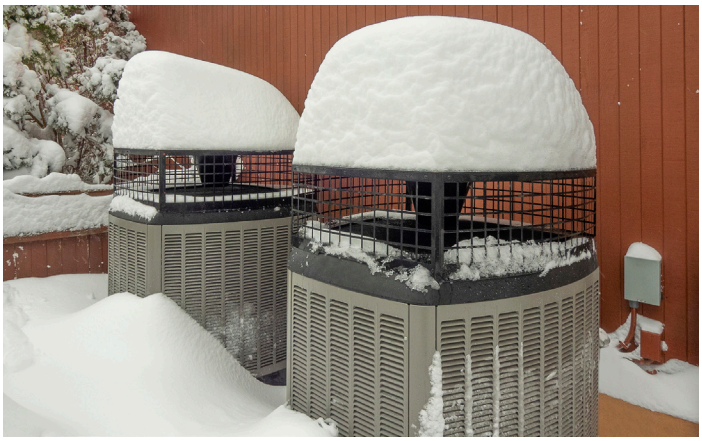
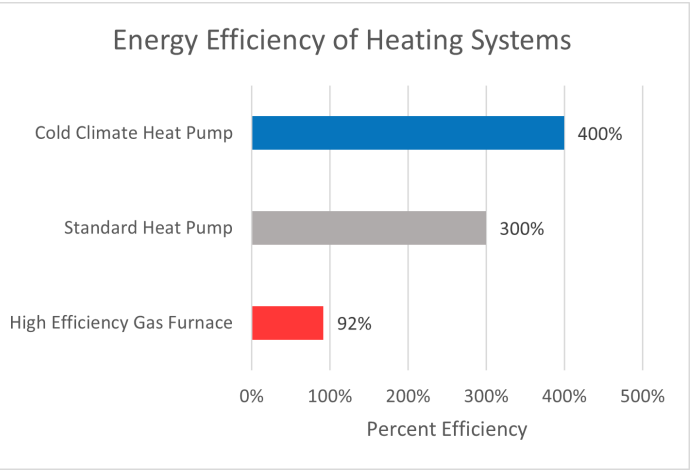
SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Cold Climate Heat Pumps

What are Cold Climate Heat Pumps?

Heat pumps are not a new technology, but until recently their implementation has been largely limited to warmer climates because traditional heat pumps lose capacity and efficiency at lower ambient temperatures. In recent years, that threshold has become much lower due to improved refrigerants and improved system design. The availability of cold climate heat pumps allows even states with extreme winter conditions, like Alaska, Maine and Minnesota, to encourage consumers to adopt the technology.





Benefits of a Cold Climate Heat Pump

The primary benefit of a cold climate heat pump is energy efficiency. A traditional heat pump transfers **300%** more energy than it consumes. Cold climate heat pumps may outperform that, hitting **400%** efficiency or higher. For comparison, the thermal efficiency of modern *high efficiency gas-fired furnaces* is typically around *92%*.

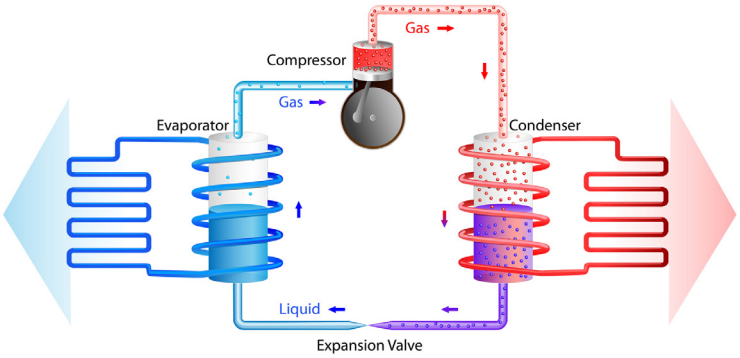
Other benefits align with those of standard heat pumps but are now applicable in colder climates. These include versatile applications from heating & cooling (ducted or ductless systems) to water heating to laundry drying.

Cold Climate Performance

Air source heat pumps work by transferring heat from outdoor air to indoor air via a compressor, refrigerant, coils and fans. This process is reversed during hot months when air conditioning is required.

Standard air source heat pumps work best in moderate climates and require a switch to auxiliary or back-up heat in cold weather. This is often electric resistance heat, with a *higher energy penalty*.

Cold climate heat pumps are designed to operate efficiently at temperatures **as low as 5 °F**, and **many provide effective heat to as low as -20 °F**, and *sometimes lower*. These advancements allow some heat pumps to function effectively in cold climates.



smartenergy.illinois.edu/energycode | 800.214.7954 | energycode@illinois.edu
Smart Energy Design Assistance Center, 1 Saint Mary's Road, Champaign, IL 61820

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Cold Climate Heat Pumps

Cold Climate Heat Pump Technology

Variable Speed Compressors and Fans: Variable speed compressors adjust the compressor speed to match the conditioning load requirement rather than running at full capacity all the time. Variable speed fans operate at different airflows to optimize coil performance at the current load.

Enhanced Vapor Injection: This is a technology used to achieve a broader operating temperature range and increase low-ambient efficiency. A small amount of refrigerant is passed through a separate expansion valve and heat-exchanger before re-injection at warmer temperature back into the compressor.

Electronic Expansion Valves: These are metering devices that regulate the flow of refrigerant into the evaporator. They provide more precise metering of refrigerant flow, allowing these systems to deliver more liquid refrigerant to the evaporator without flooding the compressor.

Sensors and Controls: Cold climate heat pumps employ multiple sensors and advanced controls to optimize operation.

Understanding Efficiency Ratings

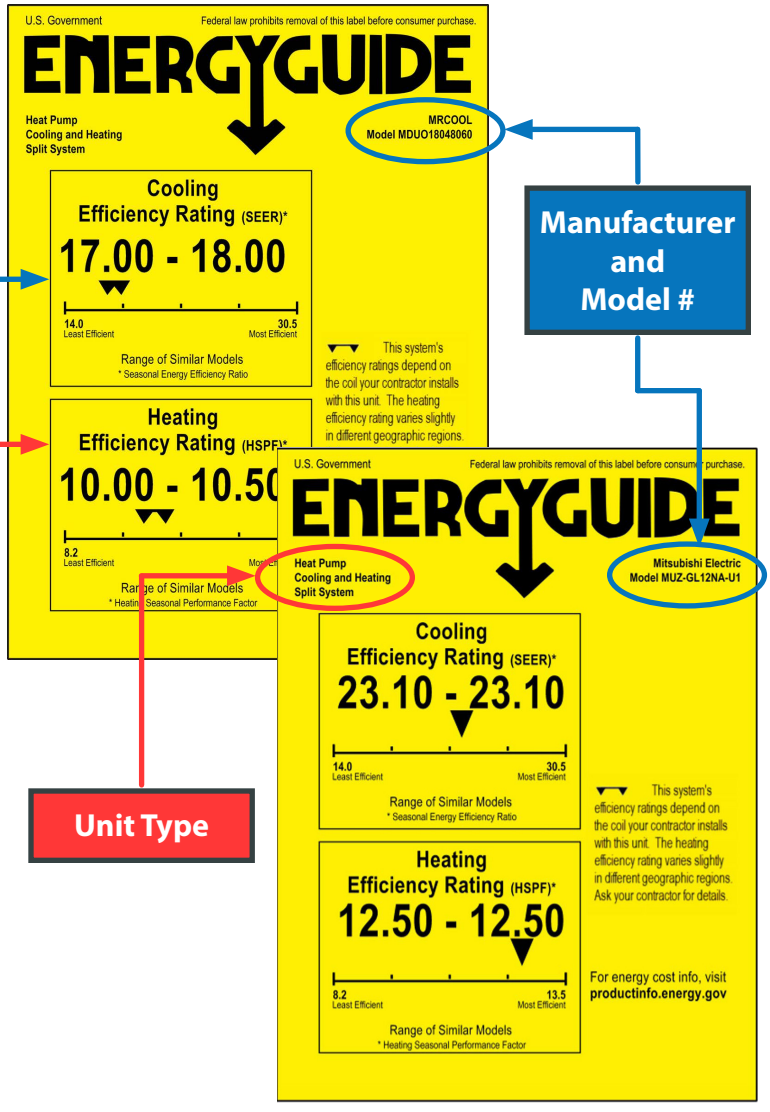
When considering heat pumps for a building or space, it's helpful to understand the differences between unit efficiency ratings displayed on Energy Guide labels.

Cooling performance:
EER = Energy Efficiency Ratio
SEER = Seasonal Energy Efficiency Ratio
EER2 = Updated EER testing procedures
SEER2 = Updated SEER testing procedures

Heating performance:
HSPF = Heating Seasonal Performance Factor
HSPF2 = Updated HSPF testing procedures
COP = Coefficient of Performance

Generally, the higher the number the better the efficiency. SEER/HSPF take into account the temperature profile of a typical year which captures changing efficiency throughout the season. EER/COP is only measured at a specific point or design temperature. EER/COP is almost always lower than SEER/HSPF, as the unit is running in a high-stress (extreme) condition versus average conditions. SEER2, EER2 and HSPF2 are updated ratings using new test parameters that are more representative of current real life conditions.

It isn't possible to determine cold climate performance from efficiency ratings alone. Further information is needed.



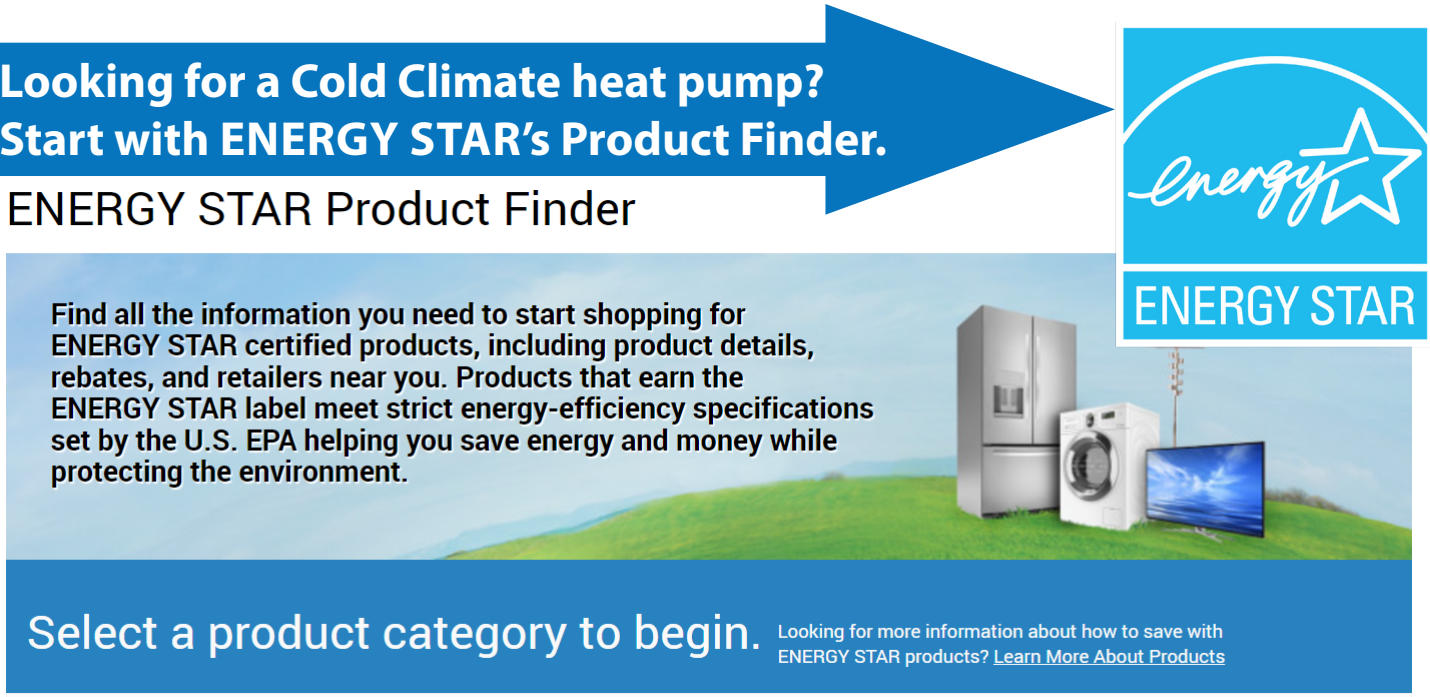
SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Cold Climate Heat Pumps

Identifying Cold Climate Heat Pumps

Identifying cold climate heat pumps can be challenging. Often engineering or performance data is required to verify performance in cold temperatures. Manufacturer performance tables indicating rated unit capacities at different conditions (i.e. temperatures) assist designers and engineers in unit selection. Some units may be called out as cold climate capable. Each manufacturer can define cold climate performance using different operating ranges and performance data as there is no set standard. Luckily, there are a few publicly available sources to help consumers compare options such as the ENERGY STAR Product Finder.

Looking for a Cold Climate heat pump? Start with ENERGY STAR's Product Finder.



Although there is no industry standard for cold climate performance, ENERGY STAR product certification now includes performance requirements for cold climate heat pumps. Using the ENERGY STAR Product Finder, consumers can filter through Ducted, Mini-Split and Geothermal heat pumps. A *'cold climate'* filter shows any units meeting the following cold climate performance requirements defined in ENERGY STAR V6.1:

- **COP at 5°F ≥ 1.75**
  Meaning when the exterior temperature is 5°F these units must be able to transfer 1.75x or 175% of the energy they consume.
- **Percent of Heating Capacity at 5°F ≥ 70% of that at 47°F**
  Meaning when the exterior temperature is 5°F the unit will provide at least 70% of the heating capacity that is provided when the exterior temperature is 47°F. This demonstrates the unit can still provide usable heat even if it cannot provide 100% of its capacity. Depending on the location and condition of the building, 70% of the heating capacity may be enough to survive a cold snap without a significant drop in interior temperatures. Carefully sized supplemental heat can be installed to increase the functional operating range for even colder temperatures. See note about *back-up* vs *supplemental* heating.
- **The performance indicated above must be achieved by the factory installed native controls operating as they would in a consumer's building**

SEDAC
SMART ENERGY DESIGN ASSISTANCE CENTER

Cold Climate Heat Pumps

'Cold Climate' Unit Labels

Some manufacturers plainly label cold climate units with special tags such as **Mitsubishi's 'Hyper-heat' or 'H2i'** units. Others call out cold climate performance with different series names such as **Daikin's 'AURORA'** heat pump series and **Fujitsu's 'Extra Low Temperature Heating' or 'XLTH'** series. Remember the actual performance of these cold climate units will vary by manufacturer and equipment selected.

MITSUBISHI ELECTRIC
HYPER-HEAT TECHNOLOGY

MULTI ZONE DUCTLESS HEAT PUMPS- OUTDOOR UNITS

BTU	18,000 (2 Indoor Units)	24,000 (2 - 3 Indoor Units)	36,000 (2 - 4 Indoor Units)
BEST	 XLTH 14°F -15°F AOU18RLXFZH	 XLTH 14°F -15°F AOU24RLXFZH	 XLTH 14°F -15°F AOU36RLXFZH
BETTER	 14°F 5°F AOU18RLXFZ	 14°F 5°F AOU24RLXFZ	 14°F 5°F AOU36RLXFZ1

Back-up vs. *Supplemental* Heat

Current practice is to install back-up heating meeting **100%** of the heating load should a heat pump fail. For context, typical gas heating systems are *not* installed with full 100% back-up systems. Do we really need to treat heat pumps differently? In short, yes. Even cold climate heat pumps lose capacity when the outside temperature is low enough. Depending on the location, projects may need a source of *supplemental* heat to maintain occupant safety and building integrity. The key point here is that cold climate heat pumps may need ***supplemental*** heat, not ***back-up*** heat. *Why?*

- **First,** electric resistance heat (a common choice) requires **at least 3x** the peak electricity as a heat pump. This means your electrical panel/service may need a costly upgrade.
- **Second,** full *100% back-up* heat will cover up any heat pump failures. Building occupants may not notice a problem until their next electrical bill which could be **3x higher, or more!**

State Incentives and Federal Tax Credits

The federal government is currently incentivizing heat pump adoption by offering a sizable tax credit through the Inflation Reduction Act. This tax credit can cover **30 percent** of the total purchase cost of the heat pump, *including labor and installation,* **up to $2,000**. This incentive is available through the end of 2032. Additional programs are being developed to provide greater tax incentives for low and moderate income households.

Additionally, states and/or utlities are now offering rebates. Depending on your income, you could be eligible for up to **$8,000** back for a building heat pump.

Who We Are

Have a Question About the Energy Code? Contact Us.

SEDAC is the Energy Code Training Provider on behalf of the Illinois EPA Office of Energy. Attend SEDAC's workshops and webinars to learn more. We also offer online courses and technical support.

Workshops | Webinars | Online Courses | Technical Support

smartenergy.illinois.edu/energycode | 800.214.7954 | energycode@illinois.edu
Smart Energy Design Assistance Center, 1 Saint Mary's Road, Champaign, IL 61820