBs**

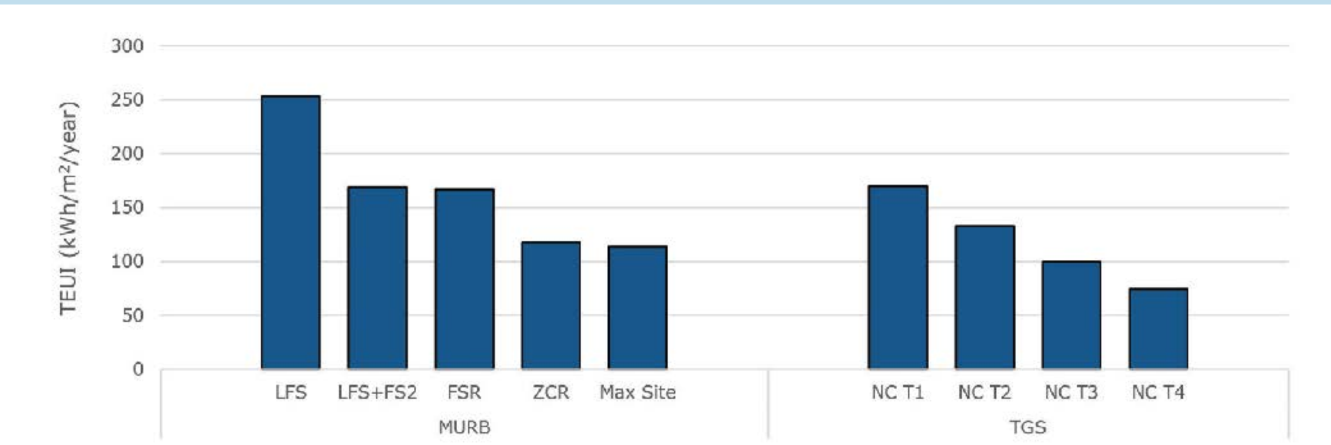



**Figure 16: Package TEUI Performance vs. TGS for MURBs**

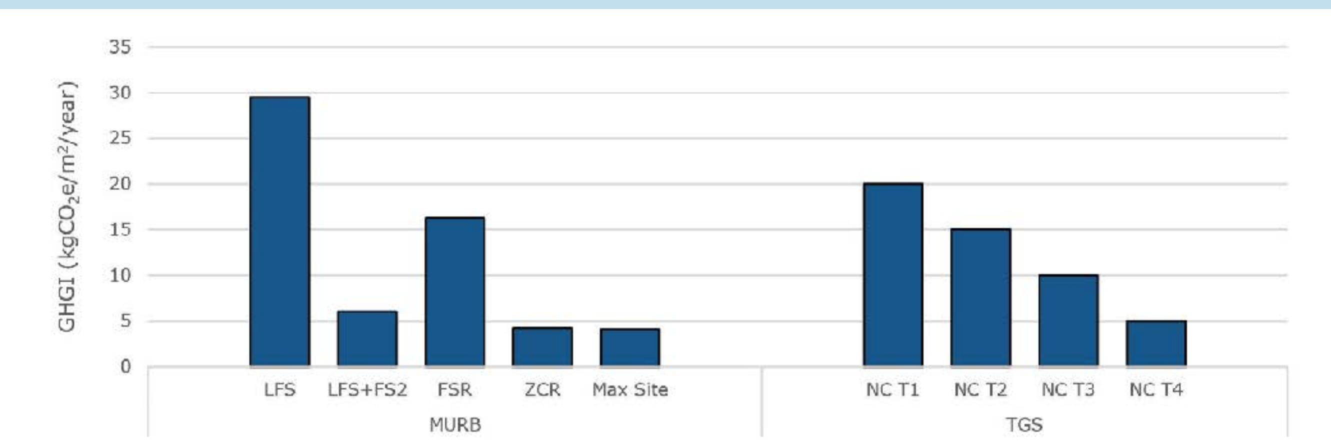



**Figure 17: Package GHGI Performance vs. TGS for MURBs**

Though the clustering process does not match up exactly with the archetypes used in TGS v3, it is still illustrative to compare the package-level results to the key TGS performance metrics for the aligned facility types. The comparison for MURB is included below, which shows the package performance of the LFS, LFS+FS2, FSR, ZCR and Max Site designs alongside their four performance thresholds for TGS v3 MURB. Details on other archetypes are provided in **Appendix A**.

In general, the TEDI and GHGI results are aligned with and on the same scale as new construction performance expectations, reflecting predictably lower performance in the existing building space than in new construction.

The best TEDI performance results (ZCR and Max Site packages) are in line with EnerPHit[xxiv]– the existing building version of the Passive House standard, considered one of the highest performance building standards in the world. This alignment mirrors the goal of TGS v3 to achieve Passive House levels of enclosure performance for the benefits of passive survivability, especially in MURB and SFH. More discussion of this important co-benefit is included in Section 2.4.6, below.

TEUI results are somewhat misaligned, as they do not include reductions in plug loads and lighting that are assumed as part of TGS v3. As discussed above, these load reductions have a mixed impact on GHG reduction, but can contribute significantly to energy cost savings.

**Package Performance – Capital, Life-cycle Cost and Life-cycle Cost per Tonne**

The LFS package represents a minimum or baseline performance because it reflects current industry standard action towards improved performance overlapping likely capital expenditures. It's also true that a "like-for-like" situation is not very likely, given existing (and accelerating) GHG mitigation policy and the relatively a-political view that some emissions reductions are required within the building industry over the next 30 years. Given these important assumptions, we present the LFS case as a baseline for net capital cost increase, incremental life-cycle cost (ILCC) and to calculate the combined metric of ILCC per Tonne of GHG reduced vs. business-as-planned.

These three metrics are each important for their own reasons:

- ***Capital is the main decision-making tool of the real-estate sector.*** Total capital (and even incremental capital) costs can far outweigh total energy costs for some measures, given the currently very low cost of energy in Ontario.
- ***Life-cycle cost reflects the total cost of ownership and the potential for investments to be cost-neutral over time.*** Life-cycle cost reflects the benefit of the longer service life of some technologies vs. others (e.g. for geo-exchange) and the benefit of energy cost payback (e.g. for PV).
- ***ILCC/tonne allows for decarbonization actions to be compared to one another across buildings and sectors.*** This important metric is becoming a standard reference for investment decisions across options for decarbonization, and in comparison, to the established cost of carbon.

Table 7 shows an example of the difference across the three cost effectiveness metrics for Cluster 12 (MURB, circa 1990, 50-200,000ft²). Similar results tables are provided for each focal cluster in **Appendix A**.

**Table 7: Comparision of costs for each package (MURB circa 1990, 50k - 200k ft²)**

| Package | Capital Cost ($/ft²) | Life-Cycle Cost ($/ft²) | ILCC/ tonne ($/tonne) |
|---|---|---|---|
| **LFS** | $30 | $78 | — |
| **LFS+FS-1** | $32 | $89 | 406 |
| **LFS+FS-2** | $37 | $87 | 172 |
| **FS Ready** | $47 | $84 | 183 |
| **ZC Ready** | $66 | $95 | 290 |
| **ZC Ready - no PV** | $63 | $96 | 326 |
| **Max Site** | $86 | $116 | 660 |
| **Max Site - w/o PV** | $84 | $118 | 704 |
| **Full Fuel Switch Only** | $17 | $78 | 3 |

What is evident immediately from this comparison table is how much capital costs vary between the different packages – ranging from $30/ft² to almost $90/ft². Although no packages offer life-cycle cost savings as compared to the LFS package, several packages are close to the $170/tonne cost of carbon now projected for 2030, indicating a potentially cost effective decarbonization investment.[xxv]

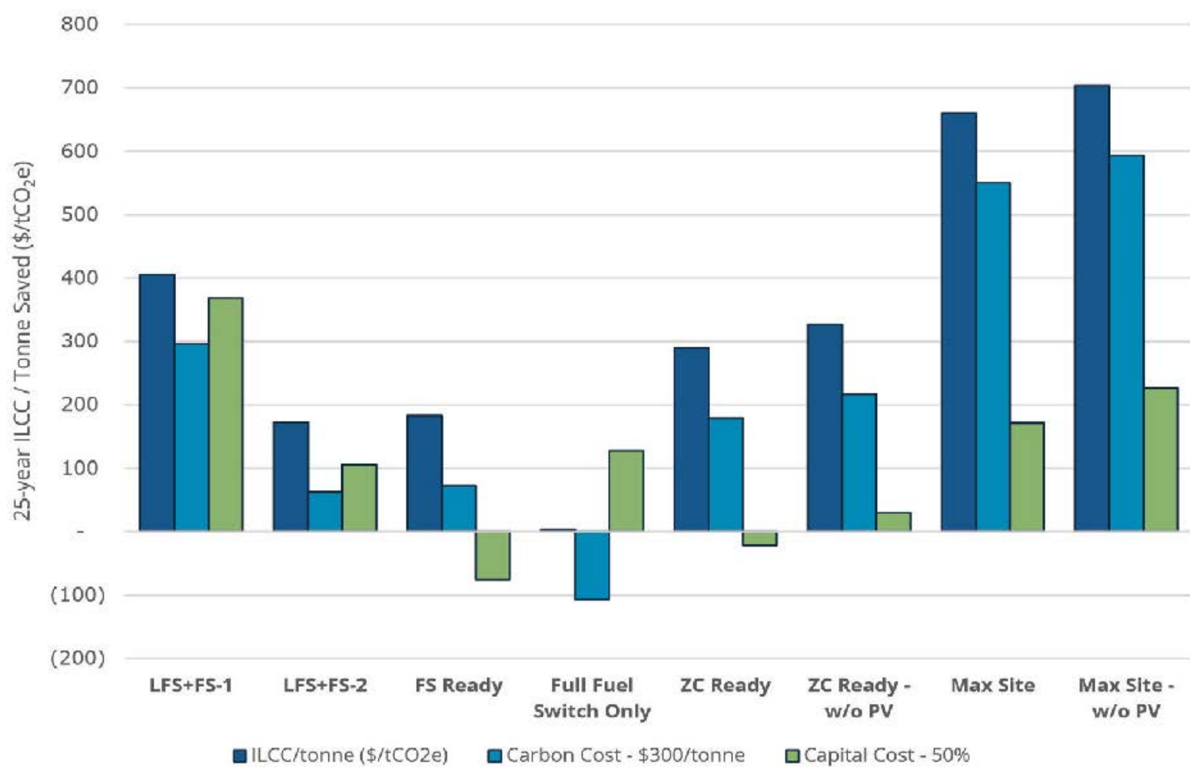



**Figure 18: Comparison of ILCC/tonne of different packages for focal cluster 12 with sensitivity to carbon cost and capital cost**

It is not the purpose of this work to delve deeply into the most cost-effective packages for each focal cluster – this package-level analysis is meant to highlight potential pathways towards zero carbon over time. A site-specific assessment is the best and perhaps the only way to reveal the most appropriate combination of decarbonization measures. That said, some useful insight about cost-effectiveness come from the Cluster 12 ILCC/tonne results as shown in Figure 18, which shows the ILCC/tonne results from Table 7 in solid blue with two sensitivity analyses:

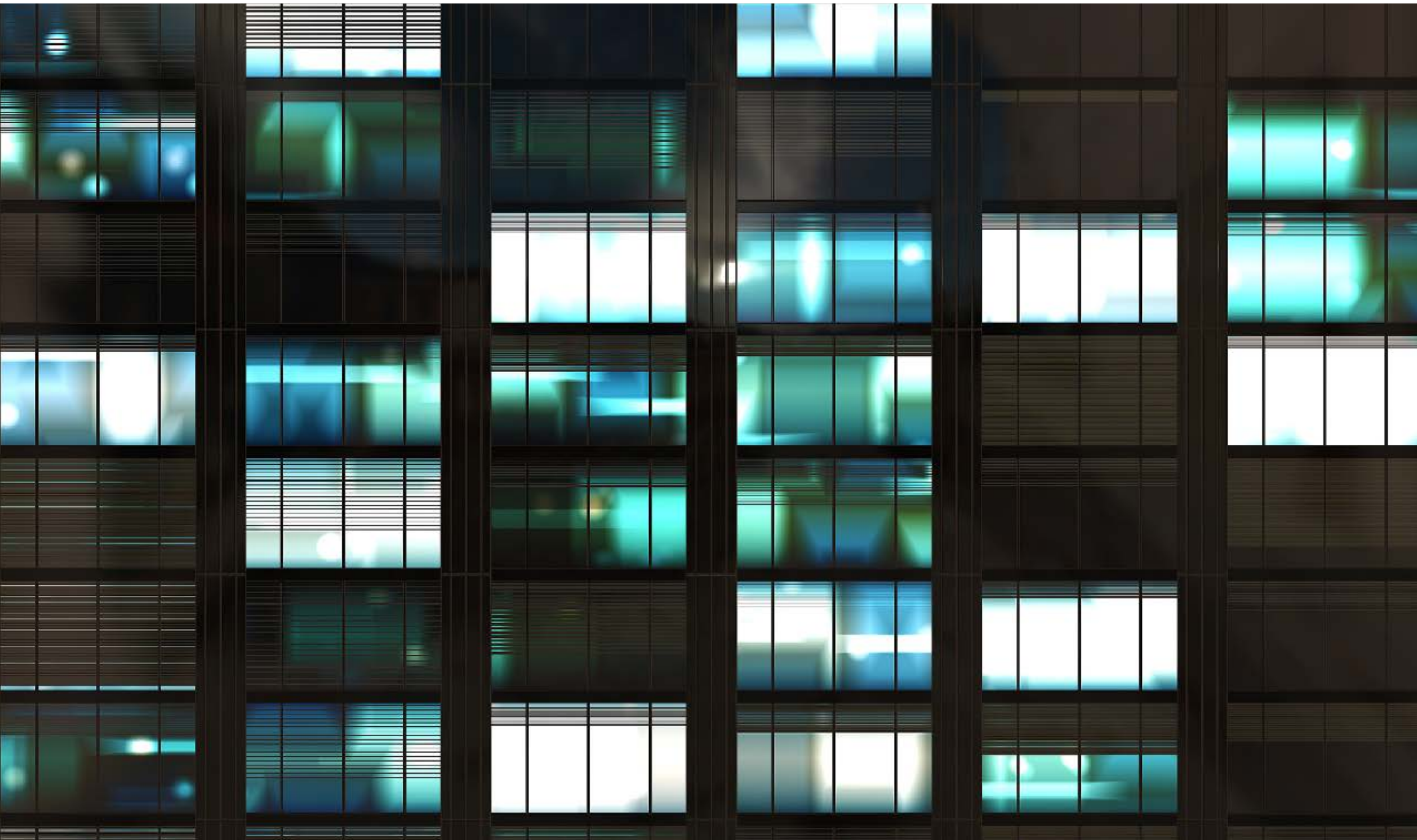
1. Doubling the average cost of carbon up to $300 between 2020 and 2050 (in hatched blue)
2. Reducing the capital cost of measures by 50%, including the LFS baseline (in striped blue)

A mirror of these results at the city-wide scale is presented in Section 2.4.5; however, this example cluster offers more detailed insights.

First, **changing these costs brings the more aggressive packages below a $300/tonne threshold**. For this example, at least, the $300/tonne threshold currently used by the Federal Government at the time of this study as a shadow price of carbon is delivered by all packages under one condition or the other. This result is not true for all focal clusters, but the trend is similar.

Second, **changing these factors can produce life-cycle cost negative (i.e. cost saving) results**. While the packages that achieve this result are different for each focal cluster (and for each sub-sector in aggregate), there is at least one package that achieves this result across all sectors. For Cluster 12, the FSR and ZCR packages become negative with a 50% cost reduction, while the full fuel switch crosses the line with a doubling of the cost of carbon.

Finally, **the cost of carbon benefits packages with fuel switching, while the capital cost benefits packages with more significant enclosure upgrades.** This feature may affect the kinds of incentives that are developed to promote action of one kind or another.



Producing these capital, life-cycle cost and ILCC/tonne results has resulted in several key observations of this work that are important to identify to provide the necessary perspective to adequately interpret the remainder of the analysis.

**1) The capital costs shown here are likely high.** Costs were generated by a cost consultant and compared to other similar projects, as well as checked against the broader experience of the project team. However, capital costs are still likely high due to the following reasons:

- HVAC capital cost reductions were accounted for, but potential benefit may be understated[8]
- Significant reductions in maintenance costs that can come from installing newer, part-load optimal systems have not been accounted for
- The capital cost of packages is the sum of measure-level costs, which may not reflect the benefit of aggregation across similar projects or within one larger project
- Reference projects were mostly studies, since very few data sets of costs for similar retrofit activities exist, particularly in the Toronto market

**2) Packages are by no means optimal.** As stated in Section 2.2 (and repeated above) the purpose of developing these packages was not to optimize each one, but rather to identify a set of distinct packages for each significant category of building that demonstrated the breadth and variation in GHG reduction potential, capital cost, cost-effectiveness and co-benefits/co-harms.

**3) Packages should be coupled with other utility cost savings measures to be more cost-effective.** This is already discussed above, but bears repeating – electricity and water cost savings measures that can be done at the same time as deeper investments in enclosure and fuel-switching result in incremental costs that can show a capital return over a longer period. Likewise, overlapping other planned renewal activities with deep retrofits can achieve significant benefits, especially regarding disruption of tenants/occupants and renewal of zonal systems such as HVAC delivery equipment and lighting.

8 For example, as discussed above in 2.3.1, typically the greatest cost savings benefit from load reductions comes from removing unneeded equipment or reusing existing piping and ductwork. These effects were not accounted for.

## Case Study: NOW House Project

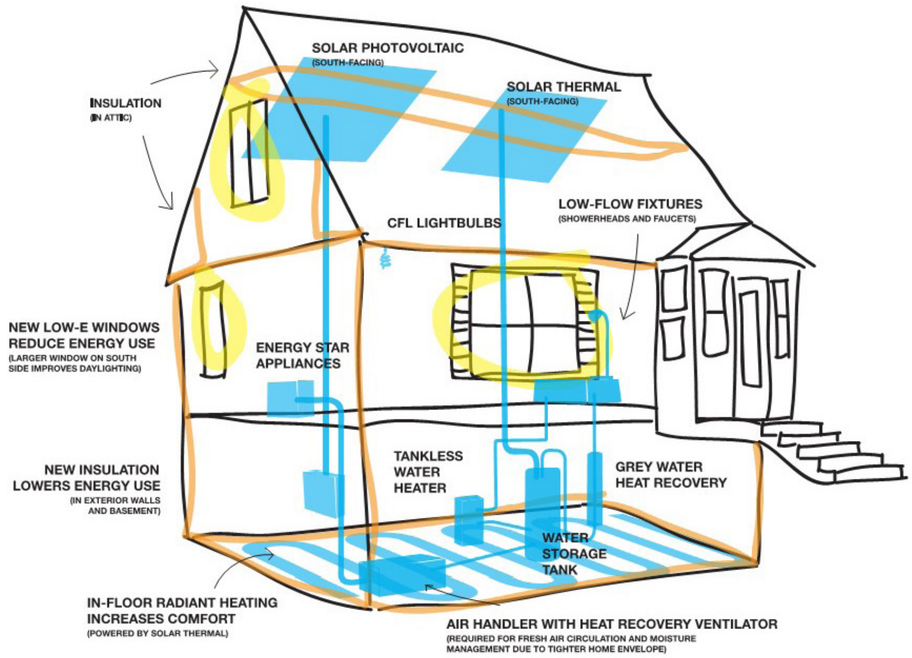



**Figure 19: Different NOW House retrofit package components**

The 2010 *NOW House Project* in Windsor involved five 1½ storey post-war homes that were deeply retrofitted to achieve zero energy consumption. Five retrofit packages were selected, ranging from basic insulation and air sealing, to renewable energy systems, to test the cost-effectiveness of different approaches. Each house was modelled to identify different energy reduction scenarios, with two of the five houses targeting net zero energy. Between these two net zero energy houses, the total capital costs ranged between \$56,000 - \$66,000, with the most cost-effective house retrofit found to have an incremental cost to reduce 1kg of $CO_2$ of \$7/ kg$CO_2$e with a simple payback of almost 20 years.

Results from the NOW House project were useful as a verification of costing data collected for this study. NOW House prices showed a significantly reduced capital cost for similar retrofit measures, reflecting a variety of potential factors affecting cost, including:

- Variation in construction labour rates across Ontario (e.g. Windsor vs. Toronto)
- Increased shortage of skilled labour in the construction sector in the past decade (2010 vs. 2020)
- Labour market was possibly deflated in 2010
- The package price from trades for a variety of measures across multiple buildings is likely lower than the sum of individual measure prices on a per-building basis
- Preferred product purchasing (e.g. product sponsorship or bulk buying) can help reduce costs
- Rebates were more readily available in 2010 than today

The last three of these potential differences between the NOW House pricing vs. the pricing used in this study reflect important potential portfolio and policy levers that can be employed to reduce the cost of retrofits.

### 2.3.3 City-level Actions

While the example of each package's performance has been shown as a hypothetical single investment resulting in a 25-year life-cycle performance, it is more likely that at many facilities decarbonization will happen in pieces, over time, including major investments across different systems as they become ready for capital renewal. Many facilities will not likely be able to achieve zero emissions operations in a single retrofit action, and many will require significant investment in enclosure upgrades or other load reductions before fuel switching can be viable. As such, several pathways to near zero emissions will be required, as illustrated in Figure 20.

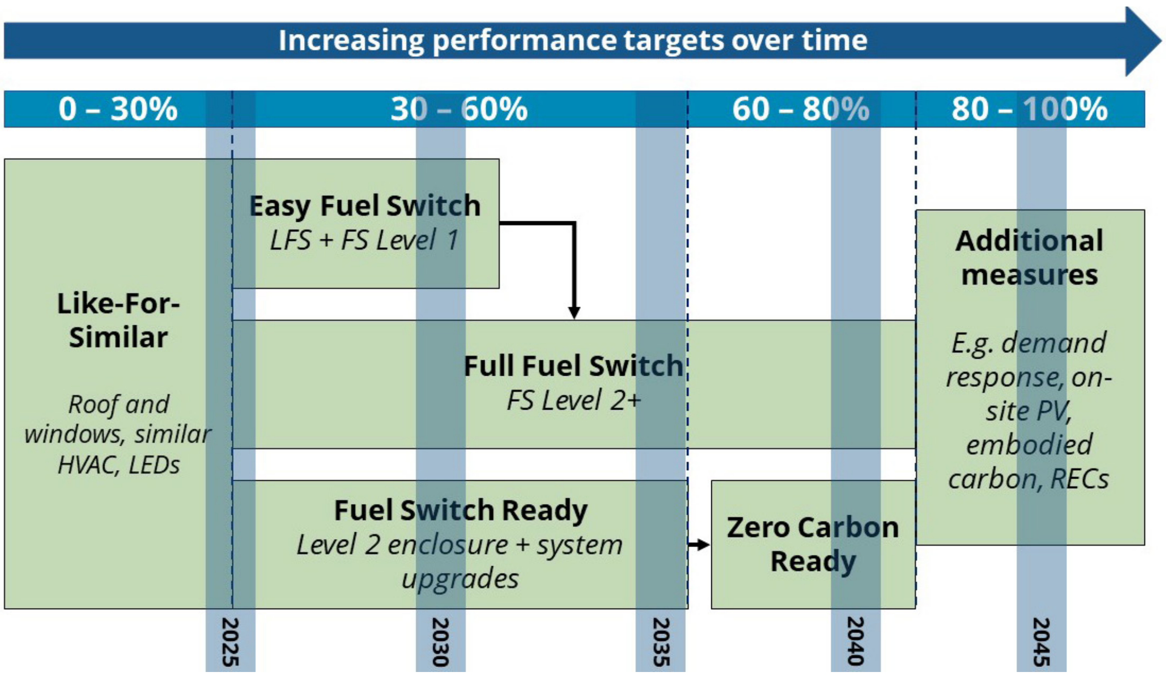



**Figure 20: Pathways to near-zero emissions**

This figure demonstrates four near-net zero pathways that achieve an 80% on-site reduction in emissions that will be needed across most facilities in order to achieve a city-wide net zero by 2050 target. The pathways for the majority of existing buildings include the following:

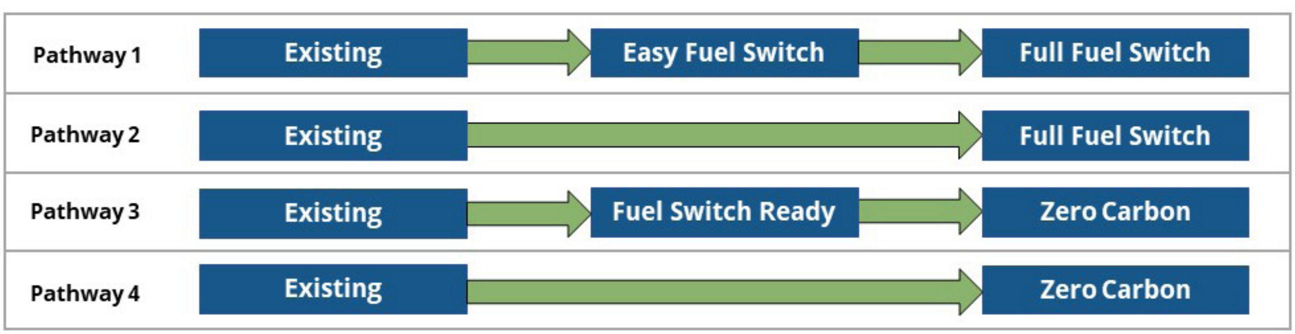



**Figure 21: Primary pathways for existing buildings to achieve 80% on-site emission reductions**

In addition to the pathways noted above, it is likely that some older buildings and many of Toronto's newest buildings (i.e. those built to modern energy codes with improved enclosure requirements, such as 2004 and newer) will require fuel switching, but not require significant investment in other systems to achieve similar levels of GHG reduction to the pathways above. This pathway is referred to as a Full Fuel Switch Only or FS2 Only approach. Additionally, some buildings may go directly to a Max Site package, but this is likely a small number of facilities.

By 2030, TGS v3 will essentially require fuel switching across all facility types; as such, this city-wide analysis assumes that new construction built after 2016 but before 2030 will also follow an FS2 Only path. These buildings have already been required to meet higher levels of energy efficiency, making it comparatively easier (and less expensive) to execute a facility-wide fuel switch.

### A prototypical city-level analysis

The energy results from the 32 clusters, the package financial performance of the nine focal clusters, and the sector-specific versions of the pathways above were used to prepare a city-wide analysis of GHG reduction between 2016 and 2050. This includes the quantification of a variety of metrics of performance as defined by the City of Toronto in the TransformTO and other important contributing work.

The purpose of the city-level analysis was to allow City staff and other stakeholders to develop a prototype recommended trajectory to near zero emission for each major sector that could inform the policy direction and targets in the near and medium term. To facilitate this process, three comparative scenarios were developed:

1. ***Business-as-planned,*** reflecting the use of LFS packages/levels of improvement across all sectors
2. ***Least capital net-zero ready,*** or a least-cost, net zero scenario reflecting a typical pace and the lowest capital approach to an 80% on-site reduction for all buildings
3. ***Aggressive net-zero ready,*** or a net zero scenario reflecting the level of acceleration and action needed to achieve a 66% chance of avoiding greater than 1.5°C of global warming, while maximizing both investment in holistic upgrades and co-benefits.

A final recommended pathway was developed by reflecting on the performance differences of these three scenarios and via dialogue with the broader study team. The prototype recommendation was foundationally based on two key questions:

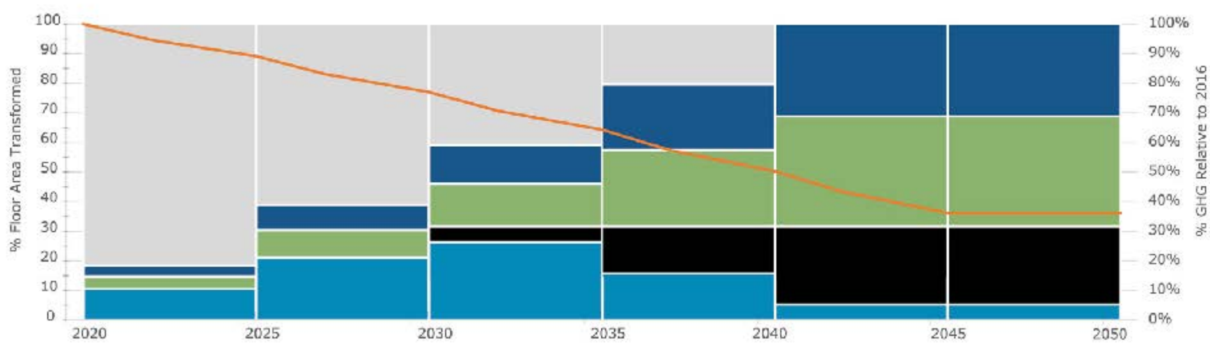
4. What is the appropriate pace of change across each sector, recognizing that the necessary transformations are significant and potentially very difficult to implement as compared to standard practice?
5. What mix of final packages yields a reasonable balance of capital, GHG reduction and co-benefits and/or avoided co-harms?

**The series of graphs shown in Figure 22 present a summary of the prototype recommended scenario over time (in 5-year increments)**. Each stacked bar shows the mix of packages and the percentage of the stock that is assumed to have implemented the given packages on the left-hand axis. The red line, tracking downwards from left to right, shows the associated emissions (relative to 2016 emissions) across the sub-sector in each period, with the final result on the right-hand-side showing the final site-level GHG emissions by 2050 (e.g. in (a) institutional buildings, emissions are 35% of 2016 levels or a 65% reduction). Note that some packages are assumed to be implemented in the first 15 years and later replaced or augmented with further fuel-switching in subsequent years (i.e. following one of the multi-pitch pathways above).

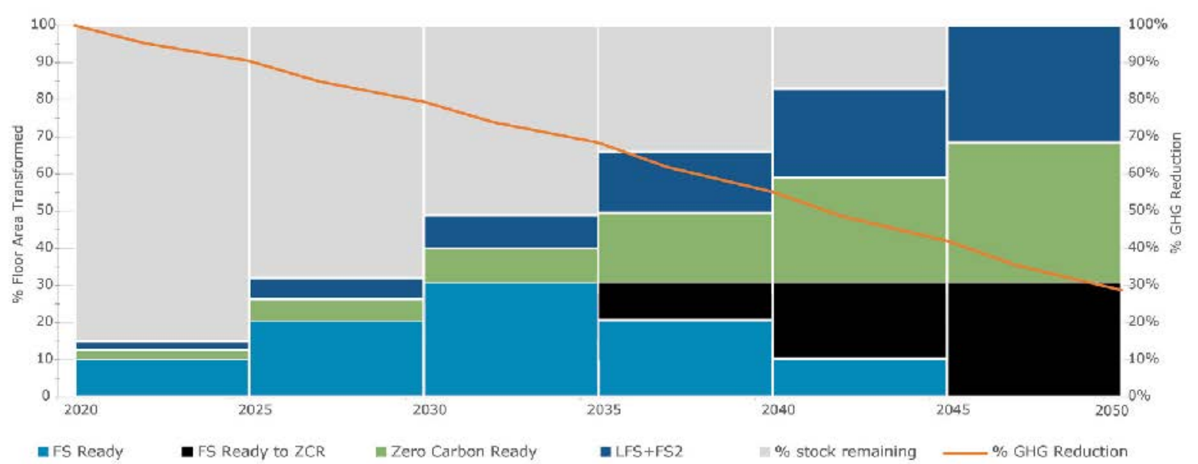
### Using the prototype to set targets

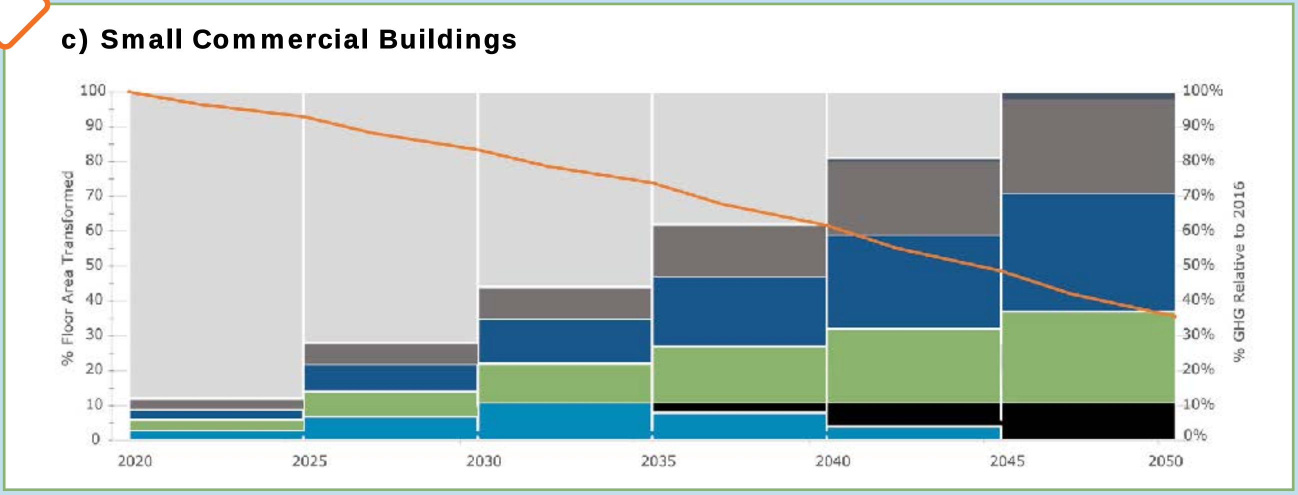
The prototype recommended scenario is not an optimal scenario. More data, iteration, and dialogue are required to evolve the scenario development process for the building sector beyond its current form. Respecting this limitation, for the purpose of using the results to inform draft policy, the recommended scenario was transformed into a set of sector-specific reduction targets, as discussed in Section 4.1.1. As with the results in Section 2.4, these targets should also be seen as prototypical – useful for engagement and to help set expectations for the next few years, but open to debate and designed to support deliberative dialogue in the immediate term. **As noted above, there is no mix of packages that results in a zero emissions building sector, as a result of the remaining emissions associated with Ontario's electricity. As such, additional measures such as the installation or procurement of renewable energy, carbon offsets, or grid decarbonization will be necessary to achieve the City's net-zero emissions target.**

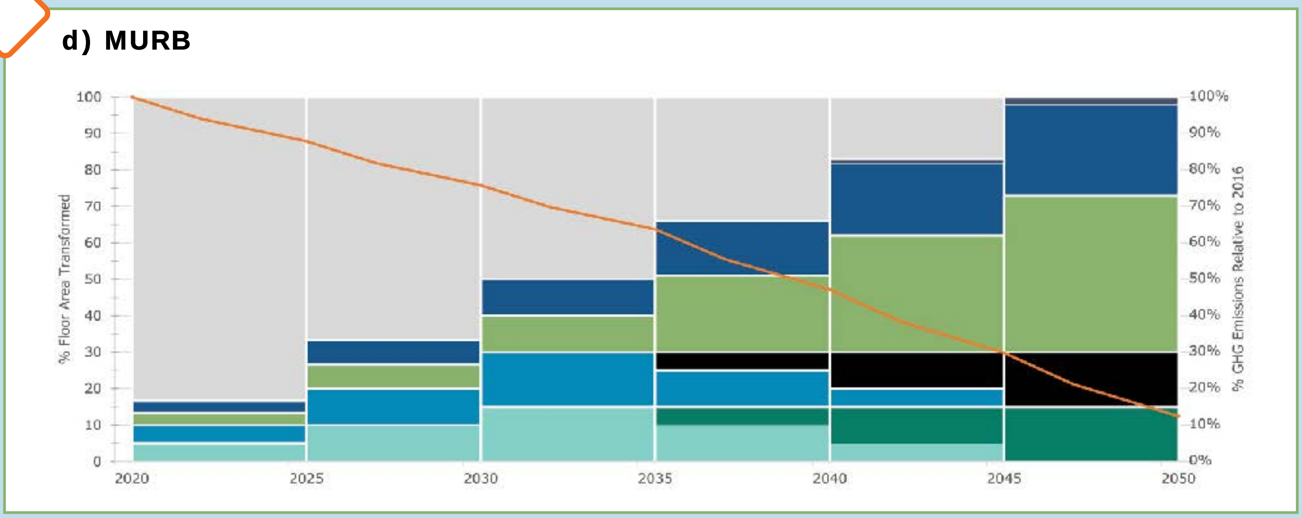
**a) Institutional Buildings**




**b) Large Commercial Buildings**





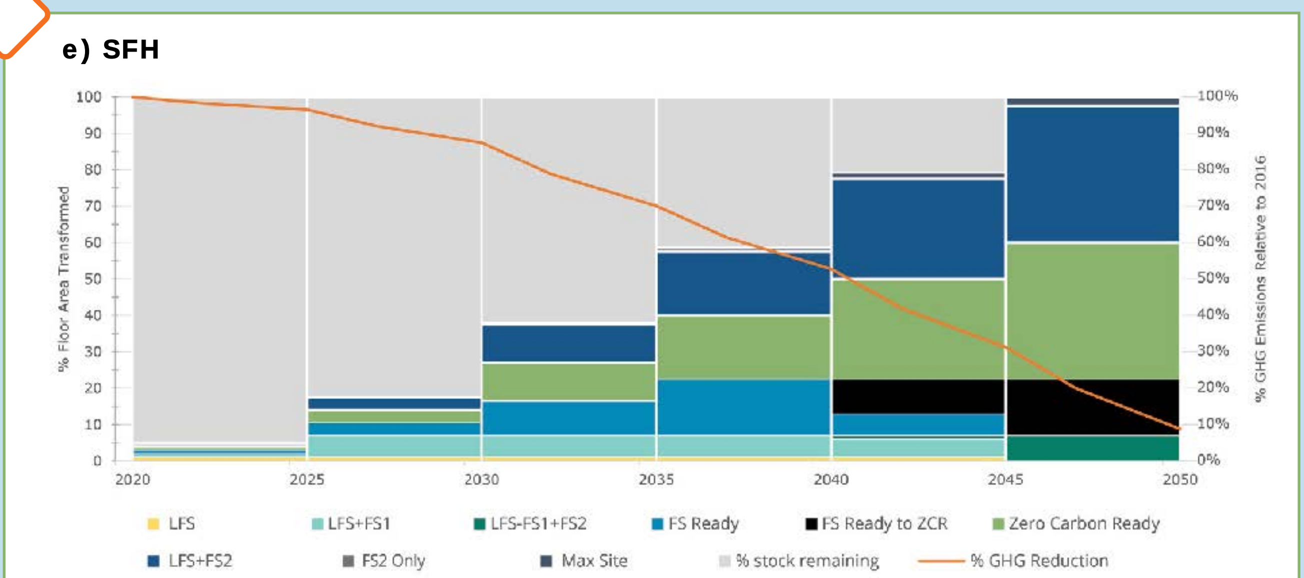




**Figure 22: Package implementation and associated emissions reductions for a) institutional buildings b) large commercial buildings c) small commercial buildings d) MURB and e) SFH**

## 2.4 An Emissions Reduction Scenario For Toronto

The recommended emissions reduction scenario seeks to balance an ambitious scope and scale of emissions reductions with a pace that considers the complexities of renovating Toronto's entire building stock. It is important to note that this scenario represents a prototype that will require further refinement as conditions change. In its current form, it is already a refined iteration of the work completed as a part of the TransformTO overall zero emissions planning process. As new programs and regulation ramp up and the market is spurred on by support for action across multiple levels of government, the pace and depth of change to 2050 will certainly need to be adjusted. Indeed, the announcement by the federal government of an increasing price of carbon in December 2020 is not fully reflected here. [xxvi]

The package and pace details of the scenario are included in Figure 17 above, but the key features of note for the discussion below include the assumptions that by 2050:

- All older buildings (i.e. approximately those built before 2004) will undergo a like-for-similar or better level of upgrade to enclosure and HVAC systems
- All buildings currently using gas-fired heating – even homes and buildings yet to be built – will undergo a fuel switch to electric heat pumps or alternative source of low emissions heating
- Rooftop solar PV will generate approximately 14% of the total studied building stock electricity.

The current TransformTO ambition of retrofitting or renovating 100% of buildings across the City is also reflected in the scenario, which results in an approximately 3% pace of building change per year (i.e. retrofit or renovation investment in 3% of building floor space per year across all sectors). This differs slightly by building type: a faster pace is assumed for institutional buildings, a more or less constant pace is assumed for MURB and commercial/industrial facilities, and a slower (but accelerating) pace is assumed for single family homes.

It is also important to understand that while the necessary investments are presented as happening simultaneously (i.e. as part of one or two retrofit projects) it is likely that some owners and portfolio managers will complete work over a longer period of time to spread out capital costs. In these cases, effort should be made to complete load reductions in advance of fuel switching to gain the benefit of downsizing cost savings at the plant level.

The recommended scenario is explored in further depth in the sections below by exploring three different but important implications: GHG emissions reductions, economic implications (for both home and building owners as well as across the city), and implications for building-level and citywide resilience.

### 2.4.1 GHG Reductions

GHG emissions reductions can be explored in terms of both absolute emissions reductions at key milestones (i.e. 2030 and 2050), as well as those emissions accumulated over time to 2050. In terms of absolute emissions reductions, Figure 23 shows an overall reduction in sector-wide emissions of >80% from the baseline year of 2016 to 2050, as compared to a 34% reduction achieved by the BAP scenario.

Though an 80% reduction is laudable, **the scenario does not achieve net zero emissions, as targeted across all sectors based on the City of Toronto's Climate Emergency Declaration in October 2019**. It also misses the City's 2030 target of 65% reduction vs. 1990 levels. **More effort is therefore required, likely from broader efforts in other sectors or through synergy of actions across sectors, to achieve these more ambitious goals.** Further discussion of the benefit of grid-level action is provided in Section 2.4.2 below.

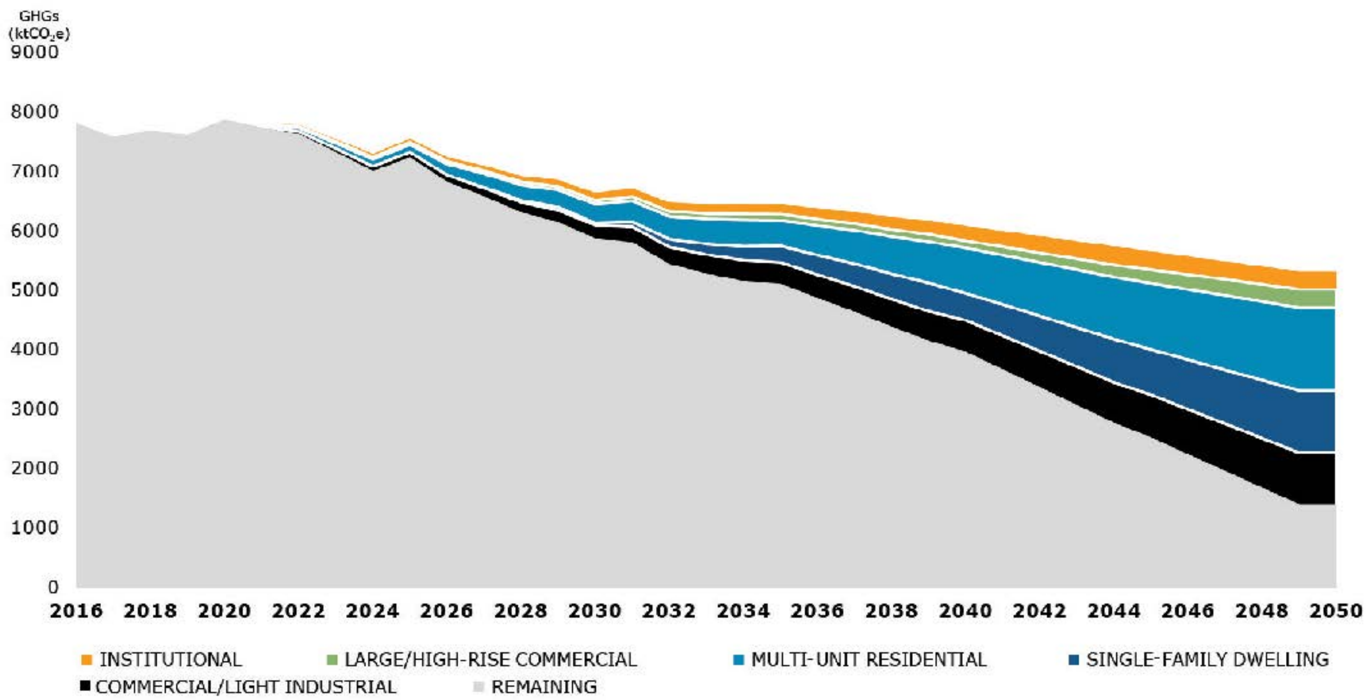



**Figure 23: GHG reduction by sector compared to business-as-planned to 2050**

With respect to accumulated emissions, the recommended scenario achieves a 25% reduction over the BAP, which is a significant improvement. However, the accumulation is not as low as science-based targets recommend in order to have a chance of staying below 1.5°C of global climate warming[9]. While such a scenario was explored, the pace of change required to achieve this aggressive level of accumulated emissions reduction presents a significant challenge for the building sector. For more insight on the City's ability to achieve this target across all sectors, see the most recent TransformTO modeling report.[xxvii]

**Table 8: Total and cumulative emissions for 2050**

| | Scenario | High Rise ICI | Low Rise ICI | MURB | SFH | Total |
|---|---|---|---|---|---|---|
| **Emissions in 2050 (ktonnes C02e)** | BAP | 1,027 | 1,558 | 1,293 | 1,441 | 5,319 |
| | Recommended | 417 | 163 | 244 | 573 | 1,397 |
| **Cumulative Emissions by 2050 (ktonnes C02e)** | BAP | 36,120 | 58,470 | 56,230 | 49,690 | 200,510 |
| | Recommended | 26,820 | 40,060 | 45,140 | 37,360 | 149,390 |

9 This target is set based on the notion that an approximately 65% reduction by 2030 and zero carbon by 2040, as compared to 2020 global emissions, aligns with the aggressive reduction curve required and recommended by IPCC to avoid additional accumulated emissions in excess of 340 $GtCO_2e$ globally.

### 2.4.2 Grid Factor Variation

**Neither the 2030 target of 65% below 1990 levels, nor the zero emissions by 2050 target are achieved by the prototype scenario without further reductions in grid emissions.** Ontario's emissions from electricity generation dropped 90% due primarily to the phase-out of coal-fired generation plants between 2004 and 2014.[xxviii]Ontario's electricity is now over 95% generated from renewable or zero-emissions sources, with natural gas providing the remainder.[xxix]Natural gas, however, is primarily the source used to generate electricity during peak demand. Changes in electrical loads, either from improved efficiency or increased demand, are therefore most likely to impact the amount of natural gas used to generate Ontario's electricity[xxx]. Additionally, several of Ontario's nuclear plants are slated to be refurbished or retired in the coming years and replaced by natural gas, which will further increase electricity generation from gas. Consequently, Ontario's electricity GHG emissions intensity is projected to increase over the next 15 years.[xxxi,xxxii]

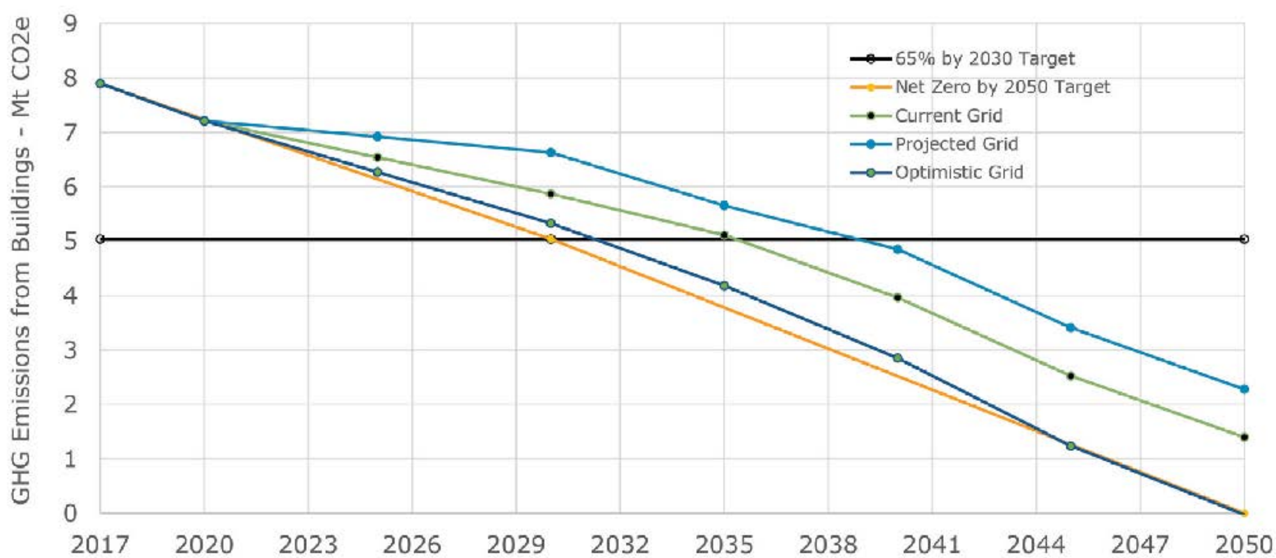



**Figure 24: GHG reduction sensitivity to grid emission intensity**

A sensitivity analysis of how Ontario's electrical grid may change over the next 30 years is summarized in Figure 24. Three different emission factor projections are used to predict emissions between now and 2050 (for exact numbers, see **Appendix A**). The different factors (and their outcomes) include the following:

- **Projected Grid (IESO 2020 outlook):** This trend represents the current projection to 2040 with constant trend beyond, to 2050 and reflects minimal to no decarbonization of the current grid. This worst-case sensitivity result increases projected 2050 emissions by >50% under the recommended scenario.
- **Current grid (Consistent performance):** This trend was the same used for the TransformTO Report #2 and reflected a more or less constant emission factor between now and 2050. This is the projection used for all other charts, graphs and results presented in the result of the report.
- **Optimistic grid (Nearly full grid decarbonization):** This trend shows an almost simultaneous effort to decarbonize the grid resulting in an average electricity GHG emission intensity to be similar to other low emissions provincial grids by 2050 (e.g. British Columbia). This scenario is the only one presented in the report that results in zero emissions by 2050 and brings the recommended scenario very close to achieving the 2030 target.

### 2.4.3 Beyond Scope 1 and 2

While the reported building sector emissions follows the globally recognized standard for reporting on emissions from this sector, it does exclude three important sources of emissions: embodied, upstream methane and refrigerant leakage.

**Embodied emissions.** Embodied emissions are those generated at points in the building's life cycle other than during operation, including from when the building materials or equipment are created (i.e. from mining raw materials, materials processing, transportation, and/or manufacturing), from construction, and during building end of life (i.e. demolition and disposal). Considerations of what materials are used within buildings may not impact the reported emissions for the sector, but can have a significant impact on global GHG emissions. There is increased interest and movement with regards to embodied carbon policy and reporting.[xxxiii]

As part of the impact assessment work in this study, as discussed in Section 2.3.1, analysis was completed on the potential reduction in embodied emissions that comes from selecting alternative, bio-based materials with carbon storing benefit and low embodied emissions for enclosure upgrades. Figure 25 compares the embodied emissions between the lowest cost enclosure options explored compared to a best-case option. Figure 25 shows the accumulated effect for improved embodied emissions over the entire building stock and demonstrates that a significant reduction for embodied emissions associated with enclosure materials can be achieved by considering best selection of materials (net reduction in the recommended scenario). The figure also illustrates that the opportunity in residential buildings – especially in single-family homes – to reduce embodied emissions is significant and even results in negative embodied emissions (i.e. net carbon storing). Further analysis into these sectors showed when compared to the lowest cost option, net storage in embodied emissions is achievable with a life-cycle cost per tonne at or below $75/tonne (for more details, see **Appendix A**). This result confirms the assertion in Section 2.3.1 that embodied emissions should be considered, especially where significant enclosure improvements are planned. However, the impact of embodied emission to the overall Scope 3 emissions is small compared to other sources, as discussed further below.

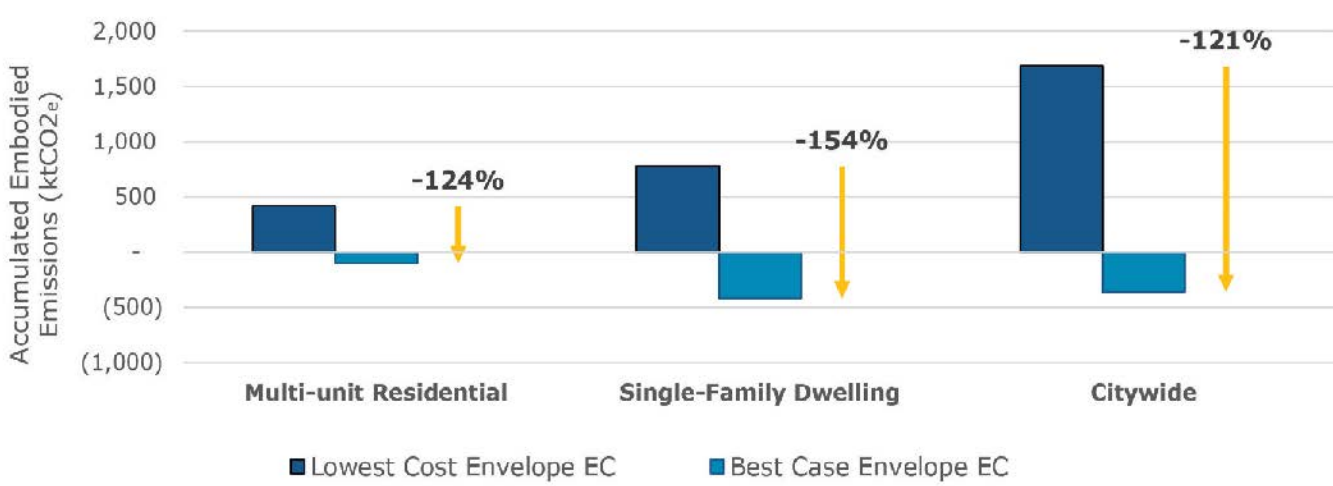



**Figure 25: Citywide and Residential Sectors Embodied Emissions (Lowest Cost vs. Best Case Materials)**

**Upstream methane from natural gas production and transportation.** An additional concern with natural gas consumption in Toronto's homes and buildings is methane leakage from the extraction, processing and distribution of natural gas. Leaks are most significant at extraction, but continue throughout distribution piping, gas meters, and appliances.[xxxiv] From a life cycle perspective, homes and buildings that use natural gas are therefore responsible for even more emissions than what are combusted within the building, as shown in Figure 26. Methane has a much higher global warming potential than carbon dioxide, but is considered a short-lived climate pollutant with a relatively short atmospheric lifetime.[xxxv] This short lifetime means that while methane is still an important contributor to GWP, reducing natural gas use in buildings offers an opportunity for fast reductions in atmospheric GHG concentrations that may help avoid accelerated climate warming.[xxxvi] This uncertainty in the contribution of methane emissions in the GHG emissions was studied by Pereira and Posen, who conducted emission lifecycle analyses based on variations reported in literature. The study produced refined GHG emission estimates from Ontario's electricity generation given these variations, which can be seen in Figure 26.[xxxvii]

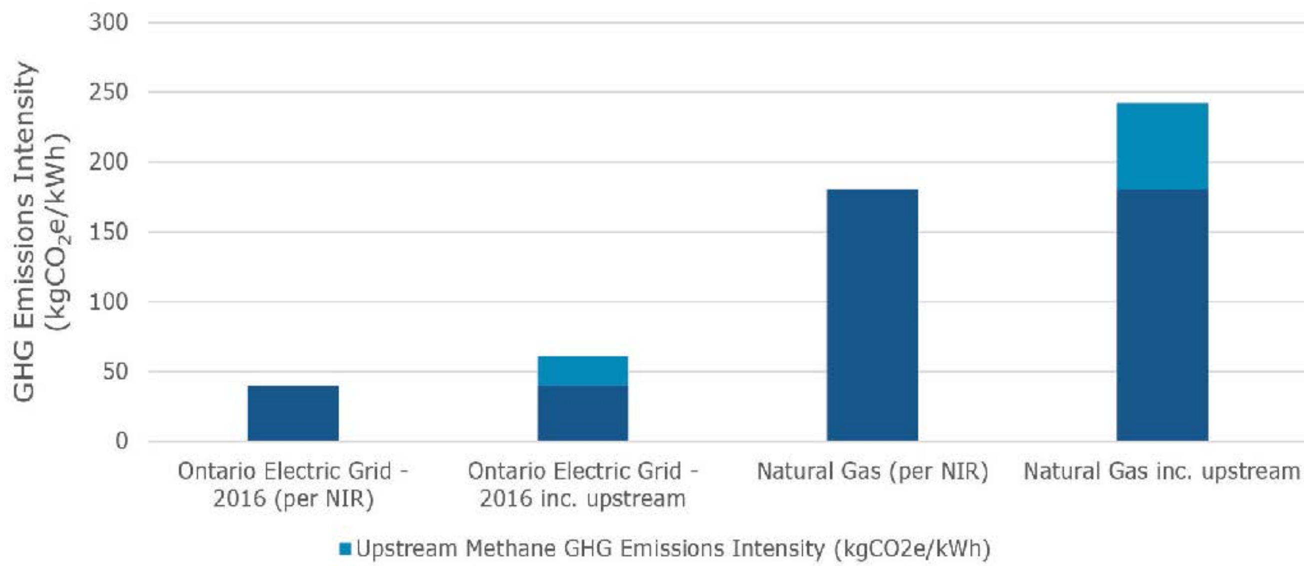



**Figure 26: Electricity and natural gas emission intensity compared to emission intensity considering upstream methane emissions**

**Refrigerants.** Electric heat pumps are an energy efficient method for space and water heating. With Ontario's low carbon electricity, they are also a low carbon solution for space and water heating. However, heat pumps operate using refrigerants, many of which have very high global warming potential.[xxxviii] There are therefore emissions implications to heat pumps based on refrigerant leakage during operation and refrigerant disposal at equipment end of life. Refrigerant selection and minimizing or eliminating refrigerant leakage from equipment are important considerations when recommending wide-spread electric heat pump adoption. These fugitive emissions from refrigerant can be estimated based on system, refrigerant type and best practice refrigerant charge according to industry best practices.[xxxix]

Using appropriate sources, it is possible to add the three categories of additional emissions identified above to the Scope 1 and 2 emissions for the recommended scenario accumulated over 30 years. Figure 27 shows the breakdown of each accumulated emission source as pie chart, with percentage breakdown.

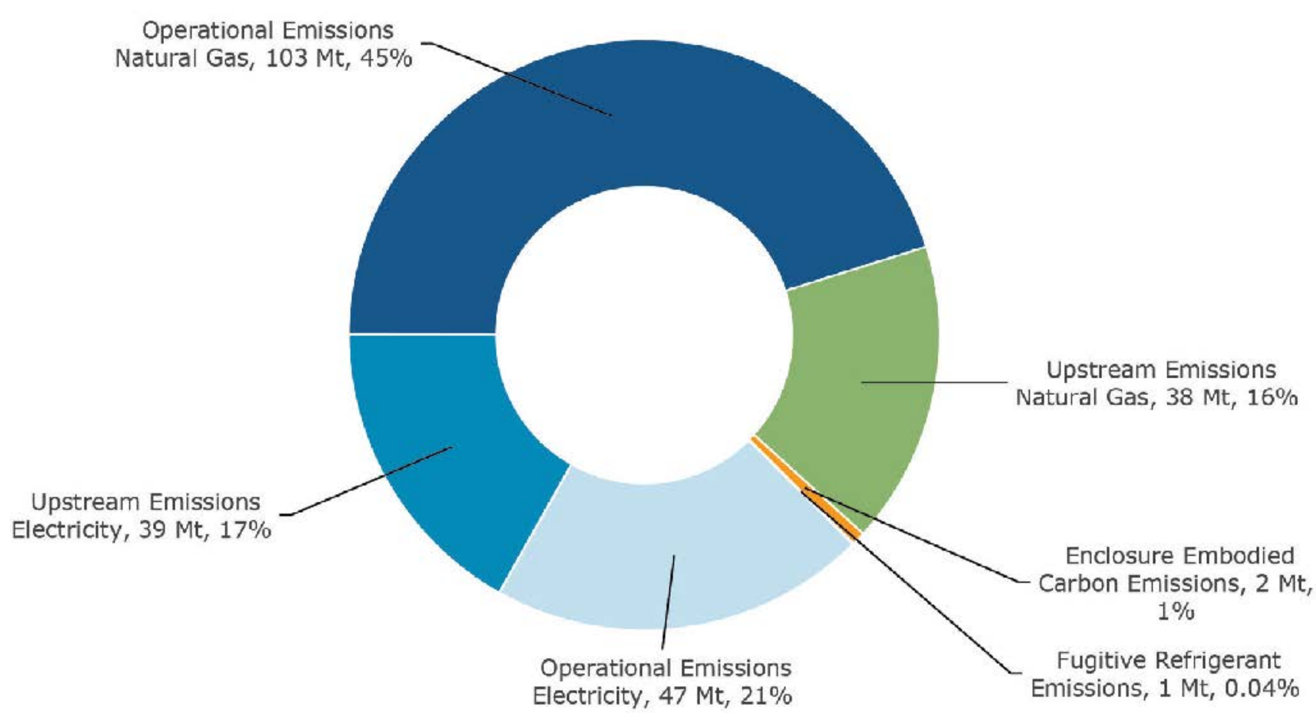



**Figure 27: Accumulated Operational, Upstream, Embodied and Fugitive Emissions**

Taken altogether, Figure 27 shows that natural gas used on site and its upstream effects represent over 60% of accumulated emissions from the building sector, while electricity and upstream methane make up the majority of the rest. For the existing building sector, the impact of embodied and fugitive refrigerant emissions is very small. That said, the embodied emissions reduction and carbon storing benefits offered by natural materials and the best practices associated with the replacement and maintenance of refrigerants are important to consider and are discussed further in Section 4.

### 2.4.4 Facility Level Economic Impacts

Figure 28 compares the upfront investments and energy/GHG cost savings (i.e. compared to current energy costs) over 25 years for both the BAP and recommended scenario. A few important observations can be made from this comparison.

First, the incremental cost between the BAP and recommended scenario is at least 30%, and as high as 270%, depending on the sector. This is due to the significant investment in enclosure upgrades across most sectors and packages. However, costs to the owner are high across all major sectors – even for the BAP – due to the high cost of replacing building systems and equipment. Indeed, this is why many organizations use capital reserves tied to capital plans - to ensure sufficient resources exist to deliver on needed repairs when they come due. That said, the additional costs associated with the recommended scenario significantly increases this need for capital. Even with some likely over-estimation (as discussed in Section 2.3.2), the size of the increase is material. **In sum, as noted above, the recommended scenario is a significant increase in capital cost over the business-as-planned scenario, especially for the large ICI and residential sectors. Further motivation for this significant investment is offered via a discussion of co-benefits below.**

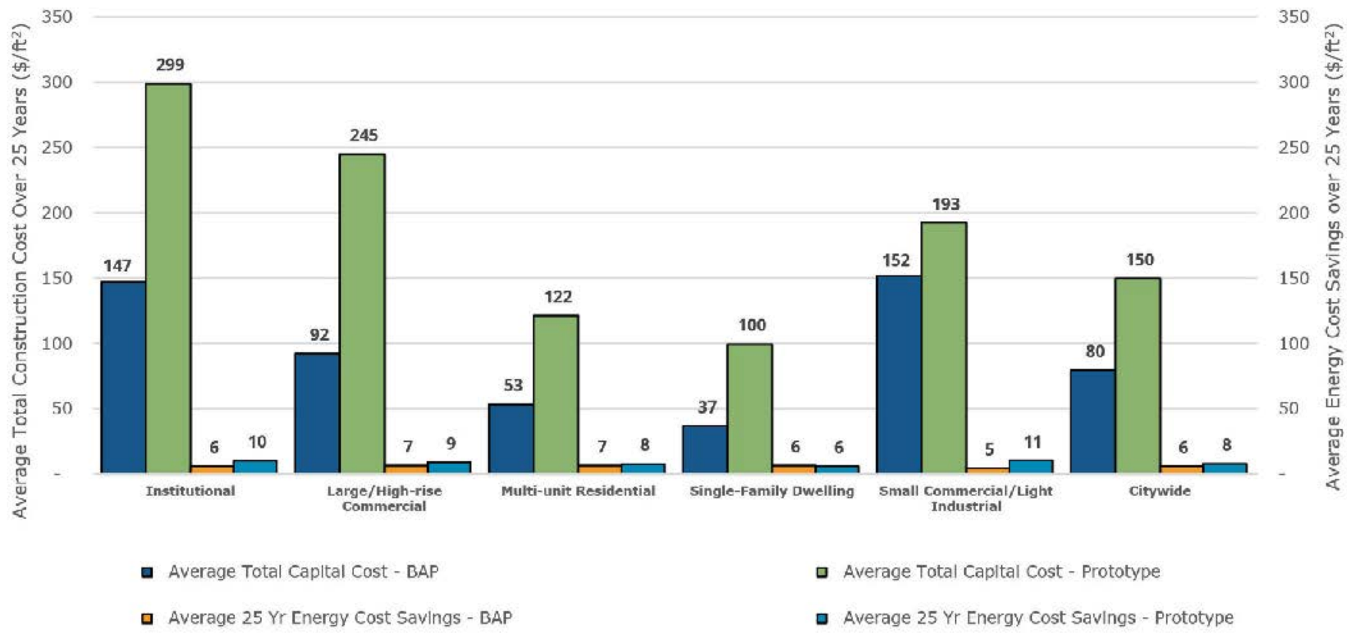



**Figure 28: Average total construction cost compared to average total energy and carbon cost savings over 25 years per sector**

Second, there are no scenarios where a simple payback analysis balances out the energy and carbon cost savings with the incremental capital cost. While the sensitivity analysis below does push the result further towards cost-neutrality over 25 years, this point cannot be overstated. **The efforts required to achieve zero emissions across all sectors do not have a simple financial payback, even with a carbon tax as high as an average of $150/tonne between now and 2050.**

Another important issue to note is that, across all sectors, the cost of energy does not increase. This is the result of using high efficiency cold climate heat pumps, coupled with at least a like-for-similar upgrade for other equipment and systems. While this outcome translates into a low risk of exacerbating energy poverty, it is possible that landlords and property owners wishing to recoup the cost of necessary capital investments may drive up rental costs. Both voluntary and mandatory programs, as discussed below, should consider this potentially negative impact.

The life-cycle cost analysis in Section 2.3 for packages at the focal cluster level can be reflected at the city-scale by a metric called Total Cost of Ownership (TCO). TCO excludes the time value of money, but otherwise captures the various cashflows paid (or saved) by the owner over a 25-year study period, including regular maintenance and replacement and any residual value of capital at the end of the study period. The incremental TCO per tonne saved is a weighted average of the package level incremental TCO divided by the accumulated emissions reduction, as compared to the BAP. It should be noted that TCO and ILCC (as presented for the package level in Table 7) are not equivalent in financial analysis; TCO was used in city-scale analysis due to the complexity associated with applying life-cycle cost analysis across many sectors with phased package implementation over a fixed study period. However, given that the metrics both reflect the potential return on investment, TCO is an appropriate metric for indicating overall cost effectiveness of city-scale action.

The relative TCO performance of different packages within each sector changes depending on various sector-specific factors. From an owner's perspective, one package may be better than another; as such, the recommended scenario assumes significant diversity in the pathways to zero that will be selected or promoted, as shown in the example of the MURB sector package-level Marginal Abatement Cost Curve (MACC) in Figure 29.

This curve shows the savings in accumulated emissions across the sector on the x-axis and the 25-year incremental TCO/tonne for each pathway/package combination on the y-axis. Similar curves for each sector are included in **Appendix A.** The average for the entire sub-sector (i.e. MURBs, in this case) is shown as an overlay.

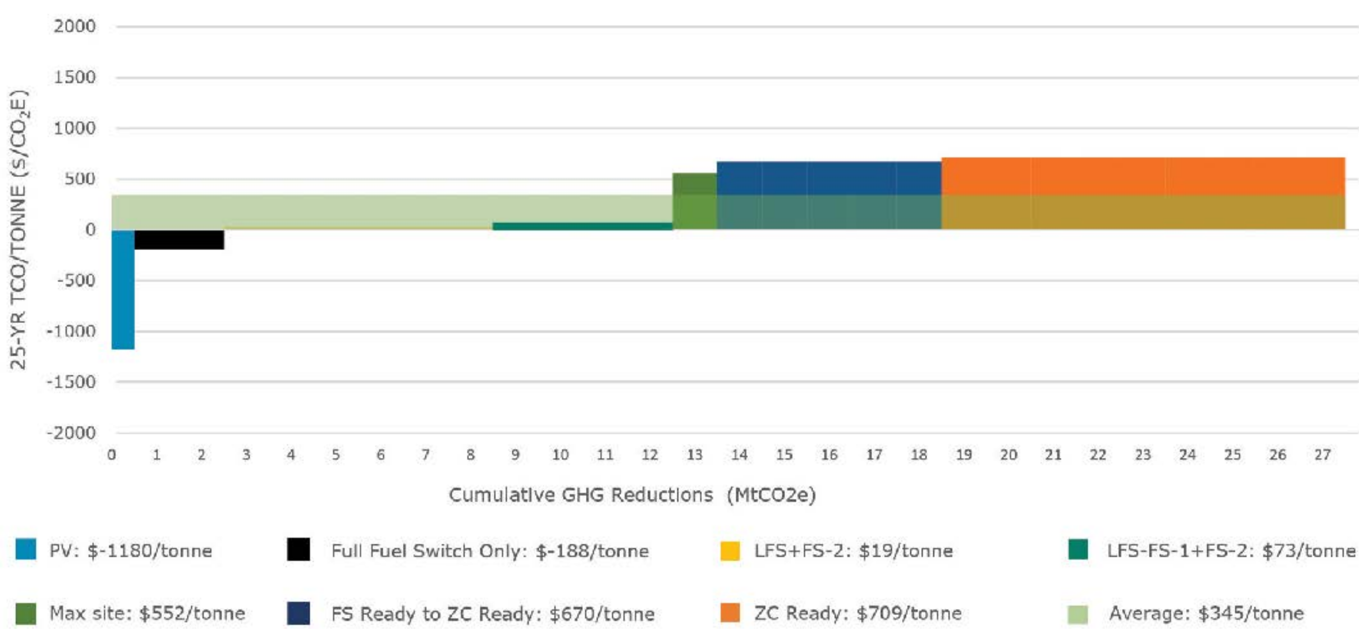



**Figure 29: Example Sectoral MACC by Package for MURB**

This chart represents the average of all MURB clusters of which cluster 8 is the most predominant and that cluster has an improved Max Site result due to HVAC change differences between the Max Site and the FS Ready package. Also there is more cost savings to be had in the Max Site package. Overall, this is not an optimized scenario (as discussed in the report) but this does suggest that likely the different between these two packages is not significant over 25 years. TCO also does not include consideration for time value of money compared to the ILCC results which can impact the performance as well. However the TCO results for MURBs are consistent with the conclusions for the cluster 8 ILCC results.

### 2.4.5 Macro Economic Impacts

Similarly, the long-term investment implications can be seen at the macro economic scale (i.e. across all facilities and owner decisions), as shown in the overall MACC for the recommended scenario (Figure 30). This city-wide MACC compares the proposed actions across all the sectors in terms of accumulated GHG savings and incremental TCO.

On the surface, the TCO per tonne assigned to the large/high-rise commercial and institutional sectors seems aggressive as compared to the other sectors. However, the benefit to tenant retention and/or supporting corporate zero carbon mandates, as well as the low cost of capital available to this sector, makes this deeper investment more worthwhile – especially if implemented in accordance with existing renewal timelines. Based on the small data set of facilities studied for this class of buildings, the more robust (i.e. zero-carbon) pathway may be the better investment in the long term (see Section 4.2 for an example).

As shown in Figure 30, the average TCO/tonne for the recommended scenario is $330/tonne. This performance over 25 years is not far from the current Greening Government shadow pricing of $300/tonne, the number used by Federal agencies as a part of investment decision-making. The recommended scenario is a balance between emission reductions, co-benefits and total cost of ownership and is not designed to be a cost-optimal solution. Further work is required at all scales of analysis to explore these cost-effectiveness results, but the assumption is that costs shown reflect the high side of likely costs across most sectors.

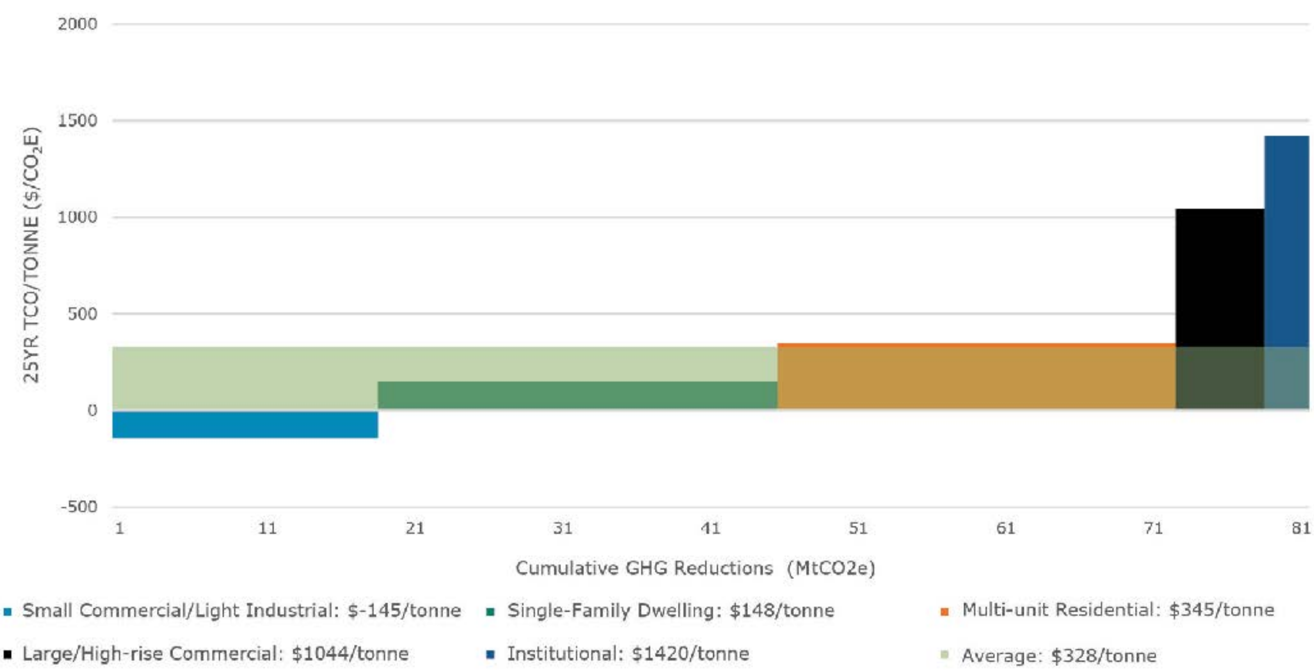



**Figure 30: Overall Recommendation 25 Year Total Cost of Ownership by Sector**

Should this assumption hold true, it is likely that prices will come down over time as the pressure from carbon pricing increases and the efficiency of the retrofit market improves. To determine the impact of potential future reductions in cost, the sensitivity of the overall package TCO/tonne performance was investigated in two ways: by reducing the upfront capital cost by 50% and by increasing the carbon tax to an average of $300/tonne[10]. The resulting change in TCO/tonne for the two scenarios are shown in Figure 31. The result is similar to that shown for the example focal cluster in Section 2.3.2: cost reductions and further carbon tax increases within the realm of probable outcomes bring investment across the sector into a range of around $100-200/tonne.

The purpose of carbon pricing and capital cost reduction using incentives and preferred financing rates is to motivate business decisions towards long-term decarbonization. Given the assumptions included in the study work to date, it is clear that either stronger carbon pricing beyond 2030 or financial support (or ideally, both) would be required to bring the 25-year cost of investments below the current projected carbon price (i.e. below $170/tonne).

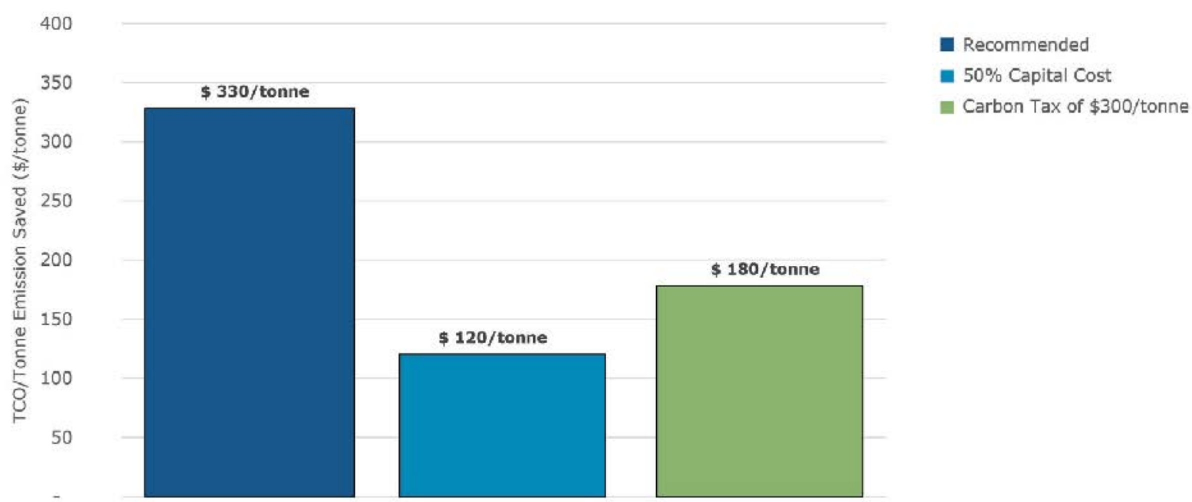



**Figure 31: Recommended TCO/tonne scenario and sensitivty to carbon pricing and capital cost changes**

Though TCO per tonne informs the relative financial benefit of the recommended scenario, the macro-economic impacts are more forceful when summarized as an accumulated, city-wide capital investment and job creation opportunity (see Table 9). In short, an incremental investment of almost $140B translates into an estimated 422 million new job-hours in local construction, energy services and supportive work.  Refer to **Appendix A** for more information.

10 From an average of about $150/tonne based on the current proposed carbon price at the time of analysis

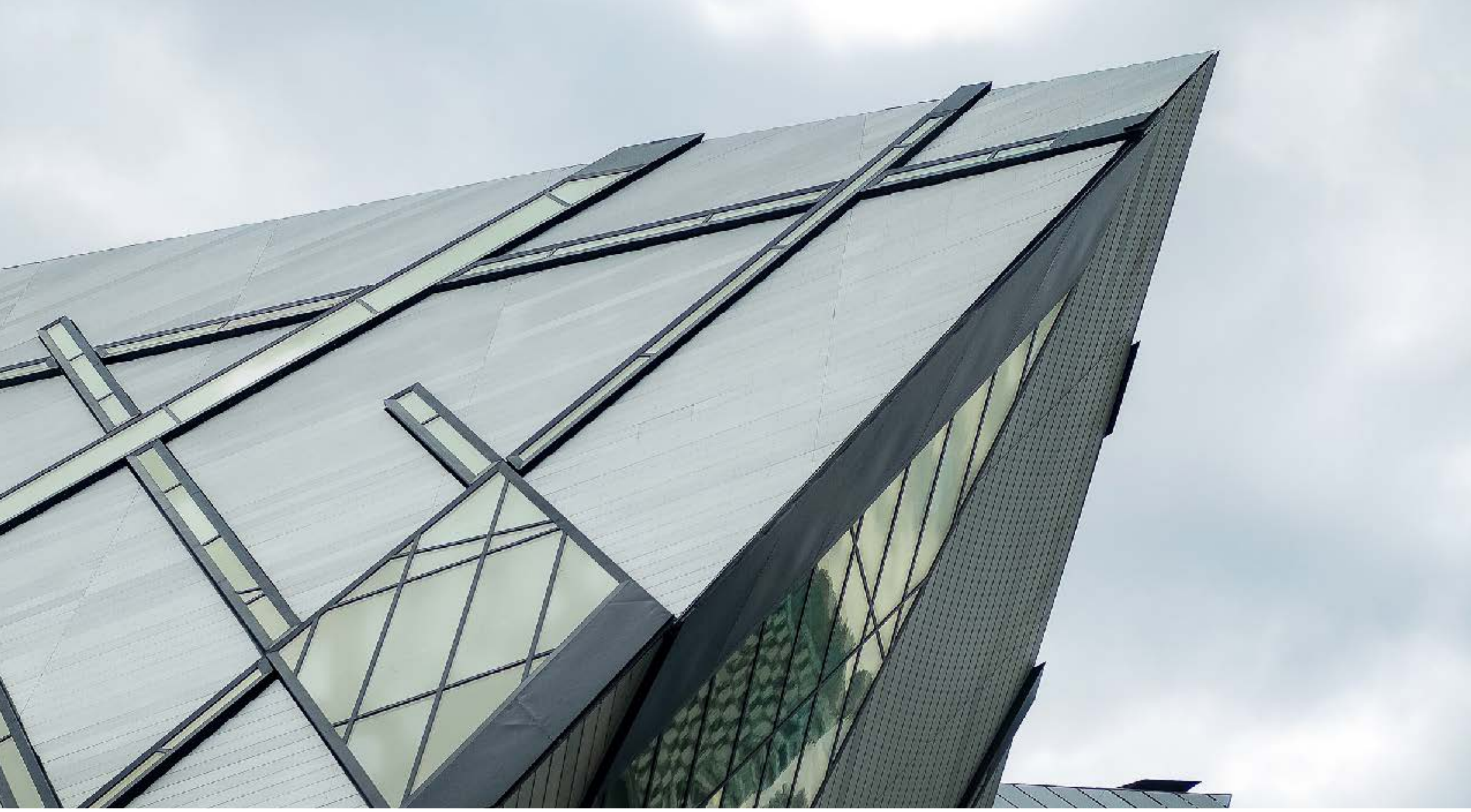


**Table 9: Overall macro economic results**

| Scenario | Business-as-Planned | Recommended |
|---|---|---|
| Overall Economic Activity | $161B | $302B |
| Average Annual Investment (Over 30 Year Period) | $5.4B | $10B |
| Direct, retrofit related Job-Hours | 665 million job-hours | $1,087 million job-hours |
| Approximate numbers of direct, full time jobs created by the work, over 30 years | 11,100 | 18,100 |

Based on a summary of building permit data prepared by Statistics Canada in 2019,[11] the recent value of construction is approximately $8B per year in the Greater Toronto and Hamilton Area. This is spread out over many sectors but is heavily weighted towards MURBs and commercial real estate. Some existing building permits would also be included in this data, but much of the work would likely be for new construction or major renovation. Based on this trend, an estimated value of permits for the same purposes to 2050 would be in the $200-300B range across the city, meaning that the incremental cost of the recommended scenario (i.e. assuming the BAP is accounted for in mostly non-permitted activities) would increase the value of permits by ~50-70%. This way of summarizing the impact is useful, since it puts into context the pace of change and potential overall economic benefit of action to the City and the construction and energy services industry. These job creation statistics also indicate a significant training effort, since construction trade jobs are already anecdotally understood to be in short supply in Toronto and elsewhere in the province and country.

11 Statistics Canada. Table 34-10-0066-01 Building permits, by type of structure and type of work (x 1,000). Data is for the CMA of Toronto, which is essentially the Greater Toronto Area, a population of approximately 7 million. An estimated share of the permits for the City of Toronto is about 40-50% of the value.

### 2.4.6 Facility Level Sustainability & Resilience Impacts

Implemented carefully, investment in deeper retrofits can also yield positive outcomes for the overall quality of space, indoor environmental quality, as well as improved resilience to the impacts of climate change. Three key issues are of note with respect to improved building resilience: reductions in thermal energy demand intensity (TEDI), the addition of cooling, and back-up power.

At a city-wide scale, the recommended scenario's improvement to TEDI reflects a 50% reduction compared to the baseline, and a smaller reduction (approximately 4%) in CEDI as shown in Figure 32. The TEDI range of improvement across the sectors was between 31% to 60%. As demonstrated in Toronto's Zero Emissions Building Framework[xl], lower TEDI values derived from improved building envelopes correspond to improved passive survivability, or the ability to maintain liveable indoor temperatures under conditions of power outage. As storm events are projected to increase with the warming climate, the ability to provide comfortable indoor spaces under conditions of power outage will be of increasing value, especially in MURBs, single-family homes and public spaces designated as community refuge areas.

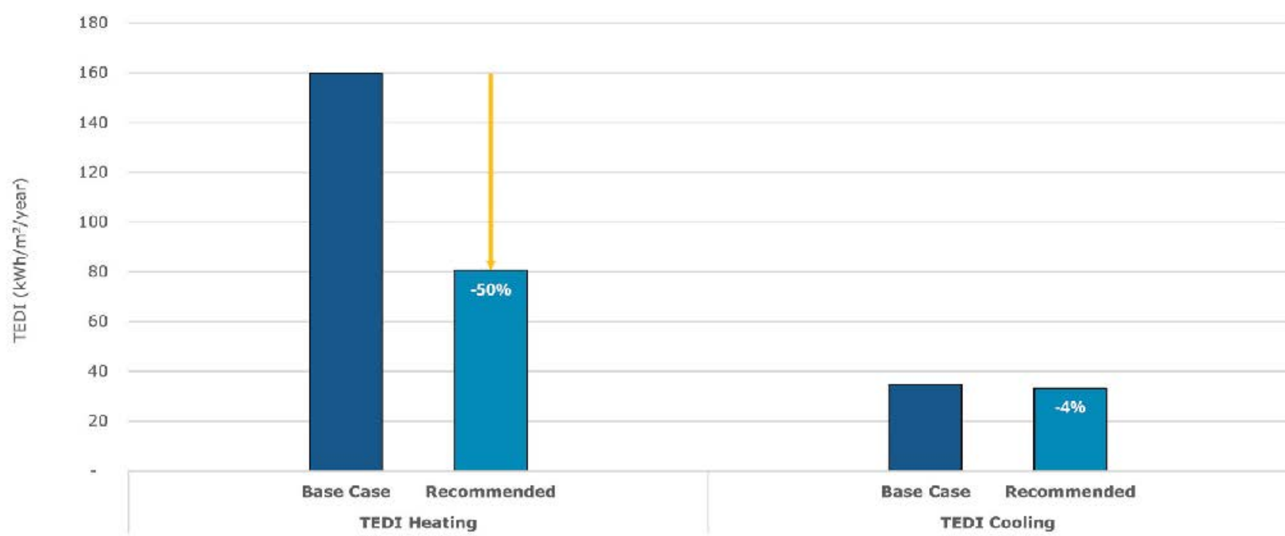



**Figure 32: Overall TEDI (heating) and CEDI (cooling) results**

As the climate changes, the city is also projected to become hotter and wetter. Toronto's Resilience Strategy[12] identifies a number of goals and actions that overlap with GHG reduction efforts in existing buildings, but of particular relevance here is the infrastructure goal that would see "Toronto [as] more resilient to climate change, including the hazards of flooding and heat". Supporting flood resilience action can overlap with the recommended scenario's investment in deep retrofits, especially HVAC and enclosure upgrades identified in the more aggressive packages (i.e. those ending in Zero Carbon Ready or Max Site packages), as many flood resilience upgrades may require updates to building structure and envelope, as well as the potential location of HVAC equipment. These projects can align with the needed investment in flood preparedness and education, as has already been the case for several MURB pilot projects led by Toronto Community Housing and a variety of other City organizations.

12 https://www.toronto.ca/ext/digital_comm/pdfs/resilience-office/toronto-resilience-strategy.pdf

Cooling load reductions (i.e. CEDI savings) and fuel switching, by comparison, overlap with the goal of heat wave preparedness, since installing heat pumps also provides a cooling system to buildings that do not already have one. This is particularly important from a heat wave preparedness standpoint, as Toronto Public Health and Climate Change Canada estimate that heat contributes to 120 premature deaths each year[xli] and residents of MURBs are particularly vulnerable. This is even more important when considering that Toronto Public Health projects a doubling of heat-related mortality[xlii] as it is anticipated that number of heat waves is expected to more than triple by 2050[xliii].Heat pumps that can do both heating and cooling are installed in 100% of facilities in the recommended scenario. In contrast, the recommended scenario does not significantly reduce CEDI, though opportunity exists when building retrofits include window upgrades, as discussed in Section 2.3.1. **Further work to understand the cost-effectiveness of combined CEDI and fuel switching opportunities is recommended, especially as the state of the grid changes.**

Backup power for shelter-in-place situations is also an important resilience consideration that overlaps with the recommended deep retrofit scenario. TEDI improvements allow for back-up equipment in MURBs and single-family homes to be more appropriately sized; however, the current scenario does not include the cost of installing battery or other back-up systems in homes and buildings where they do not currently exist. Such systems may be important in the future where more frequent storms in all seasons are projected to cause black or brown-out conditions and affect heating systems that are now entirely served by electricity.

### 2.4.7 Marco Sustainability & Resilience Impacts

Investment in back-up systems also aligns with the broader desire for improved grid resilience and decarbonization, since battery energy storage systems (BESS) and other demand response technologies can help to achieve a more cost-effective and resilient, zero emissions grid operation. Load reduction is also an important measure to achieve similar grid stewardship, as discussed in Section 2.3.1 and illustrated in Figure 33.

Though the Ontario grid has some surplus renewable energy in times of low use – espeically in winter months[xliv] – the use of electrification as the principal means of fuel switching in the building sector risks substantially increasing electricity demand, especially at peak periods (when even cold climate air-source heat pumps have COPs at half or less their rated performance). This situation was explored in the Least Capital scenario, which primarily represents fuel-switching only across the city. A very high-level estimate of the potential increase in heating-season demand associated with this scenario is shown in Figure 33. In contrast, and reflecting the average TEDI reduction of 50%, the recommended scenario does not see as significant an increase.

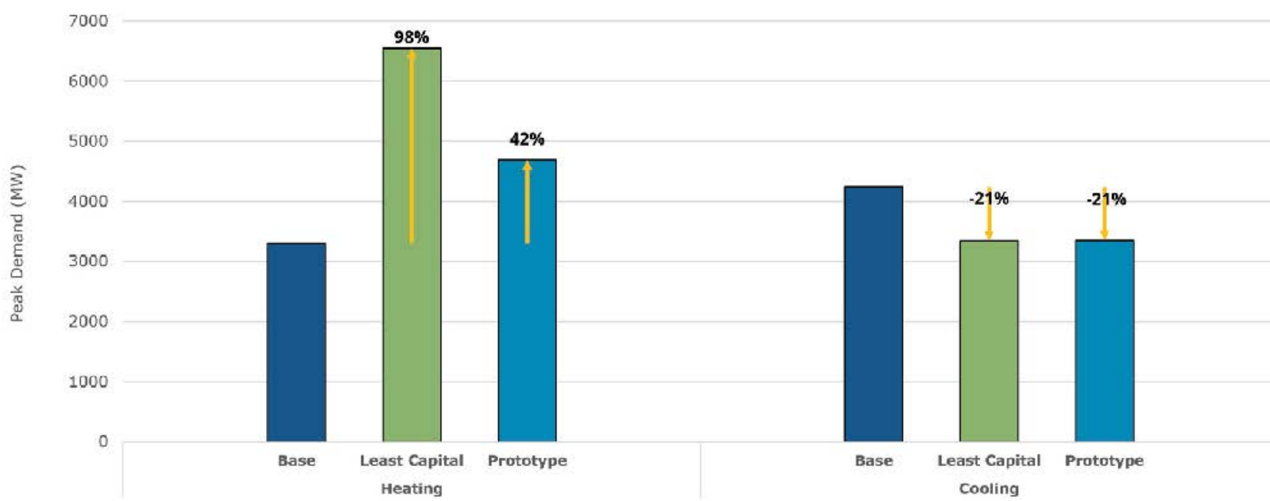



**Figure 33: Impact to the electricity grid**

Notably, the same impact does not occur on the cooling demand side. The important conclusion comes, however, when comparing the heating and cooling graphs to each other. The recommended case is higher, overall, than the cooling base demand, but not by much. If the least cost scenario were followed, the increase would be substantially more, potentially necessitating significant investment in additional generation.

Electricity demand analysis was not fully in scope for this study project, so the graphs above are provided as a very high-level indication that serious consideration needs to be given to the implications of fuel switching on the grid, an idea supported by other recent reports on the topic[13]. With the support of Toronto Hydro, the IESO and the OEB, the broader goal of reducing grid emissions can be achieved, simultaneously with deep retrofits by effectively valuing (and incenting) the following kinds of actions, all of which overlap with improved GHG reduction on site as well:

- Base electrical load reduction (i.e. mainly user-driven load and occupancy-based controls)
- Peak load reductions (i.e. mainly enclosure and HVAC-delivery system improvements)
- Heat pump efficiency improvements (i.e. especially improved cold climate ASHPs, switching to geo-exchange and other energy storage opportunities)
- On-site generation coupled with battery storage and/or demand response improvements

**Supporting a more cost-effective and resilient retrofit at each home and facility across the city can be mutually beneficial to grid operators, owners and occupants and should be a requirement of financing and incentives offered to buidling owners under-going fuel switching.**


13 For two examples, see the following reports:
https://www.cga.ca/wp-content/uploads/2019/10/Implications-of-Policy-Driven-Electrification-in-Canada-Final-Report-October-2019.pdf
https://ontariogeothermal.ca/ClientFiles/images/Dunsky-OGA-Benefits-of-GSHPs-for-Beneficial-Electrification-FinalRevised.pdf

## 2.5 Key Considerations

The results of the recommendations and analysis presented in Sections 2.3 and 2.4 highlight a number of key considerations when exploring how the City of Toronto can reduce its building sector emissions.

**Measure and Package Insights**

A summary of the most salient points that emerged from studying the measures and combinations of measures required to achieve zero emissions across the city (i.e. in Sections 2.3.1 and 2.3.2) are provided below.

- User-driven loads represent a likely starting-point from which most facilities would engage in further upgrades.
- Considering embodied impacts in deep retrofit design will be an important feature of projects that invest significantly in enclosure upgrades and fuel switching.
- All suitable packages include fuel switching to electric heat pumps (except where a low carbon district energy system may be available).
- Load reduction and near-temp system design reduces the electricity demand and overall capacity of fuel switching equipment.
- Facilities in downtown or high-intensity areas should explore low/zero emission co-generation and district energy node opportunities before deciding on their fuel switching and renewable energy strategies
- Modeling-supported life-cycle cost analysis is the best way to compare complex HVAC configurations and the trade-offs between load reduction, fuel switching and grid-conscious improvement packages
- Solar PV improves the business case for all retrofit packages while also addressing grid issues, and therefore should be promoted for all suitable buildings
- A site-specific assessment is the best (perhaps only) way to reveal the most appropriate combination of decarbonization measures

### City Scale Insights

Three important and interconnected policy-related conclusions emerge from the city scale analysis summarized in 2.3.3 and 2.4.

**First, while the pace of change proposed in the recommended scenario above has sought to strike a balance between speed and feasibility, it is nevertheless still swift, representing a 3% average change in floor area per year.** However, several programs and studies have seen or recommended similar rates of change. For example, this pace seems in line with the assumptions of several, similar recent studies including:

- *The EU's "Assessment of Long-Term Renovation Strategies under EE Directive"* which also targeted a 3% per year ICI transformation; and
- *Pembina Institute's "Building Retrofit Potential in BC Forum"* which targeted a 2% per year transformation across ICI and Residential sectors.

A similar pace was also achieved by the LiveSmart BC program when incentives were initially released (approximately 2.5% of existing residential floor area was renovated per year). Windfall Ecology Centre data analysis moreover revealed that at the height of the federal ecoENERGY retrofit incentive program in 2010, there were over 25,500 EnerGuide retrofits completed in the City of Toronto, or about 3% of the city's single-family homes at that time.[xlv] The federal incentive of up to $5000 was matched by the province with a simple homeowner-friendly delivery model, and retrofits resulted in an average emissions reduction of 28% per home. The success of the program shows the importance of incentives in driving retrofit activity (see Figure 34).

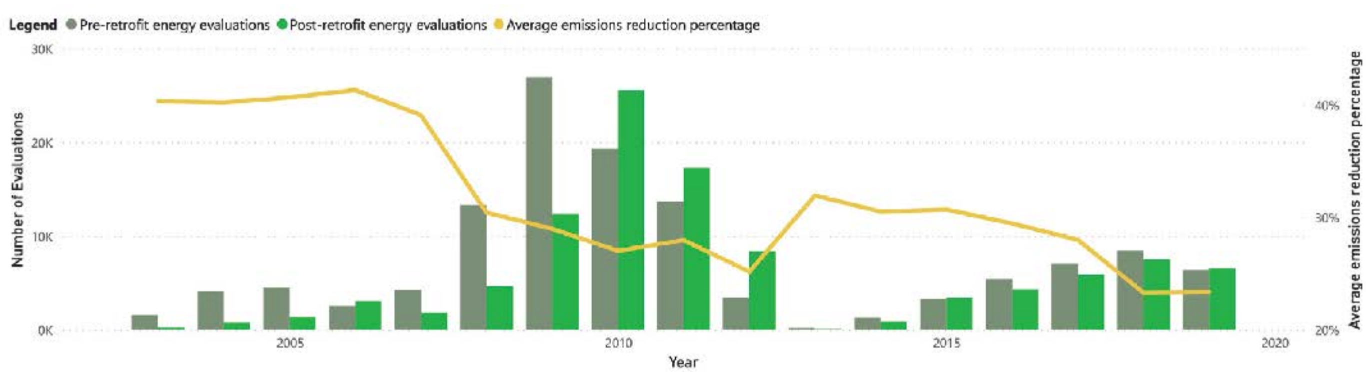



**Figure 34: Number of home energy evaluations by year in Toronto (Source: https://windfallcentre.ca/data-tools/retrofit-performance/toronto/)**

The key to such a high pace of change will rely on an open-minded, flexible, consolidated, and harmonized effort by all interested parties (i.e. utilities, other levels of government, non-profit actors, the City and building owners). It is essential that all incentive programs align with the federal offering and be additive. Competing incentives create consumer confusion and frustration like that experienced in Ontario with unaligned GreenOn and utility offerings. With a complete, easy-to-access and fulsome set of programs and supports, complex energy retrofits can be transformed into a regular part of capital planning and renewal for all building types.

**Second, it is important not to shy away from the fact that deep emissions retrofits at the level and scale necessary to affect market transformation are not cost effective in the traditional sense, even based on the current planned cost of carbon.** Retrofit measures with a reasonable short-term payback are likely already being undertaken by many building owners, but do not achieve the emissions savings necessary to hit the City's targets. As will be noted in Section 3, this is the key reason for both strong regulation to require deep emissions retrofits, as well as strong financial support for home and building owners. Wherever possible, retrofit actions should additionally seek to take advantage of any co-benefits or aligned priorities that also require retrofit, including for improved resilience in the face of potential future pandemics (e.g. flexible work location, enhanced ventilation effectiveness) and climate-related changes (e.g. flood and heat wave preparedness). Further, the opportunity to increase density through renewal could be immensely valuable to improving the affordability of housing and workspaces. Deep retrofits could also enable carbon storage opportunities that are not available in any other pathways.

**Third, making the switch to lower-carbon sources of energy is both necessary and, if implemented carefully, can be the lowest cost way to achieve deep emissions reductions. That said, the importance of grid decarbonization cannot be overstated.** Wherever possible, fuel switching should be aligned with renewable generation to keep capital and cost savings in the city and support a much needed decarbonization of the grid. As has already been envisioned and evolved through TransformTO and related initiatives, the opportunities to build renewable energy systems within the city are already available and will grow existing and new markets and reduce/control costs of electricity over time. Both community-scale (i.e. district energy, community-scale renewables) and site-level (i.e. heat pumps, PV and battery storage) decarbonization efforts can enable a lower-cost model over time, and discussion with the province about long-term electricity system planning benefits of such action may allow for additional long-term savings to be brought forward.

# 3. Recommended Policies And Actions

As the previous section outlined the means through which emissions reductions can be achieved across Toronto's buildings, this section now turns to a presentation of the recommended policies and actions the City of Toronto can implement to make them happen.

This series of recommendations for Toronto's Net Zero Existing Buildings Strategy has been created to approach deep emissions retrofits in the existing building sector as a transition from supporting voluntary action in the short term as a way to build capacity and collect information, to a more regulatory approach that would see mandatory requirements for building and home upgrades in the longer term. In general, all policies presented here should be understood as the primary levers through which the City of Toronto and its partners can enable, encourage, require or otherwise increase the uptake rates of the packages of measures described in Section 2.

## 3.1 Guiding Principles

The recommended steps outlined in this Strategy have been crafted and founded on a set of principles that have guided their development to ensure their integrity and success. To that end, the Strategy seeks to embody the following qualities:

1. **Transparent** – sending a clear signal of future policy well in advance
2. **Transitional** – shifting from voluntary to mandatory requirements over time
3. **Supportive** – providing resources and support to owners and industry members
4. **Data-driven** – making use of actual performance and cost data to continuously inform policies and programs
5. **Collaborative** – working together with key governments, agencies, organizations and institutions
6. **Beneficial** – maximizing benefits and minimize negative impacts on owners, tenants and occupants

## 3.2 Key Policies And Actions

There are several cross-cutting policies and actions that will be necessary for the City to take to decarbonize its existing building stock in a way that achieves the core principles of the Strategy. They make up the foundational moves that together can achieve a net zero emissions target by 2050 or sooner, and address a range of sub-sectors, from single family homes to larger institutional facilities. They have been derived from a combination of research on best practices in existing building policy and action and examples from leading jurisdictions across the world, as well as from a series of targeted stakeholder consultations on key issues such as residential retrofit action, financing tools, and the technical and cost implications of retrofit measures. They have been tailored to suit the unique environment and context of Toronto, and include the following:

| Purpose | Category of Policy / Action |
| --- | --- |
| **Set requirements** to assess performance and create a path to Net Zero | 1. **Require annual performance reporting and public disclosure** to improve building owners' and the City's understanding of the performance of Toronto's homes and buildings<br>2. **Establish emissions performance requirements** to gradually require performance improvements in a way that allows flexibility and acknowledges sector-specific challenges<br>3. **Require energy audits and retro-commissioning** to support building owners in understanding how to improve their energy and emissions performance and meet upcoming requirements |
| **Provide support and resources** to make retrofits easier and more affordable | 4. **Provide and support financing and funding** to ramp up the amount of capital available to home and building owners for deep emissions retrofits<br>5. **Provide integrated retrofit support** to reduce the complexity, cost and time associated with retrofits, and support building owners with lower capacity in navigating the many processes and decisions they face when exploring retrofit options<br>6. **Adapt and streamline permitting and approvals** to support building owners in navigating the permitting processes for deep emissions retrofits |
| **Lay the groundwork** for market transformation | 7. **Build awareness and capacity of home and building owners** to provide them with the information they need to make wise retrofit investments<br>8. **Support workforce development and training** to ensure a strong and sufficiently numbered workforce is ready to meet the new demand for deep emissions retrofits<br>9. **Advocate for action at other levels of government** to enable the necessary changes to make retrofits a smart, dependable investment |

The following sections outline the rationale and key actions associated with each of these nine policy recommendations. **It is important to note that each recommendation will require special consideration in terms of how it is applied to each sector, and tailored to suit the unique needs and characteristics of different building and ownership types.** How each sector will be addressed is detailed more fully in Section 4. The specific order in which each action is recommended to occur is outlined in further detail in **Appendix B**.

### 3.2.1 Require Annual Performance Reporting & Public Disclosure

**Key Benefits**

- Provide home and building owners and/or managers with the information they need to understand how their building is performing in comparison to others, as well as the impact of renovations or changes
- Provide prospective buyers or tenants with important information on energy and emissions performance to inform the decision to buy, rent or lease a space or building
- Collect actual building performance data for the City to use in designing effective and targeted programs to the sectors or areas of the city most in need of improvement

A now commonly heard adage in the building sector is that *'you can't manage what you don't measure'*. The Province of Ontario's *Energy and Water Reporting and Benchmarking* (EWRB) initiative has been celebrated as one of the only benchmarking programs in Canada, and foundational to the improvement of existing building performance by providing both authorities having jurisdiction and owners themselves with the information they need to understand building performance across the sector. Initially requiring owners of commercial, residential and industrial buildings with a gross floor area of 250,000ft$^2$ or greater to report their data to the Ministry of Energy, Northern Development and Mines (MENDM), this threshold was lowered to 100,000ft$^2$ in 2019 and will be extended to all buildings over 50,000ft$^2$ in 2023. Buildings of smaller sizes than those required are also now permitted to voluntarily submit their performance data. In September 2020, MENDM released the 2018 energy and water performance data set for buildings 250,000ft$^2$ and above, which is now available online on the Ontario Data Catalogue.  However, the MENDM data published online remains anonymized, which makes it useful for data analysis of the sort found in this report, but limited in its ability to drive market transformation or support performance requirements.

While benchmarking requirements do not directly translate into energy or emissions reductions, they provide both building owners and provincial and municipal jurisdictions with the information necessary to implement the measures and policies that do. When requirements to benchmark and report data are coupled with a requirement to disclose that information to the public annually, or at key decision-making points, it can then be used by tenants and future buyers to make an informed choice when deciding to lease, rent, or purchase a space. Disclosure and labelling also helps new and existing homeowners to plan for and prioritize retrofit measures in the future, and gives them clear information on the scale of improvements following a renovation. However, disclosure at time of sale or rent must happen early enough in the transaction process to meaningfully impact decision making. Experience from the European Union has furthermore shown that displaying energy ratings generally have a positive impact on property sale prices[xlvi].

The continued roll-out of the EWRB to smaller buildings will improve the understanding of the performance of Toronto's building stock, in turn helping to inform policy and programmatic decisions/adjustments needed to enable the transition towards mandatory emissions performance targets. However, it will be important to extend reporting and disclosure requirements to smaller buildings and homes for the value of reporting and disclosure to take effect across the sector. The City will be required to embark on a process of engagement with key stakeholders to garner buy-in to the development of a widespread benchmarking and labelling requirement, especially in the absence of provincial support. Once any issues are resolved (e.g. maintaining privacy), such a requirement would be relatively fast to scale up across the sector, especially where working in partnership with local utilities.

**Key Actions**

| No. | Action |
|---|---|
| 1.1 | Engage in advocacy to higher levels of government for the continuation and expansion of the EWRB<br>• Advocate to the Province of Ontario for a continued roll-out of the EWRB to smaller buildings of 25,000ft² and eventually buildings between 25,000 ft² and 10,000ft²<br>• Advocate to make public disclosure and labelling of energy and GHG emissions performance mandatory annually both online and at building entrances/lobbies<br>• Advocate for transactional disclosure of energy and emissions performance at sale, lease, and rental—including requirements that the disclosure happen early enough to inform the transaction<br>• Work with the Province of Ontario, utilities and the Ontario Energy Board to simplify data collection and submission processes, including mandated implementation of the "Green Button" standard by electricity and natural gas companies, to provide customers with electronic access to utility data, with particular focus on direct automated upload of utility data to ENERGY STAR Portfolio Manager using the Portfolio Manager Web Services API, for both individual meter and aggregated whole-building data |
| 1.2 | Develop a program for labelling for EWRB covered buildings<br>• Continue to provide dedicated City staff to support Toronto's building owners in complying with provincial EWRB reporting requirements<br>• Expand the support City staff provide for data reporting and disclosure to smaller building sizes not covered by EWRB regulation<br>• Work with the Province to make EWRB reporting data public, as a necessary component of a performance standard program<br>• Encourage voluntary labeling of building performance at lobbies or entrances, and explore making labeling mandatory as part of eventual performance standards |
| 1.3 | Expand home energy disclosure and labelling using EnerGuide, beginning with a voluntary program as a part of education and awareness raising activities and transitioning to a mandatory program. Link home performance data collection to a centralized online retrofit support platform (see Section 3.2.5)<br>• Require building and home energy and emissions disclosure and labelling as a prerequisite to accessing City support programs or City funding for retrofits. Integrate requirements for home energy assessment, disclosure and EnerGuide labelling into City programs and incentives<br>• Identify a transition to mandatory home and building performance disclosure and labelling at key interfaces with the City, including title transfer, sale/lease, landlord registry/licencing, and major renovation/permitting |

| | |
|---|---|
| 1.4 | Work with NRCan to simplify the EnerGuide for Homes audit and reporting processes for better uptake<br>• Integrate GHG emissions information more explicitly into the EnerGuide label<br>• Explore the potential to create an EnerGuide label customized for the Toronto market tied to performance requirements<br>• Link home energy assessments and labelling efforts to the development of a whole Home Renovation Roadmap that identifies retrofit options and financing over time, providing a full map of necessary upgrades that can be transferred from one owner to the next<br>• Subsidize EnerGuide home assessments to encourage uptake of voluntary disclosure and labelling, tying subsidies to demonstrated completion of retrofit action |
| 1.5 | Over time, use disclosed data to refine and inform future City policies and programs<br>• Use reported data to identify and target priority sectors, areas of the city and/or property types in greatest need of performance improvements<br>• Consider establishing fines and public disclosure of non-compliant properties to encourage compliance with labelling requirements |
| 1.6 | Re-assess the City's approach in response to the Province's continued roll out of the EWRB<br>• Consider the value of developing a City-based reporting platform to streamline integration of benchmarked data into mandatory performance standards (see section 3.2.2)<br>• Consider the City's ability to expand reporting requirements to building size thresholds of 25,000ft² and possibly smaller (e.g. 10,000ft²) within Toronto<br>• Explore additional reporting scope beyond the current EWRB (i.e. Energy Star) and EnerGuide focus, including occupancy, refrigerant maintenance, and material selection for significant upgrades |
| 1.7 | Support a broader market transformation via integrated, large-scale disclosure<br>• Work with real estate institutions to increase literacy, promotion and voluntary labelling of energy and emissions performance in sales and leasing<br>• Support connection between EnerGuide assessments/performance ratings and property appraisals to further send the market signal that emissions performance is important<br>• Advocate for the active use/integration of home energy and emissions performance in MLS listings |

### 3.2.2 Establish Emissions Performance Requirements

**Key Benefits**

- Provide clear targets and timelines to give the building sector the clarity and certainty it needs to make the right investments and decisions
- Making performance targets mandatory moves beyond voluntary measures to drive the scale and depth of emissions reductions necessary for Toronto to meet its net zero by 2050 target

While requiring reporting and disclosure and providing financial and other support to building and homeowners for deep emissions retrofits is a key part of this Strategy, without establishing targets and firm requirements there is a lack of clarity as to necessary levels of building performance and little to directly motivate retrofit action. Establishing performance targets is an increasingly well-established way of driving performance improvements, as it allows owners to identify the most cost-effective and appropriate means of improving performance in their buildings. The structure of a performance-based standard also allows implementing jurisdictions to pinpoint the likely impact on sector-wide emissions reductions, as well as on the growth of the retrofit market. Several jurisdictions now require buildings to meet emissions performance targets, including Vancouver, New York City, St Louis, Washington DC, and Washington State[xlvii].

There are four broad considerations the City must address when creating a performance standard:

1. Performance requirements should be selected to elicit the desired outcome – in this case, emissions reductions.
2. Covered buildings and homes must be provided with plenty of advance notice of incoming performance requirements, as well as the opportunity to identify the right path forward prior to compliance being enforced. Allowing sufficient time before more stringent levels of performance are required also helps to ensure the market is ready.
3. Requirements must be revisited over time using actual performance data to ensure they are both feasible and sufficiently stringent to achieve Toronto's climate targets.
4. Performance requirements themselves must be designed to push for better performance at reasonable levels and intervals for specific building sectors while allowing some flexibility in compliance – especially where deadlines are misaligned with equipment service life. Outlining specific penalties for non-compliance while providing a range of alternative compliance pathways helps to ensure goals are met while not unduly burdening property owners and occupants. This is especially true where there are concerns regarding overall affordability and the risk of increasing tenant costs.

A promising avenue for requiring or encouraging compliance is the City's existing property assessment, valuation and tax processes, which could be modified to include rates that reflect the emissions performance of a home or building. In addition to performance requirements for operational emissions, many jurisdictions are also beginning to explore means of encouraging or requiring reductions in embodied emissions. While this is an area that has only begun to be addressed in new construction, it is important for the City to identify means of supporting the use of lower embodied carbon materials. However, a key first step for the City of Toronto will be to clarify its precise authority regarding the regulation of existing building emissions, and to work with the Province where additional clarity or powers are required.

**Key Actions**

| No. | Action |
|---|---|
| 2.1 | Set performance requirements for key building archetypes (i.e. single family detached, low- and high-rise MURB, commercial office/mixed use, institutional) based on energy and emissions modelling results and benchmarked building data |
| 2.2 | Engage in a widespread information campaign to inform building and homeowners of upcoming requirements well in advance of first compliance deadline<br>• Ensure owners are aware that targets will be voluntary in early stages, with the intent to transition to mandatory targets at a later date<br>• Ensure new construction projects are aware of existing building requirements to help avoid the risk of higher emissions technology lock-in, or harmonize/align these requirements<br>• Use time of sale, title transfer, replacement, rental, and lease permits as opportunities to flag incoming requirements<br>• Make use of building benchmarking, EnerGuide and other datasets to target applicable properties and notify owners on the timing of upcoming first performance threshold and what programs are on offer |
| 2.3 | Tie the achievement of thresholds of performance to voluntary programs and available funding/financing to encourage early uptake:<br>• Gather information on current building performance and emissions reductions that can be expected from different combinations of retrofit measures and approaches<br>• Offer recognition/incentives for those who take advantage of early program offerings/who commit to deeper retrofits<br>• Leverage participation from Green Will participants and showcase successes and case studies in portfolio-wide decarbonization |
| 2.4 | Identify and implement a pathway to transition over time to the enforcement of mandatory performance requirements, based on modelled and actual building performance, and gradually increase over time (see Section 4 for detailed recommendations by sector)<br>• Work with the Province of Ontario to identify any necessary expansions in regulatory authorities<br>• Signal the first set of targets in 2021/2022 and gradually require more stringent targets over time<br>• Explore and set alternative compliance pathways for select building types, including for district energy-connected buildings and facilities<br>• Coordinate with TGS targets for new construction to ensure alignment of building performance expectations |

| | |
|---|---|
| 2.5 | Establish a means of encouraging compliance and/or penalty for not achieving performance thresholds<br>• Explore adjustments to municipal tax structures to reflect emissions performance and allow good emissions performance to be rewarded (and vice versa)<br>• Leverage reported building performance data to determine an appropriate level and approach to tax abatement with low administrative costs<br>• Work with the Province of Ontario to explore adjustments to the property assessment and tax regime (including the Land Transfer Tax) to explore additional methods of recognizing good performance<br>• Consider the use of Section 37 agreements to secure retrofits to existing buildings that are on the same site as a new development<br>• Use potential fines levied from non-compliant properties to directly fund programs and initiatives supporting deep retrofit projects, subsidize Retrofit Coordinator services, and lowered interest on performance-based structured funding |
| 2.6 | Alongside a performance requirement for operational emissions, identify and implement measures to support and eventually require reductions in embodied emissions<br>• Similar to how it has been addressed in the TGS, begin to collect data on embodied emissions performance in retrofits (e.g. narrative of how embodied emissions were minimized, documentation on product choices)<br>• Issue a products list of materials that should be avoided or minimized in retrofits, shifting from information provision to prohibitions on specific materials (e.g. standard concrete, foam-based materials)<br>• Explore means of using embodied emissions reductions or ‘removals’ as a means of meeting operational emissions performance requirements |
| 2.7 | Monitor performance and re-calibrate targets using data gathered through reporting requirements |

### 3.2.3 Require Energy Audits and Retro-commissioning

**Key Benefits**

- Ensure building owners and managers have the information they need to understand how best to improve their building's performance

Where benchmarking and disclosure requirements help building owners to understand how their building performs in comparison to others in its class, energy audits help to pinpoint specific areas of improvement. To date, approximately half of the 30 jurisdictions across North America that have adopted benchmarking requirements have gone further, mandating energy audits, retro-commissioning, building tune-ups, or similar lighter-touch policies aimed at helping building owners understand exactly what they need to do to improve performance and encourage retrofits. Most of these focus on requirements for a combination of energy audits and/or retro-commissioning (RCx), which help identify inefficient equipment and systems and identify the set of upgrades or operational improvements that can help achieve energy savings, reduce emissions, and improve occupant comfort. The City of Toronto can customize energy audit requirements to include a focus on building resilience, including criteria such as air quality, thermal resilience, backup power generation, and access to water during power outages. Resultant actions from energy audits and RCx can both yield significant energy savings, as high as 30% where significant measures are adopted but with an average savings of around 5%.[xlviii]

Requiring energy audits and/or RCx can help poorer performing buildings in the City of Toronto understand how to improve their energy and emissions performance, as well as the measures that will be required to comply with future requirements. When coupled with a requirement to align the results of audits with capital planning, such a requirement helps to confirm that owners are aware of what they need to do to meet upcoming targets, and have integrated the necessary considerations into capital planning processes to ensure deeper retrofit measures can be properly anticipated and accounted for. The City may wish to consult the Canadian Federation of Municipalities Green Municipal Fund's *Community Buildings Retrofit Initiative*,[xlix] which includes a guidance document for low carbon feasibility studies that addresses the issue of incorporating audits and capital planning. The guidance outlines an approach for conducting audits that falls between an ASHRAE Level II and Level III audit, balancing the lower level of effort associated with an ASHRAE Level II audit and the focus on capital investment planning associated with a Level III process.

**Key Actions**

| No. | Action |
|---|---|
| 3.1 | Require buildings to demonstrate that an energy audit or RCx has been recently completed (i.e. within two years) as a prerequisite for participation in City programs, as well as those offered by other key partners (e.g. Enbridge, Toronto Hydro, IESO)<br>• Ensure energy auditors are certified and/or recognized by the City of Toronto as qualified service providers<br>• Ensure audits include the identification of potential measures to improve occupant health and overall building resilience alongside potential energy and emissions reduction improvements (e.g. indoor air quality testing, air tightness testing, etc.) |
| 3.2 | Require buildings subject to performance requirements (see Section 3.2.2) to demonstrate that they have undergone an energy audit and that results have been incorporated into a “Retrofit Roadmap” that identifies how upgrades necessary to meet performance requirements will be aligned with conventional assessment and capital planning processes<br>• Roadmaps should provide a summary and timeline of planned upgrades over a minimum of 10-15 years, and demonstrate how capital planning/renewals will be aligned with future performance requirements<br>• Roadmaps should also highlight co-benefit measures beyond traditional energy management (e.g. embodied carbon, resilience, health, equity)<br>• Building owners with lower capacity should be provided support in developing Roadmaps via subsidized Retrofit Coordinator services<br>• Potential exemptions from this requirement include:<br>o Demonstration via EWRB data that the building already meets upcoming performance requirements for the next 15 years<br>o Instances where the results of a previous energy audit/RCx investigation are in the process of being implemented, making a new audit/RCx premature<br>o Projects that can demonstrate achievement of one of the following certifications, and where the most recent calendar year EUI does not deviate by more than 15% from the EUI at the time of certification:<br>◇ LEED Gold or Platinum O+M (with an ENERGY STAR Score of 75, if available),<br>◇ ILFI Living Building, Petal (including Energy Petal), or Net Zero Energy certifications<br>◇ Passive House EnerPHit, or<br>◇ Canada Green Building Council’s Zero Carbon Building-Performance certification |
| 3.3 | Require approved audits and updates to be completed at change of use/ownership and before all major renovations<br>• Consider exemptions as noted above, as well as for buildings that have been recently subject to the same requirements as a result of their reported EWRB performance |
| 3.4 | Use the information and data provided in audit reports to inform future performance targets and direct additional support to poorly performing buildings |

### 3.2.4 Provide & Support Finanacing and Funding

**Key Benefits**

- Expand access to financing and reduce the risks and long payback periods associated with deeper retrofits for large building projects
- Provide smaller scale projects (e.g. smaller commercial and residential buildings, single family homes) better access to financing, despite their relatively high-risk profile compared to larger projects

Providing incentives and financing is one of the most common and important tools with which governments can encourage the accelerated uptake of energy and emissions retrofits. Rebates and incentives help to lower the costs of specific services or equipment, while financing makes it easier for owners to foot the bill and manage the costs of more or deeper retrofit measures.

The City already provides financing for retrofits via three key programs. *The Energy Retrofit Loan*[l] program offers low-interest loans to help owners of commercial, institutional, and multi-unit residential properties to improve the energy efficiency of their buildings. The *High-Rise Retrofit Improvement Support Program* (Hi-RIS)[li] provides financing with up to 20-year terms at competitive fixed rates to residential apartment buildings of three-storeys or greater for improvements in energy and water consumption, including on-site PV systems and geo-exchange. These programs provide financing for up to 100% of project costs, at a rate established to reflect the City's current return on its investment portfolio, with repayment terms up to 20 years. Based in the province's Local Improvement Changes (LIC) regulation, the payment obligation of these loans is tied to the property and not the owner, and secured by the City's statutory priority lien. Finally, the *Home Energy Loan Program* (HELP)[lii] provides homeowners with financing of up to $75,000 and flexible terms to cover the cost of energy and water efficiency upgrades, fuel switching, and renewables.

These programs have already received good uptake and have supported a significant number of upgrades across the city, including multiple streams of coordinated financing. Rebates are also currently available from provincial and federal agencies and utilities to help reduce the costs of energy efficiency upgrades or equipment, as well as support for low-income households.[liii] However, to achieve the scale of retrofits necessary to meet the City's emissions reduction goals, significant cost reduction measures will be necessary to relieve home and building owners of additional debt and make investments into emissions reductions more accessible. Specific interrelated tools to consider include the establishment of a Green Bank, the aggregation and securitization of retrofit projects, credit enhancement, and rebates.

### Green Banks

Green investment banks, or Green Banks, are public-purpose finance institutions designed to facilitate private investment in energy and emissions reduction projects. Already in use by several US states, Green Banks represent an effective tool to demonstrate new energy efficiency markets and financing approaches in their ability to raise capital through a range of mechanisms. Among the mechanisms available to Green Banks, one important tool is project aggregation and securitization. Under this model, multiple projects that are too small, scattered and/or high-risk to attract the attention of financial institutions are aggregated together to create a more attractive investment. Green Banks can act as the intermediary between the multiple retrofit project owners and lenders to help make investment in retrofit financing more appealing, and at lower rates and transaction costs than would be otherwise possible for building owners. This process of aggregation and securitization allows the Green Bank to recapitalize its warehouse, generating additional capital.[liv,lv]

A regional Green Bank could act as a means of pooling together some of the financing streams that have already been made available (e.g. via the Canada Infrastructure Bank) with new sources of private and public capital to increase the total pool available for building retrofits. Wherever possible, it is important to ensure that available financing can be used for multiple dimensions of a single retrofit project, to avoid forcing home or building owners to secure separate portions of a single project. Leveraging a single channel helps to reduce complexity for owners by streamlining different sources of financing, ideally layering in any available incentives. Once risk profiles have been reduced and a market is established, deep emissions retrofit financing can shift from a publicly financed model to one fueled by private sector investors. The green bank could also have a role in administering a Commercial-PACE program to allow financing through property assessments.

### Credit Enhancement

Credit enhancements mobilize private capital by encouraging lenders to provide long-term financing or lower interest rates, lowers the overall cost of capital for retrofit financing, and makes financing available to customers who would not otherwise be eligible for credit. Forms of credit enhancement include:

- *Loan loss reserves and loan guarantees*, in which a government works with one or more financial institutions to set aside a portion of money to cover all or a portion of a borrower's debt obligation in the event that they default, lowering the risk to lenders; and
- *Interest rate buydowns* (IRB), in which a government can subsidize or 'buy down' the standard interest rate for private loans offered by a financial institution. IRBs are typically paid by a government to the private loan provider in a single upfront sum equal to the total subsidized interest charge over the agreed-upon term.

Credit enhancement tools represent important means of ensuring that all home and building owners have access to no- or low-cost financing for deep emissions upgrades. Loan loss reserves and loan guarantees can also offer relatively low-cost ways to enhance the flow of capital into retrofit projects, allowing for a broader reach and support to a greater number of retrofit projects while remaining relatively affordable for the City and other governments.

## Rebates and Incentives

Rebates, incentives and grants all help reduce the up-front costs of retrofit measures by covering a portion of the total cost of a specific service (e.g. audits) or measure (e.g. equipment). When offered consistently and coupled with other forms of support and financing, these cost reduction measures can significantly lower the cost barrier associated with deep emissions retrofits. While often offered by utilities or higher levels of government, cities can support cost reductions by connecting owners to existing rebate programs, matching current offers or offering top-ups to those programs, or offering subsidies on specific services (e.g. audits, retrofit coordination) or measures. Cities can also create incentives via existing structures, such as by increasing or decreasing property or other taxes to reflect home or building performance.

In general, incentive programs can be divided into the following categories:

1. *Prescriptive rebates* for specific equipment (such as heat pumps), which can be provided either directly to consumers or "upstream" via manufacturers, distributors, and contractors
2. *Direct-install programs*, which see the installation of equipment at no cost to the consumer
3. *Comprehensive whole-building programs*, which provide custom incentives to building owners regardless of the meter payment, and can incentivize deeper system replacements, and
4. *Performance-based incentives*, which increase in value according to performance improvements realized to a maximum amount per unit area or suite.

In general, rebates often need to cover a substantial portion of the cost (i.e. 30% or more) to be effective in eliciting deep emissions retrofits or enticing a fuel switch. For certain low-emissions equipment (e.g. heat pumps), traditional rebate models may work well if sufficiently funded and promoted. Heat pump incentives for the single-family dwelling sector in particular are most effective when offered "upstream" in partnership with manufacturers, or "mid-stream" in partnership with wholesale distributors, creating a seamless experience and lower costs for contractors and customers.

For complex multi-measure retrofits, envelope upgrades, and operations and maintenance improvements, performance-based incentives (especially pay-for-performance, or P4P), are more appropriate than traditional rebates. While P4P incentive programs often simply compare weather-normalized energy consumption pre- and post-retrofit, more sophisticated programs use interval data coupled with a regression analysis to model and compare "business-as-usual" energy consumption with actual post-retrofit performance to estimate real savings while accounting for weather and use variation. These kinds of incentives can also be structured to pay out at higher levels per unit of energy (or emissions) savings to incentivize projects to target higher levels of efficiency. This structure offers flexibility by setting significant but achievable energy use or emissions reduction thresholds ahead of mandatory requirements. Thresholds for higher rebate amounts could be set according to future targets to continue to drive action.

Overall, incentives and rebates should ideally provide a simple means of rewarding improved whole-building performance and that help overcome barriers to deep emissions upgrades. Rebates and other incentives are often confusing when they are offered by multiple actors (e.g. utilities, provincial governments, federal government). To be more successful, rebates should instead be streamlined into a single actor, and integrated into financing and loan forgiveness structures directly to help reduce complexity and relieve owners of the burden of having to apply for multiple streams of financial support.

However, one of the challenges that jurisdictions face in streamlining rebates is that they are often offered by energy utilities that tie their receipt to reductions in the use of a specific fuel. This can create conflicts of interest as well as a substantial challenge to fuel switching. For example, an electricity incentive program that measures success solely based on kWh savings cannot effectively finance electrification programs; a natural gas utility program focused on installing new gas equipment is not likely to incentivize a shift to lower emissions sources of energy. Some US jurisdictions (e.g. Vermont, Massachusetts, New York, and the District of Columbia) have addressed this challenge by creating incentive programs that span energy sources and use performance targets measured in fuel-neutral energy savings or greenhouse gas emissions reductions.

Another challenge many rebate and incentive programs face is the common disconnect between who pays the utility bills and who arranges for energy efficiency investments. Comprehensive whole-building programs can resolve this somewhat, but a more promising solution is the use of utility-ESCO partnership approaches, such as the Metered Energy Efficiency Transaction Structure (MEETs) being pioneered in Seattle (discussed more in the following section).[lvi]

**Bulk purchasing**

In addition to providing financing or other cost reduction measures, cities can use bulk pricing approaches to secure reduced prices for equipment or retrofit packages by guaranteeing a large volume purchase. Programs such as Energiesprong have demonstrated the potential of this economy of scale in reducing the up-front costs of retrofits. This program takes advantage of the standardized social housing typology to aggregate demand for multiple retrofit measures, leveraging principles of mass customization and industrialization to streamline both costs and installation times. Upgrades are financed through energy cost savings and reduced maintenance and repairs.[lvii]

**Key Actions**

| No. | Action |
| --- | --- |
| 4.1 | Work with key federal and provincial partners to establish a Green Bank at an appropriate scale to support the rapid scaling up of retrofit market using improved financing mechanisms:<br>• Explore the use of a Green Bank to provide robust financial support for significant retrofit projects across all markets to demonstrate their viability and collect data on project challenges, successes, costs and net performance outcomes<br>• Support the blending of federal, provincial and private sources of capitalization (e.g. seed funding, underwriting, loan loss reserve, etc.) with existing City financing to bring more capital to typical projects at reduced risk to all contributors<br>• Explore delivery models that adapt to meet local needs and interests while meeting those of higher levels of government or with government-adjacent organizations (e.g. Canada Infrastructure Bank, Federation of Canadian Municipalities) and national groups of private lenders. Where co-developing/contributing to a provincial or national Green Bank is unfeasible, build on existing structures (e.g. TAF) to create a regional centre. |
| 4.2 | Continue or modify City programs for no- or low-interest financing for retrofits, exploring the potential for larger loans and/or greater terms based on the achievement of deeper emissions reductions. If a Green Bank is established, it might operate at least some of these programs.<br>• Expand on existing HELP, Hi-RIS, and ERL programs to finance deeper measures with longer payback horizons (e.g. 30+ years) at lowest possible rates<br>• Evaluate the ERL program to finance decarbonization measures shifting from a financial business case to a carbon pricing model<br>• Explore an interest-rate reduction or partial loan forgiveness mechanism tied to actual emissions reductions (and assuming all other conditions of service quality are maintained)<br>• Require the achievement of co-benefits as conditions for loan approvals (e.g. embodied carbon, improved resilience, occupant health, grid stewardship)<br>• Harmonize and integrate financing conditions with the City's existing building decarbonization requirements<br>• Explore the subsidization of relocation costs for tenants during major retrofit activities, as well as other means to reduce the risk of "renovictions" |
| 4.3 | Support aggregation and securitization to help de-risk investment in multiple smaller retrofit projects<br>• Work with the Green Bank to identify and pool retrofit projects, drawing on benchmarking and energy audit data<br>• Use loan guarantee, loan loss reserve, or interest rate buydown to encourage lenders to provide private financing to owners on more favourable terms<br>• Decrease credit enhancement and funding opportunities over time as financial market becomes established |

| | |
|---|---|
| 4.4 | Identify and provide both internal (i.e. City-funded) and external (i.e. federal or utility) rebates and incentives to encourage emissions reduction upgrades<br>• Advocate for enduring and adequately resourced retrofit equipment and service rebates at the federal and provincial levels<br>• Advocate for renewed provincial ratepayer funded incentive programs that align with federal incentives and expand accessibility to low-income families, including tenants<br>• Champion incentive and rebate offerings that are additive, non-competing, and address split incentive and free ridership issues<br>• Champion incentive and rebate programs that are fuel-neutral and can incentivize fuel switching and decarbonization in addition to same-fuel energy efficiency<br>• Implement targeted incentives for retrofit measures with low embodied carbon where options are available<br>• Consider partial loan forgiveness as a performance-based rebate strategy |
| 4.5 | Work with industry partners to explore the potential for bulk purchasing arrangements to reduce costs for multiple retrofit measures in standardized typologies |

### 3.2.5 Establish Integrated Retrofit Support Services

**Key Benefits**

- Build home and building owners awareness of the different options and benefits of different packages of retrofit measures
- Make the clear and consistent program information and the right service providers easy to find
- Reduce the time, complexity and costs associated with retrofit activities

Owners often face considerable complexity and confusion when trying to understand and improve their home or building's performance. From energy benchmarking, to retrofit and capital planning, to navigating permitting processes, owners face an array of steps and choices and may have little time or capacity to understand them all, much less act. To support their building industry, several jurisdictions including Cambridge, New York City, and a number of states and European countries have implemented various forms of support services to help provide owners with help in planning, identifying, selecting, financing and undertaking retrofit measures. Such services can also help to increase the pace of retrofits and help ensure that retrofits are carried out correctly and realize the multiple co-benefits that home and building upgrades can provide.

Two key pieces have been found to be central in providing strong support for home and building retrofits. First, a website where owners can find the full set of information and services needed to implement deep emission reductions. This helps to centralize information and resources in one easy-to-navigate place. This informational website should in turn be connected to the second form of support: City- and/or industry-led retrofit coordination services, which help owners to identify their retrofit needs and options, select packages and contractors, streamline the retrofit process, and verify improvements in performance. Sometimes referred to as "one-stop-shops", these services remove the burden from owners of managing every step of the retrofit decision-making process, reducing complexity and disruption, while improving outcomes. One-stop-shop retrofit services have been available to the residential sector in Europe for more than 10 years. In 2018, the European Parliament amended the Directive on the Energy Performance of Buildings to include the creation of turnkey integrated energy renovation services (Directive 2018/844/EU). As an example, Germany's one-stop-shop home retrofit coordination service is federally subsidized and delivered by independent energy advisors licensed by the German government. The same advisors also deliver pre- and post-energy audits akin to those provided by NRCan licensed energy auditors in Canada.

An appropriate model for the City of Toronto is one that leverages existing industry associations, organizations, and existing City platforms to create an owner-centric renovation process. Indeed, The Atmospheric Fund (TAF) has already begun to design a deep retrofit delivery centre for multi-unit residential buildings across the Greater Toronto and Hamilton Area. The City's Better Buildings Navigation & Support Services also already provides building owners, operators, and property managers support in navigating energy efficiency and emissions reduction upgrades. The Sustainable Towers Empowering People (STEP) program additionally provides direct support to owners and managers in benchmarking and reporting their energy, water and waste performance. Any City-run or supported services could eventually transition to a majority third-party model in which a variety of certified service providers act as trusted advisors, with certification necessary for compliance with City programs and requirements. In either case, the City of Toronto will need to identify its preferred approach (i.e. City-run vs. third-party supported) to supporting home and building owners navigate the retrofit process.

**Key Actions**

| No. | Action |
|---|---|
| 5.1 | Explore means of building on existing City platforms to create a central online resource that allows home and building owners to:<br>• Access online information on the benefits of deep emissions retrofits and available programs<br>• Conduct a simple online assessment that helps them identify typical issues for homes or buildings of their age and type, as well as recommended retrofits<br>• Create an account to upload their building's performance and compare it to past performance and others in their area or of similar age/type<br>• Contact a customer service agent (both online and via phone) familiar with their neighbourhood or sector as a first point of contact for home and building owners. Roles of the Customer Service Agent could include:<br>o Fielding questions from home and buildings owners<br>o Connecting owners to available programs and qualified service providers<br>o Connecting owners to Retrofit Coordinators<br>o Pointing owners to relevant resources on the City online support platform |
| 5.2 | Work with industry partners to build Retrofit Coordinator services that leverage current City programs and provide hands-on professional support to facilitate the complete retrofit process. Roles of a Retrofit Coordinator could include:<br>• Fielding questions from building owners on programs, requirements, rebates, and general building performance issues<br>• Supporting the development of capital plans aligned with audits and performance requirements<br>• Connecting building owners to appropriate service providers<br>• Coordinating between service providers on behalf of the owner<br>• Verifying quality service provision<br>• Submitting financing and incentive documentation |
| 5.3 | Connect the use of Retrofit Coordinator services to City programs and provide subsidized access to their services for owners voluntarily pursuing exceptional levels of performance ahead of the curve, as well as priority populations<br>• Over time, shift to a fully pay-for-service model of retrofit delivery centres to ensure Retrofit Coordinator services are available to building owners subject to compliance with mandatory performance requirements, but continuously subsidized for low-income housing operators and mid-tier building owners<br>• Work with local organizations to help them act as service delivery agents in their own communities, drawing on the support of the City's programs and initiatives |

| | |
|---|---|
| 5.4 | Support enhanced Energy Service Company (ESCO) services for the building industry, including community-based delivery models<br>• Work via Retrofit Coordinator services to help less experienced building owners establish ESCOs contracts, including the ESCO's share of savings and the performance period<br>• Act as a third-party support to enable innovative ESCO delivery approaches, such as the Metered Energy Efficiency Transaction Structure (MEETs), which allows the delivery of "Energy Efficiency as a Service", providing services to a group of properties with different owners, rather than being tied to a single owner's portfolio(similar to existing LIC programs)[lviii]<br>• Support others seeking a purely private ESCO model by making public/transparent the types of contracts supported and endorsed by City-certified projects |

### 3.2.6 Support Permitting & Approvals Process

**Key Benefits**

- Support efficient navigation of the permitting and approvals process for deep retrofit projects
- Leverage permitting as a key intervention point to engage and educate building owners on emissions performance targets and retrofit support resources

Permitting structures for renovations are crucial to ensuring a sound construction and building sector in Toronto. However, as the complexity of buildings and deep retrofits increase in response to Toronto's climate change policies the process can become more challenging for building owners to navigate efficiently, particularly for homeowners. Providing greater clarity and support for building owners in navigating the permitting process can help enable code compliance for higher volumes of projects with greater efficiency. Creating and enhancing a permit navigation service to support permit applicants will become increasingly important for these reasons.

**Key Actions**

| No. | Action |
|---|---|
| 6.1 | Identify ways to provide greater clarity, transparency and support for Building Code users in helping them achieve general code compliance and develop a means of supporting the navigation of permitting and approvals processes for deep retrofits, particularly for projects accessing City programs or incentives. and link this to the City's centralized online retrofit support platform and Retrofit Coordinator services (see Section 3.2.5) |
| 6.2 | Use permitting processes as key triggers for providing home and building owners with information on upcoming requirements and available programs |

### 3.2.7 Build Awareness & Capacity of Home & Building Owners

**Key Benefits**

- Give homeowners the information they need to help them make decisions around reducing the impact of their homes
- Give building owners the information and resources they need to ensure their buildings meet higher levels of performance
- Provide meaningful examples of low-cost and effective building retrofits to showcase the way forward

Providing home and building owners with the information they need to make wise retrofit investments is key to the success of almost every emissions reduction action in this Strategy. Consumer education and targeted marketing represent two relatively low-cost pathways to improving energy efficiency and reducing emissions by building market demand for retrofits. *Consumer education* refers to providing building owners, managers, occupants, and tenants with the resources and skills they need to make informed decisions about energy efficiency and emissions reductions. *Targeted marketing* refers to the process of identifying individuals responsible for making decisions affecting building performance (e.g. owners, managers) and targeting these people with information, products and tools that are most relevant or of interest to them.

The success of both approaches hinges considerably on engaging owners and decision makers and enabling them to see a clear and feasible path to low or zero emissions. This is often best achieved when a building or homeowner is offered a glimpse into what their peers have achieved in terms of deep emissions retrofits, including the steps that were taken to achieve them. Friendly competitions that pit peers against one another while exchanging lessons learned has been a successful approach used in other jurisdictions, especially when paired with other incentives and supports. Other strategies include the use of key information channels, including trusted industry members, to relay important information and encourage good practices. This could include information on potential strategies to employ in reducing emissions, where to find help or qualified contractors, as well as ways to reduce costs.

The City’s role in raising awareness should be focused on leveraging partnerships with existing industry associations to craft compelling educational resources, and ensuring that they get into the hands of the home and building owners who need them

**Key Actions**

<table>
<tr><th>No.</th><th>Action</th></tr>
<tr><td>7.1</td><td>Use existing EnerGuide data for homes and EWRB building performance data for larger buildings to identify target markets (e.g. poor performing sectors or neighbourhoods) and develop targeted materials that address their particular needs and interests (e.g. equipment replacement, cost savings, health benefits, etc.)</td></tr>
<tr><td>7.2</td><td>Collaborate with key industry actors (e.g. green building advocates, social enterprise partnerships) on the development and dissemination of educational materials<ul><li>Identify and test messaging appropriate to different target groups (e.g. large building portfolio owners, millennials, retirees, etc.), including the co-benefits of retrofits</li><li>Make use of multiple formats, from online to in-person</li></ul></td></tr>
<tr><td>7.3</td><td>Provide education/marketing materials and connect owners and tenants to available programs and incentives at key touchpoints, especially with City staff:<ul><li>Prior to equipment replacement/failure</li><li>Time of renovation/permitting</li><li>Sale/listing/lease</li><li>Title transfer</li><li>Participation in City programs</li></ul></td></tr>
<tr><td>7.4</td><td>Work with industry organizations to profile buildings/portfolios that have made deep retrofits, via testimonials, green building tours, and workshops</td></tr>
<tr><td>7.5</td><td>Support industry associations in the development of deeper educational programs via multiple channels for delivery, including in-person/online sessions for small groups & neighbourhood-scale initiatives, as well as traditional education classroom/workshop sessions.<ul><li>Over time, refine education materials based on updated home and building performance data from participation in City programs/incentives that require data disclosure</li></ul></td></tr>
<tr><td>7.6</td><td>Integrate all education and awareness raising activities into a centralized online retrofit support platform, with targeted support to help owners upload their performance data, access support services (see Section 3.2.5)</td></tr>
</table>

### 3.2.8 Support Workforce Development & Training

**Primary Barriers Addressed**

- Numbers of skilled trades and energy auditors will be sufficient to meet demand in a way that guarantees emissions reductions and ensures customer satisfaction
- Contractors will become familiar with the technologies or practices necessary to achieve deep emissions reductions, and certified to deliver them properly
- Trades will have access to the education and resources they need to participate in a new market

Dramatically improving the performance of existing buildings depends on industry stakeholders, including architects, engineers, contractors and skilled trades, being well-informed and comfortable with new approaches, designs, products, and construction methods. That means ensuring that industry members have the information they need to understand the emissions and other impacts of different retrofit measures, and to be confident they are setting the building up for long-term success. While many dimensions of deep emissions can be undertaken using conventional materials and technologies, others will require more advanced tools and techniques, which may in turn require specialized skills.

Familiarizing designers, installers, energy auditors and others with the building technologies, implementation strategies and validation processes that help reduce energy use and emissions is a foundational action to the success of the overall Strategy. Industry supports and training need to highlight the benefits of building technologies and tools that may be unfamiliar to the industry, as well as the important new economic opportunity that will be created by improving the performance of the building stock. This need for widespread education and training extends beyond trades themselves, to the many individuals and professions involved in selling, designing, constructing, supporting, and maintaining zero emissions buildings. Making high performance building retrofits an attractive career and ensuring an experienced and rapidly growing workforce is ready to meet the new demand for deep emissions retrofits will in turn help to build consumer confidence and achieve the City's performance targets for buildings.

Industry associations are already in the process of identifying the skillsets, resources, training and certification programs necessary to educate the workforce in deep emissions retrofits and ensure high quality work. Notably, the Canada Green Building Council's Workforce 2030 represents a cross-sectoral coalition of employers, educators, practitioners across the construction ecosystem working to build a low-carbon building workforce via the skills development, talent recruitment, and workplace innovation. However, the City of Toronto has a role to play in building awareness and supporting the development of these programs, as well as ensuring that they reach the individuals and communities that often experience barriers to these kinds of opportunities and can best benefit from them. It will also have a role to play in supporting the education of other parts of the building industry, including real estate agents, building operators, and maintenance trades. Given how important building a skilled workforce is to the success of this overall Strategy, it will be important for the City to support the rapid development of this sector and to include clear and standardized requirements for certain levels of training into City programs.

### Workforce development

There are a number of existing programs that the City can build on or support in equitably building the capacity of the workforce.

The Toronto Community Benefits Network already supports job creation and opportunity development in the construction sector for historically disadvantaged communities and equity seeking groups.

Building Up provides a model of what can be achieved in supporting people facing barriers to employment in developing skills for the zero emissions workforce. The pre-apprenticeship program offers a 16-week paid training program in energy and water efficiency upgrades in affordable housing buildings.

**Key Actions**

| No. | Action |
|---|---|
| 8.1 | Support industry associations in updating, enhancing, and/or creating education and training programs, requirements and certifications that ensure a strong workforce in deep emissions retrofits<br>• Leverage increasing need for improved economic opportunities and activity and healthy/ safe spaces driven by COVID-19 and associated stimulus spending<br>• Help identify and remove any barriers to improving participation in training programs (e.g. geographic location, financial barriers), and identify means of improving access, funding, and other support for marginalized and/or underrepresented communities<br>• Promote on-the-job training programs to help improve equity and remove barriers to engaging in the retrofit industry<br>• Promote benefits of education and training to contractors to encourage support and uptake |
| 8.2 | Work with industry partners to co-develop and support the launch of standardized training materials and/or micro-certification programs based on identified knowledge or performance gaps, and promote incorporation into licencing requirements. Programs should focus on:<br>• Fuel switching, heat pump installation, auxiliary heating, and energy/heat recovery ventilation for HVAC contractors<br>• On-site renewable energy systems and battery storage for HVAC contractors and electricians<br>• High performance envelope upgrades, including minimizing thermal bridging<br>• Co-benefits of retrofits to resilience, health and safety<br>• How to reduce embodied emissions and the benefits of natural materials |
| 8.3 | Once developed, require identified micro-certification(s) and/or hours of training for trades to participate in City programs and gain access to incentives in the short term, shifting to requirements for certification for compliance with performance targets in longer term |
| 8.4 | Work with industry partners (e.g. HRAI, OGA, NAIMA, SAWDAC) to support the development of a contractor database with an associated search tool for owners to better connect with qualified, trained, licensed and insured contractors in their area<br>• Include resources for homeowners to help select the right contractor, e.g. what to look for, how to file complaints, etc.<br>• Link the database/platform to the City's centralized online retrofit support platform<br>• Work to connect the search tool with accreditation or pre-qualification criteria |
| 8.5 | Work with real estate institutions to develop education and training materials to support realtors in understanding the value and marketability of deep emissions upgrades and home and building performance |

### 3.2.9 Advocate For Action At Other Levels of Government

**Primary Barriers Addressed**

- Expanded access to financing will reduce the risks of long payback periods associated with deeper retrofits
- Adjusted utility rates could encourage electrification and the fuel switch to lower emissions sources

While the City of Toronto has many avenues to directly to support and even require the decarbonization of the existing building sector, there are a number of trends and responsibilities that lie outside its control but could nevertheless improve the success of the Strategy. A major factor in improving the conditions for deep emissions retrofits is the need for changes to current utility structures and pricing models. As the cost of electricity is roughly three times that of natural gas in Toronto, making the shift to electric systems can result in significant operational cost increases when not paired with measures to reduce overall demand.

Many jurisdictions are exploring means of reducing this disparity by rolling out new pricing models and rates that favour high efficiency systems that make use of electricity – for example, Good Energy's heat pump tariff recently launched in the United Kingdom.[lix] Other important shifts include making time-of-use pricing more aggressive, allowing service providers to take advantage of energy shifting technologies and on-site generation to shift loads to lower rate periods. Changes to utility pricing that bring the price of electricity closer to that of natural gas would also help to make a combination of fuel switching and efficiency measures a cost-effective investment over shorter timeframes (e.g. 20 years). The City can leverage its position as the capital of Ontario while working with other municipalities to galvanize these and other necessary actions at federal and provincial scales.

**Key Actions**

| No. | Action |
|---|---|
| 9.1 | Work with other municipalities to advocate to the *Province of Ontario* for:<br>• The decarbonization of the provincial electricity supply<br>• Continued roll-out of the EWRB to smaller buildings, and to expand reporting requirements to include homes and other building types<br>• Add mandatory disclosure/labelling of EWRB data, so that individual non-anonymized property data is available and can be used for program targeting and compliance<br>• Mandated implementation of the "Green Button" standard by electricity and natural gas companies, to provide customers with electronic access to utility data via the *Download My Data* (DMD) XML format and the *Connect My Data* (CMD) Application Programming Interface (API)[lx]<br>• Requirements for utilities to provide direct automated upload of utility data to ENERGY STAR Portfolio Manager using the Portfolio Manager Web Services API, for both individual meter and aggregated whole-building data[lxi,lxii]<br>• The regulatory adjustments deemed necessary for the City to move forward with mandatory building performance requirements<br>• The expedited creation of a retrofit code for existing building retrofits that includes carbon emissions targets<br>• The establishment of financial penalties for non-compliance with the EWRB<br>• The creation and/or support of a Green Bank, as well as consistent and significant cost reductions via the provision of grants and/or rebates for retrofits<br>• The establishment of high energy efficiency equipment standards<br>• Demonstrated leadership through deep carbon retrofits in provincially owned or leased buildings |
| 9.2 | Advocate to the *federal government and associated agencies* for:<br>• Continued commitment to planned increases in carbon pricing in Ontario via the Greenhouse Gas Pollution Pricing Act<br>• The continued commitment to honouring the intent to develop an Alteration to Existing Buildings code, require benchmarking and labelling, and provide additional financial support for retrofits<br>• The continued commitment to the continuous improvement of energy efficiency equipment standards as laid out in the 2018 Energy and Mines Ministers' Conference<br>• The creation and/or support of a Green Bank, including substantive financial contributions to flow to sectors with the greatest need and opportunity for emissions reductions<br>• Additional grant programs and tax incentives to improve the business case for the deep carbon reductions with long paybacks<br>• The commitment to work with municipalities to ensure rebates and financing for deep emissions retrofits flows effectively and directly to recipients<br>• NRCan to include emissions/carbon more explicitly into the EnerGuide rating system<br>• Support of regenerative forestry and agricultural practices that contribute to the widespread availability of low embodied carbon, biogenic materials for the building industry<br>• A carbon tax aligned to spur action at the level needed to achieve significant emissions reductions, building on the Greening Government Strategy's shadow price guidelines |

| | |
|---|---|
| 9.3 | Work with allies to advocate to the *Ontario Energy Board, IESO, and relevant utilities* for:<br>• Integrating greenhouse gas emissions reductions into their decision-making framework and mandate<br>• Rate structure changes that favour electrification and fuel switching away from natural gas (e.g. more aggressive time of use pricing, heat pump rates)<br>• Strengthening the capacity of the electrical grid to accommodate the existing buildings sector to fuel switch away from natural gas<br>• The development of utility mechanisms to help support/invest in deep emissions retrofits<br>• Continued retrofit cost reductions measures, such as performance-based rebates for improved energy and emission performance<br>• Mandated implementation of the "Green Button" standard by electricity and natural gas companies, to provide customers with electronic access to utility data via the *Download My Data* (DMD) XML format and the *Connect My Data* (CMD) Application Programming Interface (API)[lxiii]<br>• Requirements for utilities to provide direct automated upload of utility data to ENERGY STAR Portfolio Manager using the Portfolio Manager Web Services API, for both individual meter and aggregated whole-building data<br>• Enhanced Demand-Side Management (DSM) programs under the IESO Conservation and Demand Management (CDM) that focus on temporal emissions intensity as well as peak energy consumption, and thus support cost-effective reductions in GHG emissions as well as in peak demand |
| 9.4 | Engage with Council members to act as strong advocates to the Province, utilities and key partners<br>• Join forces with other Ontario municipalities interested in strong climate action in the building sector |
| 9.5 | Identify and engage industry associations, non-governmental associations and community partners to help implement the Strategy |

# 4. Actions & Policies By Sector

As noted above, while the overarching policies and actions recommended in the previous section will support the decarbonization of the building sector, many of them will require careful and tailored application to different sectors. The appropriate requirements and forms of support that will shift the large commercial building sector towards net zero emissions differ considerably from those needed by single family homeowners, or indeed other types of buildings.

This section thus turns to a review of the specific requirements and kinds of support that are recommended for Toronto's major building sectors. It outlines the targets and key actions necessary to support a transition from the current state of the market, through to the supported adoption of voluntary emissions reduction measures and finally to a well-established regulatory environment in which net zero emissions buildings become the norm. While there are a number of potential pathways that such a transition can take, the approach taken here reflects the principles outlined in Section 3.1, as well as the results of modelling and industry engagement.

## 4.1 Setting Sectoral Targets

The average GHG reduction that results from the recommended city-wide action across each sector (as summarized in Section 2.3.3 above) can be translated into a draft set of sector-specific targets for emissions reduction at individual facilities.

How targets are set in part depends on how and when they are required to be met, or the performance requirement trigger. In general, three major triggers are contemplated for this Strategy, each of which have already been used by other jurisdictions and are described in Table 10. The type of trigger used in setting performance requirements varies in appropriateness by building type; what is fair and effective for one will present challenges for others.

**Table 10: Potential triggers for performance requirements**

| Approach | Description | Pros | Cons |
|---|---|---|---|
| **Temporal** | Performance upgrades required at a certain point in time (e.g. 2024-2029) | • Offers regulators more certainty in terms of when emissions reductions will occur city-wide<br>• Compliance and enforcement straightforward (verified by EWRB)<br>• Simple to communicate<br>• Precedents elsewhere | • Lower flexibility for the regulated industry<br>• Risks requiring replacements ahead of capital plans/equipment end of life |
| **Time of permit** | Performance upgrades required at time of permit/ replacement | • Better aligned with capital planning<br>• Simple to communicate and enforce | • Work that requires a relevant permit happens very infrequently<br>• Risks incentivizing owners to avoid or postpone pulling permits<br>• May disincentivize maintenance or important upgrades<br>• Worst performing buildings often least likely to undertake upgrades |

| | | | |
|---|---|---|---|
| **Time of sale** | Performance upgrades required at time of/prior to sale | • Requires upgrades when are already likely to be completed/ when capital is available | • Select building types are not regularly sold<br>• Risk of previous owner hastily completing upgrades that could have been improved<br>• Requires strong communication and education/support of real estate sector |

### 4.1.1 Setting Temporal GHG Targets

Draft temporal targets can be developed using the average recommended performance improvement across each sector, as shown in Figure 22. If the average reduction required is known, GHGI or GHG reduction targets per facility can be developed by overlapping the current distribution of performance across the sector and making assumptions about what action will be taken at each performance milestone.

Figure 35 and Table 11 summarize this target-setting process for the single-family home sector (see **Appendix A** for additional sector-specific tables). The blue bars in Figure 35 show a histogram of GHGI: the distribution of building GHGI performance (x-axis) and number of buildings in the city at that level of performance (y-axis). Based on the average sector-wide reduction target recommended for each five-year period, GHGI targets are identified by assuming that at the end of each period, all facilities below a given target will have taken just enough action to cross the threshold. Using this logic for each 5-year period results in the target thresholds shown in red in the figure and as Draft GHGI Targets in the table.

Using this "worst performers take minimum action" approach is a conservative way of setting the targets and should be explored by the City as more data becomes available in the next few years (e.g. from voluntary action in each sector) or using further modelling/analysis as additional mandatory reporting (i.e. EWRB data) becomes available and makes statistical distribution generation easier and more accurate.

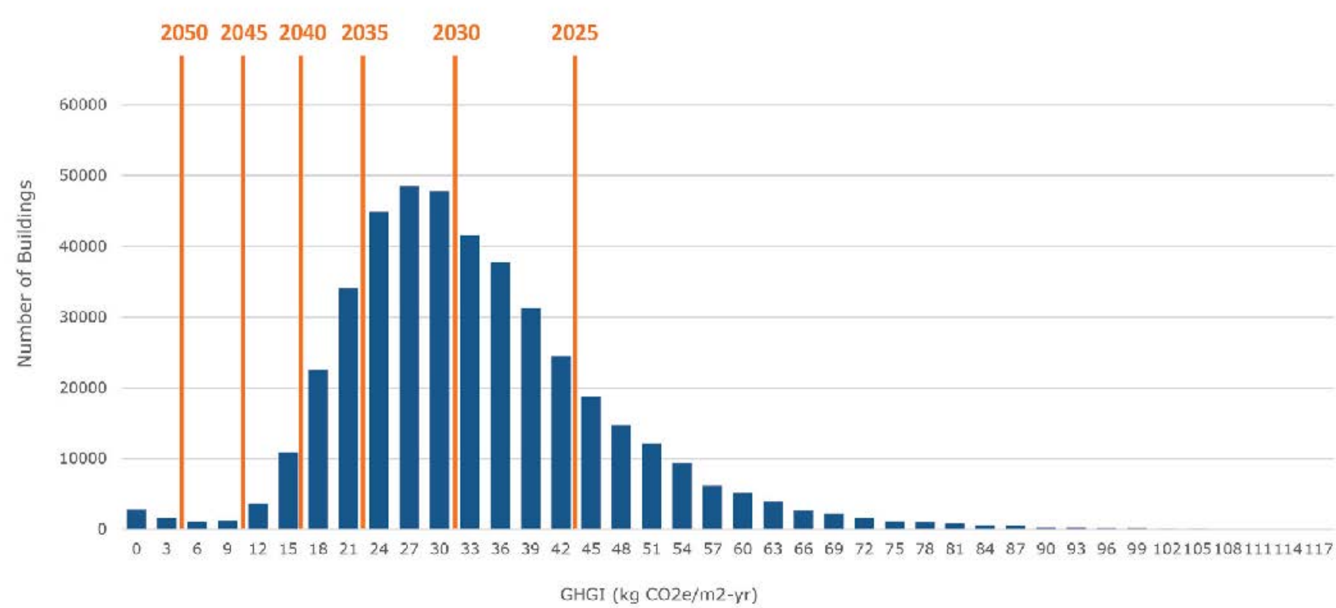



**Figure 35: Target setting process (SFH)**

**Table 11: Setting draft temporal targets (SFH)**

| **Single Family Home Example** | | | | | | |
|---|---|---|---|---|---|---|
| | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
| **Average Performance Improvement (% emissions reductions), Recommended scenario (See Figure 18)** | 6% | 17% | 33% | 50% | 69% | 90% |
| **Draft GHGI Target (kg/m²)** | 42 | 32 | 24 | 18 | 10 | 4 |

### 4.1.2 Setting Permit/ Sale Triggered GHG Targets

Setting draft targets for time of sale or permit triggers is more straightforward to extract from the recommendations summarized in Section 2, as the city-wide analysis process assumes that action at the facility level will be aligned with major capital planning milestones. In other words, the citywide emissions reduction scenario assumes that major upgrades would occur in harmony with replacement cycles, and so easily aligns with a proposed approach of setting targets based on these cycles, as major replacement often require permits. An example of this approach to target setting is shown for small commercial facilities in Table 12.

**Table 12: Setting draft time of sale/permit triggers (small commercial)**

| **Small Commercial Example** | | | | | | |
|---|---|---|---|---|---|---|
| | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
| **Average Performance, Recommended (from Figure 13, red line / RHS axis)** | 7% | 17% | 26% | 38% | 51% | 64% |
| **Min Package Reduction at Permit Trigger** | 45% | 45% | 45% | 62% | 62% | 62% |
| **Cluster 10 (Office) GHGI (kg/m²)** | 27 | 27 | 27 | 19 | 19 | 19 |
| **Avg Package Reduction, Permit/Sale Trigger** | 59% | 59% | 59% | 64% | 65% | 65% |

The ***average performance*** aligns with a given percentage of the sector taking significant (i.e. permit-required) action within the five-year window. The ***minimum GHG reduction package*** permitted during each period is taken from the worst-performing (and typically lowest-cost) package included in the mix during that window. In the example given, a LFS+FS1 package (45% reduction) is the minimum until 2040, while the LFS+FS2 package (62%) is the minimum beyond 2040. That minimum percent-reduction then translates into a maximum ***GHGI threshold*** for each cluster within the sub-sector.

Of course, some facilities will take the lowest-cost approach, while others will invest more money because of broader renewal goals, voluntary incentive opportunities, or because of the long-term cost-effectiveness of deeper action. The prototype recommended city-wide scenario assumes significant action beyond the minimum and this difference is reflected in the table above by the difference in minimum package reduction as compared to ***average package reduction***. As time goes on, the gap between these two series closes, as what is mandatory becomes closer to the maximum achievable voluntary action.

### 4.1.3 Recognized Uncertainty & Offering Flexibility

It is important to note that while the draft performance targets presented for each sector in the sections that follow represent a reasonable starting point, they will need to be revisited and updated regularly over the next few years for a number of reasons:

1. With the exception of buildings over 100,000 ft², the data used for the statistical distribution plots are not based on high-quality building or facility level data. The policies and actions related to building energy and emissions performance data (Require Annual Performance Reporting and Public Disclosure, see section 3.2.1) have been recommended explicitly to address this current data gap. Collecting and analyzing home and building performance is a key step in being able to set specific targets based on a clear understanding of the sector's current performance. As the EWRB is rolled out to include more buildings (and the recommended reporting requirements come into effect), better data will be available to set more specific targets. Efforts to improve EnerGuide and the Canadian version of Energy Star will also hopefully support and simplify the target-setting process across various jurisdictions.
2. The current performance trajectory outline for each sector is high-level and should be refined based on the verified potential of measures and packages to achieve the targets. It is likely that current estimates of savings are over-stated, since modelling-based analysis at the facility level can tend to over-simplify controls and operational challenges that can arise in practice. This feature of the draft targets is one reason why it is more appropriate to assume that targets are only achieved and not exceeded at each temporal threshold.
3. There will be considerable variability in the targets as a function of grid de/re-carbonization over the next 30 years. Current city-wide assumptions (and targets) reflect a near constant emission factor for electricity, but as discussed in Section 2.4 above, greater collective action could cost-effectively achieve load reductions that can cost-effectively achieve a zero emission grid transformation over the same timeline proposed for existing building retrofits. This potential alignment should be explored further and promoted and will allow for greater flexibility in achieving targets. The opposite case – allowing grid emissions to rise to twice or three-times current levels – is to be strongly avoided if the goal is to see significant emissions reductions between now and 2050 – and the City's target of net zero.

**As such, the draft targets included in this Strategy should be considered a starting point for future target setting exercises. Of greatest importance is the need for the City of Toronto to signal the overall intent to establish a framework for increasing performance requirements, as well as the end goal – i.e. net zero emissions buildings.** While the first thresholds proposed for 2025 can be used as a low but meaningful first performance threshold, all other targets (save for the end target of net zero emissions) should be considered interim targets that can and should be updated as more information becomes available.

As discussed above, it is the goal of voluntary programs and other supportive activities to inspire action and success beyond minimum targets. Grid decarbonization coupled with fuel switching will have also significant benefits to achieving zero emissions and may accelerate faster than current performance or future predictions suggest. As new policy and voluntary action ramp up over the short term, the potential for acceleration and deepening of reductions should be monitored and encouraged.

To allow for flexibility in compliance, a range of compliance pathways for achieving performance requirements are proposed in Table 13. The way in which each proposed compliance pathway could be pursued by specific building types and verified by the City of Toronto, as well as the kinds of support that could be made available to each sector, is described in further detail in the sector-specific sections below.

**Table 13: Proposed compliance pathways**

| Compliance Path | Description | Applicable Building Types |
|---|---|---|
| **Performance pathway** | The emissions performance threshold set for a specific compliance period is achieved. | Commercial buildings over 50,000ft²<br><br>All condos and apartment buildings |
| **Portfolio pathway** | Emissions reductions are permitted to be achieved across an owner's entire portfolio by submitting a portfolio-wide plan to achieve reductions in alignment with the City's climate targets. | Multi-property commercial or residential owners |
| **Performance pathway-Deferral** | Compliance with an emissions performance threshold is deferred until the following compliance period.<br><br>*Building owners* will be required to pay a penalty/fine until upgrades are completed and compliance with the next threshold can be demonstrated. Fines levied for non-compliance will be held by the City in escrow until such time as necessary upgrades are completed and compliance with the next performance threshold has been demonstrated. Fines accrued are returned to building owners to help support the cost of upgrades, minus an administrative fee retained by the City.<br><br>*Single-family homeowners* will instead be subject to variations in property taxes or similar structures (e.g. increase for poor performance, decrease for achievement/exceedance of targets)<br><br>Owners will be permitted to request a deferral until the next compliance period without penalty if they meet one of the following criteria:<br>- *Low/fixed-income household*<br>- *Apartment buildings located in areas with high core housing needs (e.g. that score high on the Low Income Measure After Tax)*<br>- *Pending/planned demolition (e.g. via a teardown index)*<br>- *Heritage building protection*<br>- *Demonstration of retrofit integration into capital plans* | All building types |

| | | |
|---|---|---|
| **Performance pathway- RECs / offsets** | Compliance with a performance threshold is supported via the purchase of approved Renewable Energy Certificates (RECs) or carbon offsets[14]. The total number of RECs or offsets that can be purchased towards achieving the threshold will be capped at 20%.[15]<br><br>Purchased RECs must be certified by ECOLOGO or Green-e and generated from green power facilities that fed into the Greater Toronto Area*<br><br>Purchased carbon offsets must meet one of the following criteria:*<br>- Certified by Green-e Climate or equivalent; or<br>- Derived from carbon offset projects certified under one of the following high-quality international programs:<br>o Gold Standard<br>o Verified Carbon Standard (VCS)<br>o The Climate Action Reserve<br>o American Carbon Registry | All building types |
| **Performance pathway - Embodied emissions** | Compliance with a performance threshold is supported via the demonstration of embodied carbon emission reductions, or removals. | All building types |
| **Prescriptive pathway** | Complete a specific upgrade or equipment replacement that results in significant emissions reductions. Often required at time of sale or replacement. | Commercial buildings under 50,000ft²<br><br>Rental apartment buildings |

**Criteria for use of RECs and offsets are derived from the CaGBC's Zero Carbon Building Standard v2.*

14 Carbon offsets refer to quantified and verified reductions of GHG emissions from a given facility, operation or project that is additional to any existing voluntary or regulatory requirement, where such GHG reductions have been verified by an independent third party verifier, and may be serialized and listed through a GHG registry

15 This maximizes the focus on getting up to 80% of the improvements through efficiency, electrification, and on-site renewable generation, while acknowledging the possibility of up to 20% of grid emissions remaining after all feasible on-site strategies are implemented.

### 4.1.4 Other Important Metrics and Targets

The focus of the impact analysis work completed to date has been on the potential for action to reduce operational GHG emissions over the next 30 years. However, several important conclusions relevant to emissions and to the co-benefits of action have led to important additional recommendations that can be translated into performance-based targets for projects. Important examples include the following:

- ***Setting a stable emissions intensity for each performance cycle:*** As noted in Section 2.4.2, there is substantial annual variation in the GHG intensity of Ontario's electricity grid. To support retrofit planning, any given emissions limit for a building should come with a fixed assumption for grid GHG intensity. This allows building owners to more precisely plan the electricity and natural gas intensities needed to achieve the GHGI target. These grid emissions assumptions need not all be set at the start of the program; rather, they should be set at five-year intervals, and ideally at least three years prior to the applicable cycle (e.g. the grid emissions intensity assumption for 2030 would be set in 2027). A possible side effect of this approach is that actual reported emissions via EWRB may differ from the emissions number needed to assess compliance.
- ***Setting a TEDI target in residential facilities undertaking significant upgrades to motivate passive survivability and comfort improvements.*** Though results are not conclusive enough to specify an exact TEDI target, using a target in the range of 30-50 kWh/m²/year – aligned with EnerPHit thresholds – may be appropriate for facilities that are undertaking more significant investment enclosure upgrades. Further work is recommended to refine these targets for both single-family homes and MURBs.
- ***When fuel switching, setting a peak electricity demand target in a similar range to current facility electricity demand to promote grid stewardship.*** Such a target would allow for flexibility in how peak demand is addressed (e.g. with load reductions, geo-exchange vs. air-source heat pumps, demand response technology, etc.) while still imposing the necessary restrictions on load required to avoid significant increase in electricity system costs.
- ***Setting an embodied carbon reduction target, including the carbon storage potential of bio-based materials, during deep retrofits for single-family homes.*** Though the embodied emissions of most retrofits are small compared to the associated scope 3 emissions from operational GHGs, the materials selected matter when both significant enclosure upgrades and full fuel switching are being considered, as with the Zero Carbon Ready and Max Site packages discussed above. When these packages are being pursued, it could make sense to include at least data collection of embodied emissions, if not (eventually) requiring that upstream emissions at least be mitigated through appropriate material selection.

While these additional metrics matter a great deal to overall facility performance and broader emissions reduction goals, work completed to date does not support setting notional targets in the same way that operational GHG targets have been explored. Further work is required, ideally based on data collected during early voluntary projects, to solidify these targets and include them formally within voluntary or mandatory programs.

## 4.2 Institutional Buildings

### Overview

Leadership by those with the greatest interest and capacity for deep emissions reductions is an important part of this overall Strategy. Early voluntary action ahead of the rest of the industry helps to test and prove out technologies and practices for deep decarbonization, build industry capacity, and share lessons learned with those sectors with less experience. This is why leadership on the part of the City of Toronto itself, as well as other public sector institutions in the broader public sector, or Municipal, University, School and Hospital (MUSH) sector, is a foundational component of this Strategy. These government-funded facilities are already required to track energy use as part of O. *Reg 507/18*, and many have conservation demand management (CDM) plans for energy use across their organizations. Significant reductions in energy use have also already been realized via past and ongoing CDM programs, and while specific targets for emissions reduction are not yet in place for all organizations, some have set voluntary organizational targets for emissions alongside their established energy targets[lxiv].

Many actors in the MUSH sector (as well as progressive commercial actors) have already shown that they are willing and able to meet the challenge of a decarbonized building sector alongside the City as Toronto via their participation in the City of Toronto's voluntary Green *Will Initiative*.[16] Introduced in late 2019 as part of the *Better Buildings Partnership*, this voluntary program is intended to target building portfolios and support buildings owners as far along as possible in energy management to empower them to continuously drive their own GHG emission reduction opportunities in the long term. This will be accomplished through three pillars of the program working in tandem:

1. **Pathway to Net Zero:** Focusing on Strategic Energy Management Services to walk participants through developing foundational changes for energy management.
2. ***Collaboration:*** To continuously engage participants throughout the program to enable information sharing and new opportunities.
3. **Recognition:** Showcase accomplishments and disclosure of building portfolio GHG emission performances to motivate participants to continuously improve.

The program objectives outlined will likely be supported by more recent commitments on the part of the federal government to see CAD$2 billion invested in large public and private real estate owners to modernize their assets, improve energy efficiency and reduce emissions.[lxv]

16 For some examples, see the organizations who have signed on to mayor John Tory's Green Ways Initiative: https://www.thestar.com/news/city_hall/2019/10/02/mayor-john-tory-enlists-landlords-in-emissions-plan-as-toronto-declares-climate-emergency.html

### Sector-Specific Actions

The overall approach that should be taken by this sector is one that sets and achieves net zero emissions targets ahead of other building sectors, and shares lessons learned to help build the capacity of the rest of the market. The role of the City of Toronto will be both to lead, as well as to galvanize leadership by other MUSH and progressive commercial and industrial partners. As part of action aligned with the Climate Emergency declaration, the City has prepared its own decarbonization plan, showing leadership by setting a zero carbon target by 2040 and engaging with the IESO to discuss changes to regulations which current limit municipalities and other public organizations from entering into Power Purchase Agreements (PPAs). This kind of early, transparent and engaged commitment to action has the potential to create a continuous improvement cycle that will benefit facilities across the sector and support rapid policy refinement and innovation in the coming years.

| Short Term (2021-2025) |
|---|
| **Short term** recommendations for the City of Toronto and its institutional partners are to:<br>• Commit to benchmarking and disclosing annual performance at the facility scale<br>• Set portfolio-wide net zero emissions targets by 2045 and disclosing the associated capital plans<br>• Engage in best practices in auditing, retro-commissioning, and continuous commissioning and share lessons learned from their application<br>• Harness federal stimulus funding to help refine and prove out a market for deep emissions retrofit financing |
| **Medium term (2025-2030)** |
| **Medium term** recommendations for the City of Toronto and its institutional partners are to:<br>• Regularly report progress that demonstrates the City of Toronto and its MUSH partners are on track to achieving their net zero emissions targets<br>• Continuously demonstrate how performance targets are achieved by showcasing improvements achieved via commissioning and upgrades to the rest of the industry |
| **Long term (>2030)** |
| **Long term** recommendations for the City of Toronto and its institutional partners are to:<br>• Continue to be at the forefront of emissions reduction technologies and processes and to collect and communicate performance and lessons learned on financing and life-cycle costs<br>• Partner with geographically adjacent non-institutional facilities to help support or enable district and neighbourhood-scale decarbonization of energy services and aggregated renovation projects |

### Performance Requirement

As noted above, the overall expectation of this sector is to voluntarily set and achieve portfolio-wide net zero emissions targets one full compliance cycle (i.e. five years) ahead of any other sectoral requirement. City authorities may verify performance improvements via O. *Reg 507/18*.

**Table 14: Proposed compliance pathway for institutional buildings**

| Application | Available Pathway | Requirement | | | | Verification of Compliance |
|---|---|---|---|---|---|---|
| Institutional buildings and portfolios | Portfolio pathway (temporal) | Create and submit portfolio-wide plan that demonstrates compliance with sectoral climate targets | | | | City verification |
| | | **2025** | **2030** | **2035** | **2040** | **2045** |
| **Average GHG reduction vs. 2016 baseline recommended for this sector** | | 7% | 17% | 26% | 38% | 51% |
| **GHGI (kg/m²/year)** | | 45% | 45% | 45% | 62% | 62% |

**Case Study: PSPC's Project GHG Options Analysis methodology**

The PSPC's Project GHG Option Analysis Methodology is a guideline to evaluate Real Property investment decisions in a way that considers both GHG emissions reduction opportunities and financial impacts[lxvi]. The methodology uses energy modelling and life-cycle cost analysis to quantify capital, energy and operational cost savings and GHG emission reductions from energy conservation measures over a 40-year study period and assuming a shadow price of carbon of $300/tonne. Each *Investment Analysis Report* (IAR) analyzes the following four design options to help PSPC make informed decisions: 1) Baseline – Design to meet minimum departmental commitments; 2) Option 2 – Design to achieve cost-neutral GHG emission reductions; 3) Option 3 – Design to achieve maximum GHG emission reductions, and 4) Option 4 – Hybrid GHG Emission Reduction Design (a combination of ECMs from Option 1, 2 or 3 that provide the best value to the Crown). PSPC's first application of this methodology was used as part of the major retrofit planning for their Arthur Meighen Building in north Toronto. When weighing all the life-cycle cost, GHG savings and other co-benefits for the project, PSPC decided to pursue a package of improvements that achieved a nearly maximum GHG reduction on site (i.e. close to Option 3 performance).

## 4.3 Large Commercial Buildings

### Overview

The large commercial building sector represents some of the city's (and indeed the country's) largest real estate portfolio owners. Illustrative of this fact is that, as of January 2021, seven of the 16 participants in the City's Green Will initiative are large real estate owners and operators, and as such have committed to working on a pathway to net zero emission across their portfolios. These real estate investment trusts (REITs) and other portfolio owners also represent the members of Toronto's building industry with the greatest understanding and ability to achieve deep emissions reductions as a result of their relatively high access to the financial means and expertise required. Many are being spurred on to achieve emissions reductions by the demands of their current or prospective investors and tenants, who are increasingly looking to Environmental, Social and Governance (ESG) performance as a marker of which portfolio to support or lease from. Like large public sector portfolio owners, facilities held in this sub-sector have also been earmarked as potential recipients of federal retrofit financing via the Canada Infrastructure Bank.

All of the above characteristics make the large commercial building sector an ideal candidate for demonstrating leadership in deep emissions reductions. A key opportunity in the near term will be aligning deep emissions retrofits with the upgrades necessary to ensure their tenants have access to safe and flexible workspaces in a post-pandemic world. Among the key challenges for this sector is the need to support tenants and owners in working together to achieve emissions reductions. While owners often only have direct control over (and thus responsibility for, and incentive to improve) the energy efficiencies of façades, central plant equipment and common area systems, tenants' actions will of course have significant impacts on overall building performance and the financial performance of measures packages, as discussed further in section 2.2, above.

### Sector-Specific Actions

Given the overall potential and capacity of this sector, the recommended approach to its participation in the market transformation to zero emissions ready buildings in which leadership is expected, but also supported. Like institutional buildings, large commercial portfolio owners' experiences can be used to help educate and support the rest of the commercial and residential building industry in understanding and achieving deep emissions reductions. Building off the Green Will initiative, there is an opportunity for owners to align their entire portfolios with the targets and trajectory needed to achieve net zero emissions across the city. A combination of allowing flexibility in achieving emissions reductions, the injection of low-cost financing, and the consistent recognition of the achievements of this sector can, together, transform this sector over the next few decades. The proposed actions outlined below generally apply to large commercial, retail and industrial properties over 100,000 ft² (which aligns with the analysis in Section 2 of large buildings that are already reporting data under EWRB).

| Short Term (2021-2025) |
| --- |
| **Short term** recommendations for the large commercial building sector are for the City to:<br>• Ensure large commercial building owners are aware of upcoming performance requirements<br>• Support/facilitate the effective transfer of federal stimulus financing as needed, including the use of alternate delivery models (e.g. ESCO-type arrangements) to bring greater opportunity, skills and competition to the retrofit service market<br>• Support the ESCO market by providing support and coordination services for:<br>  o Traditional ESCO-style projects, including facility transformations with longer traditional payback periods and increased project complexity<br>  o Alternative ECSO-like approaches (e.g. MEETS), including support for defining criteria for success, managing relationships and channelling funding from private investors<br>  o Multi-facility retrofits across a portfolio and across multiple organizations where shared action can facilitate greater reductions or more cost-effective results, or both.<br>• Ensure owners are aware of ESCO opportunities<br>• Work with industry organizations to hold workshops on getting to zero emissions for larger portfolio owners and REITs, building off the Green Will program to garner interest and participation by broader number of REIT owners |
| **Medium term (2025-2030)** |
| **Medium term** recommendations for the large commercial building sector are for the City to:<br>• Require performance improvements at established intervals (see Table 15)<br>• Encourage large, multi-property owners (and their tenants) to make use of partnerships with centralized energy service providers, cost-effective energy services companies and private financial institutions to achieve reductions across multiple properties<br>• Provide owners with continuous support in accelerating and enabling action at scale to reduce the burden of compliance and support the cost-effective growth of the market, while verifying and recording performance improvements<br>• Continuously promote an environment of cost-effective and high-quality service within the energy services sector, including quality, consistency and transferability |
| **Long term (>2030)** |
| **Long term** recommendations for the large commercial building sector are for the City to:<br>• Require all portfolios to disclose the results of their contribution to city-wide emissions reductions annually, by sector and facility type |

**Performance Requirement**

It is recommended that annual building emissions limits expressed as greenhouse gas intensity (GHGI) be set for large commercial buildings beginning in 2025 and gradually increased over 5-year increments. Compliance for individual buildings can be verified using the data submitted as a part of the province's EWRB. However, the expectation is that many building owners in this sector will adopt a portfolio-wide approach whereby a long-term portfolio-wide retrofit plan will be aligned with the sector's emission reduction targets and verified on an annual basis by City staff.

**Table 15: Proposed compliance pathways for large commercial buildings**

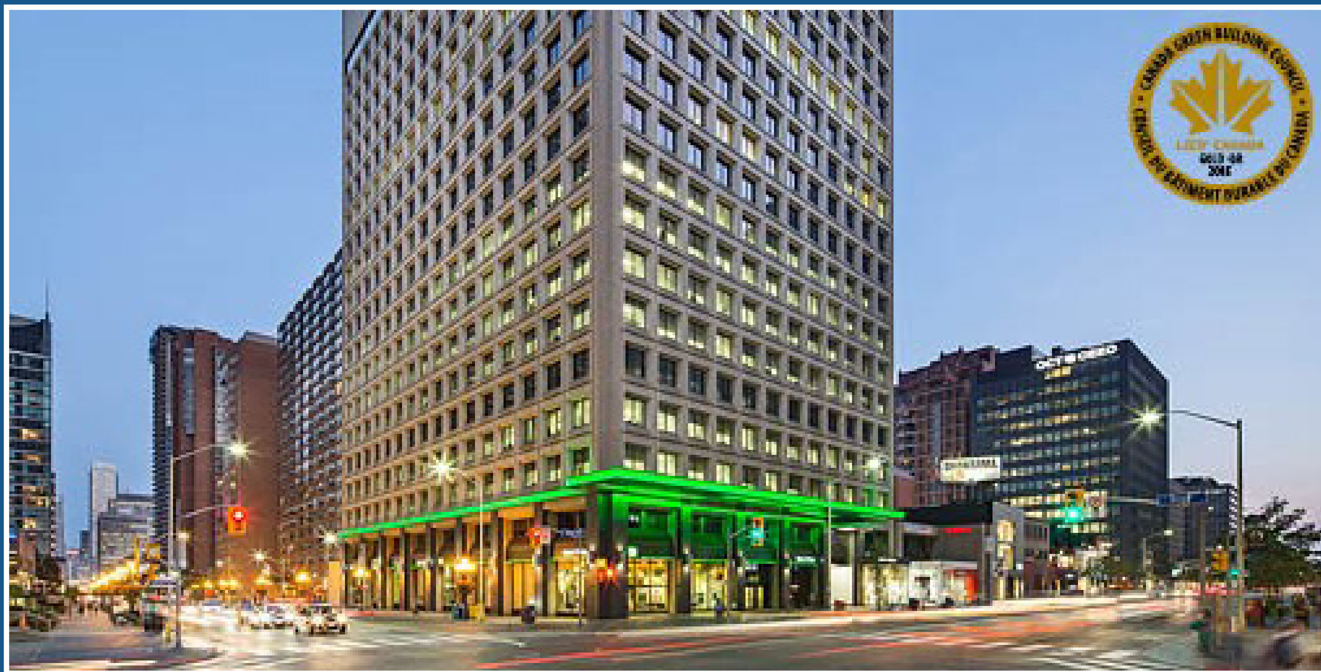
| Application | Available Pathway | Requirement | Verification of Compliance |
|---|---|---|---|
| Commercial properties over 100,000 ft$^2$ | Performance path (temporal) | Achieve annual building emissions limits expressed as greenhouse gas intensity (GHGI) beginning in 2025 and gradually increased over 5-year increments | EWRB |
| | Portfolio pathway | Create and submit portfolio-wide plan that demonstrates compliance with sectoral climate targets | EWRB, City vertification |
| | Deferral | Defer compliance and pay fines until next compliance period | City verification |
| | REC/ offsets | Achieve compliance with performance pathway via purchase of RECs or offsets (up to 20%) | |
| | Embodied emissions | Achieve compliance with performance pathway via the demonstration of embodied carbon emission reductions/ removals | |

| Application | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|
| Minimum performance improvement at temporal trigger | 10% | 21% | 32% | 45% | 58% | 71% |
| GHG (kg/m$^2$/year) | 52 | 35 | 25 | 20 | 15 | 10 |

### Best Practices & Resources

- Rocky Mountain Institute's report on Deep Energy Retrofit of Commercial Buildings presents a "pilot to portfolio" approach to scaling up deep retrofits across multiple buildings. Their Guide to Building the Case for Deep Energy Retrofits provides information for owners and managers to evaluate retrofit opportunities.
- Green Lease Leaders offers a library of resources pertaining to green leases – an important way to achieve energy and emissions targets in cooperation with tenants.
- NYC's Building Energy Exchange's report on High Rise/Low Carbon outlines key opportunities for reducing emissions in high-rise commercial towers.

## Case Study: 77 Bloor West Refurbishment



Morguard Properties worked with Ledcor Renew to deliver a deep retrofit of this ~340,000 ft$^2$, 20-storey office building in downtown Toronto [lxvii]. The key objectives of the work were to:

- Revitalize the building (both interior and exterior)
- Reduce energy use by 25% and save $250,000 in annual operating costs
- Complete the work over a 9-month design period and construction period primarily in winter
- Complete significant upgrades of both building envelope and HVAC systems
- Convert mechanical floor to leasable office space
- Achieve LEED EB:OM Gold Certification

The project was broadly successful, with most of the construction occurring during unoccupied hours within the target construction period. The retrofit achieved a >30% reduction in energy use and qualified for the most stringent tier of the Race to Reduce performance in its inaugural year of post-retrofit operation.

Of particular importance was the replicability of the business case from Morguard's perspective – the success of the project motivated them to go ahead with a similar retrofit of 60 Bloor Street, situated kitty-corner to 77 Bloor. This building is an example of how overlapping needed capital investment with efficiency improvement and enhanced environmental performance aligned both with tenant and owner goals.

## 4.4 Small And Medium Commercial Buildings

**Overview**

Medium-sized commercial office, retail and industrial buildings (i.e. 50,000 – 100,000 ft²) and small commercial office, retail and industrial buildings (i.e. under 50,000ft²) make up a significant proportion of Toronto's commercial floor area, as well as approximately one quarter of the city's building sector emissions. Made up largely of owners of single and often older, mid-tier buildings, this sector is characterized by both significant challenges as well as opportunities. A study by the IESO released in August 2020[lxviii] identified mid-tier commercial real estate owners as an important sector to focus efforts to raise awareness of the value of technologies and lease mechanisms to help reduce energy consumption and emissions. While several owners surveyed indicated interest in achieving the economic and sustainability benefits associated with improving energy efficiency, the sector's overall understanding and capacity to achieve these opportunities remains low. Such owners tend to rely heavily on vendors to identify and execute opportunities to increase energy efficiency, and action tends to be concentrated on implementing low-cost lighting upgrades with short payback periods, followed by HVAC system retrofits. Engagement and capacity of on-site staff to engage in building audits, ongoing system maintenance and retrocommissioning also remains low.

**Sector-Specific Actions**

Achieving deep emissions reductions in this sector will therefore require a significant effort on the part of the City of Toronto to work in partnership with utilities and organizations such as BOMA to increase the awareness and capacity of building owners and managers. Active communication using multiple channels will be necessary in the short term to build the sector's capacity to track, understand and report building performance prior to any performance requirements. Engagement should take multiple formats, from information provision on upcoming opportunities and requirements at key touchpoints with City staff, to the development of knowledge sharing cohorts and pilot projects for both owners and managers. In addition to knowledge sharing and capacity building, the transition to net zero emissions in this sector will also rely in large part on ensuring owners have access to subsidized support services, as well as the capital necessary to make the changes.

| Short Term (2021-2025) |
|---|
| **Short term** recommendations for the small commercial building sector are for the City to:<br>• Focus on outreach and education on opportunities and upcoming requirements for building emissions performance. Build awareness of the value of upgrades, capital planning, and the importance of using qualified contractors<br>• Link building owners/decision-makers to City-supported Retrofit Coordinator services to identify a pathway to deep emissions upgrades aligned with replacement cycles<br>• Offer subsidized audits to yield info on performance and opportunities for improvements and ensure performance requirements are integrated into capital plans<br>• Require benchmarking, labelling and disclosure for buildings over 25,000 ft² that are not covered by the EWRB as a condition of participating in voluntary programs and when accessing funding, with support services available to help support compliance.<br>• Connect owners to existing utility rebates and City financing programs (e.g. ERL) |
| **Medium term (2025-2030)** |
| **Medium term** recommendations for the small commercial building sector are for the City to:<br>• Require benchmarking and labelling for commercial buildings over 25,000 ft², and making public disclosure and labelling mandatory annually. Work with real estate sector to require disclosure at sale, lease and rental<br>• Shift from supported voluntary performance upgrades as a part of program participation to mandatory requirements for performance upgrades (see Table 16)<br>• Continue to provide subsidized retrofit coordinator services, connect to rebates and low-interest financing, and other supports to achieve performance requirements |
| **Long term (>2030)** |
| **Long term** recommendations for the small commercial building sector are for the City to:<br>• Require performance improvements at established intervals<br>• Continue to provide access to support, rebates and competitive financing for building owners, with additional support for owners seeking levels of performance above current requirements<br>• Encourage and provide support to building owners via subsidized Retrofit Coordinator services and audits, RCx and/or continuous commissioning services to ensure they are meeting performance targets as effectively as possible and to make sure systems are performing as intended<br>• Connect owners to Energy Service Companies to help reduce the burden and costs of compliance |

### Performance Requirement

Recommendations for setting requirements for improved building emission performance are outlined in Table 16. Note that the proposed requirements for commercial properties between 50,000ft² and 100,000ft² are the same as those recommended for larger commercial buildings. However, the expectation here is that many of these owners, to the extent they differ from the owners of larger buildings, are likely to require increased support and capacity building efforts. To help these building owners meet established performance requirements, the City will need to provide subsidized support for initial capital planning, as well as streamlined financial support to reduce up-front costs.

**Table 16: Proposed compliance pathways for small commercial buildings**

| Application | Available Pathway | Requirement | Vertification of Compliance |
|---|---|---|---|
| Commercial properties 50,000 ft² - 100,000 ft² | Performance path (temporal) | Achieve annual building emissions limits expressed as greenhouse gas intensity (GHGI) beginning between 2025-2030 and gradually increased over 5 year increments | EWRB |
| | Portfolio pathway | Create and submit portfolio-wide plan aligned with sectoral climate targets | EWRB, City verification |
| | Deferral | Defer compliance and pay fines until next compliance period | City verification |
| | REC/ offsets | Achieve compliance with performance pathway via purchase of RECs or offsets (up to 20%) | |
| | Embodied emissions | Achieve compliance with performance pathway via the demonstration of embodied carbon emission reductions/ removals | |
| Commercial properties under 50,000 ft² | Time of permit/ replacement | Upgrade to one of several prescriptive target packages developed by City or use percent-reduction performance path to achieve minimum package GHG percent reduction. See example prescriptive packages below | Permit process/ reported data |
| All small commercial properties | Time of scale | Upgrade to one of several prescriptive target packages developed by City or use percent-reduction performance path to achieve minimum package GHG percent reduction. See example prescriptive packages below | Title transfer/ reported data |

| Application | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|
| Minimum performance improvement at temporal trigger | 7% | 17% | 26% | 38% | 51% | 64% |
| GHG (kg/m²/year) | 51 | 41 | 33 | 27 | 20 | 15 |
| Minimum performance improvement at Time of Replacement/ Sale | 45% | 45% | 45% | 62% | 62% | 62% |
| Example Prescriptive Packages | (a) Upgrades roof<br>(b) Replace gas-fired rooftop units with to heat pump rooftop unit with gas-fired back-up and heat recovery ventilation | | | (a) Upgrades roof<br>(b) Upgrade storefront glass<br>(c) Full fuel switch to cold climate air-source heat pumps for heating and domestic hot water | | |

**Best Practices & Resources**

- New Brunswick's Commercial Building Retrofit Program offers rebates and incentives to small and large commercial buildings.
- The Building Resilience online resource provides building owners with a "sustainable building toolkit" to help foster an understanding of the opportunities to engage in retrofits that improve overall building sustainability while protecting heritage value.

## Case Study: 501 Alliance[lxix]

The 501 Alliance building is the latest project from Strashin Developments and an example of what's possible when retrofitting a mid-tier commercial property. The project involved repurposing the former Cooper Canada sporting goods factory into a modern office space targeting green technology and IT companies looking for larger rental space at lower costs than in the downtown core. The retrofit is targeting LEED platinum certification and includes a geothermal heat pump system for heating and cooling, a 300kW on-site solar farm, a high performing envelope and glazing, passive make up air units and a high SRI roof with local crushed marble. Natural gas has been eliminated except for cooking, and the anticipated electrical use intensity is half that of typical buildings downtown. The aim of the project is to revive the existing 501 Alliance building and set an example for others in creating a new "clean" tech hub in the Midtown West of Toronto.

## Existing Programs - Buildings

- IESO's Save on Energy program offers energy efficiency incentives for businesses and industry, including retrofit support and equipment upgrades, and funding to hire energy managers[17,lxx]
- Enbridge's RunitRight Program[lxxi] aims to find energy efficiencies for commercial buildings. The utility also offers custom-tailored incentives for commercial and industrial customers

17 Note that the Province of Ontario has directed the IESO to act as the central delivery agent of all Toronto Hydro energy efficiency programs until December 2020.

## 4.5 Multi-Unit Residential Buildings

### Overview

Multi-unit residential buildings (MURB) make up a large proportion of the residential sector, as well as 29% of the city's building sector emissions. Typically defined as a residential building of three storeys or greater, MURB can be broken down into two broad different ownership types: privately owned condominiums (condos) or strata developments, and rental apartment buildings, including affordable housing.[18]

There are a number of challenges to deep emissions reductions in the MURB sector. With respect to condos, these buildings tend to have lower overall energy intensity when compared to rental buildings, but exhibit higher energy intensities on a suite by suite basis, likely reflective of lower occupant densities and higher household incomes. [lxxii]Run by boards or councils, condos are required to complete Reserve Fund Studies every three years (as per the *Condominium Act, 1988*) to identify necessary repairs and replacements and ensure sufficient funds are available to make them. Many such funds are likely limited in their ability to extend to the kinds of retrofit measures necessary to achieve deep emissions reductions, including the upfront capital necessary to employ skilled engineers or consultants to identify them. Indeed, there is often limited awareness on the part of condo board members of the importance and value of energy efficiency and emissions reduction upgrades.

These financial and capacity limitations are also present in rental apartment buildings, where owners have few resources to rely on when considering major upgrades. This is especially the case in affordable rental buildings, where there is a very real risk of more costly upgrades being passed down to tenants, reducing the city's overall affordability. For these reasons, it is not uncommon for maintenance and replacement to be deferred, often at the cost of the overall quality of housing as well as higher energy costs for tenants.

### Sector-Specific Actions

The issues above create both a need and an opportunity to invest significantly in emissions reductions in Toronto's MURBs. Condo boards and rental apartment owners will both require considerable support to help them understand and effect the changes necessary to achieve deep emissions reductions and their benefits. Efforts to transform the rental apartment sector can fortunately build on the considerable successes and program infrastructure developed via the Hi-RIS and Tower Renewal programs, which already provide support and low-cost financing for energy and other upgrades. This sector is of particular importance, not simply because it represents a significant proportion of Toronto's affordable housing stock, but because energy efficiency improvements and emissions reductions have the

---

18 A smaller number of MURB are also owned and run as cooperatives.

potential to achieve a number of other important objectives, from improved resilience to power outages, to improved thermal comfort for occupants, to improvements in occupant health. Improving energy efficiency also has the potential to improve the overall quality of the rental building stock and reduce energy costs for both owners and tenants.

The overall thrust of program support for this sector relies on active education and support for owners in the short term, including additional support for early adopters and those who pursue higher levels of performance than required. Significant support in the form of competitive financing, cost reductions via rebates, and retrofit coordinator services will be necessary to help owners and condo boards align their capital plans with the retrofits necessary to meet targets over the long term. As support for voluntary action shifts into penalties for non-compliance in the medium and long term, support should continue to be available for those who pursue a more aggressive emissions reduction pathway.

| Short Term (2021-2025) |
|---|
| **Short term** recommendations for the MURB sector are for the City to:<br>• Focus on outreach and education on opportunities and upcoming requirements for building emissions performance, including for condo board members<br>• Link building owners/decision-makers to City-supported Retrofit Coordinator services to identify a pathway to deep emissions upgrades aligned with replacement cycles<br>• Offer subsidized audits to yield info on performance and opportunities for improvements and ensure performance requirements are integrated into capital plans<br>• Require benchmarking, labelling and disclosure for buildings not covered by the EWRB as a condition of participating in voluntary programs and when accessing funding, with support services available to help support compliance<br>• Connect owners to existing utility rebates and City financing programs (e.g. ERL), while identifying and providing new rebates and incentives as necessary to help reduce retrofit costs |
| **Medium term (2025-2030)** |
| **Medium term** recommendations for the MURB sector are for the City to:<br>• Require benchmarking and labelling for smaller buildings and make public disclosure and labelling mandatory annually. Work with the real estate sector to require disclosure at sale, lease and rental<br>• Shift from support for voluntary performance upgrades as a part of program participation to mandatory requirements for performance upgrades (see Table 17)<br>• Continue to provide subsidized Retrofit Coordinator services, connect to rebates and low-interest financing, and other supports<br>• Provide support and tie financing to conditions for owners of low-income residential buildings to demonstrate that costs of retrofits will not be passed on to low-income tenants, unless offset by decreases in utility bills, so as to hold low-income tenants harmless<br>• Require market rental owners to demonstrate that efforts have been made to reduce any additional costs to tenants as a result of upgrades |

**Long term (>2030)**

**Long term** recommendations for the MURB sector are for the City to:

- Require performance improvements at established intervals
- Continue to provide access to support, rebates and competitive financing for building owners, with additional support for owners seeking levels of performance above current requirements
- Encourage and provide support to building owners via subsidized Retrofit Coordinator and audits, RCx and/or continuous commissioning services to ensure they are meeting performance targets as effectively as possible and to make sure systems are performing as intended

### Performance Requirement

Recommendations for setting requirements for improved building emission performance are outlined in Table 17. This approach assumes a considerable level of support will be provided by the City and its partners, including via upcoming programs for deep emissions retrofits in the residential sector proposed by The Atmospheric Fund. While other jurisdictions have elected to take a softer approach on residential buildings in setting initial performance requirements, Toronto already has significant program infrastructure in place that can be leveraged to support this group of buildings.

**Table 17: Proposed compliance pathways for MURB**

| Application | Available Pathway | Requirement | Vertification of Compliance |
|---|---|---|---|
| All condos regardless of size<br><br>All rental apartment buildings over 50,000 $ft^2$ | Performance path (temporal) | Achieve annual building emissions limits expressed as greenhouse gas intensity (GHGI) beginning between 2025-2030 and gradually increased over 5 year increments | EWRB |
| | Portfolio pathway | Create and submit portfolio-wide plan aligned with sectoral climate targets | EWRB, City vertification |
| | Deferral | Defer compliance and pay fines until next compliance period | City vertification/ reported data |
| | REC/ offsets | Achieve compliance with performance pathway via purchase of RECs or offsets (up to 20%) | |
| | Embodied emissions | Achieve compliance with performance pathway via the demonstration of embodied carbon emission reductions/ removals | |
| All small commercial properties | Time of scale | Upgrade to one of several prescriptive target packages developed by City or use percent-reduction performance path to achieve minimum package GHG percent reduction. See example prescriptive packages below | Title transfer/ reported data |

| Application | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|
| Minimum performance improvement at temporal trigger | 12% | 24% | 37% | 53% | 70% | 87% |
| GHG (kg/$m^2$/year) | 51 | 38 | 30 | 20 | 14 | 6 |
| Minimum performance improvement at Time of Replacement/ Sale | 61% | 61% | 51% | 85% | 85% | 85% |
| Example Prescriptive Packages | (a) Upgraded roof<br>(b) Upgradeed windows<br>(c) New/ replacement heat pump coolingand first-stage heating system | | | (a) Over-clad walls<br>(b) In-suite ERVs<br>(c) Full fuel switch to cold climate air-source heat pump system serving fan-coils and for domestic hot water | | |

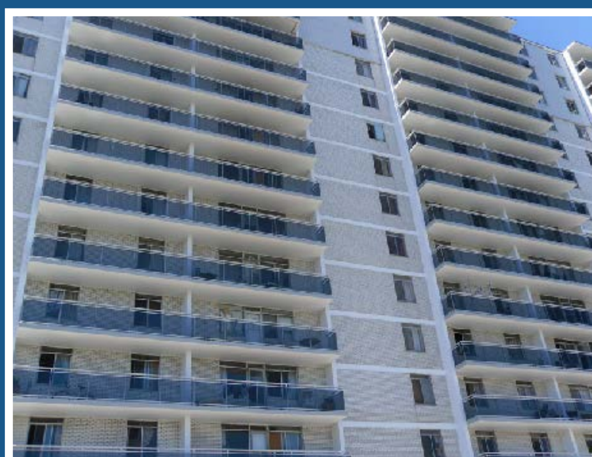
**Best Practices & Resources**

- Energiesprong in Canada. Sustainable Buildings Canada has begun to develop an Energiesprong program to help encourage large scale investment in retrofits in the affordable housing sector.
- The Atmospheric Fund's report on The Case for Deep Retrofits offers a business case evolution and financing options for MURB retrofits.
- The University of Toronto offers a number of resources for MURB, including a MURB Design Guide *and* Thermal Resilience Design Guide.
- BC Housing's Building Smart program offers a range of resources for the residential construction sector, with many transferrable to the Toronto context.
- BC Housing's Mobilizing Building Adaptation and Resilience program outlines strategies for improving the resilience of MURB to climate change .
- The BC Housing Design Guide Supplement on Overheating and Air Quality identifies strategies for increasing building resilience to overheating and air quality issues.
- The City of Vancouver-supported Hey Neighbour program in BC is a resident-led initiative aimed at increasing social connectedness, neighbourliness, and resilience in multi-unit buildings.

**Existing Programs - Multi-Unit Residential Buildings**

- IESO's *Save on Energy program* offers energy efficiency incentives for businesses and industry, including retrofit support and equipment upgrades, and funding to hire energy managers
- Enbridge's *Affordable Multi-Family Housing Program* offers up to $20,000 for upgrades to social and municipal housing providers, shelters, co-ops, rent-geared-to-income housing, and market-rate multi-family buildings.

**Case Study: 15 Orton Park Road**



A participant in the Hi-RIS program, the owner of the 14-storey apartment building at 15 Orton Park Road provides an example of the kinds of retrofit measures that have already been implemented in Toronto's MURB stock. Constructed in 1967 and home to approximately 300 residents across 147 units, this building underwent a full window replacement (from single to double pane glazing) and modernized both elevators to include variable speed motors. The building will be enrolled in the Tower Renewal Green Champions conservation and awareness training program to help resident leaders teach their neighbours and peers strategies they can use to improve energy efficiency, reduce water conservation and increase waste diversion. Improvements reduced the building's annual GHG emissions by an estimated 138 tCO2 while improving residents' thermal comfort, as well as the efficiency and reliability of their elevators.

## 4.6 Single Family Homes

**Overview**

Toronto's homes represent over 30% of the city's total building emissions, making it one of the most important sectors of focus in this Strategy. Alongside MURB, homes are also where we live – where we find comfort and security, where we invest our money and our time. For these reasons, deep emissions retrofits in the single-family home sector present an opportunity to meet a number of other goals, from improved health and comfort, to increased safety and resilience.

However, as many opportunities as there may be, there are also a number of pitfalls and challenges to be faced in retrofitting this sector to zero emissions. Like many other building owners, many homeowners are unaware of the options available and benefits that home energy upgrades can bring, and can be easily overwhelmed when facing decisions around the kinds of upgrades to pursue. Many homeowners also already shoulder a consider burden of debt and are unwilling or unable to take on additional loans – especially those with low or fixed incomes. There are also unique challenges for this sector. Unlike owners of multifamily and commercial buildings, homeowners may not actively consider their home's energy use, may not use traditional financial thinking in making decisions, and may be unfamiliar with or resistant to government intervention in their private space. Laws around personal privacy may also require careful consideration when regulating this sector.

Fortunately, recent developments are promising to see considerable support flow to this sector. In *Building Back Better: A Plan to Conquer the COVID-19 Recession*[lxxiii], the federal government committed to providing $2.6 billion over seven years to help homeowners improve energy efficiency, including:

- Up to 700,000 grants of up to $5,000 for energy efficiency improvements
- Up to one million free EnerGuide energy assessments
- Support to recruit and train EnerGuide energy auditors to meet increased demand
- The development of a low-cost loan program

The City of Toronto has an opportunity to build on this deep investment into home energy upgrades at the federal level, as well as leverage the infrastructure and program successes of Better HomesTO and HELP. City programming will be especially important in providing thousands of homeowners across the city with the information, resources, and financial support they need to reduce their home's emissions, well in advance of any specific performance requirements. Other opportunities lie in the economies of scale that can be achieved when supporting retrofits at the neighbourhood or community scale.

**Existing Programs - Low-Income Homes**

- Through the Home Efficiency Rebate program, Enbridge offers their customers incentives of up to $5,000 to replace outdated mechanical equipment with more efficient alternatives and/or to undertake envelope improvements[lxxiv]
- The *AffordAbility Fund Trust*, supported by Government of Ontario, offers in-home visits from Home Energy Advisors and free upgrades to income-qualified households[lxxv]
- *Enbridge's Home Winterproofing Program* provides free insulation, draft proofing, and smart thermostats to qualifying homeowners, renters, and social housing providers[lxxvi]
- The *Home Assistance Program*, delivered by Save on Energy for IESO, offers free energy-efficiency upgrades for income-eligible homeowners, renters, and social housing providers[lxxvii]

**Sector-Specific Supporting Actions**

The overall approach to emissions reductions in Toronto homes is one of a gradual movement from incentivized early action to requirements for performance upgrades at specific transactional points. As with other residential buildings, single family homeowners will require significant support in understanding and undertaking retrofits to achieve upcoming requirements, and many will need to rely on the support of coordination services to support them. This includes ensuring owners are aware of upcoming requirements well in advance, as well as the compliance and financial options available to them. Federal commitments to financing home energy retrofits will help alleviate the burden to comply with such requirements. As above, as support for voluntary action shifts into requirements for improved performance in the longer term, support should continue to be available for those who pursue a more aggressive emissions reduction pathway.

Annual reporting, labeling, and disclosure requirements that work for large buildings may not be appropriate for single-family homes—many homeowners would struggle to comply, enforcement across such a diffuse set of actors would also be challenging, and regulations around privacy might be impacted. Fortunately, homes also are more uniform than other building sectors. As is being explored in the City of Vancouver, automated virtual energy audits can likely estimate home efficiency for most homes within a reasonable degree of accuracy. If requirements are tied to the results of such an audit, homeowners should be given the opportunity to get their own EnerGuide score and correct the record. Such an approach would require substantial utility cooperation. Alternately, labeling and disclosure could be required when a property is being rented or sold.

| Short Term (2021-2025) |
|---|
| **Short term** recommendations for the single-family home sector are for the City to:<br>• Engage in a widespread awareness-raising campaign to ensure homeowners are aware of upcoming performance requirements and related opportunities<br>• Support voluntary home labelling and disclosure via EnerGuide. Require labeling and disclosure for homeowner participation in voluntary programs and when accessing funding<br>• Work with utilities and the Ontario Energy Board to create a program for automated virtual energy audits and labeling via EnerGuide<br>• Provide homeowners with subsidized Retrofit Coordinator services, energy audits and equipment, as well as access to competitive financing tied to requirements for disclosure and labelling<br>• Identify and provide appropriate rebates and incentives to single-family homeowners to reduce costs of upgrades using a streamlined delivery model<br>• Use City programs and permitting processes to connect owners to a City-run online platform to provide information and resources and allow homeowners to conduct simple online assessments and access customer service support<br>• Subsidize Retrofit Coordinator services for participants in City programs and the achievement of deep emissions retrofits ahead of future performance targets<br>• Provide homeowners with information signalling opportunities and benefits of deep retrofits, as well as upcoming future requirements<br>o Work with industry associations to develop education and information campaigns and materials and integrate them into the City's online platform<br>o Tailor education and engagement materials to address 'early adopters' seeking deeper retrofits and early majority homeowners seeking targeted shorter payback retrofits, as well as specific demographics/homeowner types (e.g. renters, new Canadians, landlords, new Canadians)<br>o Release information seasonally (i.e. spring for cooling, fall for heating), tying the concepts of energy efficiency upgrades to maintenance and repairs for homeowners, making it clear that retrofits are now part of the home maintenance calendar |
| **Medium term (2025-2030)** |
| **Medium term** recommendations for the single-family home sector are for the City to:<br>• Require labeling and public disclosure at time of sale or rental listing<br>• Require disclosure to the City when seeking and major renovation/permit<br>• Shift from support for voluntary performance upgrades as a part of program participation to mandatory requirements for performance at the key transactional intervals of sale, lease, and permit<br>• Once established and aligned with city-wide targets, shift the role of the customer support service to one of compliance education, reporting, and verification<br>• Use home and energy performance data to message homeowners proactively in anticipation of equipment replacement and signal incoming performance targets |

| Long term (>2030) |
|---|
| **Long term** recommendations for the single-family home sector are for the City to:<br>• Integrate regulated disclosure of performance for all homes as a part of property taxation and GHG target compliance<br>• Require performance improvements at established intervals<br>• Provide information on benefits and requirements in an ongoing manner, linked to service providers, financing options and other opportunities to reduce cost and complexity |

**Performance Requirement**

Recommendations for setting requirements for improved building emission performance are outlined in Table 18. Establishing a total GHG emissions cap that decreases at key intervals has been recommended to provide certainty and stability for this market, and to provide simplicity and relative ease in communicating the impact of different energy sources and systems. In comparison to GHG intensity metrics, a total GHG cap can also be set to reduce the effort necessary for smaller homes. Jurisdictions such as the City of Vancouver and the Province of Nova Scotia have both made use of similar approaches, including the use of virtual EnerGuide energy audits to verify home performance and compliance with set requirements. The City of Toronto can follow the precedent set by these jurisdictions in working with NRCan to develop a similar means of ensuring compliance with its performance requirements. Such online assessments can also be completed alongside periodic on-the-ground assessments and/or confirmation of actual usage, particularly following upgrades and prior to sale. While not included as a specific trigger, time of sale and major renovation represent key opportunities to incentivize additional action. Time of sale is an especially potent opportunity when linked to a requirement to disclose home performance at time of sale, as it will help to inform buyers' decisions. The extent to which performance targets should be mandatory and how they would be enforced requires further consideration for the single-family sector in particular.

**Table 18: Proposed compliance pathways for SFH**

| Application | Available Pathway | Requirement | Vertification of Compliance |
|---|---|---|---|
| All homes | Performance path (temporal) | Achieve building emissions limits expressed as total annual GHG emissions, beginning in 2030 and gradually increased over 5-year increments | Virtual and/ or conventional EnerGuide assessmen |
| | Deferral | Defer compliance with some form of penalty (e.g. increased property tax) until next compliance period | |
| | REC/ offsets | Achieve compliance with performance pathway via purchase of RECs or offsets (up to 20%) | |
| | Embodied emissions | Achieve compliance with performance pathway via the demonstration of embodied carbon emission reductions/ removals | City review |

| Application | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|
| Minimum performance improvement at temporal trigger | N/A | 17% | 33% | 50% | 69% | 90% |
| GHG (kg/m²/year) | N/A | 35 | 24 | 18 | 10 | 4 |
| GHG (tonnes) target per average single- family home (~1750 ft²) | N/A | 5 | 4 | 3 | 2 | 1 |

### Working at Scale

Neighbourhoods and blocks represent a scale at which retrofits can be effected in greater numbers and, where paired with bulk purchasing or rebates, at lower costs. The City of Toronto has an opportunity to build off programs such as *Toronto's Greenest Neighbourhoods and the Climate Action Champions* to create a Neighbourhood Retrofit program to encourage deeper retrofits at scale. Working with community partners and organizations who are both trusted and technically equipped, such programs could help to mobilize community action by informing homeowners of options, provide participants with assistance in coordinating bulk/group purchase rebates, accessing discounted support services, and celebrating successes on social media. Tools such as online mapping, green home tours, and friendly competitions between communities can further help to galvanize action.

### Best Practices & Resources

- The Pocket Change Project is working to pilot a community-based approach to home retrofits and make deep emissions reductions more accessible and affordable for its community members.
- The Harbord Village Residents' Association has completed several neighbourhood programs, including coordinated group solar energy purchases and community home energy audit and retrofit coordination.
- The Institute for Catastrophic Loss Reduction provides resources to help homeowners understand how to protect their home from various hazards, from ice storms to floods and extreme heat. Many upgrades can and should be taken alongside energy efficiency upgrades.
- Edmonton's Climate Resilient Homes platform offers homeowners and local governments an interactive road map for improved resilience.
- This University of British Columbia report on thermal imaging explains how it has been a tool used by communities across the world to show the potential of energy retrofits in a compelling visual way.
- The Province of BC's group purchase rebate offers increasing rebates on heat pumps based on the number of people who procure one.
- Innovate offers guidance on how to develop attractive retrofit packages for homeowners using one-stop-shop models.

**Case Study: Beechwood deep energy retrofit**

Completed by Greening Homes, the Beechwood project is an award winning, deep energy retrofit that began as an uninsulated masonry bungalow located in the East York neighbourhood of Toronto. The owner's goals were to develop an energy-efficient home that could integrate seamlessly with the surrounding building fabric and respect the environmentally sensitive site[lxxviii]. The design followed an integrated design process incorporating Passive House design principles, including a well-insulated, high performing envelope, thermal-bridge-free construction, strategic orientation of building geometry and glazing to optimise natural daylight and passive solar gains in the winter and minimize solar heat gains in the summer. Mechanical ventilation is provided via an energy recovery unit, which combined with the high performing envelope helps minimize space conditioning requirements. A heat pump system combined with a shallow geo-thermal loop provides heating and cooling; distributed via ceiling radiant panels and a basement slab. Early post-occupancy results showed no supplementary heating was required during a winter where temperatures dropped below -2°C. When modelled using Passive House software, the resulting building has an annual heating demand of 30kWh/m², and an airtightness level of 0.44ACH @50Pa, exceeding both the Passive House standard for retrofits (1.0 ACH) and new builds (0.6ACH).


TORONTO
#HostCity2015

# 5. Implementing The Strategy

The nine recommended policies and the sector-specific actions described above are intended to be taken as a complete strategy, as the success of any one component will rest on the earnest implementation of the others. For example, expecting building owners to comply with requirements for performance improvement relies on the existence of a trained and adequately numbered workforce to deliver the necessary upgrades. Similarly, supporting home and building owners in making the transition to a zero-emissions building sector will necessarily have to leverage support and funding from other actors (e.g. utilities) and scales (e.g. federal and provincial governments) to be sufficient to meet the challenge. Taken together, these nine recommendations have the potential to elicit a market transformation in Toronto's building sector and achieve the goal of net zero emissions by 2050 or sooner.

**Appendix B** provides a summary of the key actions that have been outlined in this Strategy, including the key timelines, partners and City departments necessary for their successful implementation. As conditions and markets change, the City will need to review and revise the nature and timing of these recommended actions to ensure they meet the City's goals and its emission reduction targets. This will necessarily include ensuring alignment with other citywide plans and strategies, including the forthcoming city-wide Net Zero strategy update to TransformTO, the *Corporate Real Estate Management Portfolio Energy Plan*, future updates to the Toronto Green Standard (including TGS v4), as well as the expansion of low-carbon district energy systems cross the city.

There are additionally a few key issues of note that bear emphasizing in order to ensure the success of the Strategy as it has been proposed:

- Among the most important steps to take in this Strategy is ensuring that the building industry, from homeowners to REIT, labour unions to industry associations, energy modellers to energy advisors, architects to contractors, are all aware of the end goal the City has set, and the ways it plans to get there. Further engagement with key groups and stakeholders will be important to note only raise awareness, but garner support and identify and potential pitfalls or issues that may have been overlooked in the creation of this Strategy.
- As noted in Section 4.1.3, the draft targets that have been included in this Strategy were created using the best available data. While other jurisdictions (e.g. New York) have had several years of benchmarked data to use in drafting targets, the EWRB only provides data for Toronto's largest commercial and residential buildings. As such, it is of utmost importance that the City continue to collect home and building performance data to calibrate and adjust performance requirements over the next several years. The first set of draft targets for 2025 can be used as a low but meaningful first requirement, but all others should be considered approximate interim targets that will be updated as more data becomes available.
- While all of the actions and policies proposed here are important to effect the necessary market transformation to achieve zero emissions existing buildings, none of them will be successful in meeting the City's targets without clear authority on the part of the City of Toronto to require performance improvements in existing buildings. On their own, building industry capacity, educating homeowners, or even providing financing and incentives are not enough to shift the market to a state where zero emissions buildings are the norm. This means working with the Province of Ontario to clarify what, if any, regulatory adjustments may be necessary for the City to move forward with mandatory building performance requirements

- The City of Toronto cannot effect this magnitude of transformation on its own, and will need to partner with a wide variety of other organizations for the Strategy to be successful. As outlined in Section 2.4, the changes that are necessary to effect across the building sector will require considerable effort on the part of home and building owners, that will in turn require significant support from all scales of government, as well as a number of other institutions. These range from utilities and governments, to financial institutions, industry associations, educational bodies, trades unions, real estate agents, consultants, as well as home and building owners and managers.
- Overall, the recommendations included in this Strategy will require careful consideration as well as continued dialogue with key industry members and home and business owners as the City moves towards new policy and program development. However, their successful implementation will also put Toronto on track to achieving its building sector and city-wide emissions reduction goals, and to becoming a leader in climate action in Canada.

# 6. References


i City of Toronto. (2020). *Toronto's 2018 Greenhouse Gas Emissions Inventory*

ii City of Toronto. (2016). *Toronto Green Standard Tier 2 for Capital Projects*

iii City of Toronto. (2018). *Tower Renewal Program.*

iv City of Toronto. (2020). *High-Rise Retrofit Improvement Support Program (Hi-RIS)*

v City of Toronto. (2020). *Sustainable Towers Empowering People*

vi City of Toronto. (2020). *Home Energy Loan Program*

vii City of Toronto. (2020). *Energy Retrofit Loans*

viii Government of Canada. (2016). *Pan-Canadian Framework on Clean Growth and Climate Change: Canada's plan to address climate change and grow the economy*

ix Government of Canada. (2020). *Canadian Net-Zero Emissions Accountability Act.*

x Government of Canada. (2020). *Building Back Better: A Plan to Conquer the COVID-19 Recession*

xi American Council for an Energy-Efficient Economy ACEEE. (2017). *Transforming Energy Efficiency Markets: Lessons Learned and Next Steps*

xii Natural Resources Canada. (2018). *Market Transformation.*

xiii City of Toronto. (2020). *Toronto's 2018 Greenhouse Gas Emissions Inventory*

xiv Greenhouse Gas Protocol. (2014). *Global Protocol for Community-Scale greenhouse Gas Emission Inventories*

xv Environment Canada. (2015). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada.*

xvi Greenhouse Gas Protocol. (2016).

xvii *Energy Star* (2020).

xviii *Government of Canada. (2019). Energy Star for Buildings Canada.*

xix Passive House. *Criteria for the Passive House, EnerPHit and PHI Low Building Standard.*

xx Toronto Green Standard. *Energy Modelling Guidelines Version 3.*

xxi World Green Building Council. *Embodied Carbon.*

xxii Chris Magwood. (2019). *Opportunities for Carbon Capture and Storage in Building Materials.*

xxiii See *https://mhiae.com/q-ton/* for an example

xxiv Passipedia. *EnerPHit – the Passive House Certificate for retrofits.*

xxv Environment and Climate Change Canada. 2020. *A Healthy Environment and a Healthy Economy.*

xxvi *Government of Canada. (2020). Putting a price on pollution: Carbon pollution pricing systems across Canada.*

xxvii *TransformTO Reports and Resources.*

xxviii IESO. January 2020. *Annual Planning Outlook*

xxix Canada Energy Regulator (2021). *Provincial and Territorial Energy Profiles – Ontario.*

xxx The Atmospheric Fund. (2019). *A Clearer View on Ontario's Emissions.*

xxxi IESO. *January 2020. Annual Planning Outlook*

xxxii The Atmospheric Fund. (2019). *A Clearer View on Ontario's Emissions.*

xxxiii *The Atmospheric Fund (TAF). (2017). Embodied Carbon in Construction, Policy Primer for Ontario.*

xxxiv Alvarez, R et al. (2018). *Assessment of methane emissions from the U.S. oil and gas supply chain.* Science 361(6398): 186-188.

xxxv Institute for Governance & Sustainable Development "Primer on Short-Lived Climate Pollutants", 23 April

2013. *http://www.ccacoalition.org/en/resources/primer-short-lived-climate-pollutants*

xxxvi *http://www.ccacoalition.org/en/content/why-we-need-act-now*

xxxvii "Lifecycle greenhouse gas emissions from electricity in the province of Ontario at different temporal resolutions", L. Pereira and D. Posen, October 2020, *https://doi.org/10.1016/j.jclepro.2020.122514.*

xxxviii *https://www.osti.gov/pages/servlets/purl/1324200*

xxxix *https://www.integralgroup.com/news/refrigerants-environmental-impacts/*

xl *City of Toronto. (2017) Zero Emissions Building Framework.*

xli *Anatomy of heat waves and mortality in Toronto. Lessons for public health protection*

xlii Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR). (2009). *Human Health: In a Changing Climate*

xliii Toronto Environment Office. (2018). *Toronto's Future Weather & Climate Driver Study: Outcomes Report*

xliv Ontario Society of Professional Engineers. *Retail Electricity Price Reform: Path to Lower Energy Bills and Economy-Wide CO2 Emission Reduction*

xlv *www.windfallcentre.ca/data-tools*

xlvi Stanley, Lyons & Lyons. (2016). *The Price Effect of Building Energy Ratings in the Dublin Residential Market.*

xlvii American Council for an Energy-Efficient Economy (ACEEE). (2020). *Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals.*

xlviii *Natural Resources Canada. (2018). Recommissioning for Existing Buildings.*

xlix *Community Building Retrofits Program.* (2021).

l City of Toronto. (2020). *Energy Retrofit Loans.*

li City of Toronto. (2020). *High-Rise Retrofit Improvement Support Program (Hi-RIS).*

lii City of Toronto. (2020). *Grants, Incentives & Rebates.*

liii Barrier Sciences Group (BSG). (2019). *Ontario Energy Rebates 2020.*

liv Toronto Atmospheric Fund (TAF). (2017). *Energy Efficiency Financing Tools for the Canadian Context*

lv Future Cities Canadian & Coalition for Green Capital. (2018). *Green Bank Financing to Accelerate Clean Energy Deployment in Canada through the Canadian Infrastructure Bank.*

lvi MEETS Accelerator Coalition. (2020). *How MEETS Works.*

lvii City of Vancouver. (2019). *Building Energy Retrofit Bundling Programs: Report & Recommendations for the City of Vancouver.*

lviii MEETS Accelerator Coalition. (2020). How MEETS Works. *https://www.meetscoalition.org/how-meets-works/*

lix Cooper, R. (2020). *Good Energy Set to Launch UK's First Ever Heat Pump Tariff.*

lx Environmental Registry of Ontario. (2020). *Regulatory proposal for province-wide implementation of Green Button. October 8, 2020.*

lxi ENERGY STAR. (2020). *Find Utilities that provide energy data for benchmarking. ENERGY STAR.*

lxii Crandall, K. (2019). R*ethinking Energy Data Access*. Washington, DC: Institute for Market Transformation.

lxiii Environmental Registry of Ontario. (2020). *Regulatory proposal for province-wide implementation of Green Button. October 8, 2020.*

lxiv University of Toronto, U of T News. (2018). *U of T coalition of leading universities driving climate action.*

lxv Canada Infrastructure Bank *Growth Plan*. 2020

lxvi Public Services and Procurement Canada (PSPC). (2017). *Guideline- Project GHG Options Analysis Methodology.*

lxvii For additional information see *https://www.morguard.com/news-knowledge/*

*case-studies/77-bloor-street-west* and *https://www.ledcor.com/our-projects/environmental/sustainable-building/77-bloor-street-west-office-energy-efficiency-remo?from=map*

lxviii Canadian Institute of Energy Training (CIET). (2020). *Energy Management in the Ontario Mid-Tier Commercial Real Estate Sector. Market Characterization and Engagement Strategy.*

lxix Strashin Developments. (2020). *501 Alliance, The greenest building is the one that already exists.*

lxx IESO. (2020). *Energy Efficiency For Business.*

lxxi Enbridge. (2020). *RunitRight Program.*

lxxii The Atmospheric Fund. (2012). *Energy Retrofit Opportunities for Multi-Unit Residential Buildings in Toronto.*

lxxiii Government of Canada (2020) *Building Back Better: A Plan to Conquer the COVID-19 Recession, Chapter 3.2 A Plan to Fight the COVID Recession.*

lxxiv Enbridge. (2020) *Home Efficiency Rebate.*

lxxv *https://www.affordabilityfund.org/*

lxxvi Enbridge. (2020). *Home Winterproofing Program.*

lxxvii Save On Energy Power What's Next. (2020). *Home Assistance Program.*

lxxviii Canada Eco House. (2015). *Beechwood Deep Energy Retrofit.*