PRELIMINARY TECHNOLOGY ASSESSMENT – AUGUST 2024

Cold Climate Air-to-Liquid Heat Pumps

Technology Overview

Typical air-source heat pumps can be unreliable at extremely low temperatures, limiting their application in cold climates.[1] Cold climate air-to-liquid heat pumps are fully electric and offer enhanced operational efficiency to provide reliable heating in very low outside temperatures.

Cold climate heat pumps transfer heat from the atmosphere to liquid for heating and back to the atmosphere when the building requires cooling. The heat pumps operate with an enhanced vapor injection technology using a counter-flow heat exchanger for subcooling and superheating. The technology improves system capacity and allows for increased hot water temperatures in colder ambient conditions. Cold climate heat pumps can operate in temperatures as low as -18°F, significantly lower than the standard 0°F cutoff of conventional heat pumps.

Cold climate heat pumps can be used as a primary heat source or they can supplement a heat pump that loses efficiency at lower temperatures.

Why is GSA Interested?

Electric-powered HVAC equipment plays a key role in fully electrifying GSA's building portfolio and achieving net zero emissions by 2045. Cold climate heat pumps reduce carbon emissions, improve air quality, and are more efficient than other electric-powered heating systems. The vendor estimates 60% energy savings compared to a standard electric boiler heating system.

Modular in design, cold climate heat pumps support retrofit applications and offer flexibility in sizing systems.

Deployment Potential

Cold climate heat pumps can operate efficiently in buildings up to 50,000 SF in ASHRAE climate zones 5 or higher, which is roughly the northern half of the United States. While there are no restrictions regarding building age, a sufficient electrical system is required to accommodate cold climate heat pumps. Older retrofits may require additional integration costs.

[1] heatpumps.ca. "Tackling Winter Heat Pump Problems for Canadians," https://heatpumps.ca/articles/heat-pump-problems-that-canadians-face-in-the-winter, accessed 08-2024.

Green Proving Ground (GPG), in collaboration with the U.S. Department of Energy, is evaluating the real-world performance of cold climate air-to-liquid heat pumps in federally owned buildings within GSA's inventory. The technology will be provided by Trane Technologies and coordinated with other ongoing evaluations of this technology.