Heat Pump Thermal Storage Study

Modelling the use of phase change materials to store thermal energy in residential heat pump systems.

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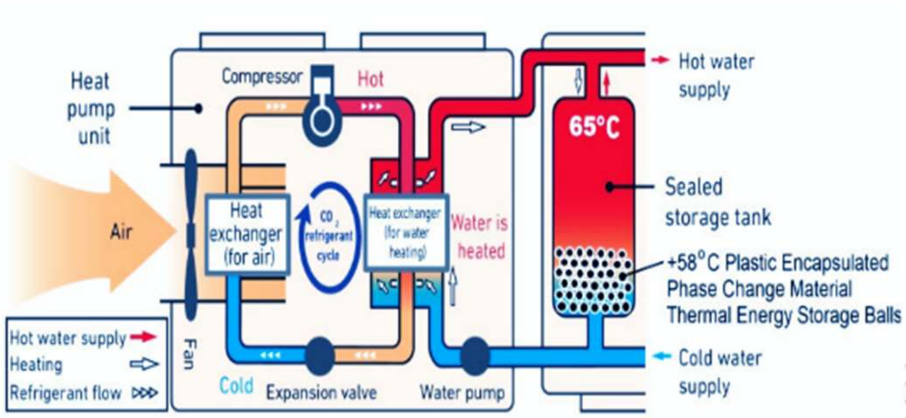

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What did we study?

- We modelled two thermal energy storage solutions for home heating from Atlantic Canada that both use air source heat pumps and phase change materials.
- Phase change materials store heat by passing through a phase transition.
- The materials modelled here have their phase change at a temperature that is feasible for an air source heat pump to reach (around 60°C).
- We used dynamic building energy simulations to estimate the ability of these systems to shift space heating electricity demand out of peak demand times.

Example thermal storage unit.
Image: Stash Energy

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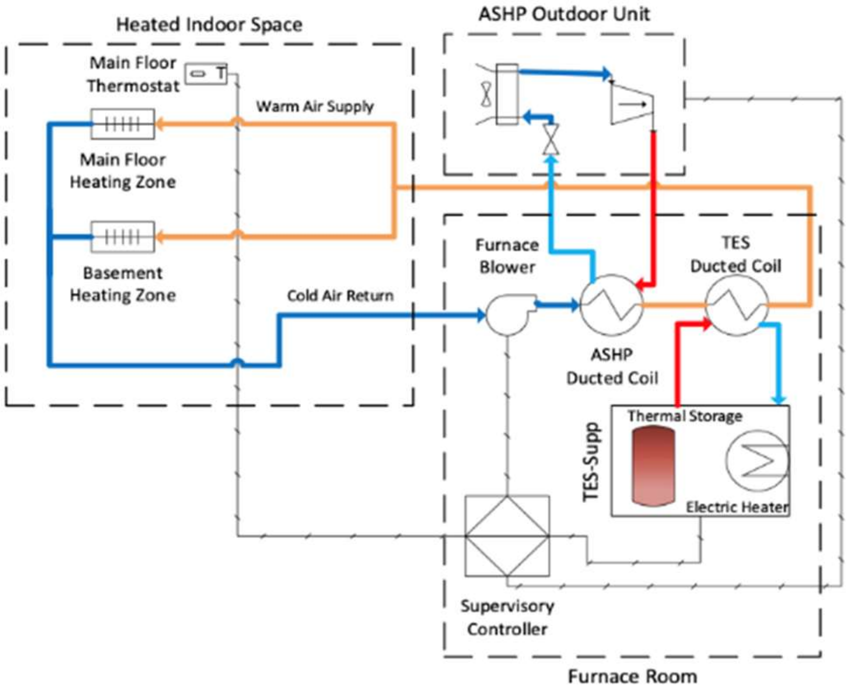
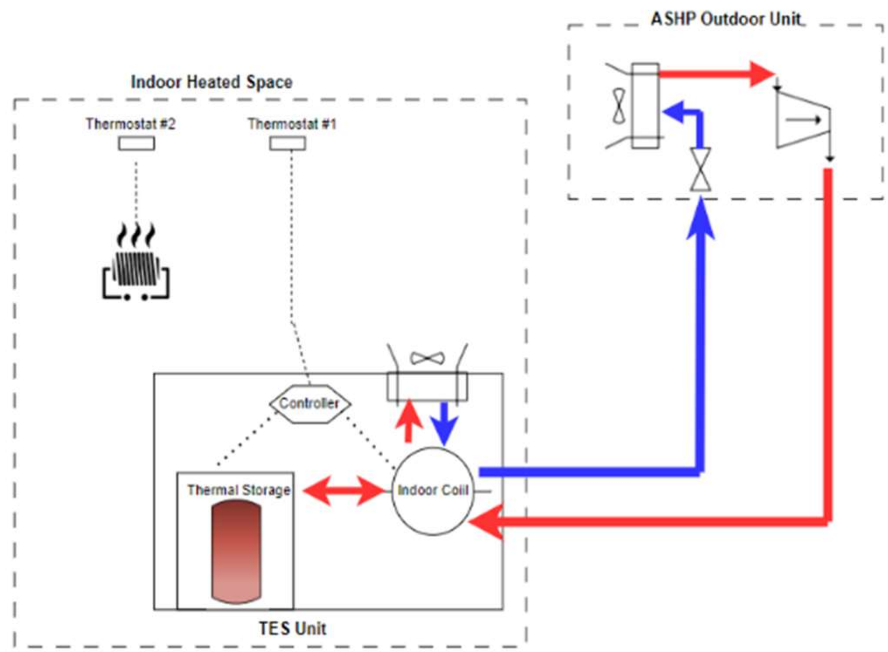
The two thermal storage solutions



Supplemental Thermal Storage



Integrated Thermal Storage

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Why Study This?

- There are approximately 400,000 single family homes in Nova Scotia.
- A significant portion already use electric heating.
- A rapid increase in the use of heat pumps for home heating is underway in this region.
- Using thermal storage can shift electricity demand away from peak hours.
- Combining heat pumps with thermal energy storage allows 2-in-1 benefits:
  - Energy efficiency of heat pumps (COP 2-3)
  - Demand response through energy storage

House #4: Halifax

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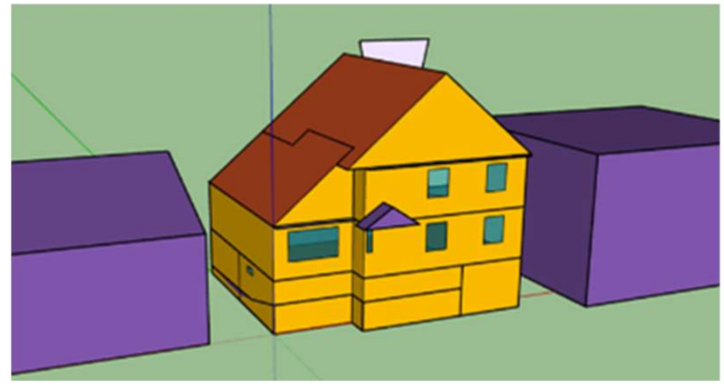
Methods

- Used TRNSYS (Transient System Simulation Tool) to model energy flow in 5 different house examples.
  - 3 were archetypes provided by NRCan.
  - 2 were models of real homes.
- Modelled performance of the two heat pump thermal storage systems through a winter heating season.
  - Used real weather data from 2015 (a cold winter).
- Used modelling to estimate how much electricity each system could shift out of peak demand times, compared with a baseline model.



TRNSYS Model of House #4: Halifax

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What did we find?

- Integrated and supplemental systems were both able to shift 50-60% of heating electricity out of the on-peak periods (for their respective heating loads).
- The integrated system led to a decrease in heating bills by taking advantage of off-peak rates but had less ability to decrease peak power demand.
- The supplemental system led to an increase in heating bills but had greater ability to decrease peak power demand.

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Discussion and next steps

- Thermal energy storage for space heating is one of a suite of tools for distributed demand response. (Other examples include domestic hot water and EV chargers).
- It can work at scale with supportive incentives.
- In future, a building-level integration system to respond to dynamic varying electricity prices can take advantage of opportunities for demand response.
- We are looking for opportunities to conduct field trials with real units to test modelling results.

House #4: Halifax

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Thank you!

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