Energy Data from Heat Pumps installed in Juneau, AK

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Background

Approximately 50 homeowners in Juneau, Alaska recently installed ductless heat pumps through the Thermalize Juneau 2021 campaign. Juneau is located near the climatic limits of many air source heat pump models. A parallel research project installed Sense energy meters on a 10 - home subset of this group in order to better assess energy usage and operational characteristics in this cold climate.

What are Heat Pumps?

- They use electricity to gather heat from the outdoor air, and step up the temperature with a refrigeration cycle, to efficiently heat homes
- Take heat from outside the home and transfer it inside using technology like a refrigerator (but in reverse)
- Can replace or displace an existing heating method (often fuel oil or electric resistance heating in Juneau)
- Have the potential to lower carbon emissions
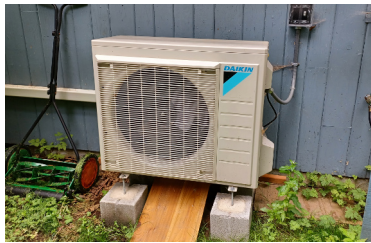- In Juneau, they are more cost effective than fuel oil or electrical resistance

Figure 1: A DaikinLV heat pump outside of one of the Thermalize Homes.

What is a Sense Meter?

- Connects to main legs of an electrical panel, with an option to also connect current sensors to one circuit (in this case the heat pump circuit)
- Uses machine learning to detect when different electronics are running and record their energy consumption (but this was not utilized in our project)
- The monitor's data can be accessed remotely

Research Questions

1. Do Sense Meters accurately record the energy usage of heat pumps installed in a lab?

2. Are heat pumps cost effective in Juneau?

3. What climatic factors influence the range of operability of ductless heat pumps?

Process and Results

Lab Evaluation:

Researchers installed a Sense meter in the CCHRC lab to compare the energy use it measured to that of an existing data logger monitoring a ductless heat pump. The Sense meter accurately recorded the energy usage of 4 different heat pumps in the lab. The data was recorded for each minute during January 3rd, 2022.
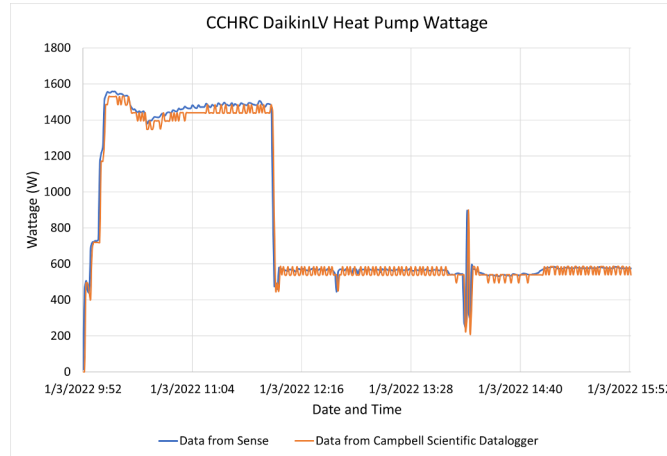

Figure 2: Energy consumption of the DaikinLV heat pump installed in the lab during January 3, 2022.

Cost of the Operation of Heat Pumps:

I used the energy usage for heat pumps from 10 homeowners to find what the heat pump operation cost the homeowners on different days for the months of November through June.
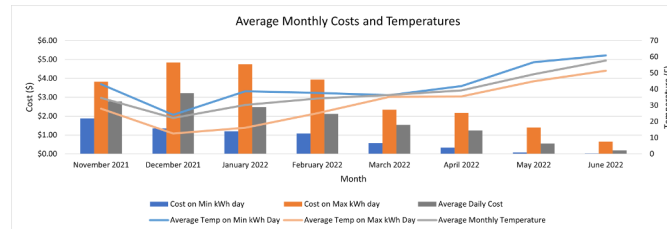

Figure 3: Average heat pump costs for 10 homeowners compared with average temperatures in Juneau.

- Max Daily Cost: $7.65 (January 8th)
  - Average Daily Cost for January: $2.48
  - Average Daily Cost for December: $3.22
- Max Monthly Cost: $117.40 (December)
  - Average Monthly Cost for December: $80.47
  - Average Monthly Cost for January: $95.72

Defrost Cycles:

A defrost cycles occurs when the heat pump reverses directions to heat the outside coil and melt any ice that has accumulated. We wanted to see how often the heat pumps were going through defrost cycles and how the outdoor temperature and humidity may impact that frequency. Figure 4 shows the relationship between defrost frequency and weather which does not show a strong correlation.
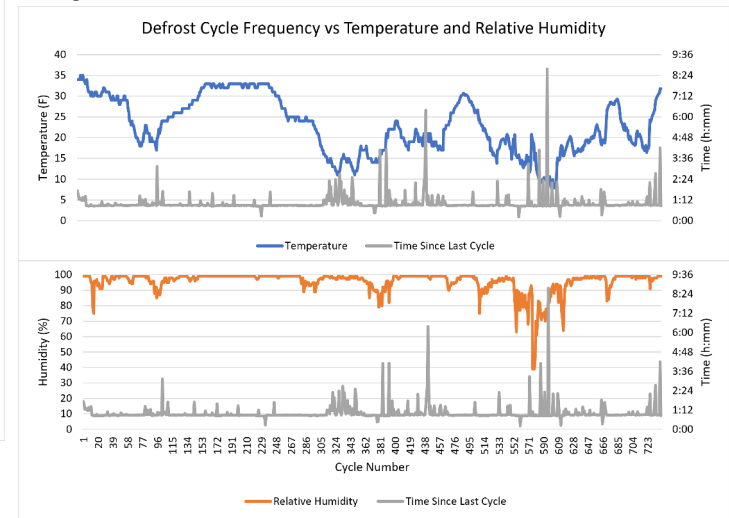

Figure 4: Sample homeowner data showing the time since the previous defrost cycle compared to the outside temperature and humidity. This represents the defrost cycles for one heat pump during the month of December 2021.

Discussion and Future Work

- We now know the average operation costs homeowners pay for their heat pump (between $0.19 and $3.22 per day depending on the month).
  - We can compare these costs to what the homeowners previously paid to heat their homes using either oil or pellets.
- We were expecting to find a correlation between the frequency of defrost cycles and the outside temperature and humidity. So far, we have not found any strong relationship in the data.
  - We will continue to look for any patterns in defrost cycles and weather.

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