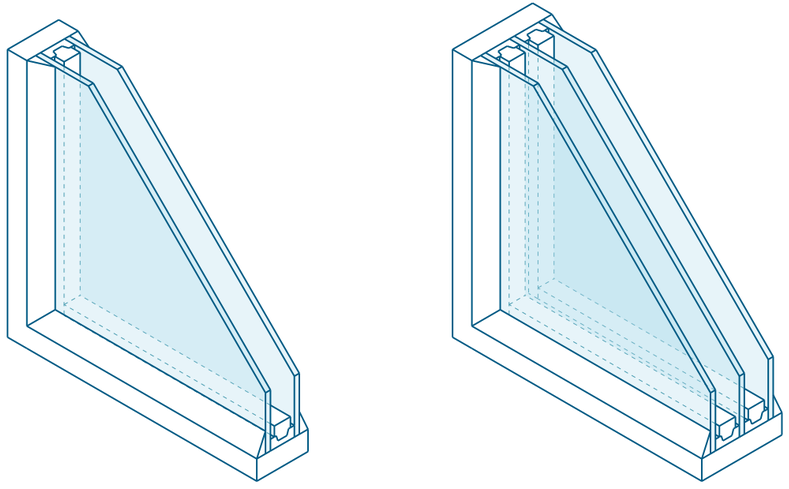
Net Zero Building Retrofit Guides

High-Performance Windows

Technology Companion Guide



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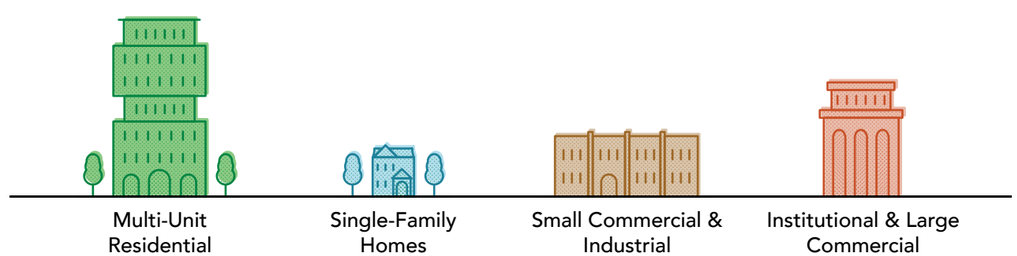

Co-benefits

Resilience	Indoor Air Quality	Occupant Comfort	Property Value
■■□□	■□□□	■■■□	■■■□

Impacts

Emissions Reduction	Utility Savings	Capital Cost	Maintenance Requirements
■■□□	■■□□	■■■□	■□□□

TORONTO

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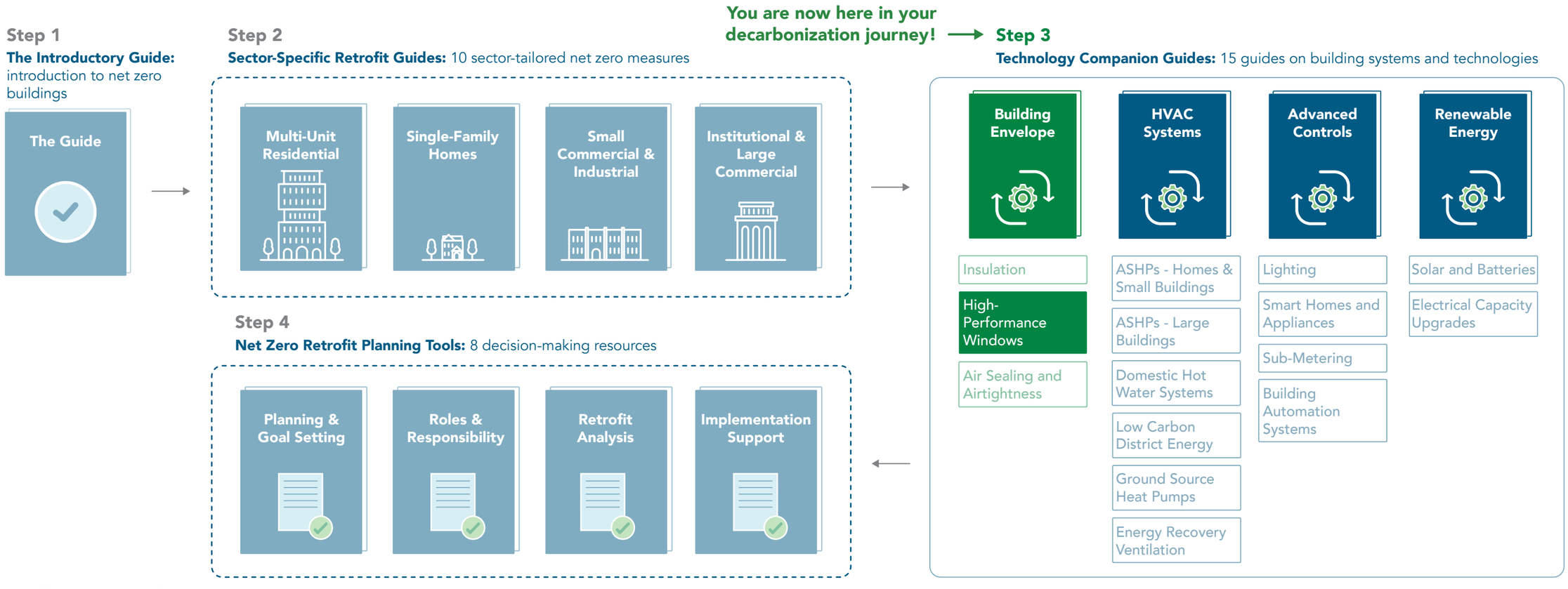
Navigating the Net Zero Building Retrofit Guides

Reducing Greenhouse Gas (GHG) emissions is a journey. It's also an opportunity to make your building more comfortable, healthier, valuable, 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 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.



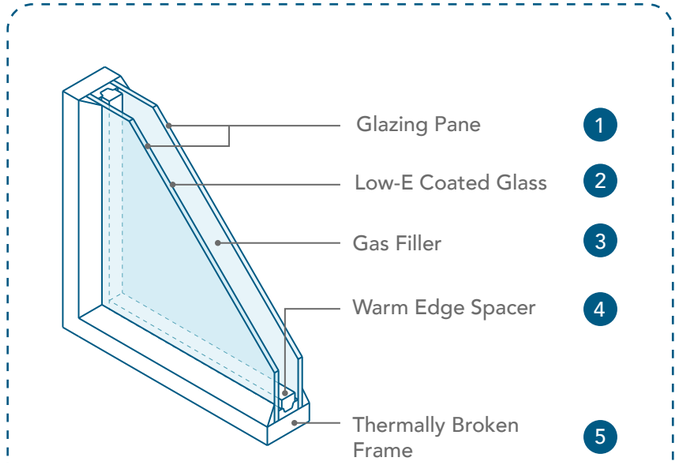
Net Zero Building Retrofit Guides Document Navigation

High-Performance Windows

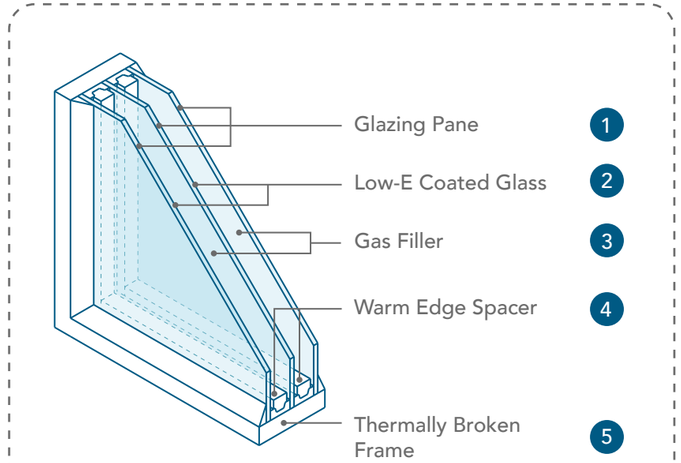
What Is This Technology

High-performance windows use modern technologies, including advanced insulating glass fills and frames, low-e coatings, airtight seals, and solar control to improve energy efficiency, comfort, and building performance. Depending on performance requirements, windows can be double or triple-glazed. Glazing refers to the installation of glass pane within the window frames, which can range from single to triple panes. The higher the number of panes, the better performance you get from your window.

High-Performance Windows



Double-glazed Insulating Unit



Triple-glazed Insulating Unit

How High-Performance Windows Work

High-performance windows combine modern technologies to make your building envelope more energy efficient. Here are the key features of high-performance windows:

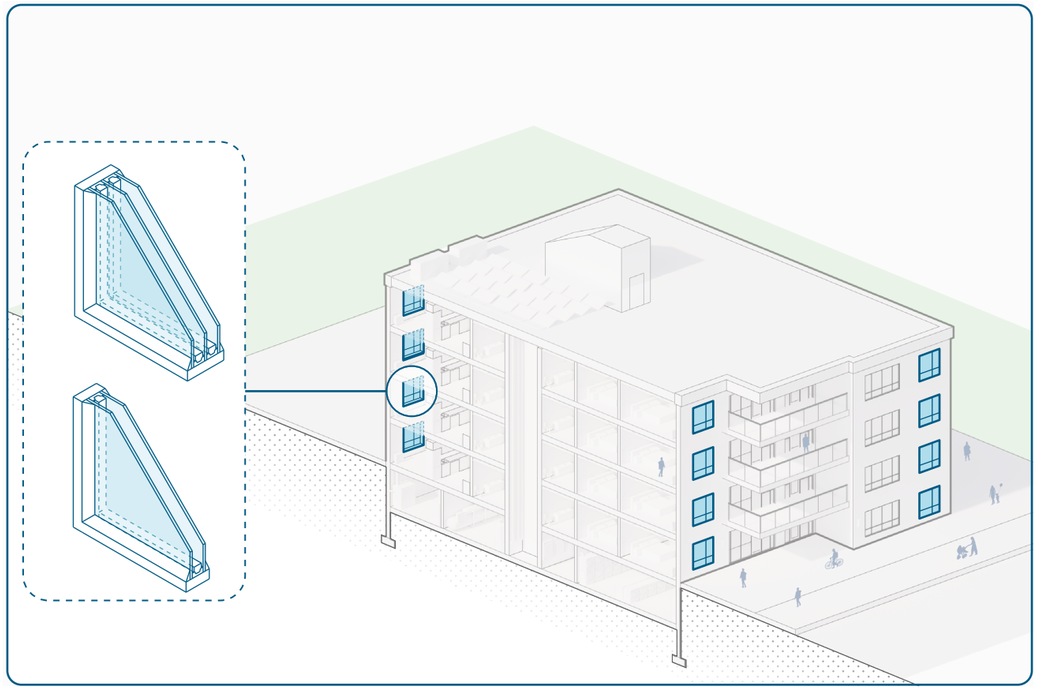
1. Multiple glazing panes, which reduce drafts, noise, air leakage and heat loss, making the building more energy efficient.
2. Low-e coating on the glass, which blocks harmful ultraviolet rays and keeps the building warmer in the winter and cooler in the summer.
3. Gas fillers like argon or krypton between the glass panes, which act like insulation to reduce heat transfer.
4. Warm edge spacers at the edges of the glass, which reduce heat transfer and prevent condensation.
5. Thermally broken frames, which reduce heat transfer between the interior and exterior of the window frame by separating the two sections of the metal frame with an insulation material.

When to Retrofit This System

Framed windows last about 30 years before they need to be replaced. Replacement with high-performance window products should be done during scheduled window replacement or building envelope insulation and air sealing upgrades. Thoughtful project timing will save cost and maximize the benefits of the overall retrofit project.

Why Retrofit This System

Older windows are usually filled with air, offering little insulation. Replacing with high-performance windows, filled with argon or krypton, helps to reduce building energy losses, reducing the demand on heating and cooling equipment and increase occupant comfort. By reducing energy consumption, you can decrease reliance on utilities and protect yourself from rising energy costs, all while lowering GHG emissions.



Building envelope elements associated with this technology

Below are co-benefits and impacts to help you better understand this technology.

Co-benefits

Resilience:
High-performance windows make buildings more resilient by withstanding strong winds and resisting moisture infiltration.

Indoor Air Quality:
High-performance windows have minimal impact on indoor air quality by reducing pollution infiltration, humidity and mould growth.

Occupant Comfort:
High-performance windows improve occupant comfort by eliminating drafts, regulating temperature, and reducing noise.

Property Value:
Enhanced aesthetics and savings from future window replacements can also increase property value.

Impacts

Emissions Reduction:
High-performance window upgrades improve thermal performance of the envelope, leading to lower GHG emissions.

Utility Savings:
High-performance windows save on energy required for heating and cooling, reducing utility costs.

Capital Cost:
High-performance windows cost more upfront but are only slightly more expensive than minimally code-compliant alternatives.

Maintenance Requirements:
High-performance windows require little maintenance. However, regular cleaning, inspection, and proper drainage are necessary to make sure they perform well. Schedule a professional inspection at least once a year.

Types of Systems and Retrofit Solutions

Existing windows typically have minimal insulation and compromised seals, are air filled and lack low-E coatings. Several retrofit solutions are available to improve efficiency and comfort.

Here are some typical window systems for existing buildings and how to retrofit them:

Punched Windows

Common in older mid-rise residential and commercial buildings, this type of window is installed individually into the wall, creating a "punched" look.

Retrofit: Replace with high-performance windows and upgrade the seals and gaskets around the windows to improve airtightness.

Heritage Windows

A heritage window usually has a wooden frame with single-pane glass with divided sections.

Retrofit: Replace with vacuum insulated glazing, one of the latest innovations for heritage buildings. Apply acrylic seals to prevent water infiltration in wood-framed windows. This protects against rain, moisture, wood rot, warping, and other weather-related damage.

Storefront System

A storefront system is a type of glass wall used typically at the ground level of shops, restaurants, and office buildings. It is non-load bearing, meaning it does not support the weight of the structure above.

Retrofit: Replace with high-performance double-glazed units with thermally broken frames and low-e coatings.

Window Wall

A window wall consists of large glass panels or windows spanning from the floor to the ceiling, commonly used in high-rise residential and commercial buildings.

Retrofit: Replace with a high-performance prefabricated window wall system. Depending on the existing condition, you can either fit new windows within the existing frame which is less invasive or replace the entire window including frames.

Unitized Curtain Wall

This system uses large, prefabricated panels, commonly seen in large institutional and commercial buildings where construction speed and precision are critical.

Retrofit: Replace with high-performance triple-glazed unit and thermally-broken frames. A thermally broken frame reduces the heat transfer by creating a thermal barrier between the interior and exterior metal frame, maintaining interior temperatures more effectively. Use advanced glazing for better daylighting.

How to Implement

Before starting, refer to the **seven-step roadmap to net zero** in the **Introductory Guide** and in your **Sector-Specific Retrofit Guide**, to ensure your retrofit aligns with your overall strategy and goals. Here are a few steps to get you started with a high perfomance window retrofit:

1. Evaluate the performance, age, and conditions of your current window, for example:
    - o What window system do you currently have?
    - o Is it reaching end of life?
    - o Are there any visible cracks or leaks?
2. Hire experts, like an envelope consultant, to advise and support you in selecting and applying the appropriate solutions for your building and setting performance targets. Your experts will help you with the following steps.
    - o Use thermographic inspection or energy modeling software to check for heat loss and performance gaps.
    - o Choose high-performance windows that meet your goals.
    - o Assess whether additional retrofits (insulation or shading devices) are required to maximize the benefits of your new windows.
    - o Measure the performance of the new windows to ensure they meet targeted energy savings and comfort levels.
3. Set up a maintenance schedule for cleaning and checking seals, frames, and glazing.

What is U-value?

A U-value, also known as thermal transmittance, measures how well a building component (wall, window, or roof) conducts heat. It indicates the rate of heat transfer through a material or assembly, with lower U-values representing better insulation and less heat loss.

For U-value requirement of envelope components, you can refer to SB-10 which is a supplementary document of the Ontario Building Code. It outlines the energy efficiency requirements for different buildings in Ontario.

Opportunities

Evaluate how this retrofit can be integrated with the following building systems to maximize potential synergies and optimize overall performance.

Lighting

High-performance windows can maximize natural light in your building, while minimizing glare and heat gain. This can reduce the need for artificial lighting during the day.

HVAC Systems

High-performance windows minimize heat loss in winter and reduce heat gain in summer. This results in smaller, more efficient HVAC systems, enhancing overall energy efficiency.

Building Controls and Automation Systems

Connecting high-performance windows with building controls for lighting, shading, and HVAC systems can help reduce your energy usage. Some building controls can be accessed from a smart phone.

Energy Generation / Energy Storage

High-performance windows reduce heating and cooling needs, allowing renewable energy systems to meet the building's energy needs.

Challenges and Solutions

Window retrofits can be challenging. Below are some common challenges you may face and how to solve them.

Challenge 1: Compatibility with Existing Systems

Solution: Work with experts to assess envelope compatibility with existing systems to ensure seamless installation and integration with existing structure and aesthetics.

Challenge 2: Cost Overruns

Solution: Create a detailed budget with a backup plan to handle extra costs from structural changes, new framing, or insulation needs.

Challenge 3: Supply Chain Availability

Solution: Communicate with suppliers to ensure availability and delivery delays. Special features may require more time to fabricate.

Challenge 4: System Complexity

Solution: Work with an experienced contractor to ensure proper installation.

Challenge 5: Regulatory Compliance

Solution: Some window upgrades may require City permits or approvals. Work with an expert to carefully plan your project.

Toronto Retrofit Considerations

Due to Toronto's climate, there are a few things to consider before implementing a high-performance window retrofit in Toronto.

Bird Friendly Glass

All new developments in the City of Toronto are required to implement bird-friendly glass within the first 12 meters of the above-grade wall, according to the Toronto Green Standard.

Gas Filler

Argon or krypton gas fillers are common practice in Toronto to meet the building's energy efficiency requirements.

Solar Heat Gain

In Toronto, the requirements for Low-E coatings on windows are primarily guided by energy efficiency standards and building codes aimed at improving the overall energy performance of buildings.

Thermally Broken Frame

Thermally broken frames help achieve the energy efficiency standards by reducing heat losses at the interfaces and improving the overall thermal performance of windows and doors.

U-Value

Install windows with a lower U-value to reduce heat transfer, which is especially important in climates dominated by heating needs.

Ready!

You should now have a better idea of what **High-Performance Windows** are, their co-benefits and impacts, and how to implement them in your building given potential synergies and challenges!

Also check your building **Sector-Specific Retrofit Guide** for steps to achieve net zero and visit the other **Technology Companion Guides** to learn more about retrofit measures.

Other guides in the Envelope Companion Guides:

- Air Sealing and Airtightness
- Insulation

Other resources in the Net Zero Building Retrofit Guides:

- The Introductory Guide
- Sector-Specific Retrofit Guides
- Net Zero Retrofit Planning Tools

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

- Net Zero Existing Building Strategy
- Transform TO 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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