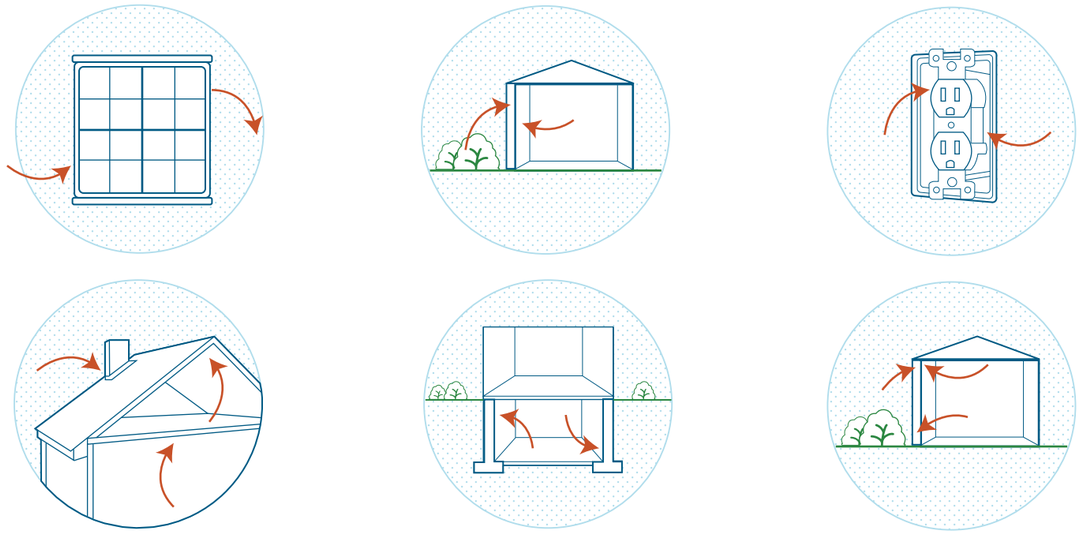
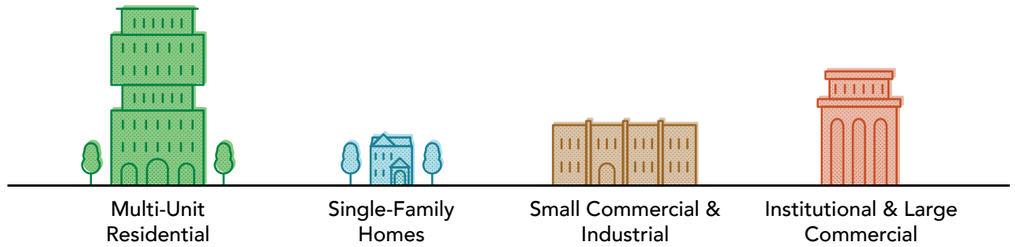
Net Zero Building Retrofit Guides

Air Sealing and Airtightness

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

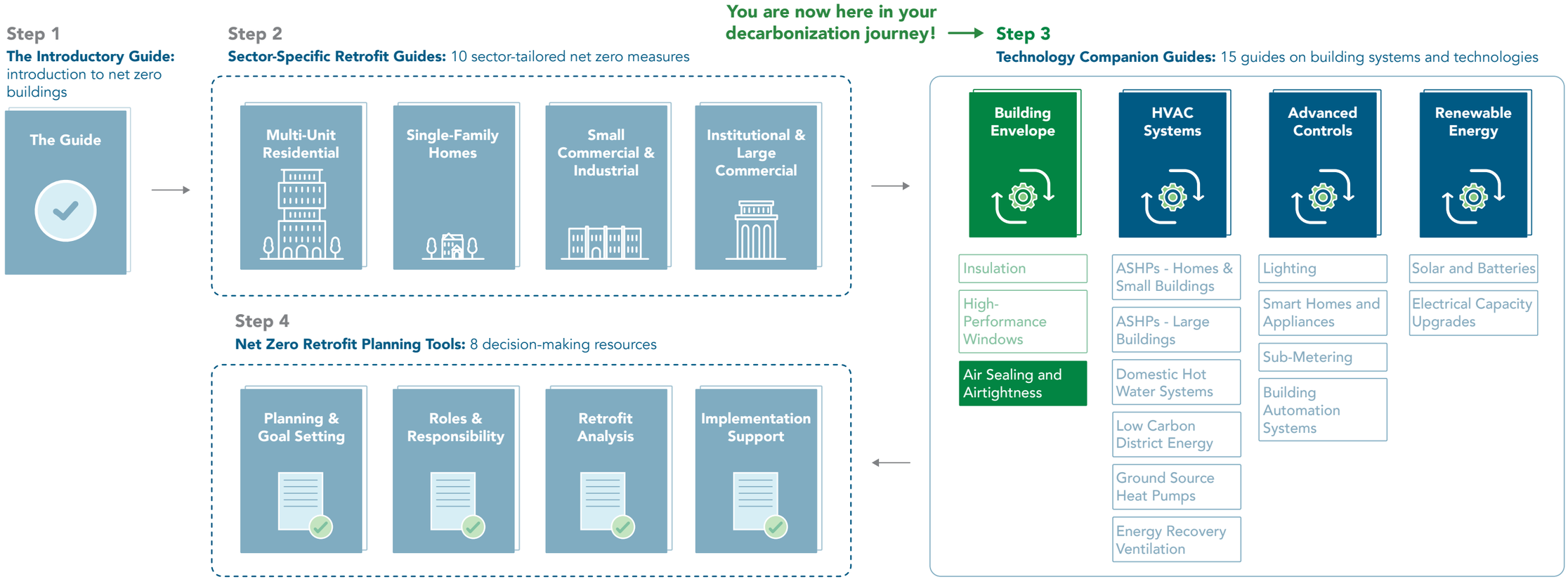
Live green Toronto

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

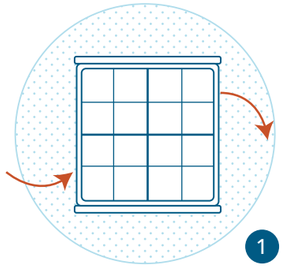
Air Sealing and Airtightness

What Is This Technology

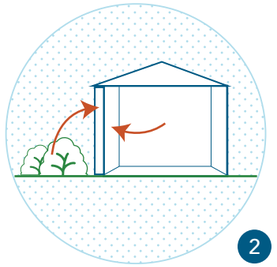
Building envelope refers to the physical barrier between the interior of a building and the exterior environment. It plays a critical role in controlling the movement of air, moisture, heat, and sound between the inside and outside, ensuring comfort, energy efficiency, and durability.

Airtightness refers to the degree to which a building prevents air leakage through its envelope. It is a measure of how well-sealed a building is against unwanted air infiltration and exfiltration.

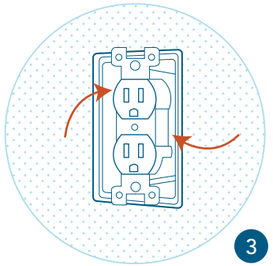
Air sealing is a series of low-cost measures aimed at identifying and sealing gaps, cracks, and unintentional openings in the building envelope to prevent uncontrolled air leaks. It includes sealing areas like windows, doors, walls, floors, and ceilings where air can flow in or out.



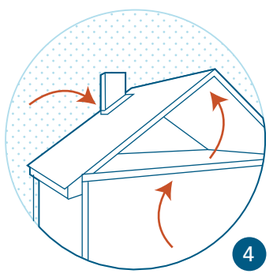
1 Air Leakage Through Gaps and Cracks Around Doors and Windows



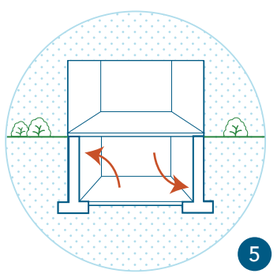
2 Air Leakage Through Damaged Air Barrier



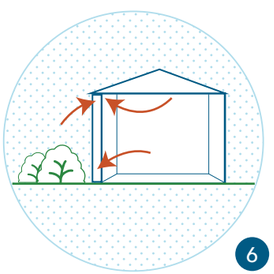
3 Air Leakage Through Fixtures and Outlets



4 Air Leakage Through Roof / Attic



5 Air Leakage Through Envelope Foundation



6 Air Leakage Through Interfaces

How Air Sealing and Airtightness Work

Regularly sealing gaps, cracks, and unintentional openings in the building envelope increases your building's airtightness. This slows the mixing of conditioned indoor air with unconditioned exterior air, reducing heating and cooling demand and related emissions. Common locations where significant air leakage might occur in existing buildings are:

1. Gaps and cracks around doors and windows.
2. Tears, holes, environmental degradation, penetrations, and unsealed terminations of the air barrier.
3. Unsealed electrical outlets, switches, and plumbing fixtures.
4. Unsealed, or improperly installed materials in attic spaces.
5. Cracks or unintentional openings in foundation walls.
6. Improper or incomplete sealing of air barrier at the interfaces between walls, ceilings, and floors.

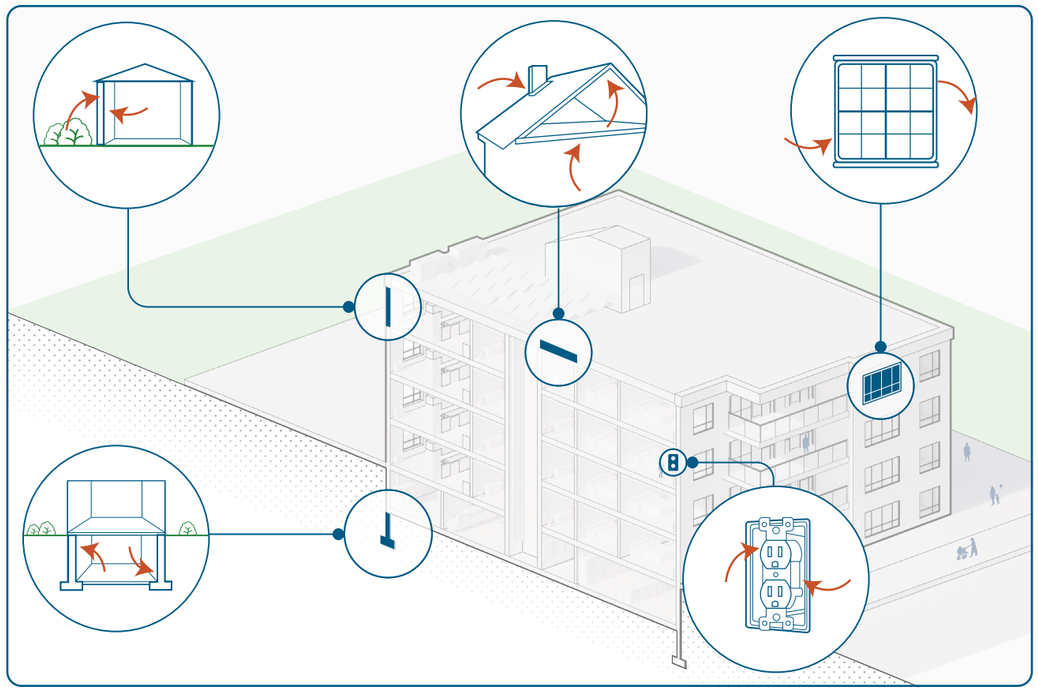
Retrofit technology explained

When to Retrofit This System

Air sealing should be done when the building envelope components are still in good shape, but the sealant has worn out. While air sealing can be done anytime, it is best to do it during an envelope retrofit. This helps ensure all gaps, cracks and unintentional openings are properly sealed, maximizing the effectiveness of the retrofit.

Why Retrofit This System

An airtight envelope reduces drafts, prevents energy loss, enhances thermal comfort by reducing hot or cold spots in the building, and reduces the pressure on HVAC systems. By reducing energy consumption, you can decrease reliance on utilities and protect yourself from rising energy costs, all while lowering GHG emissions.



Typical locations in a building associated with this technology

Below are co-benefits and impacts to help you better understand this technology. Co-benefits and Impacts ratings are for air sealing only. Air barrier replacement is not considered since the upgrade should be done along with any insulation upgrade.

Co-benefits

Resilience:
Air sealing slightly boosts resilience by extending the service life of building components and materials.

Indoor Air Quality:
Airtightness minimally improves indoor air quality by limiting the entry of airborne pollutants.

Occupant Comfort:
Air sealing makes living spaces more comfortable by reducing drafts, noise, and improving indoor comfort by maintaining temperature and humidity.

Property Value:
Airtightness minimally increases property value for proven energy efficiency and environmental benefits.

Impacts

Emissions Reduction:
Air sealing reduces the demand for heating and cooling, leading to lower GHG emissions.

Utility Savings:
Reducing uncontrolled air leakage reduces the energy required for heating and cooling, reducing utility costs.

Capital Cost:
Air sealing is relatively low-cost, but it is essential to coordinate it with other retrofits to optimize efficiency. Costs may increase if replacing a damaged air barrier is necessary.

Maintenance Requirements:
Air sealing requires minimal maintenance, involving annual or bi-annual inspections and sealing of air leakage pathways. An air seal inspection may also be necessary after significant weather events.

Types of Systems and Retrofit Solutions

Existing buildings often have poor door and window seals, damaged air and vapour barriers, and unsealed gaps around wall and ceiling joints. Reducing the air leakage through retrofits will improve your buildings energy efficiency, comfort, durability all while reducing carbon emissions.

Here are some locations for heat loss in existing buildings and how to retrofit them:

Windows and Doors

Retrofit: Apply weatherstripping (material or system used to seal gaps) along the perimeters of doors and windows to improve seals against moving parts. Use high quality sealants and caulk for small gaps around window frames, door frames, and trim.

Electrical Outlets and Switches

Retrofit: Install foam gaskets, a flexible foam material designed to fill gaps and create a barrier, behind electrical outlets and switches. These create mechanical seals to prevent any air leaks. For larger gaps, use caulk or spray foam to seal around the edges of the electrical box.

Roof and Interfaces

Retrofit: Seal any unsealed, insufficient, or improperly installed insulation at the roof, attic spaces, and interfaces between walls, ceilings, and floors. Add additional insulation and ensure it is properly air-sealed for optimal performance.

Air Barrier Membrane

Retrofit: Use specialized sealant tapes for joints in sheathing or air barrier membranes, which are external protective layers attached to a building's exterior framing.

Air barriers typically last between 5 to 15 years. If your barrier is over 10 years old, it is time to check the condition. The air barrier may require maintenance or need to be replaced.

To maximize energy efficiency and save on costs, it is recommended to replace your air barrier when completing other related envelope retrofit measures.

Larger Gaps or Penetrations

Retrofit: Seal larger gaps, openings like penetrations required for pipes, cables, and ducts, with foam boards and spray foam.

Alternatively, insert a foam backer rod to fill the space and provide a space for the caulk to adhere to. Use a high-quality caulk and a caulk finishing tool to smoothly seal the foam backer rod.

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 air sealing retrofit:

1. Evaluate the condition of your building envelope, including foundation, walls, windows, doors and ceiling.
2. Hire experts, like an envelope consultant, to advise and support you in selecting and applying the appropriate sealing materials and procedures. Your experts will help you with the following steps.
    - o Conduct a blower door test to measure the airtightness of your building.
    - o Conduct visual and thermographic inspections to identify the air leakage points in occupied buildings or in historic buildings where blower door testing is not feasible.
    - o After installation retest your building's airtightness post-installation to measure improvement and verify that your building is properly sealed.
3. Regularly check seals, caulking, and weatherstripping. Replace or repair any damaged or worn materials.

What is a Blower Door Test?

A blower door test is a diagnostic tool that helps identify issues with the air barrier by pressurizing and depressurizing the building. It quantifies the amount of air infiltration or exfiltration, which is essential for improving energy efficiency, comfort, and indoor air quality. A simple analysis of the amount of airflow, in combination with the building envelope characteristics, provides an indication of how airtight the building is.

What is a Thermographic Inspection?

A thermographic inspection is conducted with a thermal camera to identify areas of heat loss and air leakage in the building envelope. By capturing the infrared radiation emitted by objects, this testing can reveal heat patterns and anomalies that may indicate issues such as air leakage, insulation deficiencies, moisture intrusion, thermal bridging, and structural problems.

Opportunities

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

HVAC Systems

Proper air sealing stops unwanted air leaks. This reduces the strain on your HVAC systems and extends their service life.

Energy Generation

Energy Storage

An airtight envelope reduces your heating and cooling needs, allowing renewable energy systems to meet the building's energy needs.

Building Envelope

Air sealing protects the building envelope from weather-related damage by preventing water and air infiltration.

Challenges and Solutions

Repair and maintenance of the existing envelope can be challenging. Below are some common challenges you may face and how to solve them.

Challenge 1: Coordination with Other Retrofits

Solution: Since air sealing alone may not be sufficient to achieve desired performance targets, coordinate air sealing with other retrofit work to maximize efficiency.

Challenge 2: Pest Damage

Solution: Conduct regular inspections to ensure pests have not damaged air sealing materials and reapply as required. Use high-quality, durable materials that are resistant to environmental factors.

Challenge 3: System Complexity

Solution: Hire contractors that specialize in air leakage and envelope improvements. Use high quality, long lasting seals that resist environmental factors and ensure that the application is completed correctly.

Challenge 4: Access

Solution: Some areas like attics and crawl spaces may be challenging to access, while some locations may damage finishes. Coordinate air barrier repairs with other envelope retrofits.

Toronto's Climate Considerations

Due to Toronto's climate, there are a few things to consider before implementing air sealing retrofits.

Material Quality

Use high-quality sealants for gaps and cracks. Check that they are suitable for extreme temperatures.

Temperature

Follow the manufacturer's guidelines for application temperature. Use a low-temperature product or apply during warmer weather.

Thermographic Inspection

Conduct thermographic inspection during winter to identify thermal bridging and qualitative assessment of airtightness.

Ready!

You should now have a better idea of what **Air Sealing and Airtightness** 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:

- High-Performance Windows
- 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:

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