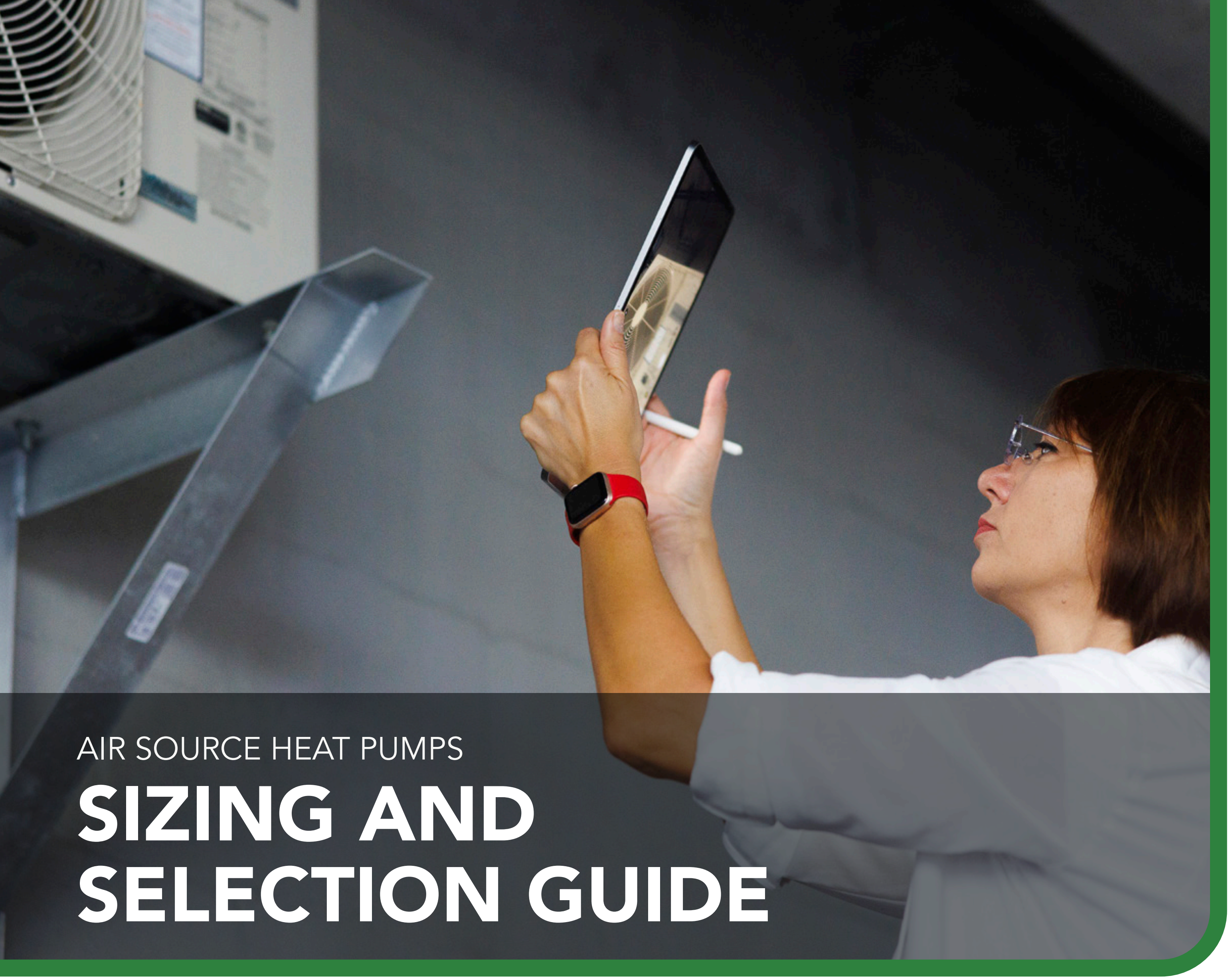

AIR SOURCE HEAT PUMPS

SIZING AND SELECTION GUIDE

Homeowners are increasingly looking to the heating, ventilation and air conditioning (HVAC) industry for cost-effective heat pump solutions that deliver comfort and value while reducing energy consumption and greenhouse gas (GHG) emissions.

Rapid advancements in cold climate heat pump technology make these systems a viable solution for year-round comfort in Ontario households, often without the need for a back-up system. The range of applications and options for air source heat pumps (ASHPs) in existing homes can create challenges in sizing, selection and installation.

This guide provides information to assist contractors in properly sizing and selecting heat pumps for Ontario's cold climate in a way that ensures high system performance and homeowner satisfaction.

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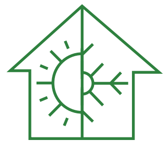
SAVE ON ENERGY POWER WHAT'S NEXT

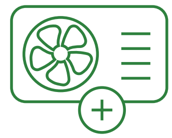
1 UNDERSTANDING HOMEOWNER NEEDS AND OBJECTIVES

A. Identify the situation

NEW HOME



FULL SYSTEM REPLACEMENT



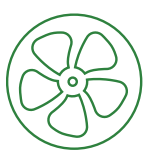
HYBRID/ADD-ON TO EXISTING SYSTEMS

Are you sizing the system to meet the full heating load or a portion of the heating load? The answer depends on factors such as climate region and heat pump performance ratings at different outdoor air temperatures, the remaining useful life of existing equipment, and the homeowner's preference or budget. Define a sizing approach that fits the needs of the local climate, the home and its occupants.

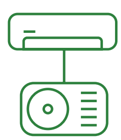
The homeowner needs or objectives may include:

- a heating emphasis
- a cooling emphasis
- a balance of heating and cooling
- as close to 100% heating as possible at the design temperature
- lowest operating cost
- greatest GHG emission reduction

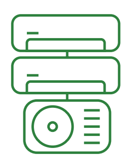
B. Define the ASHP configuration that best suits the homeowner's needs



CENTRAL HEAT PUMP – dedicated or hybrid system tied into new or existing ductwork



SINGLE-ZONE MINI-SPLIT/ DUCTLESS



MULTI-ZONE MINI-SPLIT/DUCTLESS OR MINI-DUCTED

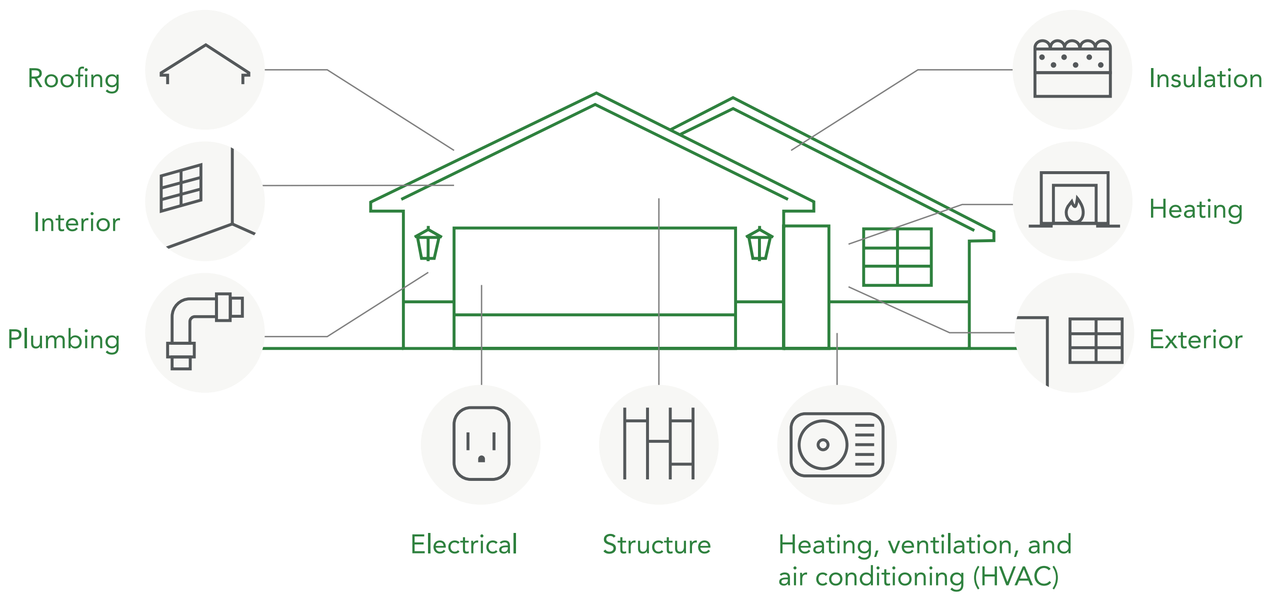
C. Determine what financial systems are in place to support the homeowner, and gain an understanding of the program requirements for any available incentives and financing

1 UNDERSTANDING HOMEOWNER NEEDS AND OBJECTIVES (CONT'D)

D. Determine available capacity at the electric panel

There may be instances where the electric capacity at the panel must be increased to handle the load of a new heat pump system. Most heat pumps require a 20A circuit breaker. If central air conditioning is already present, the heat pump will replace that load on the panel. The local electricity distribution company may be able to verify the peak load of the home if there is concern about capacity. If a panel upgrade is determined to be required, the homeowner should work with their local distribution company to submit a request. Any electrical service or panel upgrades required for heat pump installation should be handled by a licensed electrician.

E. Consider the house as a system



1. A house is a complex, multi-component system, in which all the components interact. The HVAC system being installed must appropriately interact with the existing elements and aspects of the home, including the building envelope, natural or mechanical ventilation, local climate and occupant behaviours.
2. The building envelope is particularly important in HVAC system performance. Improvements made to the building envelope such as increased insulation or air sealing might impact the design loads of mechanical systems, increase their efficiency and reduce initial capital costs.
3. Ask about planned renovations. Consider any planned major renovations such as additions or building envelope improvements that might interact with the HVAC system. You can also advise homeowners of the importance of well-planned whole-home renovations. Refer the homeowner to home energy audits as necessary. Audit reports are useful for heat load calculations, and are required to qualify for many rebate and financing programs.
4. Look for signs of moisture damage because it can indicate poor ventilation or envelope leakage. Inform the homeowner of any concerning findings.
5. Examine existing ductwork to identify any deficiencies or thermal comfort issues, and conduct an external static pressure test if necessary. Thermal imaging cameras help identify gaps and leakage areas in both the building envelope and ductwork.

2 LOAD CALCULATIONS

Before installing a heat pump, a thorough load calculation should be conducted to determine the right-sized unit for the space and intended use. Traditional rule of thumb sizing for replacing boilers, furnaces and air conditioners can result in performance and comfort issues when applied to heat pump sizing. This can lead to service calls and unhappy homeowners.

1. Oversized systems operate inefficiently and may cycle too often, which can lead to equipment failures.
2. Undersized heat pump systems, without appropriate supplemental heating, will not meet the thermal comfort needs of the home, or result in an over-reliance on supplementary heat sources.

RESOURCES FOR LOAD CALCULATIONS

Compliance with CSA F280

CSA F280 is a comprehensive Canadian standard that provides guidelines to accurately calculate residential heating, cooling and ventilation loads. It is the required standard in new construction and is recommended for determining heat loads when sizing heat pump systems in existing buildings.

Software is available to complete these load calculations quickly and easily.

Load calculations must account for:

- surface area and thermal properties of building enclosures
- building air leakage, including latent cooling loads
- duct losses, when ducts are to be used by new equipment
- solar gains from roof and windows, and internal sensible and latent heat gains
- climate considerations

Northeast Energy Efficiency Partnerships (NEEP)

Guide to Sizing and Selecting Air Source Heat Pumps in Cold Climates provides guidance, similar to CSA F280, on getting your load calculations right.

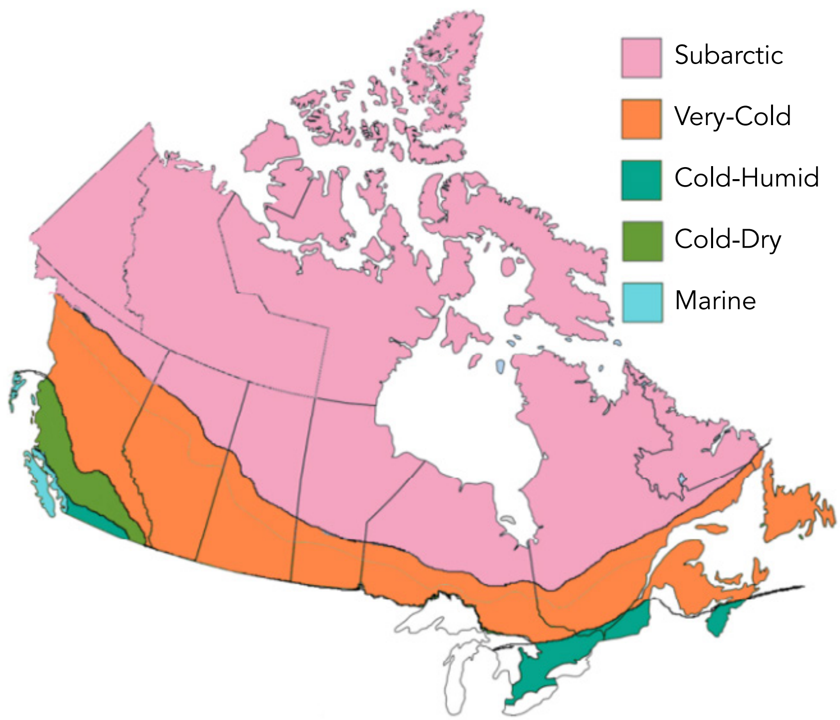
Energy audit reports from Registered Energy Auditors

- If the homeowner has had an energy audit, use this information to save time on house measurements and detailed analyses.
- For homeowners who have completed an audit through a Registered Energy Advisor, heating and cooling loads are available in the audit report generated by the Natural Resources Canada HOT2000 energy modelling software.

3 SIZING AND SELECTION APPROACH

Select heat pumps suitable for the local climate. Ensure that the system can handle local conditions and maintain efficiency throughout the year. Informed decisions based on heat pump performance ratings at different outdoor air temperatures[1] are essential to supporting the selection of an appropriate system that aligns with the homeowners' financial, environmental and comfort goals.

Climate considerations



Source: CanmetENERGY Air-source Heat Pump Sizing and Selection Guide

CLIMATE ZONES

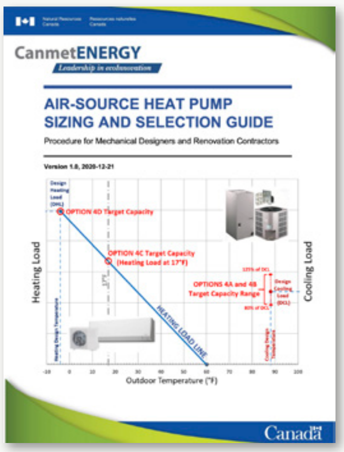
- Climate zones for ASHPs: Climate zones developed specifically for the CSA EXP-07 "Load based climate-specific testing and rating procedures for heat pumps and air conditioners". Canada is subdivided into five ASHP climate zones described as: Marine, Cold/dry, Cold/humid, Very cold, and Subarctic.
  - Ontario falls within the Cold/humid, Very cold, and Subarctic zones. Most of the Ontario population resides within the Cold/humid zone.
- Canada is subdivided into six climate zones defined by ASHRAE (i.e., Zones 4, 5, 6, 7A, 7B and 8) with HDD values ranging from < 3000 HDD (Zone 4) to ≥ 7,000 HDD (Zone 8).
  - Five of the six climate zones found in Canada also fall within Ontario. It is important to take varying zones into account when sizing a heat pump for its environment.
- To be classified as a cold climate heat pump, products must meet minimum criteria, including a coefficient of performance (COP) of 1.8 or higher at -15 degrees Celsius. Consult the Cold Climate Heat Pump Challenge.

[1] Northeast Energy Efficiency Partnerships. (n.d.). *NEEP's Cold Climate Air Source Heat Pump List*. https://ashp.neep.org

3 SIZING AND SELECTION APPROACH (CONT'D)

Sizing guides and tools

Once you have determined your load calculation, a variety of guides and tools are available to accurately estimate heat pump system sizing, some of which are listed below:



- **CanmetENERGY Air-source Heat Pump Sizing and Selection Guide**
  Developed by experts at Natural Resources Canada, this Excel-based tool is easy to use, and the companion guide provides additional support.
- **Manufacturer sizing tools**
  Some heat pump manufacturers provide training and proprietary sizing and selection tools to contractors who supply and install their products.

Select an appropriate combination of products based on the established requirements

The minimum capacity of the selected system is as important as the maximum capacity. Selecting the proper equipment for heating comfort and efficiency that has adequate turn-down to perform well in both low-load conditions and design conditions. This is an important reason to not to overestimate or overstate design loads[2].

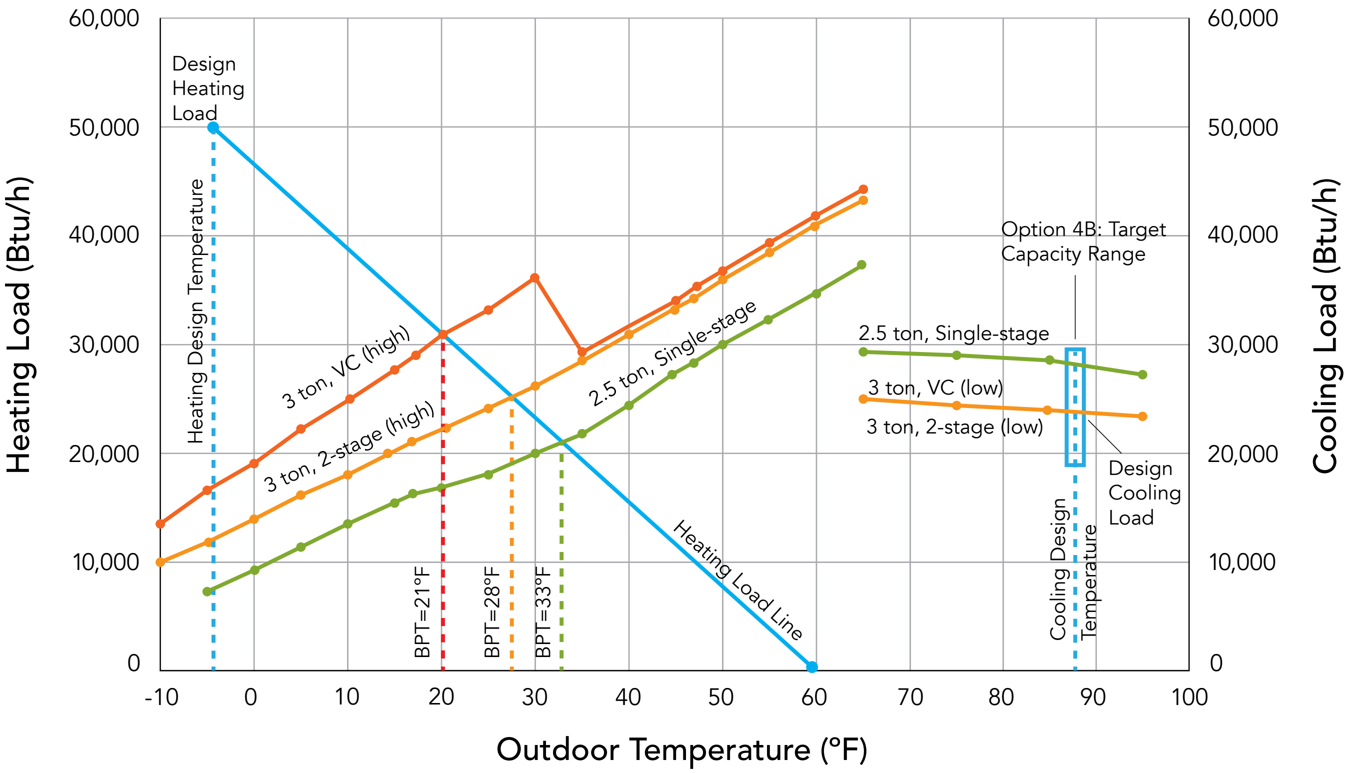
Important considerations:

- variable stage or modulating capabilities
- turn-down ratio (maximum to minimum capacity)
- low-temperature performance capabilities and low-temperature operating limits
- efficiency ratings (e.g., COP, HSPF for Region 4 or 5, SEER, etc.) and how they vary over the operating range
- noise ratings of outdoor units (dB)
- cost of equipment
- airflow – duct size (central) or room/wall configuration (ductless)
- the thermal balance point temperature (t-BPT) for the application and fraction of total annual heating provided above the t-BPT for the climate zone under consideration (see details on how to estimate the "fraction of total annual heating" in the CanmetENERGY Guide)

[2] Northeast Energy Efficiency Partnerships. (2020, April 8). *Guide to Sizing & Selecting Air-Source Heat Pumps in Cold Climates.* https://neep.org/sites/default/files/resources/ASHP Sizing & Selecting - 8x11_edits.pdf

Comparing heat pump system options and identifying the thermal balance point temperature (t-BPT).

USING CANMET SIZING OPTION 4B (BALANCED HEATING AND COOLING)



Source: CanmetENERGY guide

The t-BPT can be estimated by superimposing a plot of the heat pump heating capacity curve (using the manufacturer's capacity tables at different outdoor temperatures) onto the heating load line from the calculated heating load. Use the manufacturer specified maximum capacity information whenever available. The t-BPT is the temperature at which the heating load line intersects with the heat pump's performance curve.

For example:

- the ASHP with the green capacity curve has a t-BPT of about 0.6°C
- the ASHP with the orange capacity curve has a t-BPT of about -2°C
- the ASHP with the red capacity curve has a t-BPT of about -6°C[3]

[3] Natural Resources Canada. (2024, January 26). *Toolkit for air source heat pump sizing and selection.* https://natural-resources.canada.ca/maps-tools-and-publications/tools/modelling-tools/toolkit-for-air-source-heat-pump-sizing-and-selection/23558

4 DEFINE THE CONTROL STRATEGY

Based on the sizing approach used, back-up heating sources, fuel types and rates can define set-point values for hybrid system switch overs.

The control strategy is determined by three things:

1. The low-temperature cut-off limit of the heat pump relative to the design temperature.
2. The cost of heat from the heat pump relative to the cost of heat from the back-up heating system.
3. The sizing of the heat pump capacity relative to the total design heating load.

Additional factors when implementing control strategies

- Decide whether you are integrating the heat pump system with the back up system, or installing as a separate additional system. Integrated systems require integrated controls with crossover settings while separate systems can use separate control with a lower set-point.
- Decide on a thermal balance point control strategy or an economic balance point control strategy. The thermal balance point strategy is best suited for homeowners seeking primarily concerned with energy consumption or environmental impacts. The economic balance strategy using cut-offs that are based on time of day and day of week, while more complex, may be preferable for homeowners concerned with operating costs.

Considerations for heat pump thermostat selection

- Use the manufacturer-supplied thermostat for each heat pump system you install where possible.
- Not all thermostat models are compatible with heat pump systems. Most smart thermostats can only be used with centrally ducted heat pumps. Some thermostats may not properly control heat pumps with variable speed compressors.
- The wiring required for a heat pump system can differ from other HVAC systems. Ensure that the thermostat supports the wiring required for heat pumps.
- Not all thermostats support all components of a hybrid system. When working with hybrid systems, a thermostat that supports the given heat pump and supplementary heating system should be selected, such as an integrated multi-stage control. If this option is not available, advise the homeowner on the use of two separate thermostats and the logic used in programming their set-points.

Sources:

- Natural Resources Canada. (2024, January 26). *Toolkit for air source heat pump sizing and selection.* https://natural-resources.canada.ca/maps-tools-and-publications/tools/modelling-tools/toolkit-for-air-source-heat-pump-sizing-and-selection/23558
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