Net Zero Building Retrofit Guides

Energy Recovery Ventilation

Technology Companion Guide

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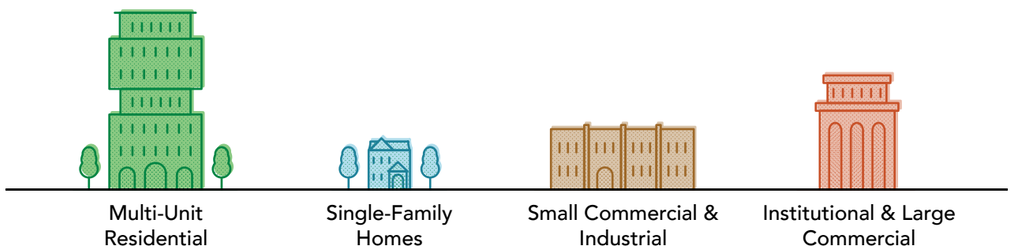

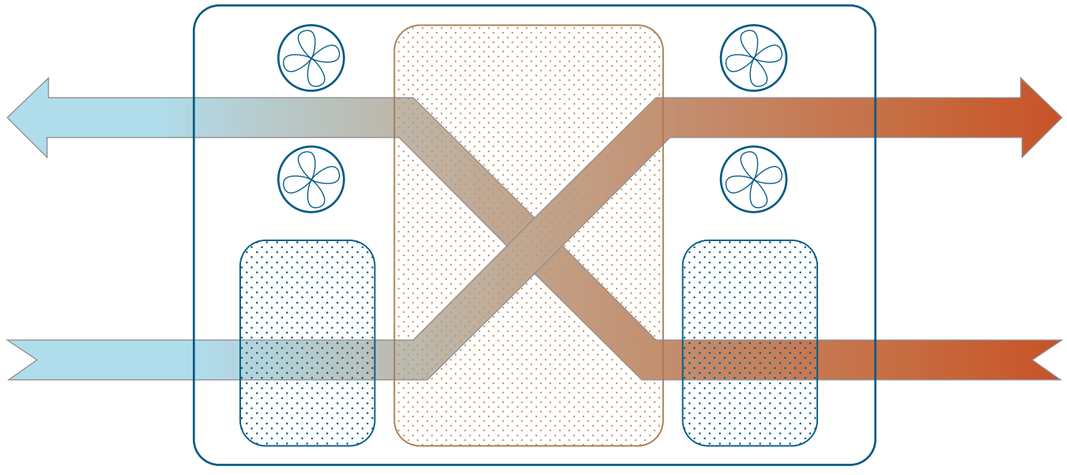

Co-benefits

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

Impacts

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

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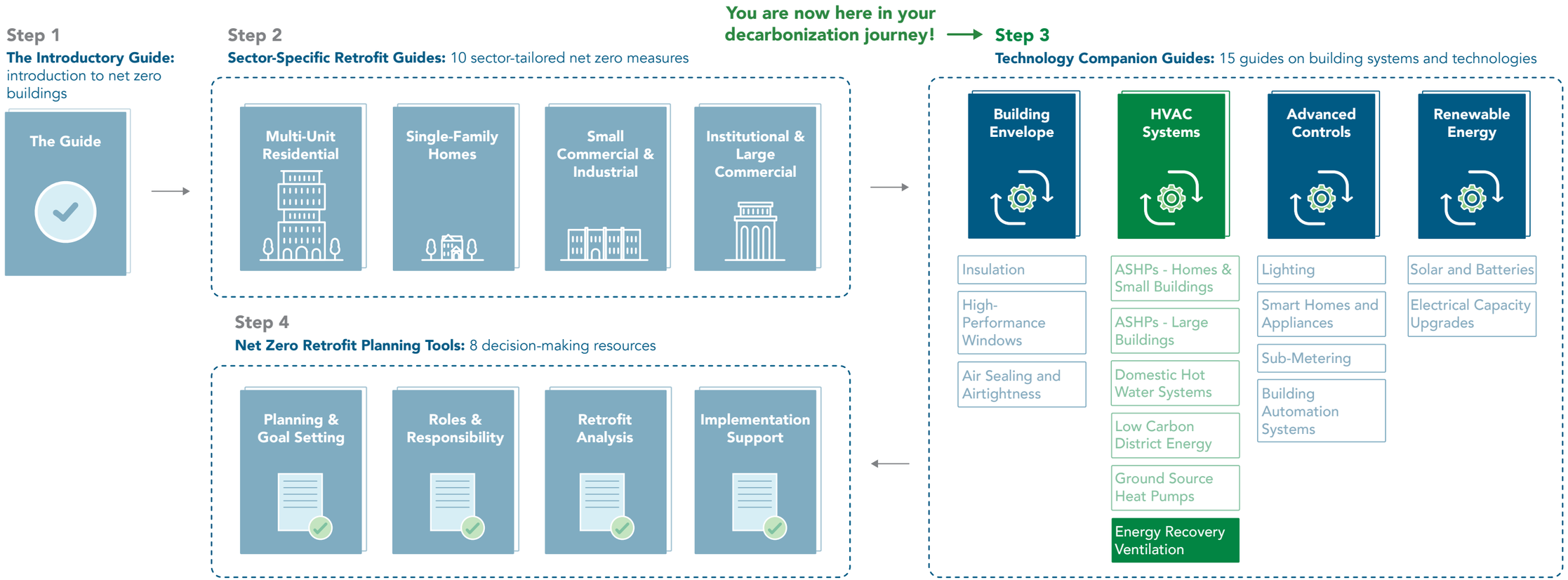
Navigating the Net Zero Building Retrofit Guides

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.



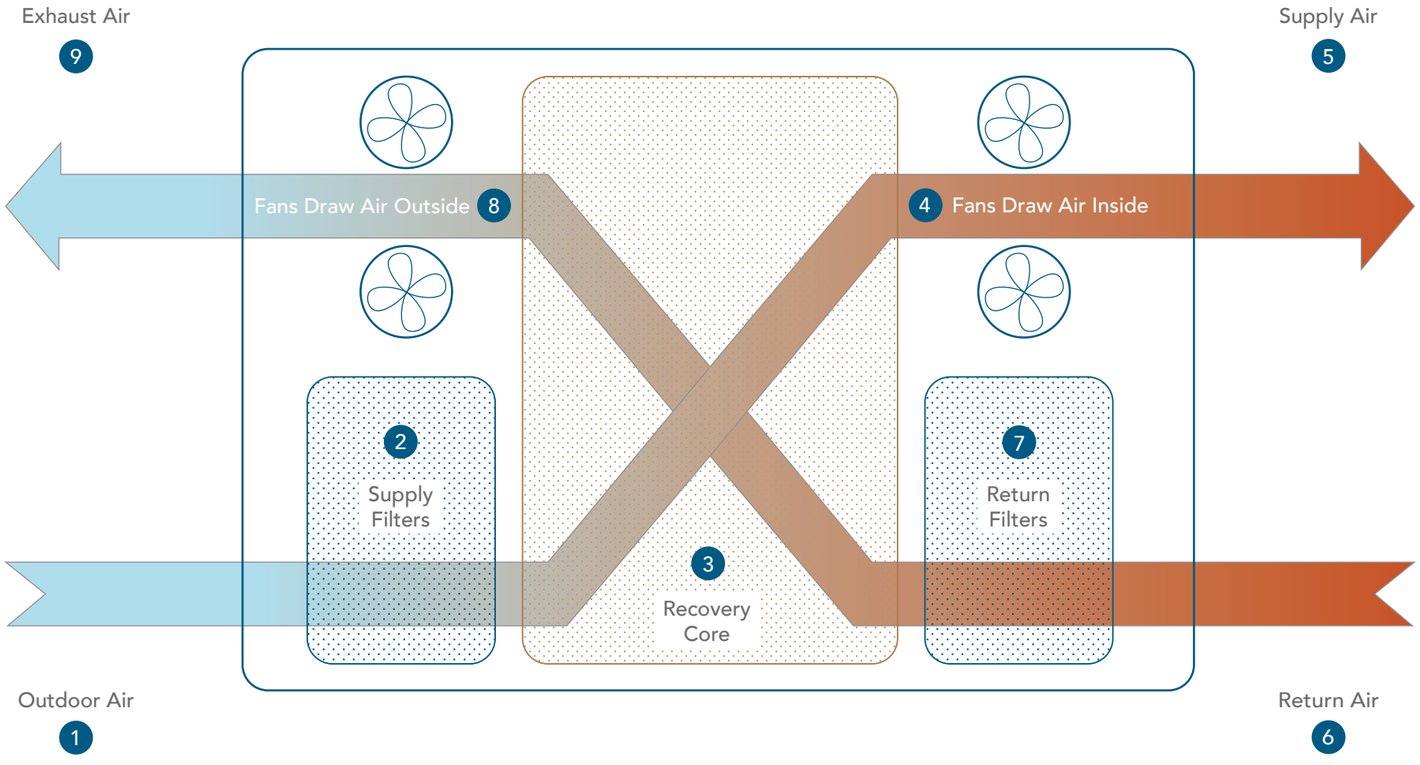
Net Zero Building Retrofit Guides Document Navigation

Energy Recovery Ventilation

What Is This Technology

In older homes, ventilation occurs passively through windows and gaps in the building envelope. Modern HVAC systems use Energy Recovery Ventilators (ERV) to provide active ventilation; supplying homes and buildings with fresh, filtered, temperature and moisture controlled air while simultaneously removing stale and contaminated air.

An ERV is a piece of HVAC equipment that is used to recover energy from either exhaust air or outdoor air. It consists of a heat exchanger and two air pathways, one for air exiting the building (exhaust air), and one for air entering the building (outdoor air). During the heating season, the ERV recovers heat and moisture from building exhaust air to pre-condition outdoor air. During the cooling season, the ERV absorbs heat and moisture from the incoming outdoor air and transfers it to the building exhaust air.



How ERVs Work

An ERV allows a building to exchange heat and moisture between its incoming and outgoing airflows, thereby reducing HVAC demands. The key steps in the operation of an ERV are:

1. Outdoor air is brought into the building to provide ventilation. Depending on the season, outdoor air is either cold and dry, or warm and humid.
2. Supply filters catch pollutants and particles in the air stream.
3. The ERV's energy recovery core transfers energy from one air stream to the other.
4. Fans draw the air through the unit and into the building.
5. Supply air is further conditioned to the optimal space temperature, and then delivered to the indoor environment.
6. Return air is directed through the ERV, where the energy is exchanged in the energy recovery core.
7. Return filters protect the energy recovery core from particles.
8. Fans draw the air through the unit and out of the building.
9. Exhaust air leaves the building.

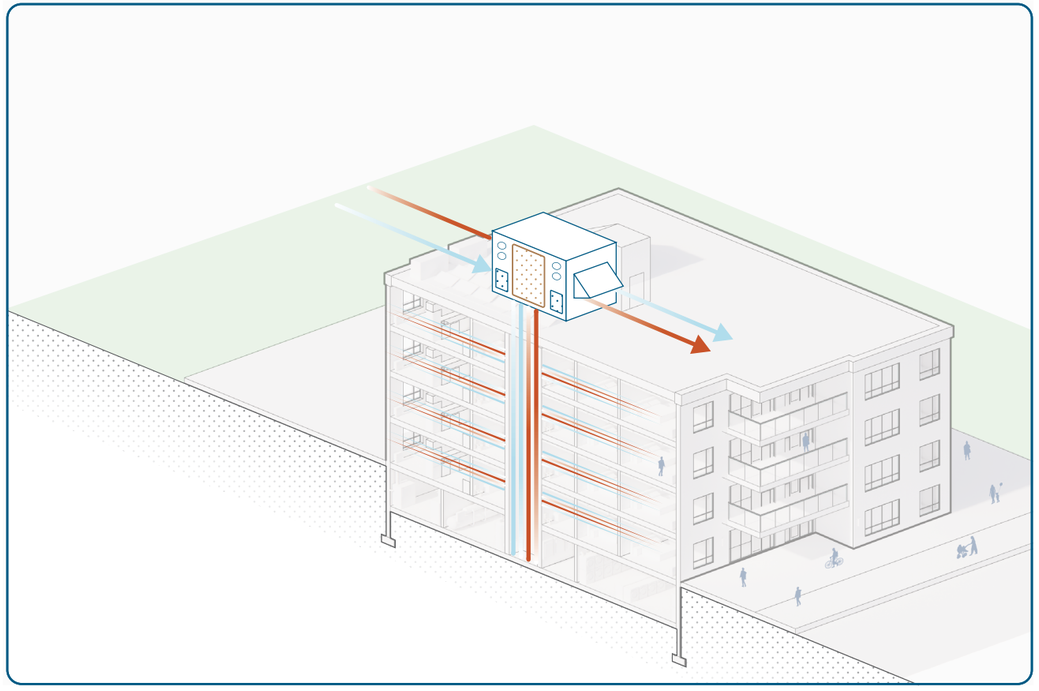
Retrofit technology explained

When to Retrofit This System

ERV retrofits should be considered as part of larger HVAC system and envelope updates to optimize air exchange and airtightness in all building types. An ERV should be included in any end-of-life or capital replacement projects for related HVAC equipment.

Why Retrofit This System

ERVs not only control ventilation, making the building healthier and more comfortable for occupants, but they also reduce the heating, cooling, and ventilation loads of HVAC equipment by recovering energy from either exhaust air or outdoor air, year-round. In most design and renovation scenarios, the addition of an ERV to your HVAC system is required by code. 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 building associated with this technology

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

Co-benefits

Resilience:
ERVs reduce HVAC system loads and help them continue to perform properly even in temperature extremes and poor air quality events, such as during smog advisories.

Indoor Air Quality:
ERVs provide targeted ventilation, removing stale indoor air while supplying filtered outdoor air; reducing pollutants, controlling humidity, and improving air quality. They also help increase indoor humidity levels in winter, while decreasing humidity levels during the summer.

Occupant Comfort:
ERVs help distribute fresh air where it is needed for occupant comfort. Fresh air has to been shown to increase productivity, concentration, and may improve symptoms of respiratory illnesses like asthma. ERVs can also help improve humidity levels, contributing to a more comfortable indoor environment.

Property Value:
Buildings with updated, efficient HVAC systems and improved indoor air quality may benefit from increased property values

Impacts

Emissions Reduction:
ERVs reduce the heating and cooling loads of HVAC equipment, leading to lower GHG emissions.

Utility Savings:
The energy recovered by ERVs reduces utility consumption. Although ERVs require some electricity to operate the efficient fans, reduced winter heating and summer cooling loads result in utility savings.

Capital Cost:
ERVs can have high capital costs as they must be integrated into the existing HVAC system. However, installation costs vary by system and adding an ERV to an existing HVAC system can be a relatively low cost investment.

Maintenance Requirements:
ERVs are a relatively simple system with low maintenance requirements. Owners should plan a bi-annual inspection and regular filter cleaning to ensure the ERV is working properly.

Types of Systems and Retrofit Solutions

ERVs systems connect to ductwork to transfer energy between building exhaust air and incoming outdoor air. Depending on the existing system, adding an ERV may be a simple or complicated technology to add to your building.

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

Dedicated Outdoor Air System (DOAS)

This is a ventilation system decoupled from the building's heating and cooling system that brings fresh air to spaces using ductwork. Commercial buildings and condos often have "make up air units" to bring large amounts of outdoor air into occupied areas.

Retrofit: Add a dedicated ERV to serve the existing DOAS.

Central Air System

This is a mixed air system that heats, cools and ventilates spaces using a central air handling unit, distributing air through ductwork to different areas throughout the building.

Retrofit: Modify and re-balance the existing HVAC system to integrate an ERV on the ventilation duct connected to the air handling unit.

Localized Systems

The building has several localized HVAC systems each serving a unit or dedicated area with its own HVAC and ventilation system.

Retrofit: Add a dedicated ERV to localized spaces and integrate it with the existing HVAC system. These are often referred to as "in-suite ERVs". Small systems could potentially incorporate ductless ERVs.

No Ventilation System

Older buildings may lack a mechanical ventilation system, relying instead on windows to provide fresh air.

Retrofit: Add a ductless ERV through walls or ceilings. Such compact systems can provide fresh air and recover energy without accessing ductwork.

Consider a larger retrofit by adding a complete ventilation system to your building, including a central ERV or localized ERVs, as well as associated ductwork and controls.

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 ERV retrofit:

1. Understand your current building and its existing HVAC system, for example:
   - Does your building have ductwork?
   - Is the HVAC system centralized?
   - Does your building have exhaust fans in bathrooms and kitchens?
   - Is your building "leaky" or airtight? Consider envelope upgrades alongside ERV retrofits.
2. Hire experts, like mechanical engineers and contractors, to advise and support you on how to apply this retrofit to your building. Your experts will help you with the following steps.
   - Conduct an air audit.
   - Identify challenges and opportunities to improve your systems.
   - Design and integrate the ERV retrofit into your existing systems and controls.
   - Test and balance to ensure everything works as designed. This is also known as 'commissioning'.
3. Keep up with the required maintenance program with bi-annual inspection and filter cleaning.

What is an Air Audit?

An air audit is conducted to determine the balance of air flow in a building. In other words, the balance between air coming into a building (outdoor air) and air exiting a building (exhaust air). It can also give insight into the airtightness of an envelope (how "leaky" a building is).

Understanding how air is flowing in your building will allow your ERV retrofit to better complement your existing HVAC system, maximizing energy savings and co-benefits, and reducing GHG emissions.

Opportunities

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

HVAC Systems

Adding an ERV requires modification to your HVAC system. This may be a good time to evaluate your current HVAC system and to upgrade any of the components to improve comfort, ventilation, cooling, and heating.

Building Envelope

ERVs work best on buildings that have tight envelopes and are well-insulated. When improving your building envelope, it is recommended to also install an ERV. Consider if your building could benefit from envelope improvements in addition to an ERV.

Building Controls and Automation Systems

Integrating controls helps your building systems work better together. Adding controls to monitor airflow, occupancy, and improve temperature and humidity can optimize your ERV alongside your HVAC system. Some building controls can even be accessed from a smartphone.

Challenges and Solutions

Adding any new system to your building can be challenging. Below are some common challenges you may face and how to solve them.

Challenge 1: Air Balancing

Solution: Make sure the system is designed properly. Hire a qualified designer to plan it and choose the right equipment. Contractors should balance the system after installation.

Challenge 2: Duct Routing

Solution: Decide on the system you need and if renovation is required to connect to existing or new ductwork. Consider impacts to the room finishes and how the system may impact available ceiling space.

Challenge 3: Space and Clearance

Solution: Consider the location of the ERV and the limitations of your building and property. Larger ERVs are installed on roofs or in equipment yards, while smaller ERVs can be installed within the ceilings or mechanical spaces depending on system configuration.

Challenge 4: Structural Requirements

Solution: ERVs can be heavy and may require structural upgrades for placement on roofs.

Toronto's Climate Considerations

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

Mounting

ERVs may require mounting hardware and must be installed above snow levels to protect the equipment and ensure proper operation.

Insulation

Ducts must be insulated to reduce energy losses and optimize efficiency. ERVs work best on buildings that have tight envelopes and are well-insulated.

Pre-heat

Air entering the ERV may be too cold and can freeze the system. Electric pre-heaters can be installed in the air stream, and many ERVs come equipped with defrost programs.

Post-heat

The air leaving the ERV may still be too cold for comfort. In this case, electric post-heaters can warm the air before it is delivered to indoor areas.

Ready!

You should now have a better idea of what **Energy Recovery Ventilation** 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 HVAC Systems Technology Companion Guides:

- Air Source Heat Pumps for Homes and Small Buildings
- Air Source Heat Pumps for Large Buildings
- Domestic Hot Water Systems
- Low Carbon District Energy
- Ground Source Heat Pump Systems

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:

- Sector-Specific Retrofit Guides
- Net Zero Existing Building Strategy
- Transform TO Net Zero Strategy
- Toronto Green Standard
- Better Buildings Partnership

Prepared for:

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Prepared by:

ARUP

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

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