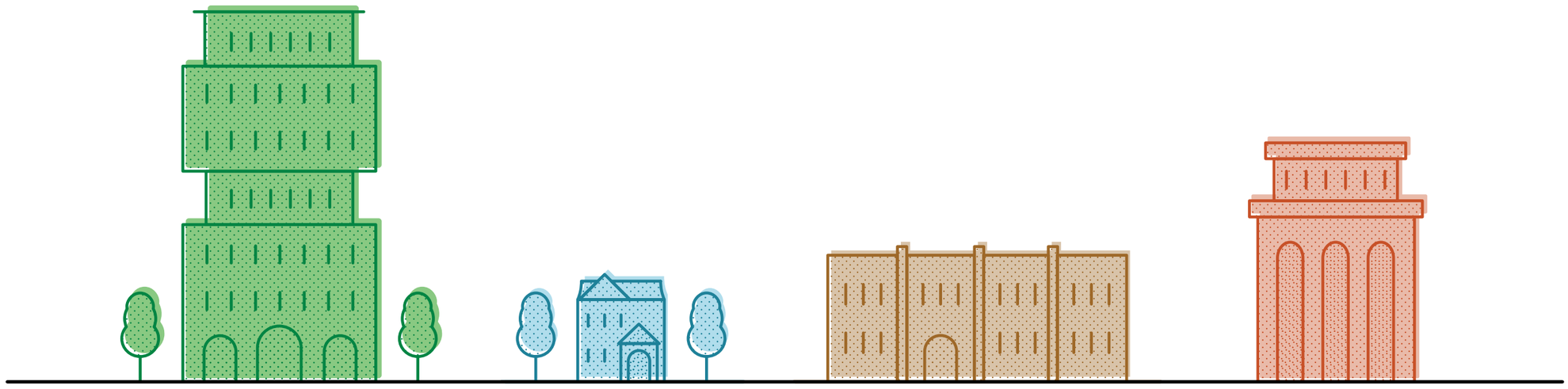
Net Zero Building Retrofit Guides

The Introductory Guide



TORONTO

Live green Toronto

Join Us in Action

The City of Toronto is experiencing the harmful effects of climate change, and in response, is accelerating its efforts to drive down city-wide emissions towards net zero. The path to net zero by 2040, as developed in the City's TransformTO Net Zero Strategy, identifies clear actions and targets across its key sectors of homes & buildings, energy, transportation, and waste[i].

Since more than half of the City's current emissions come from the homes & buildings sector, home and building owners will play a crucial role in achieving this net zero goal. This will require the transformation of Toronto's buildings to become more energy efficient and less reliant on fossil fuels. Many that have already embarked on this transformation have seen benefits beyond just emissions reductions, including utility cost savings, improved indoor air quality and comfort, and enhanced long-term property value.

This guide provides the foundational knowledge, resources, and next steps to support you on your path to decarbonization. Learn about the benefits of decarbonization, the steps to and co-benefits of achieving net zero, and how the City's resources can help you along the way.

The City stands ready as a partner in the challenge to reach net zero. Join your community in reducing the impact of climate change and building greener, healthier, more sustainable communities for future generations.

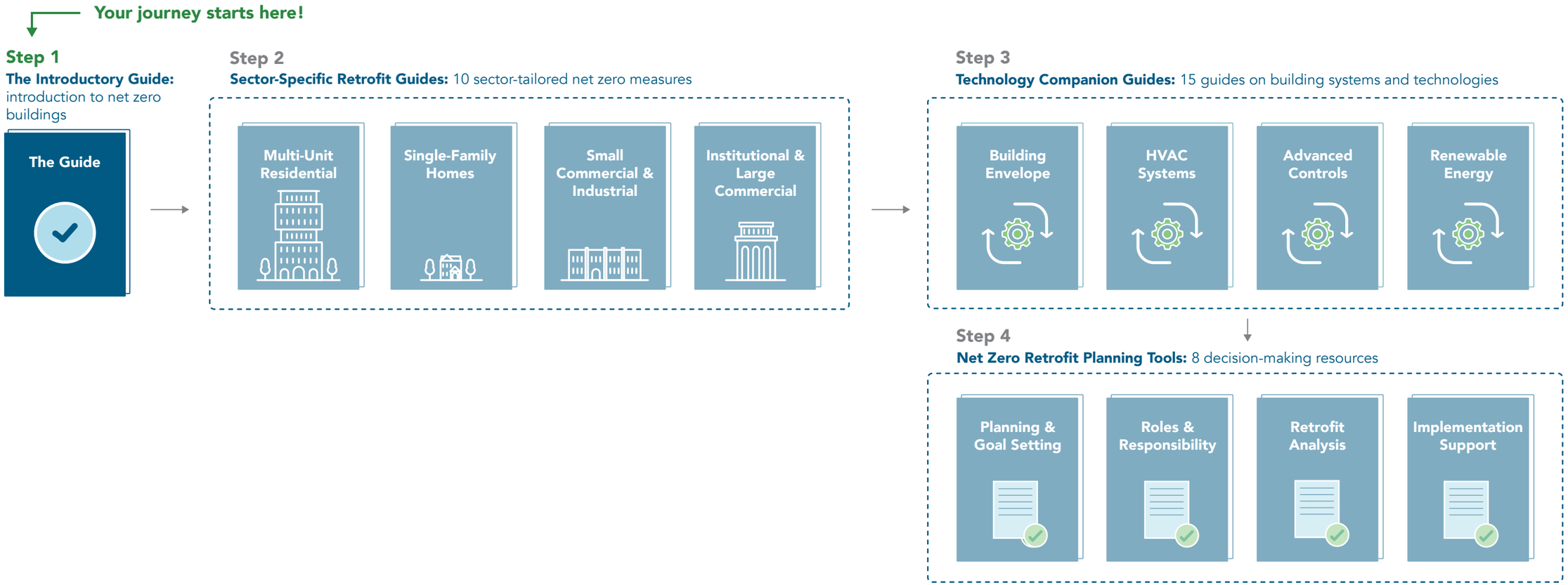
i. City of Toronto. (2021). TransformTO Net Zero Strategy – A climate action pathway to 2030 and beyond.

Navigating the Net Zero Building Retrofit Guides

Reducing Greenhouse Gas (GHG) emissions is a journey. It's also an opportunity to make your building more comfortable, valuable, healthier, and resilient to extreme weather events. Successfully arriving at your net zero destination requires careful planning and the right travel companions to ensure a smooth trip.

The City of Toronto's **Net Zero Building Retrofit Guides** include a range of documents designed to support home and building owners reduce GHG emissions from their buildings.

1. **The Introductory Guide** introduces the topic of "net zero buildings." The guide's goal is to familiarize all home and building owners with Toronto's net zero goals and concepts.
2. **The Sector-Specific Retrofit Guides** highlight net zero measures tailored to each building sector and type. These guides provide direction to identify, plan, and implement retrofit projects specific to your building.
3. **The Technology Companion Guides** provide technical information about building systems and technologies related to net zero measures and retrofits.
4. **The Net Zero Retrofit Planning Tools** provide decision-making resources to help home and building owners prioritize their retrofit projects. The tools include needs assessments, checklists, and support for contractor selection.



Net Zero Building Retrofit Guides Document Navigation

Context

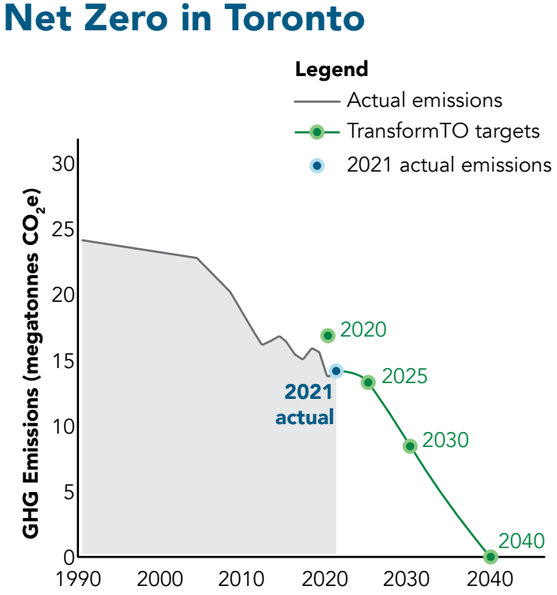
The Impacts of Climate Change

Our climate is changing, driven by human activities that release GHG into the atmosphere. We release GHG primarily through the burning of fossil fuels including oil, gas, and coal, which we use to heat our homes and buildings, power our factories, and fuel our cars.

Toronto is already experiencing weather that is hotter, wetter, and wilder. These conditions are expected to worsen. Rising temperatures lead to more frequent and extended heatwaves, along with associated heat-related illness. As rainstorms become more extreme, so does the severity and frequency of flooding. Climate change intensifies existing socio-economic challenges, disproportionately impacting those who are already facing significant hardships.

We must act now to retrofit our homes and buildings to reduce the intensity of future climate change impacts.

Net Zero in Toronto



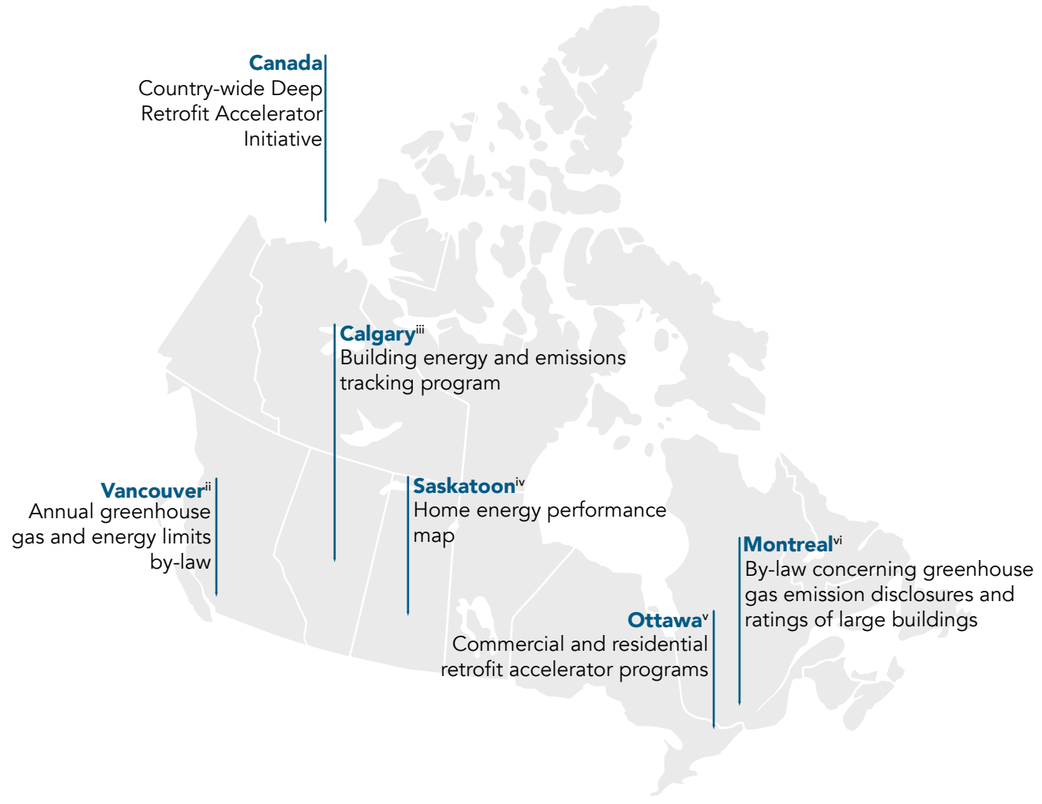
Toronto's GHG Emissions and TransformTO Targets

To reduce the intensity and long-term impacts of climate change, we need to achieve net zero emissions. Net zero means that the amount of GHG we release into the atmosphere is balanced by the amount we remove. Although we can increase the removal of GHG through natural methods, like planting more trees, and human-driven methods, such as carbon capture technologies, these efforts alone are not enough to offset the current high levels of emissions. To reach net zero, we must therefore use energy more efficiently and transition our energy sources from fossil fuels (like natural gas) to renewables (such as solar or wind power).

As part of Toronto's plan to reduce its impact on climate change, the City has set a goal of achieving net zero emissions by 2040 across the homes & buildings, energy, transportation, and waste sectors.

Net Zero Across Canada

Toronto is not alone in pursuing decarbonization initiatives. Other cities across Canada, including Vancouver, Calgary, Saskatoon, Ottawa, and Montreal, have introduced programs and policies to measure and mitigate the environmental impact of operating their homes and buildings.



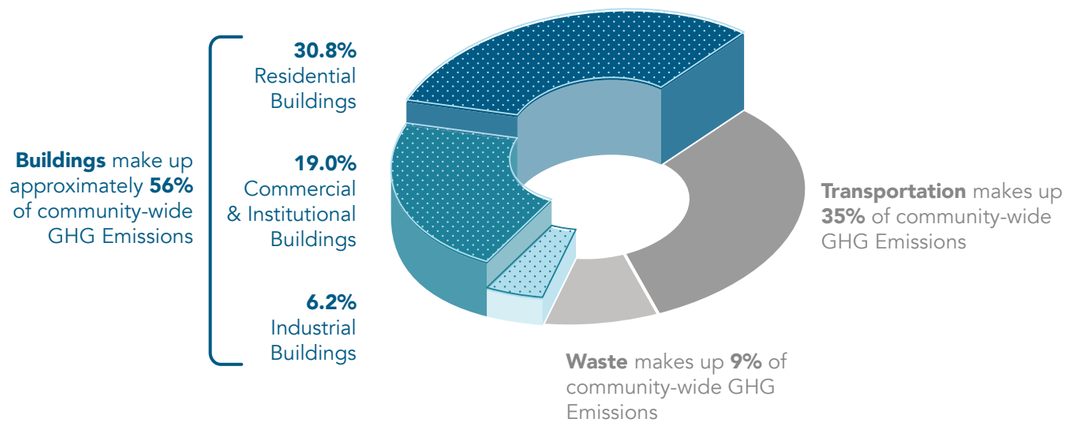
Other Net Zero Initiatives in Canada

ii. City of Vancouver. (2023). Energize Vancouver.
iii. City of Calgary. (2019). Benchmarking YYZ.
iv. City of Saskatoon. (2023). Home Energy Map.
v. City of Ottawa. (2021). Better Buildings Ottawa.
vi. City of Montreal. (2023). By-law concerning GHG emission disclosures and ratings of large buildings.

The Impacts of the Building Sector

In Toronto, approximately 56% of emissions are attributed to buildings. As of 2021, total emissions were approximately 8,000,000 tonnes annually[vii], which is equivalent to the energy consumed by more than 2.4 million passenger cars every year[viii]. Residential buildings accounted for over half of Toronto's building sector emissions, followed by commercial and institutional sectors contributing close to 30%.

This puts home and building owners at the forefront of climate action. Building retrofits are central to achieving the city-wide decarbonization goals of TransformTO.

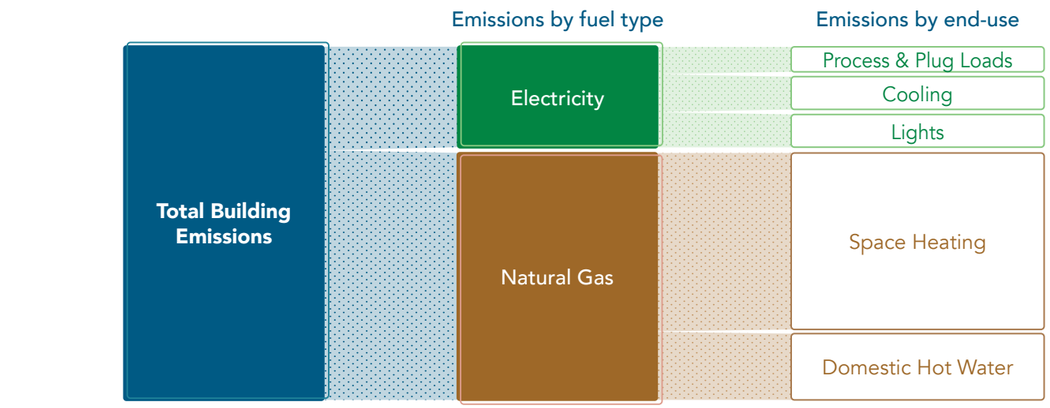


Toronto Emissions Inventory 2021

Building sector emissions referenced in the Toronto Sector-Based Emission Inventory are operational emissions driven by annual building energy demand. Operational emissions are the GHG associated with building energy end-uses, such as space heating, space cooling, ventilation, domestic hot water heating, and plug loads. These activities typically use the two primary sources of energy – electricity and natural gas – which have different GHG emissions intensities.

The Ontario grid is considered relatively "clean", with an average electricity grid emissions intensity of 30g CO_2e per kWh as of 2023[ix]. In comparison, the combustion of marketable natural gas generates approximately 181g CO_2e per ekWh (1921 g CO_2e per m^3)[ix]. This means that, in Ontario, natural gas generates nearly six times the emissions of electricity.

Below is a typical building emission breakdown by fuel type and by end-use. This highlights that the main sources of GHG emissions in existing buildings are due to natural gas boilers and furnaces that supply space heating and domestic hot water.



Typical Building Emissions Breakdown

Therefore, to transform your building into a net zero building, you must remove or dramatically reduce any dependence on fossil fuels, such as natural gas. This is done by retrofit measures focused on:

- Load Reduction,
- Electrification,
- Advanced Controls,
- Renewable Energy Generation and Storage.

These pathways are explained on Page 8.

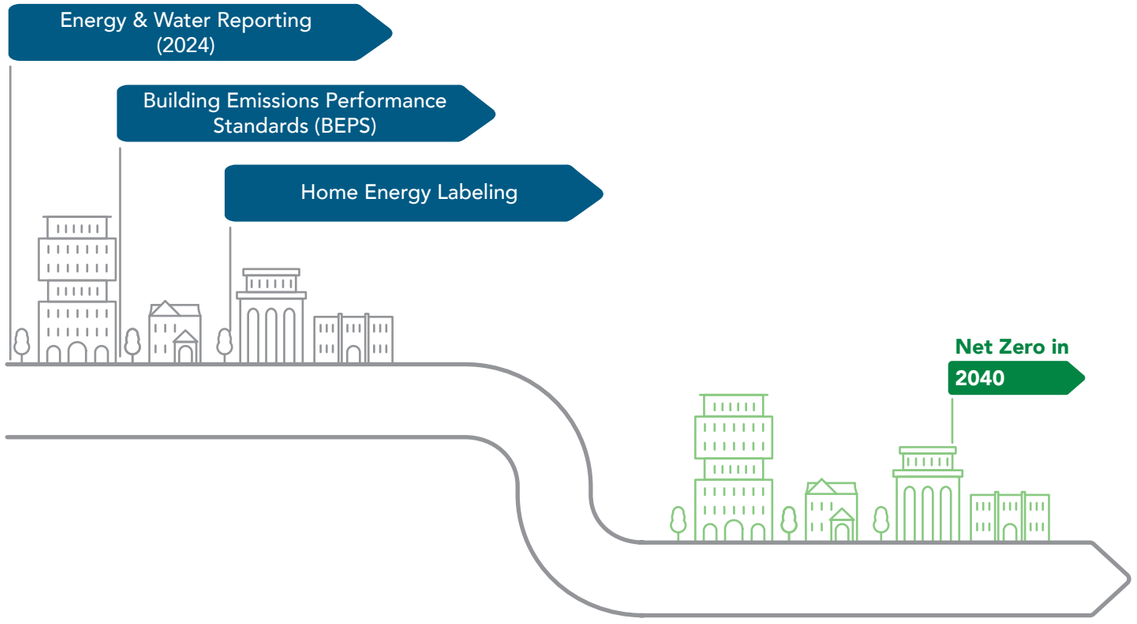
vii. City of Toronto. (2024). 2021 Sector-Based Emissions Inventory.
viii. Natural Resources Canada. (2024). Greenhouse Gas Equivalencies Calculator.
ix. Government of Canada. (2023). Emission Factors and Reference Values.

Policies Leading the Way

Building policies at the national, provincial, and municipal level are key to guide us towards a sustainable future. These policies can influence energy costs, the availability of technology, and the requirements for reporting. By understanding the policies that affect your home or building, you can take a proactive approach to compliance, and contribute to the City's sustainability goals.

In Toronto, owners of large buildings are required to report their energy and water use data annually[x]. Compiling this data set will be critical for initializing decarbonization retrofits.

In 2025, City Council will consider establishing Building Emissions Performance Standards (BEPS) to set GHG emissions targets for large buildings in Toronto[x]. The initiative aims to strengthen or create supportive policies, programs, and resources, and improve access to incentives, helping building owners, tenants, and occupants manage upfront costs and affordability challenges.



City of Toronto Policies Timeline

How These Guides Help

We have a lot of work to do, and the **Net Zero Building Retrofit Guides** are here to help.

These guides are specifically designed to offer practical direction on retrofitting your homes and buildings. They offer instructions to help you use less energy, switch away from fossil fuels, and reduce GHG emissions. In addition to this **Introductory Guide**, accompanying **Sector-Specific Retrofit Guides**, **Technology Companion Guides**, and **Net Zero Retrofit Planning Tools** will support you at each step along the way.

Although the guides are applicable to almost any building type in the City, their content focuses on buildings in the following sectors:

Sectors and Building Types Covered by the Net Zero Building Retrofit Guides

x. City of Toronto (2024). Energy & Water Reporting for Buildings.

Overview of Net Zero

Journey Towards Net Zero

The journey to reducing GHG emissions towards net zero will be unique for every home and building. There is no single path forward. However, there are decarbonization pathways that work for similar types of buildings, and that's where the **Sector-Specific Retrofit Guides** come in.

This section will explain the concept of deep retrofits, present pathways to net zero with available technologies and measures, and provide steps to achieve net zero.

What Are Deep Retrofits?

A building energy retrofit refers to an intervention applied to an existing building to reduce its energy use and GHG emissions. Within the building sector, the term "deep retrofit" has emerged to describe extensive retrofits that target significant reduction of energy use and GHG emissions. While there is no exact threshold, deep retrofits typically aim to reduce building energy use or GHG emissions by over 50%.

A 50% reduction of emissions in Toronto can only be achieved through the reduction or elimination of fossil fuel use. Therefore, fuel switching from fossil fuels to electricity is the key to achieving net zero buildings.

Deep retrofits involve upgrades across all building systems, from the building's envelope to mechanical systems and operational practices. To achieve net zero, a home or building will need to undergo various retrofit measures. Retrofits can be done in a single-phase or a multi-phase approach. Single-phase retrofits require significant upfront investment and may displace occupants but are completed faster. Multi-phase retrofits spread out costs and minimize occupant disruption, maximizing the useful life of existing equipment and systems. The ultimate goal is to maximize GHG emission reduction while simultaneously enhancing indoor comfort air quality and occupant experience.

Embodied carbon, GHG emissions associated with materials and construction, is not a focus for the **Net Zero Building Retrofit Guides** at this time. However, embodied carbon should be considered, particularly for retrofit measures involving the building envelope, including windows.

Why Retrofit to Net Zero?

Owner Co-benefits

Retrofitting your building to net zero will enhance its energy efficiency, reduce GHG emissions, and potentially lower utility and maintenance costs. Beyond these advantages, home and building owners can also enjoy additional co-benefits, such as:

Resilience: Improve the ability to resist and recover from changing weather and extreme storms caused by climate change.

Indoor Air Quality: Improve the quality of air (pollutant levels, fresh air, temperature, and humidity) inside a building directly impacting human health.

Occupant Comfort: Create indoor spaces where occupants feel comfortable (temperature, noise levels, lighting, and a sense of security).

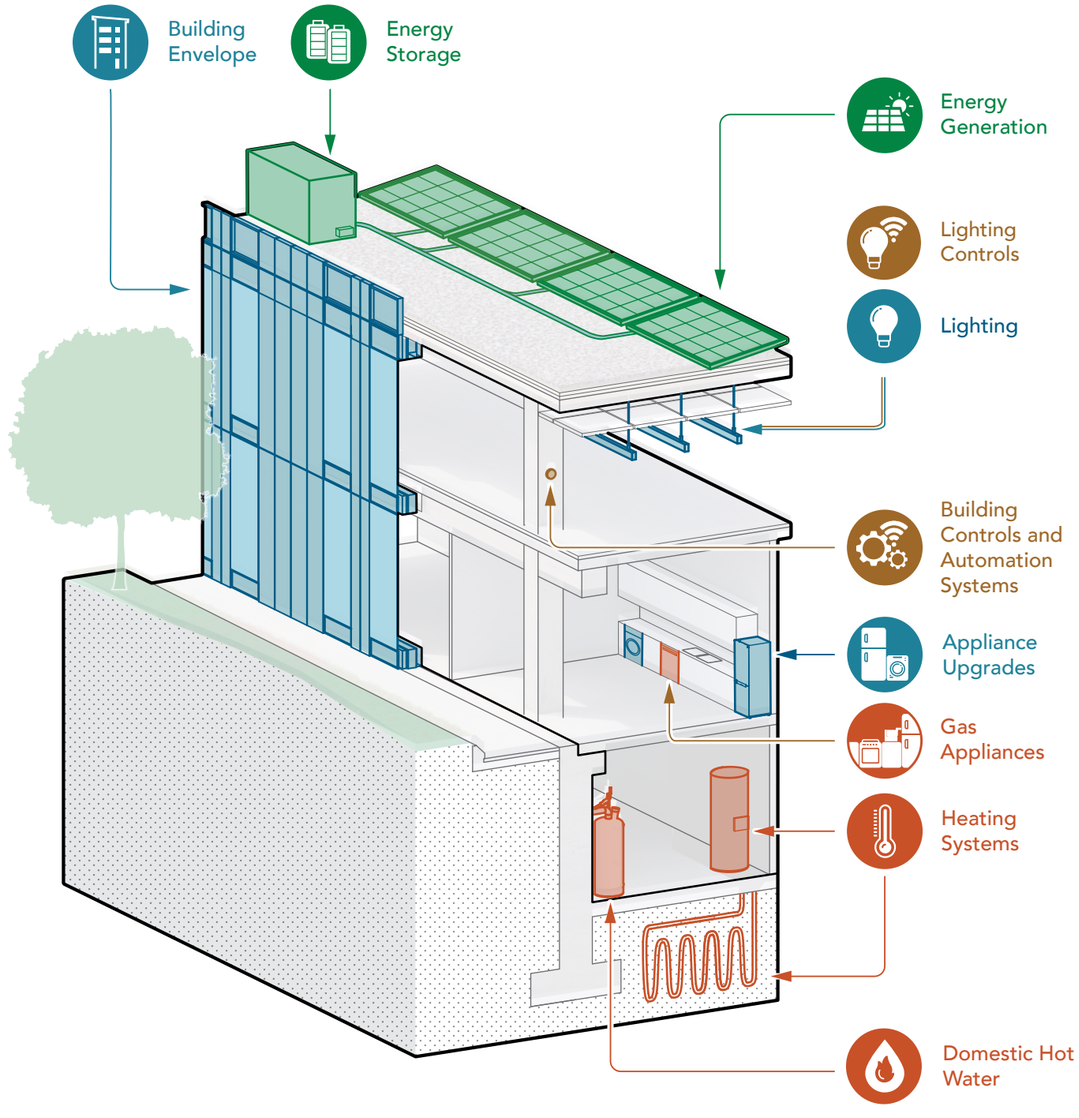
Property Value: Improve your property's market value by attracting tenants and buyers who prioritize climate change values. In addition, keep tenants longer as they will enjoy more comfortable and healthy spaces.

Community Benefits

Converting to net zero also provides upside to surrounding communities:

- **Climate Change**: Mitigate the downstream impacts of climate change on the environment, decrease occurrences of extreme weather, foster thriving ecosystems, and ensure a sustainable future.
- **Healthier Communities**: Support healthier living environments with better indoor environmental quality.
- **Infrastructure Impact**: Lower energy demand to help alleviate the need for investment in new energy generation and distribution infrastructure.
- **Equity**: Contribute to mitigating socio-economic disparities due to climate change, including health equity, affordability, and resilience for vulnerable communities.
- **Job Creation**: Create more local employment opportunities due to the labour-intensive nature of retrofitting, boosting the local economy.

Pathways to Net Zero



Building Systems Involved in Deep Energy Retrofits

Net zero retrofits fall under four categories:

Load Reduction strategies aim to improve your building's energy efficiency to minimize energy demands.

Electrification strategies focus on replacing equipment that relies on natural gas or other fossil fuels with electrical equipment. Converting your building's space heating system from fossil fuels to electricity is the most important step in reducing a building's operational emissions. Heating in our northern climate accounts for an outsized portion of a typical building's energy use.

Advanced Control strategies leverage technology and automation to minimize energy waste.

Renewable Energy Generation and Storage strategies focus on generating and storing energy on your building's site from renewable sources. This can reduce your building's reliance on the electrical grid and reduce your operational emissions from electricity.

Available Retrofit Technologies and Measures

The following is a list of retrofit technologies and measures that can reduce your home or building's emissions. The **Technology Companion Guides** offer additional details related to specific technologies and measures, such as strategies that work best for specific sectors and combinations of strategies that are sensible to implement together. The items with an * indicate that a **Technology Companion Guide** on the topic is available.

Load Reduction

Building Envelope

- Insulation *
- High-performance windows *
- Air sealing and airtightness *

Heating, Cooling, and Air Conditioning

- Energy recovery ventilation *
- Air source heat pumps *
- Ground source heat pumps *
- Variable-speed pumps and fans
- Water source heat pumps
- Drain water heat recovery
- IT heat recovery

Lighting

- Lighting *
  - LED fixtures and bulbs
  - Natural light

Appliance Upgrades

- Domestic hot water systems *
- Energy efficient appliances
  - Heat pump and electric dryers
  - Washing machines
  - Dishwashers
  - Refrigerators

Electrification

Heating Systems

- Air source heat pumps *
- Ground source heat pumps *
- Electric boilers
- District energy *

Domestic Hot Water

- Domestic hot water systems *
  - Heat pump water heaters
  - Electric water heaters

Gas Appliances

- Electric and induction ranges
- Clothes dryer
- Electric humidifiers

Advanced Controls

Building Controls and Automation Systems

- Smart home and appliances *
- Building automation system *
- Sub-metering *

Lighting Controls

- Lighting *
  - Daylight sensors
  - Automated dimming systems
  - Mobile applications
  - Smart bulbs and fixtures

Renewable Energy Generation and Storage

Energy Generation

- Solar and batteries *
  - Solar photovoltaics
  - Solar thermal
  - Building integrated photovoltaics
  - Solar air preheat

Energy Storage

- Battery storage
- Thermal storage

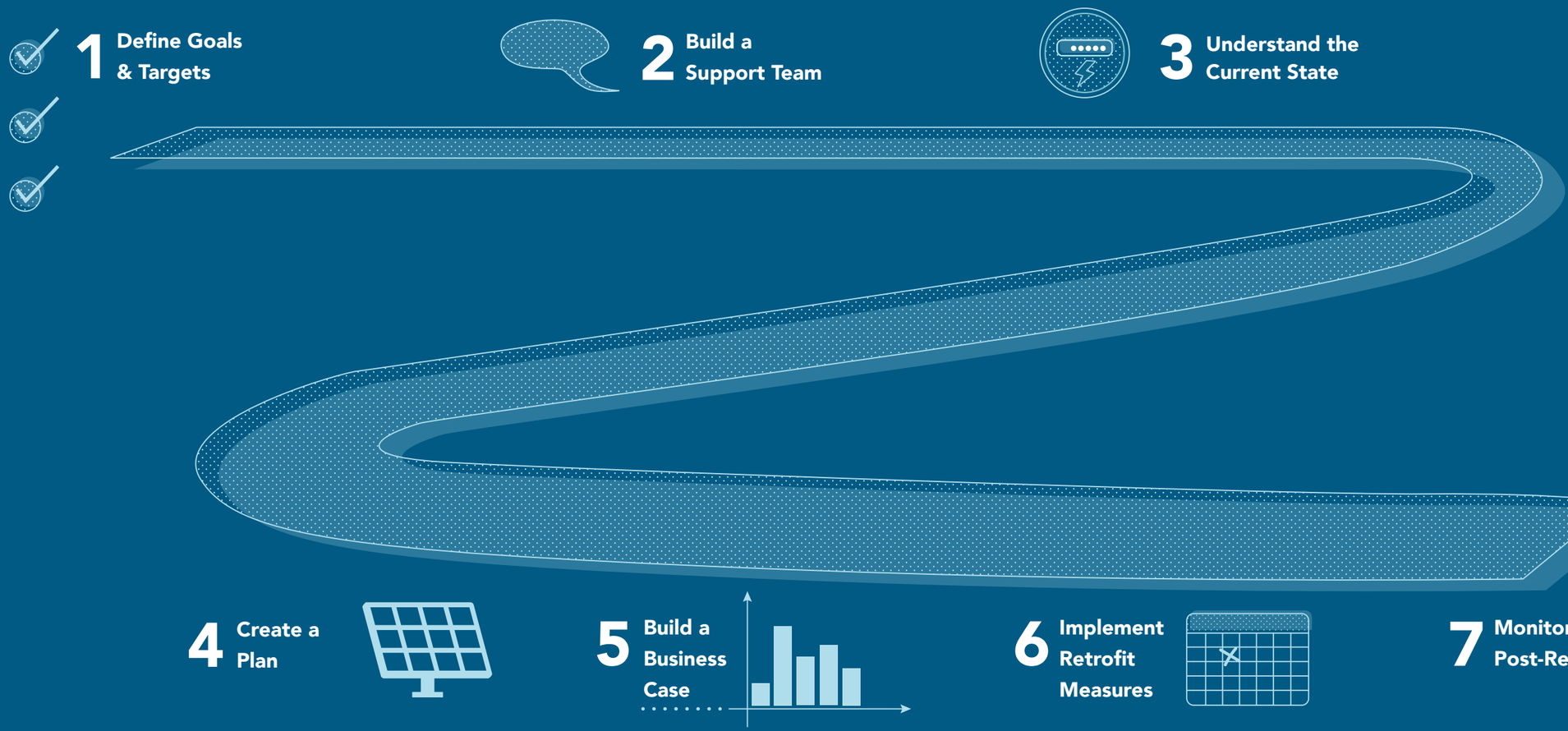
Enabling Technologies

- Electrical capacity upgrades *
- Emergency generators

Steps to Achieve Net Zero

Below is a seven-step roadmap to achieve net zero, from setting goals, to implementing and monitoring retrofit measures. Identifying and planning the right solutions for your home or building is important for successful retrofits.

Since the path to net zero will vary by building type, please refer to the accompanying **Sector-Specific Retrofit Guides** for steps tailored to your specific home or building.



Next Steps

Support from a Market Transformation

Your involvement as home and building owners is just one part of the broader market transformation needed to address the impacts of the climate change. Transformative changes will be required from many stakeholders to eliminate fossil fuel use within Toronto's homes and buildings. To ensure success, change is necessary at the following levels:

Policy & Regulation: To mandate net zero emissions requirements for new constructions and renovations. This will help to accelerate required retrofits and drive widespread adoption across the industry.

Industry Collaboration and Innovation: To drive innovative net zero solutions. Research and development efforts will need to focus on advancing energy-efficient technologies, renewable energy systems, sustainable building materials, and cost-effective construction for deep retrofits.

Financial Mechanism: To facilitate the transition to net zero buildings. Financial institutions can offer specialized loans, green bonds, and other innovative financing options. Additionally, tax credits, grants, and rebates can support retrofit projects.

Workforce Development: To successfully transform Toronto's buildings. Programs, certifications, and career pathways in green building design, energy audits, and renewable energy installation will be required to meet the demand for qualified professionals.

Technology Integration: To enable real-time monitoring and control of energy use, lighting, and HVAC systems. This will help enhance your building's energy efficiency and occupant comfort while supporting net zero goals.

Certification and Standards: To ensure quality, performance, and credibility. Such programs provide guidelines and benchmarks for net zero goals, with third-party verification enhancing transparency and trust.

Market Awareness: To drive demand and market adoption. Educational campaigns, workshops, and outreach programs can inform home or building owners, businesses, and policymakers about the economic, environmental, and social advantages of net zero construction.

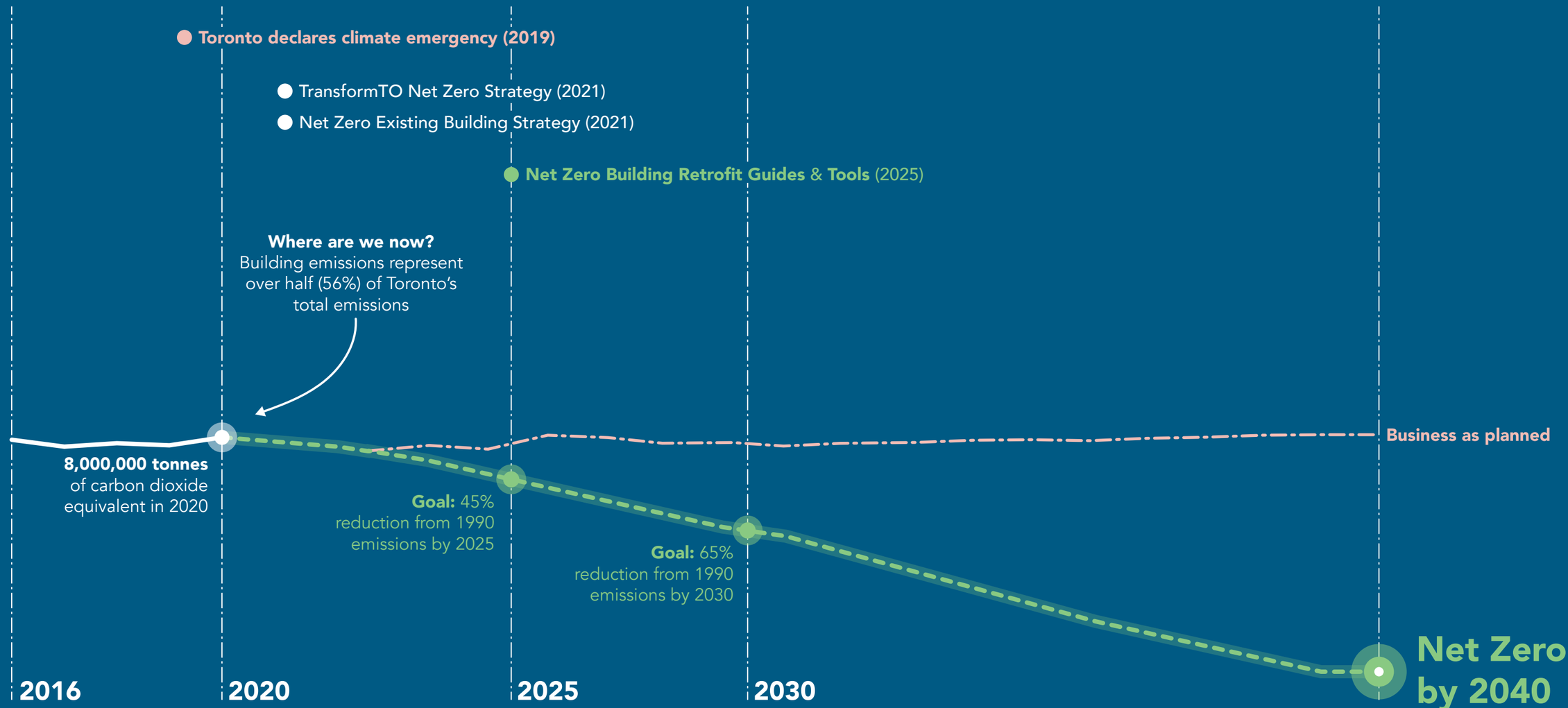
Full Market Transformation

We Are All in This Together

We hope that this **Introductory Guide** has effectively highlighted the path to a sustainable, net zero future. Strategies like TransformTO and the Net Zero Existing Buildings Strategy are central in Toronto's commitment to tackle climate change and enhance urban living. As the City joins global cities in urgent climate action, you as an owner remain key in reducing emissions from your homes and buildings. The pathways offer clear benefits like cost savings, more comfortable indoor environments, and increased property value. More information can be found throughout the **Net Zero Building Retrofit Guides**, including the **Sector-Specific Retrofit Guides**, the **Technology Companion Guides** and the **Net Zero Retrofit Planning Tools**.

Let's unite in retrofitting our homes and buildings to create healthy, sustainable communities. **Together, we can make a difference!**

Visit the City of Toronto website for more detailed information related to retrofitting your specific building type, various technology guides, and decision-making tools to support this journey.



Other resources in the Net Zero Building Retrofit Guides:

- Sector-Specific Retrofit Guides
- Technology Companion Guides
- Net Zero Retrofit Planning Tools

For more information, please refer to these other City of Toronto resources:

- Net Zero Existing Buildings Strategy
- TransformTO Net Zero Strategy
- Toronto Green Standard
- Better Buildings Partnership
- Better Homes: Green Resources for Residents
- Energy & Water Reporting for Buildings

Prepared for:

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Prepared by:

ARUP

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For homes and duplexes, contact: BetterHomesTO@toronto.ca homeenergyloan@toronto.ca