U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Residential Cold-Climate Heat Pump Technology Challenge

Cold-climate heat pumps (CCHPs) provide both space heating and cooling for homes, and incorporate advanced features that allow for improved heating capacity and efficiency at cold weather conditions compared with traditional heat pumps.
Photo credit stock.adobe.com.

Why are cold-climate heat pumps important?

Space conditioning and water heating consume over 40% of the nation's primary energy and are a major source of greenhouse gas (GHG) emissions. Electric heat pumps (HPs), which extract heat from the air and ground, are an efficient alternative to fuel-fired space conditioning and water heating equipment. However, the performance of conventional HPs declines in colder climates, which have high space heating demands. In recent years, HVAC manufacturers have developed specialized cold-climate heat pumps (CCHPs) which incorporate advanced designs to operate with greater capacity and efficiency at low outdoor temperatures (below 32°F).

Why is a technology challenge needed?

CCHPs are gaining acceptance in some regions, with support from government, industry, and utility initiatives, but additional efforts are needed to address common technical and market barriers to wider adoption by consumers, which include performance at temperatures of 5°F and below, installation challenges, and electricity grid impacts during peak demand periods.

To advance the adoption of CCHP technologies, the US Department of Energy (DOE) is launching the Cold- Climate Heat Pump Technology Challenge as part of the Initiative for Better Energy, Emissions, and Equity (E3 Initiative).

In partnership with the U.S. Environmental Protection Agency (EPA), Natural Resources Canada (NRCan) and heat pump manufacturers, DOE aims to accelerate the development and commercialization of next-generation CCHPs that meets consumer comfort and efficiency needs in cold climate regions of North America. CCHP products that meet the Challenge specification would offer high efficiency and heating capacity both seasonally and at very cold temperatures (5°F and below). The Challenge builds upon the recent ENERGY STAR specification (v6.0).

Which products are in scope?

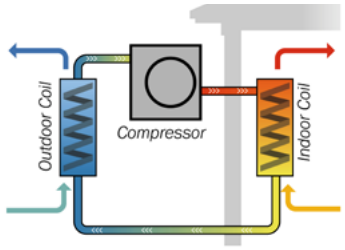
The CCHP Technology Challenge is focused on residential, centrally ducted, electric-only HPs. The Challenge has two segments: one for a CCHP optimized for 5°F (-15°C) operation and the other for a CCHP optimized for -15°F (-26°C) operation. Manufacturers can choose to participate in one or both segments of the challenge. Challenge submissions are limited to models that meet the following criteria:

- Have a nominal cooling capacity (or nominal heating capacity for a heating-only HP) greater than or equal to 24,000 Btu/h and less than or equal to 65,000 Btu/h.
- Meet all of the challenge specification requirements
- Comply with all applicable federal and state standards, regulations and laws governing these types of HPs, including compliance with all safety and environmental standards.

Advantages of Heat Pumps

Fossil fuels burned in space and water heating are some of the largest contributors to U.S. GHG emissions today. Heat pumps, when combined with low carbon electricity resources, can provide substantial GHG emissions savings for the buildings sector. A variety of heat pump solutions are available to fit individual building needs including ducted, ductless, air-to-water and other solutions. Other advantages include:

- Provides both heating and cooling
- High efficiency and performance throughout the year
- Better comfort with multi-speed operation
- Grid connectivity enables grid optimization and renewable integration
- Some products enable temperature control in different areas of the home
- Potential for improved air quality



Outdoor coil absorbs heat from the air, then the compressor concentrates the heat, and finally the indoor coil releases heat into the air.
Photo credit ORNL

What are the challenge specifications?

Performance Requirements

Seasonal Heating

- 8.5 HSPF2 (ASHRAE Region V)
- Heating at 5°F [-15°C]
- Minimum COP of 2.1-2.4 at 5°F
- Capacity ratio of 100% for 5°F capacity to 47°F capacity
- Minimum turndown ratio at 47°F
- Compressor cut-in and cut-out temperatures

Heating at -15°F [-26°C] (optional)

- HP operation at -15°F as measured by compressor cut-in and cut-out temperatures

Auxiliary heat

- Staged auxiliary heating

Low GWP Requirement

- Employ refrigerant with a global warming potential (GWP) value of no more than 750 (AR4,100 year)

Connected Product Criteria

- Offer the connected product capabilities within the latest ENERGY STAR specification (v6.0).

Further details on the challenge specifications can be found here.

How will Submissions be Verified?

DOE will collaborate with HP manufacturers to develop a test procedure to verify CCHP performance through lab testing.

In addition, products meeting the CCHP Technology Challenge will undergo field trials in cold climate regions to demonstrate performance, efficiency, and comfort in real-world applications. The field trials will be coordinated with local partners including utilities, state agencies, and other parties.

Product Prototype (Late 2021/ Early 2022) → **Lab Testing** (Early-mid 2022) → **Field Testing** (Winter 2022-2023 or 2023-2024) → **Deployment Programs/ Commercialization** (2024)

How to Participate

Manufacturer Partners

The following six HP manufacturers have committed to join the Challenge: Carrier, Daikin, Johnson Controls, Lennox International, Mitsubishi Electric, and Trane Technologies.

As manufacturing partners, they have agreed to support a new path towards clean heating and cooling systems by:

- Pledging to work with DOE towards the development of a CCHP model that meets or exceeds the CCHP Challenge specifications and timeline;
- Participating in working group meetings to coordinate Challenge activities; and
- Sharing quarterly updates on CCHP development progress, including preliminary results, product and testing challenges, and expected milestone timelines.

Utility & State Partners

Utility and state energy efficiency leaders can commit to support CCHP commercialization and deployment by signing the partnership agreement and agreeing to the following:

- Designate a CCHP Technology Challenge partnership lead;
- Participate in check-in meetings to coordinate Challenge activities (anticipated several per year).
- Assist with various aspects of the CCHP Challenge field demonstrations taking place in their territory, state, or region.
- **Utilities:** Develop customer incentives (including differentiated incentives for CCHP performance levels at 5°F and below), and pilot programs to encourage CCHP adoption, within 24 months of joining.
- **State Agencies:** Develop education and outreach campaigns, and support the development of customer incentive programs where applicable, to encourage CCHP adoption, within 24 months of joining.

DOE Support & Recognition

DOE will provide technical and administrative support throughout the field testing and will coordinate progress between manufacturers, utilities, state agencies and other stakeholders.

DOE will provide public recognition of partner manufacturers, as well as partner state, utility, and industry organizations, during the duration of the challenge and specifically when partner manufacturers successfully meet CCHP Challenge specifications and timeline.

DOE will assist Challenge partners in the research and development of educational and training materials for CCHP products."

The CCHP Technology Challenge website provides additional details, a list of committed manufacturer, state, utility, and industry partners, and regular progress updates. ■

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For more information, visit:
https://www.energy.gov/eere/buildings/residential-cold-climate-heat-pump-challenge

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