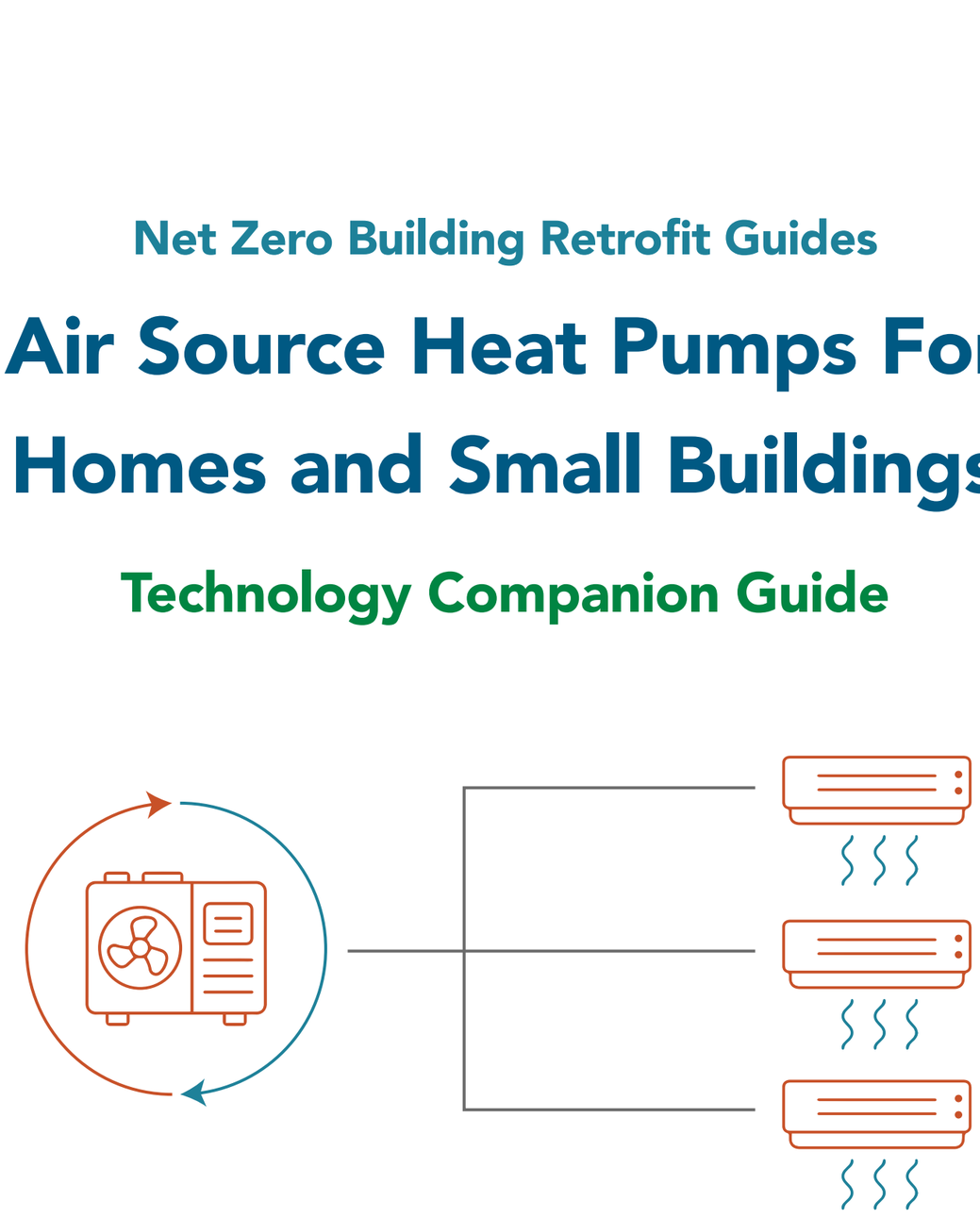
Net Zero Building Retrofit Guides

Air Source Heat Pumps For Homes and Small Buildings

Technology Companion Guide



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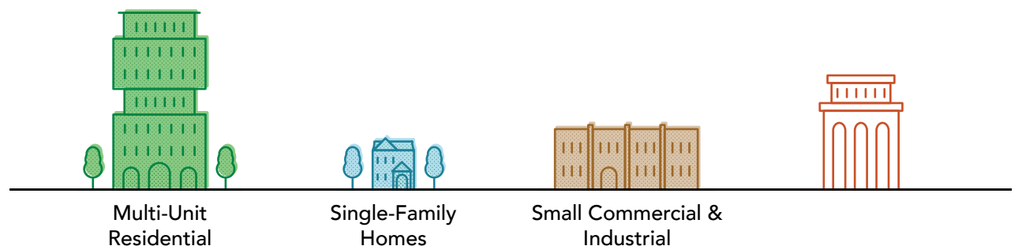

Co-benefits

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

Impacts

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

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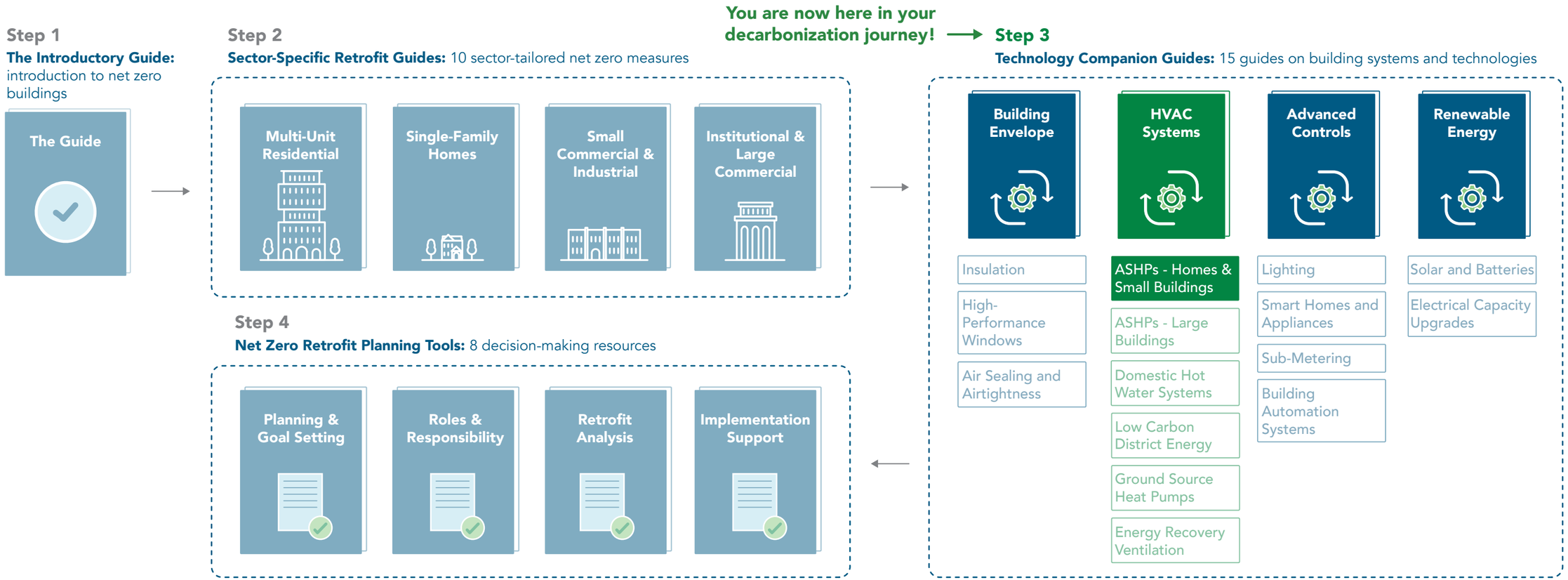
Navigating the Net Zero Building Retrofit Guides

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.

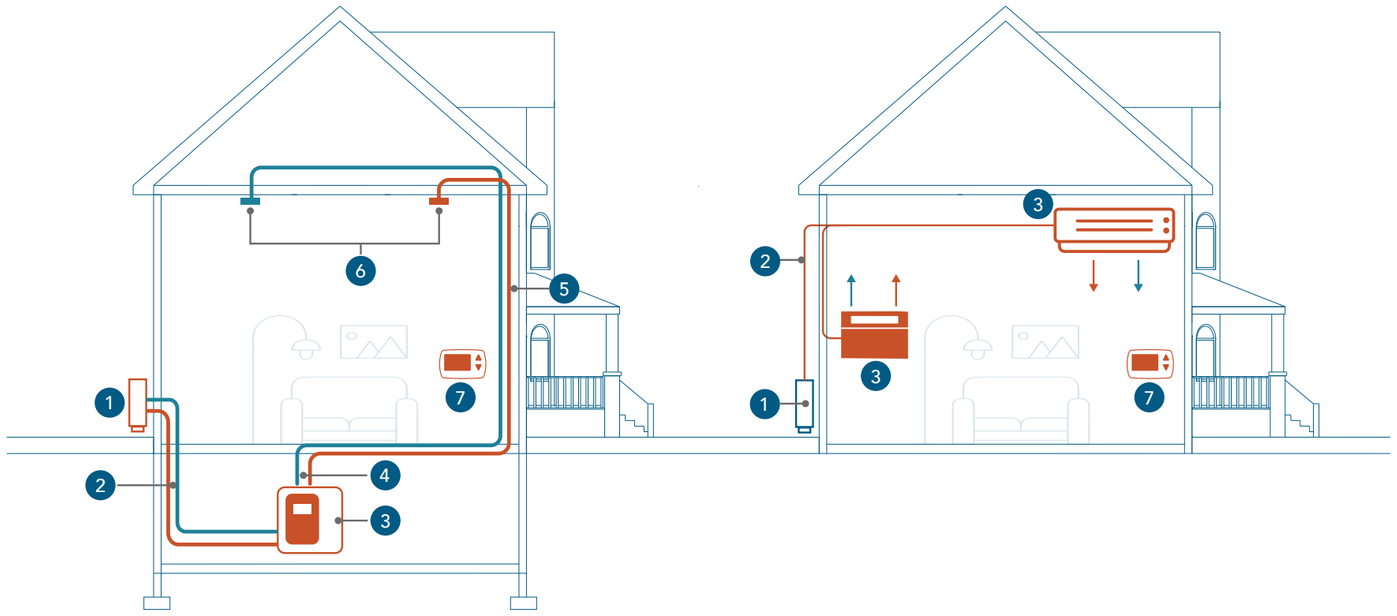


Net Zero Building Retrofit Guides Document Navigation

Air Source Heat Pumps For Homes and Small Buildings

What Is This Technology

Air Source Heat Pumps (ASHPs) are energy-efficient systems that transfer heat between outside air and inside air, capable of providing both heating and cooling depending on your building needs. Heat pump technology is continuously improving, becoming more energy efficient. This makes them a great choice for retrofit projects that aim to reduce reliance on fossil fuels.



Ducted ASHP System

Ductless ASHP System

Retrofit technology explained.

How ASHPs Work

In the winter, ASHPs extract heat from outside air and bring it inside to warm the building. In the summer, ASHPs work in reverse to remove heat from inside to cool the indoor space. Here are the key components of an ASHP retrofit applied to two different existing buildings:

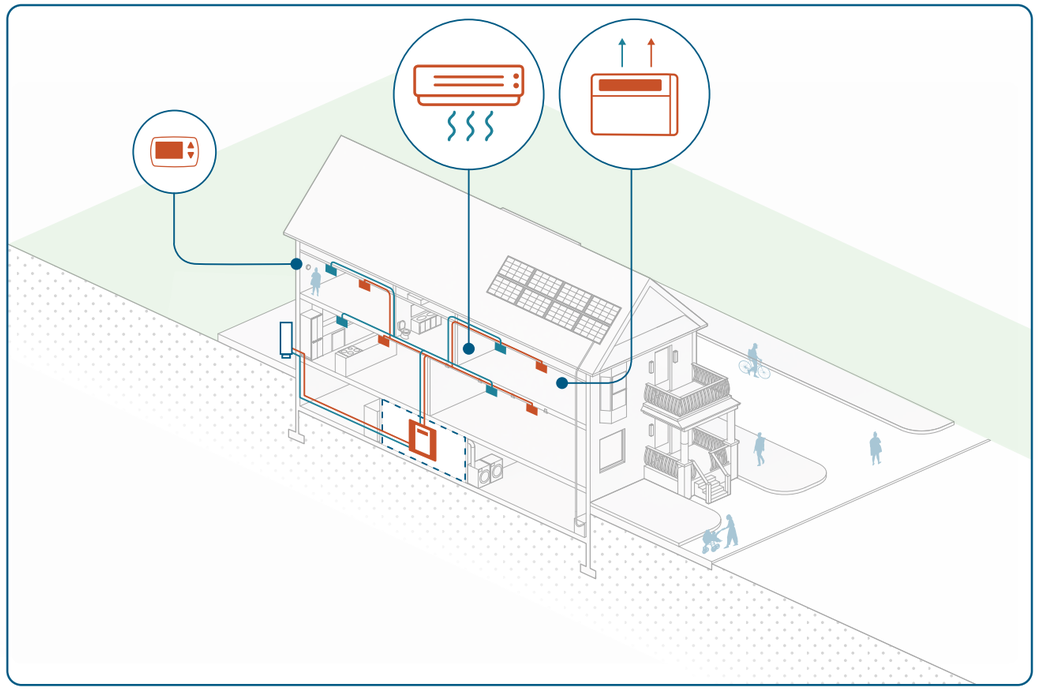
1. Outdoor units, which move heat between the indoor system and the outside air.
2. Refrigerant lines, which are small insulated pipes that connect indoor and outdoor units. The refrigerant is the means which absorbs heat from one area and releases it to another.
3. Indoor units, which distribute warm or cool air into a space. In ducted ASHP systems (left), the indoor unit is integrated into the building's air handling unit. In ductless ASHP systems (right), the indoor unit distributes warm or cool air directly into a specific space or zone.
4. Supply ducts, which distribute warm or cool air from the air handling unit to the spaces in ducted ASHP systems (left).
5. Return ducts, which bring the air back to the air handling unit in ducted ASHP systems (left).
6. Vents, which connect the ducts to areas throughout the building in ducted ASHP systems (left).
7. Thermostats, which allow you to control the temperature in a space by controlling indoor and outdoor units.

When to Retrofit This System

ASHPs are used to upgrade old or inefficient heating systems and to help transition away from natural gas. They work best in homes and small buildings that are well-insulated and sealed to optimize energy savings. This retrofit should be considered by default when your related existing equipment reaches end of life.

Why Retrofit This System

ASHPs offer a sustainable alternative to conventional heating and cooling systems. They significantly reduce emissions through fuel-switching, using electricity rather than natural gas. They also reduce a building's energy consumption as ASHPs require less energy input than natural gas heating systems. ASHPs are flexible systems that come in several configurations to meet your unique comfort and aesthetic needs. 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

Resilience:
ASHPs provide reliable heating and cooling with high energy efficiency.

Indoor Air Quality:
ASHPs are electric, so they do not rely on the burning of fossil fuels. Therefore, there is less risk of pollutants or carbon monoxide affecting your indoor air quality.

Occupant Comfort:
ASHPs are able to maintain space temperatures more responsively due to their ability to both heat and cool spaces, improving temperature control and occupant comfort.

Property Value:
Upgrading to a modern and energy-efficient ASHP system can make the property more appealing to buyers and tenants.

Impacts

Emissions Reduction:
ASHPs replace natural gas with electricity to heat your building. Converting space heating systems from fossil fuels to electricity is the most important step in reducing a building's emissions.

Utility Savings:
ASHPs replace natural gas with electricity to heat your building. You will see reductions in your natural gas bill. You may see your electrical bill increase, but will likely see overall utility savings due to the high efficiency of ASHPs.

Capital Cost:
The initial installation cost of ASHPs can be higher than traditional systems, but the energy savings over time may offset this investment

Maintenance Requirements:
ASHPs are low maintenance systems. They require routine filter changes and cleaning to maintain efficiency.

Types of Systems and Retrofit Solutions

There are a variety of HVAC systems that might be found in your building. Older systems often rely on natural gas, have relatively low efficiencies, and lack modern control features. ASHPs are a retrofit solution that can be applied to a variety of existing systems to reduce emissions and improve efficiency, comfort, and control.

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

Central Air System with Furnace

Central air systems consist of furnaces or air conditioners which use ducts and vents to supply warm or cool air throughout the building.

Retrofit: Modify your existing system by installing a ducted ASHP. You can use existing ductwork with minimal disruption.

Packaged Terminal Air Conditioners (PTAC)

PTACs are common in small hotels, retirement homes, and older residential buildings. These systems provide heating, cooling, and ventilation through the walls, with each dwelling unit having its own separate system.

Retrofit: Upgrade existing PTAC systems to benefit from improved efficiency. Modern PTACs with heat pump and heat recovery technology enable more efficient, all-electric operation.

Perimeter Heating and No Central Air

Older homes may not have central-air systems and instead rely on hot-water or electric radiators along the perimeter of rooms for heating. If they have cooling, it is usually provided by inefficient window-mounted air conditioners.

Retrofit: Install a ductless ASHP system with a single outdoor unit connected to multiple indoor units. Indoor units can be positioned based on occupant needs and interior aesthetics. These units can be individually controlled for occupant comfort.

Alternatively, you can install an air-to-water ASHP to connect with your existing hot-water radiators. This retrofit would provide heating only.

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 ASHP retrofit:

1. Identify the existing heating, ventilation, and cooling systems:
    - o Do you have gas furnaces, boilers, or electric baseboards?
    - o Do you have air conditioning?
    - o Do you have a ventilation system that brings outdoor air into the building?
2. Optimize your systems. Consider adding an energy recovery ventilator and envelope improvements alongside an ASHP retrofit. Addressing such needs will reduce your overall heating and cooling needs, so that you can right-size your ASHP.
3. Hire experts, like HVAC engineers and ASHP specialists, to design and plan your retrofit. Your experts will help you with the following steps.
    - o Conduct an energy audit. Look closely at how your building uses and loses energy.
    - o Develop a detailed plan for the installation, including the location of your outdoor and indoor units.
    - o Check if your building requires electrical capacity upgrades to accommodate the new system.
    - o Install the new ASHP system according to local codes.
    - o Test and adjust the system to make sure it operates properly.
4. Set up a regular maintenance schedule with filter replacements and system checks to ensure your system remains efficient and functional.

What is an Energy Audit?

An energy audit for an ASHP evaluates a building's current energy use and system performance to identify improvement opportunities. Conducted by professional energy auditors or certified HVAC technicians, the audit reviews existing systems, insulation, and energy consumption, ensuring the ASHP will operate efficiently and meet the building's needs.

Opportunities

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

Domestic Hot Water

Look for opportunities to share equipment between domestic hot water and ASHP heating systems. This could involve using domestic boilers for emergency heating, or using ASHPs to preheat domestic water.

Building Controls and Automation Systems

Building controls, like smart thermostats, help monitor and optimize ASHP performance, ensuring efficient operation.

Energy Generation

Energy Storage

ASHPs in combination with on-site renewable energy sources and battery storage solutions can help to enhance sustainability and energy independence.

Building Envelope

Optimize the efficiency of your building's HVAC system by improving your building envelope. Better airtightness and insulation will reduce the size and capital costs of your ASHP.

Challenges and Solutions

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

Challenge 1: Supplementary Heat

Solution: ASHPs may not provide enough heat during the coldest winter days. To ensure adequate heating, consider additional heating options, such as electric resistance heaters, or keep your existing heating system as a back-up.

Challenge 2: Electrical Capacity Needs

Solution: ASHPs will reduce natural gas usage but increase electricity usage. Plan ahead to see if your building's electrical service requires an upgrade.

Challenge 3: Compatibility with Existing Systems

Solution: Assess compatibility with existing HVAC equipment as some older systems may require modifications.

Challenge 4: Noise Concerns

Solution: Address potential noise issues from the outdoor unit. Consider the impact on neighbours. Select a heat pump model that has low noise level specifications.

Challenge 5: Permitting and Regulations

Solution: Follow local permitting processes and ensure compliance with Toronto's building codes and regulations. Your support team will be aware of these and help you navigate them.

Toronto's Climate Considerations

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

Supplementary Heat

To ensure your building has adequate heating throughout the winter, make sure to have a supplementary heating system, such as electric resistance heating.

Condensation Control

Insulate ductwork and pipes in unconditioned spaces to prevent condensation, which can lead to mold growth and damage.

Cold Weather Performance and Defrost Cycles

Choose cold-climate ASHP models that are designed to operate efficiently even at temperatures as low as -20°C, common in Toronto winters. Ensure the ASHP's defrost cycles are optimized to prevent freezing and maintain efficiency.

System Location

The placement of outdoor units is critical to prevent snow and ice buildup, which can obstruct airflow and reduce system performance. Ensure proper clearance and protection from the elements.

System Sizing

Properly size the ASHP to account for the peak cooling and heating demand for Toronto. Consider improving the building envelope (such as enhanced insulation) to help reduce heating and cooling needs.

Ready!

You should now have a better idea of what **Air Source Heat Pumps For Homes and Small Buildings** 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 HVAC Systems Technology Companion Guides:

- Air Source Heat Pumps for Large Buildings
- Domestic Hot Water Systems
- Energy Recovery Ventilator
- Low Carbon District Energy
- Ground Source Heat Pumps

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

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Prepared by:

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