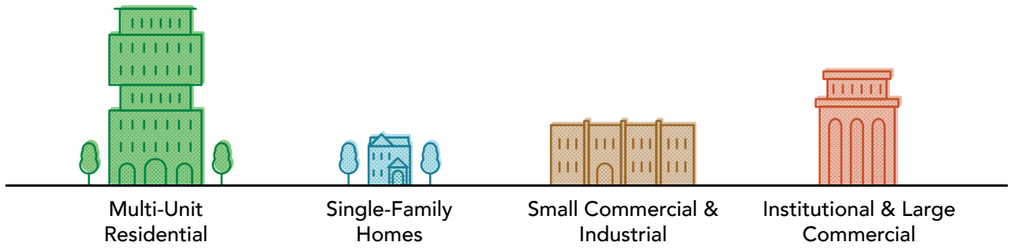
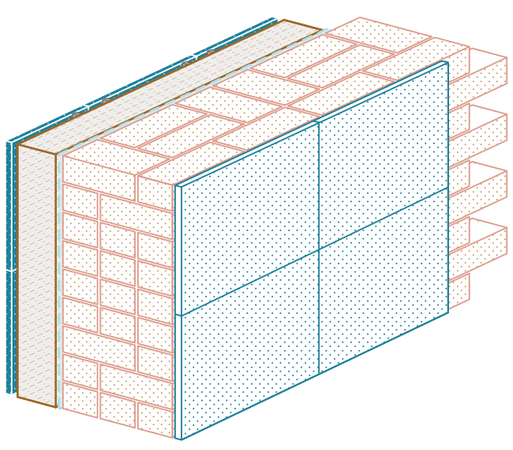
Net Zero Building Retrofit Guides

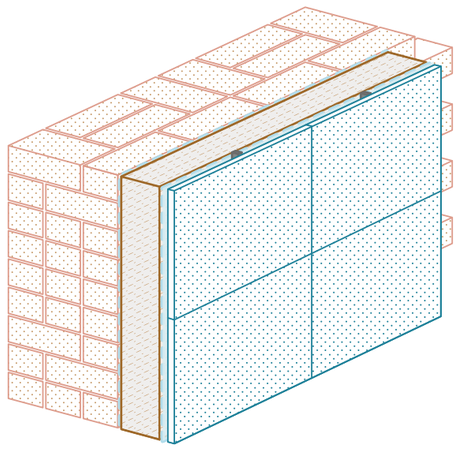
Insulation

Technology Companion Guide

Applicable to:







Co-benefits

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

Impacts

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

TORONTO

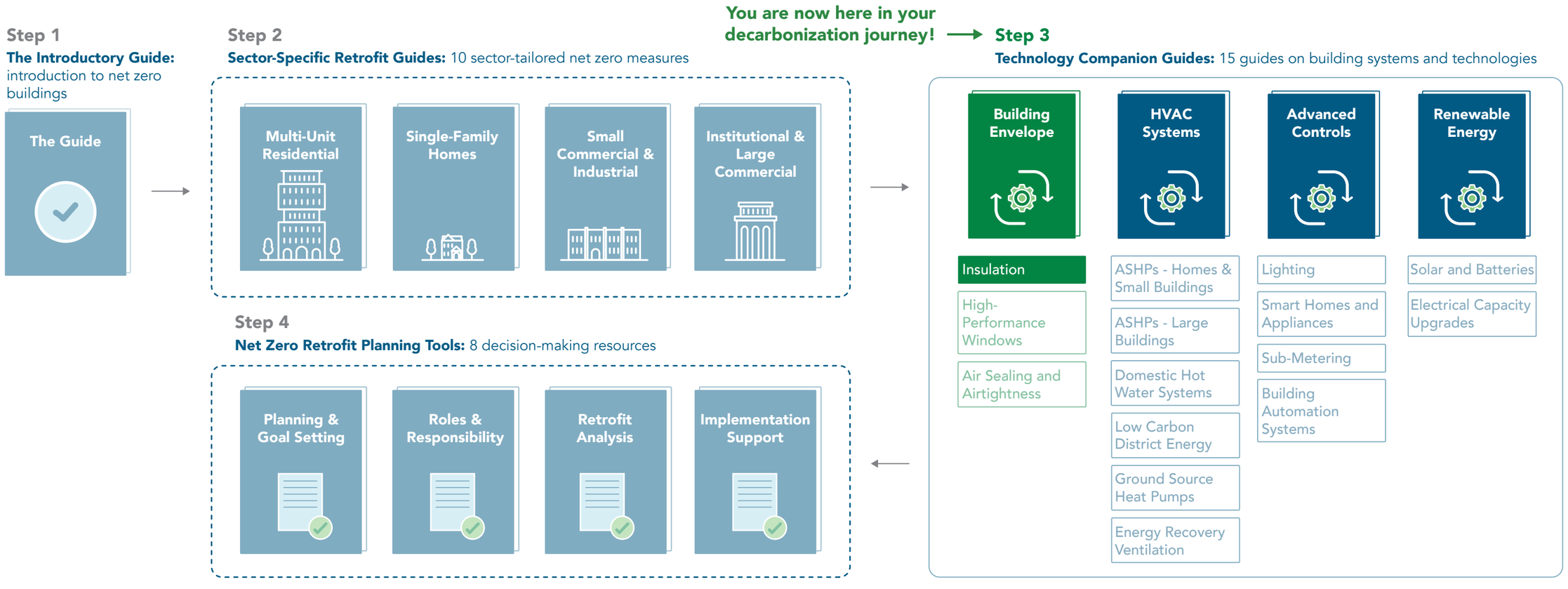
Live green Toronto

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

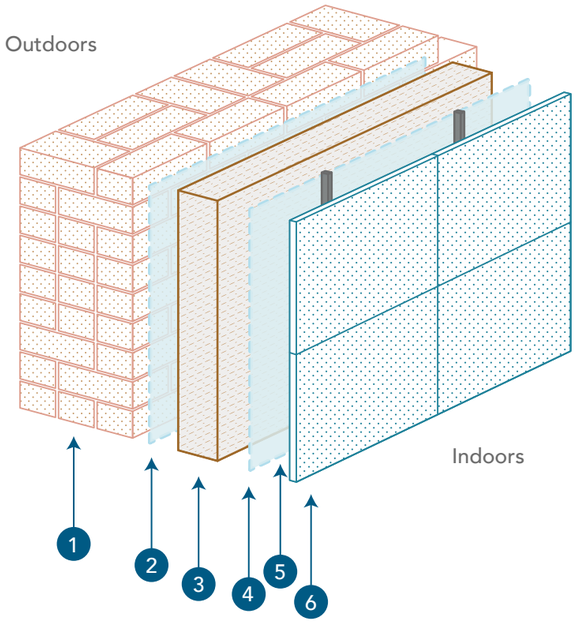
Insulation

What Is This Technology

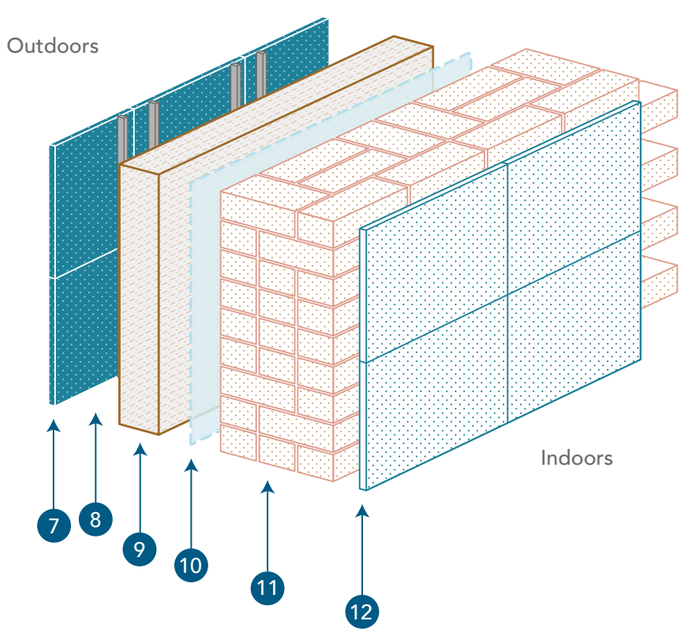
An insulation upgrade involves improving or replacing the existing insulation of walls, slabs, and roofs in a building to enhance its thermal performance, energy efficiency, and overall comfort. Insulation slows down the flow of heat in and out of a building, keeping it warmer in the winter and cooler in the summer. The following insulation retrofits are available for existing buildings:

- Interior insulation upgrade: Adding or improving of insulation on the interior side of a building facade.
- Overcladding: Adding extra insulation and new exterior finish over an existing building facade.
- Recladding: Removing and replacing the existing building facade with a new and improved one.

Interior Insulation Upgrade



Exterior Insulation Upgrade



How Insulation Works

Insulation upgrades require modifications to the building envelope, namely walls and roofs.

Here are the key components of an interior insulation upgrade for a heritage building brick wall (from outside to inside):

1. Existing brick wall
2. Vapour permeable air barrier
3. Vapour permeable insulation
4. Smart vapour retarder acts as a vapour barrier in the winter but promotes drying in the summer
5. Air gap
6. Gypsum board and interior finish

Here are the key components for an overcladding upgrade for a heritage building brick wall (from outside to inside):

7. Exterior cladding
8. Thermally broken cladding attachment system
9. Exterior rigid board insulation
10. Air and vapour barrier
11. Existing brick wall
12. Interior finish

There are many different types of wall and roof assemblies. Any related retrofits should be designed by a building facade consultant.

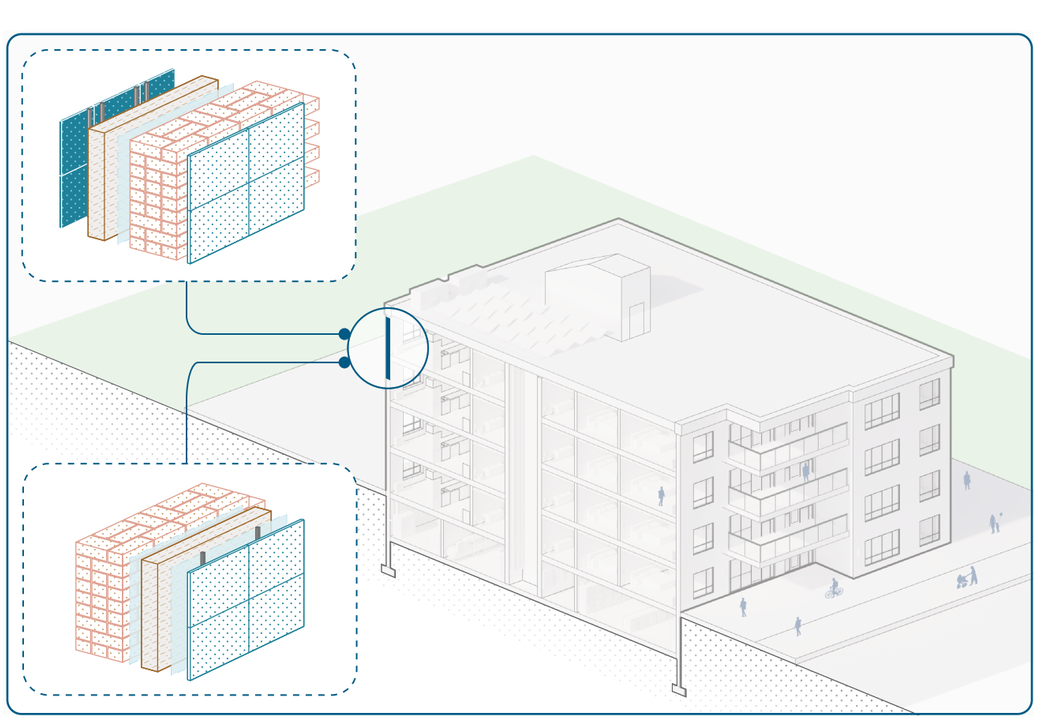
Retrofit technology explained

When to Retrofit This System

Insulation upgrades should be considered for buildings seeking high performance, during scheduled window replacements or air-sealing improvements to minimize costs and reduce disruption to residents and occupants. This retrofit should be considered during HVAC equipment replacement, as it provides an opportunity to downsize the equipment.

Why Retrofit This System

Insulation upgrades not only enhance comfort but also improves energy efficiency by reducing the demand for heating and cooling. In turn, this allows for the downsizing of required HVAC equipment. Additionally, insulation upgrades help to better control the movement of air and moisture through the building, which can impact building envelope's the performance and durability. 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:
Insulation upgrades increase resiliency by minimizing impacts of extreme weather events and power outages. They also address mould growth and water damage, extending a building's lifespan.

Indoor Air Quality:
Insulation upgrades improve indoor air quality by reducing air leaks and drafts, moisture build-up, and infiltration of outdoor pollutants like dust.

Occupant Comfort:
Upgrading wall, slab and foundation, roof and attic insulation, combined with thorough air sealing, can greatly enhance occupant comfort by eliminating drafts, keeping temperatures steady, and reducing noise.

Property Value:
Insulation upgrades boost property value by lowering utility and operating costs, improving energy performance rating, making the building more appealing to buyers or tenants.

Impacts

Emissions Reduction:
Insulation upgrades reduce the energy required for heating and cooling, leading to lower GHG emissions.

Utility Savings:
Enhanced building insulation saves on energy required for heating and cooling, reducing utility costs.

Capital Cost:
Insulation upgrades involve a high capital investment.

Maintenance Requirements:
Good exterior insulation needs little maintenance, but it is important to regularly check and clean weep holes for proper water drainage.

Types of Systems and Retrofit Solutions

Existing buildings typically have minimal or no insulation, outdated or missing air and vapour barriers, and overall poor thermal performance. There are various retrofit solutions available to enhance efficiency and comfort while meeting sustainability goals.

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

Load Bearing Masonry Wall

Common in older homes and heritage buildings, these multi-layer brick walls offer some structural benefits but provide limited insulation, making them ineffective at preventing heat loss in winter and heat gain in summer.

Retrofit: For overcladding, add new insulation with a thermally broken cladding attachment system and a new air and vapour barrier. Thermal breaks in the cladding system reduce thermal bridging, which can lead to heat loss. Use rigid board insulation for exterior insulation.

For an interior insulation upgrade, often applied to heritage buildings, use mineral wool insulation with a smart vapour retarder that adjusts water vapour transport based on humidity levels. Repair and repoint the heritage masonry wall with lime mortar. Have the final wall assembly reviewed by a building envelope consultant.

Rainscreen System

Common in commercial buildings, the rainscreen system includes an air gap behind the exterior wall to control air and moisture.

Retrofit: Add new high-performance insulation with reduced thermal bridging to minimize heat loss. Use mineral wool or any rigid foam board.

Wood Framed Wall

Common in residential buildings, wood framed walls are built using wooden studs and beams to provide a support for attaching other materials like drywall or outer wall layers.

Retrofit: Add additional insulation, replace damaged air and vapour barrier, and reduce heat loss through studs. Use batt insulation for interior applications and rigid foam board for exterior applications.

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

Attic

Attic spaces are common in single family homes with a gable roof.

Retrofit: Add additional or new insulation and a vapour barrier. Common attic insulation types include fiberglass batts, cellulose, and blown-in insulation.

Flat Roof

Flat roofs are common in high rise residential, institutional, commercial buildings.

Retrofit: Install a new roofing membrane with additional insulation when replacing the existing roof.

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 an insulation retrofit:

1. Evaluate your building's envelope, including walls, roofs, and attics.
    - Is there any missing or inadequate insulation, evidence of water infiltrations, or visible deterioration, like gaps and cracks?
    - Are there any noticeable drafts, cold or hot spots?
2. Hire experts, like a 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.
    - Use thermographic inspection or energy modeling software to check for heat loss and performance gaps.
    - Perform hygrothermal analysis to assess condensation risk in your building.
    - Choose high-performance insulation with appropriate type, thickness, and attachment systems to meet your goals.
    - Install specified insulation and simultaneously add new air and vapour barriers, or seal and repair the existing membrane.
    - Use a blower door test or thermal imaging to check insulation effectiveness and find areas needing attention.
    - Conduct post-installation energy audits to check insulation performance and adjust mechanical systems as needed.
3. Set up a maintenance schedule to monitor and address any moisture issues.

What is an R-value?

R-value measures a material's ability to resist heat flow, indicating its effectiveness as insulation. A higher R-value means better resistance to heat flow. It is an important factor in evaluating the energy efficiency of building components like walls, slabs, and roofs. When retrofitting a building, using materials with higher R-values can improve energy efficiency, lower heating and cooling costs, and increase overall comfort.

Opportunities

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

HVAC Systems

Insulation upgrades can support advanced HVAC controls and zoning systems, optimizing your energy use by targeting specific areas for heating or cooling. Insulation upgrades reduce the heating and cooling demand, resulting in smaller HVAC sizing.

Building Controls and Automation Systems

Integrating insulation improvements with BAS and controls can help to monitor and optimize energy use, based on real-time data. Some building controls can be accessed from a smart phone.

Energy Generation

Energy Storage

Combining well-insulated buildings with renewable energy systems makes better use of available energy by lowering energy demand and storage needs.

Challenges and Solutions

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

Challenge 1: Additional Weight

Solution: Conduct an engineering assessment to evaluate the load-bearing capacity of the existing structure. Make any necessary reinforcements, as an overcladding system adds weight by incorporating new insulation and cladding to the exterior of the current wall.

Challenge 2: Heritage Integration

Solution: Consult a heritage design expert to ensure cohesive and preferred aesthetics. Owners of heritage buildings should also consult the City and a heritage building expert to meet regulatory requirements.

Challenge 3: Regulatory Compliance

Solution: Obtain necessary permits and approvals from local authorities ensuring that the retrofits meet all legal requirements and codes, especially for existing buildings where retrofits must follow updated standards.

Challenge 4: Space and Clearance

Solution: Plan for innovative solutions or more complex installation methods to access tight spaces and areas with limited access.

Toronto's Climate Considerations

Due to Toronto's climate, there are a few things to consider before implementing an insulation retrofit.

Air and Vapour Barrier Placement

The air and vapour barrier membrane goes on the warm side of the insulation. This barrier helps to control moisture and air leakage, preventing mould growth.

Thermal Bridging

A thermally broken cladding attachment system uses materials with low heat conductivity, creating a barrier between the cladding and the building structure. This reduces heat transfer and enhances insulation.

Insulation Performance

Incorporating thicker insulation with a high R-value is essential in cold climates to keep indoor conditions comfortable and reduce reliance on heating systems.

Ready!

You should now have a better idea of what **Insulation** is, its co-benefits and impacts, and how to implement it 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
- High-Performance Windows

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:

TORONTO

Prepared by:

ARUP

For larger buildings, condominiums and businesses, contact: bbp@toronto.ca

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