





Master of Science Mechanical Engineering

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Project: Experimental Evaluation of a Novel Phase Change Material Heat Exchanger for HVAC Advisor(s): Allison Mahvi & Mike Wagner Sponsor: U.S. Department of Energy







- Buildings contribute to 31% of US emissions.¹ Increased flexibility is needed to decarbonize the grid.²
- Phase change material (PCM) thermal energy storage (TES) can shift electrical loads of HVAC equipment, enabling flexibility.
- In this project, the PCM TES shifts loads by running in place of the outdoor coil in summer (condenser) or winter (evaporator), using the PCM as a moderate temperature heat sink or source.
- Project will lead to advancements in PCM TES designs and improve HVAC integration.





Figure 1: A PCM TES in condenser mode.³

U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks," Reports and Assessments EPA 430R-24004, 2024 (<u>https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2022</u>),
S. Garimella et al., "Realistic pathways to decarbonization of building energy systems," *Joule*, vol. 6, no. 5, pp. 956–971, May 2022, doi: <u>10.1016/j.joule.2022.04.003</u>. [3] J. Woods et al., "Rate capability and Ragone plots for phase change thermal energy storage," *Nat Energy*, vol. 6, no. 3, pp. 295–302, Mar. 2021, doi: <u>10.1038/s41560-021-00778-w</u>.





Goal: Experimentally characterize PCM TES heat exchanger for multi-split heat pumps.

Methods: Build refrigerant loop (Figure 2) that can:

- 1. Control inlet state to TES heat exchanger to mimic conditions in HVAC system.
- 2. Measure outlet state of TES during charge and discharge.

Outcome: Compare results to computational models and identify future design changes.

