

Ductless Heat Pump Energy Monitoring in a Cold Climate

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- Alaska Heat Smart
- AEL&P
- The 14 participating households



Photo by Rachel Dodd, NREL 22115

Juneau, AK using heat pumps to reach renewable energy goal

- Juneau, AK: 80% renewable energy by 2045
- Alaska Heat Smart (AHS): Juneau nonprofit
 - Heat pump info and resources to Juneau residents
 - Alaska's first Thermalize Campaign
- AHS recruited households to monitor energy usage.
 - Two different energy meters installed



Photo by Rachel Dodd, NREL 22115

Research Questions

- What are the climatic limitations of ductless air-source heat pump installations that define the range of operability?
- Are DHPs an appropriate technology for use in cold maritime climates?
- Did the installed Sense meters reliably measure the energy use and operating parameters of DHPs in the Thermalize Juneau cohort?



Methodology

- AHS recruited 14 households from the 164 Thermalize Juneau participants
- Two meters utilized to monitor DHP and whole house electricity use.
 - Sense Solar meter
 - Two-Way Automatic Communication Systems (TWACS) meter
- Each home received either a TWACS meter, a Sense meter, or both
 - To assess the accuracy of the Sense meters
 - No cost to the homeowners and remained after the study
- Participants received a gift card for completing three interviews with research staff.

Meters

Sense Solar Meter

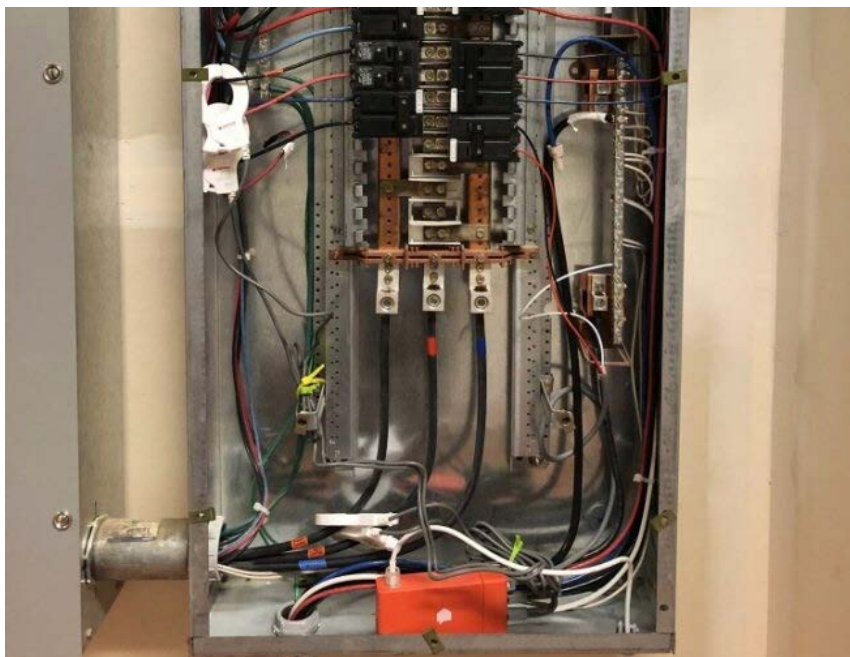


Photo by Vanessa Stevens, NREL 21537

TWACS Meter



Photo by Vanessa Stevens, NREL 21537

Climatic Limits of DHP Installations in Juneau

Daikin Aurora can operate continuously down to -13F (-25C) (Daikin, 2023)

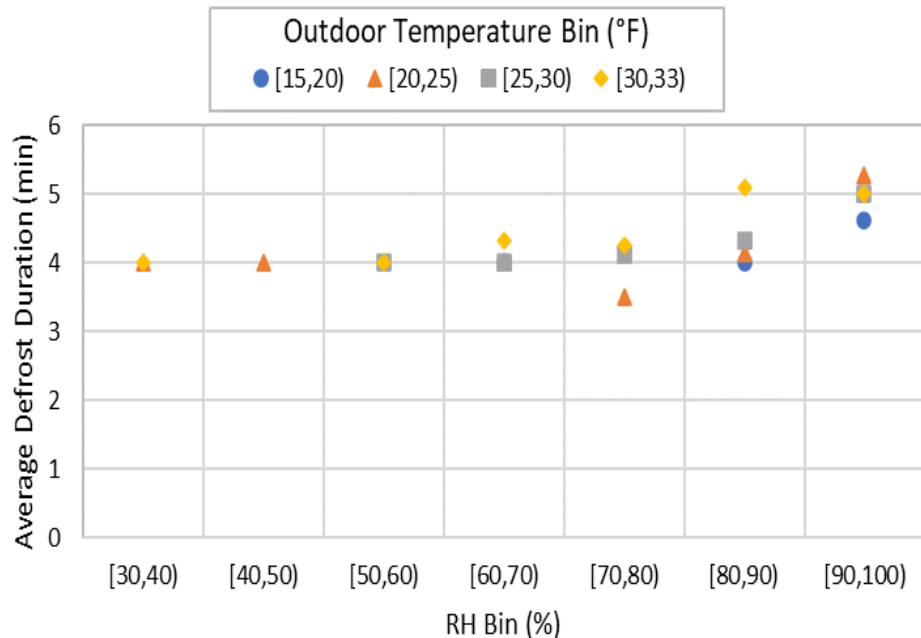
During study period: -8F on Jan 6, 2022 at the airport

Homeowners reported DHP as primary source of heating and reported DHPs were reliable and effective with little to no maintenance

Energy data collected indicated all 14 DHPs functioned successfully from install through April 2023

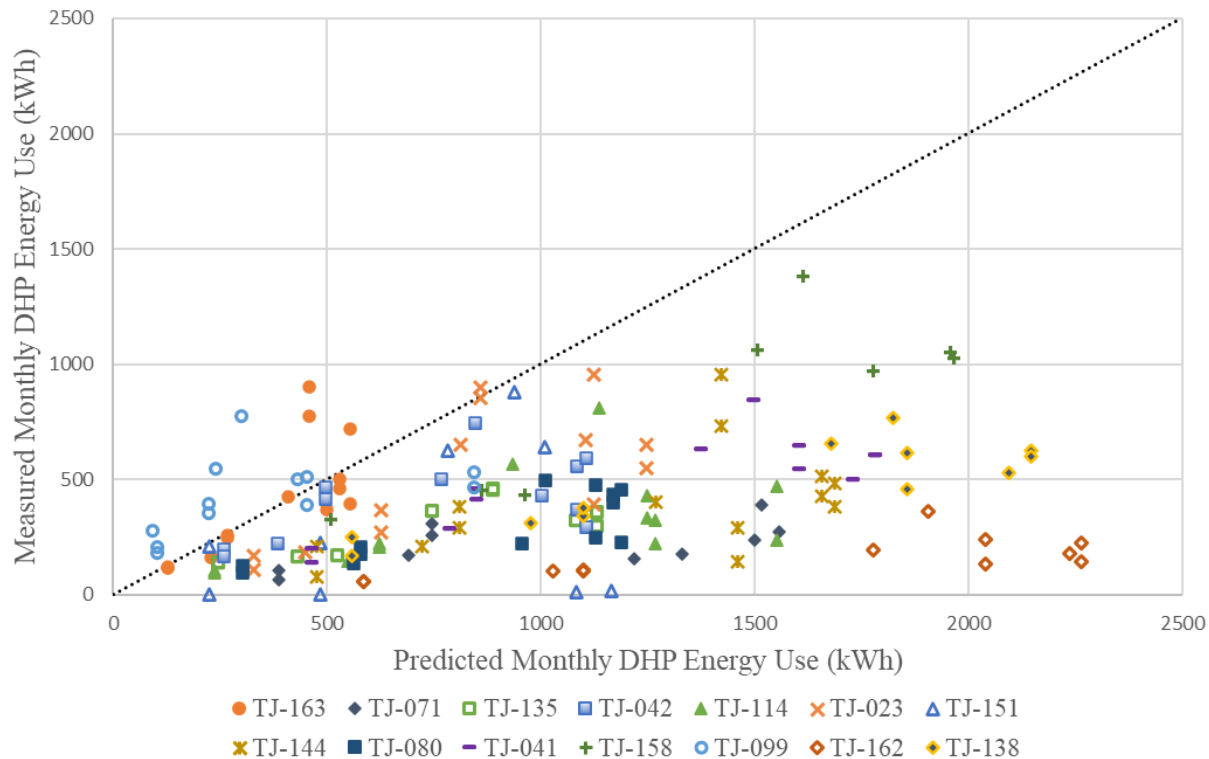
Attempted to analyze if correlation between defrost cycles, temperature, and relative humidity.

Of defrost cycles identified there was an increase in duration of cycle with increased relative humidity.

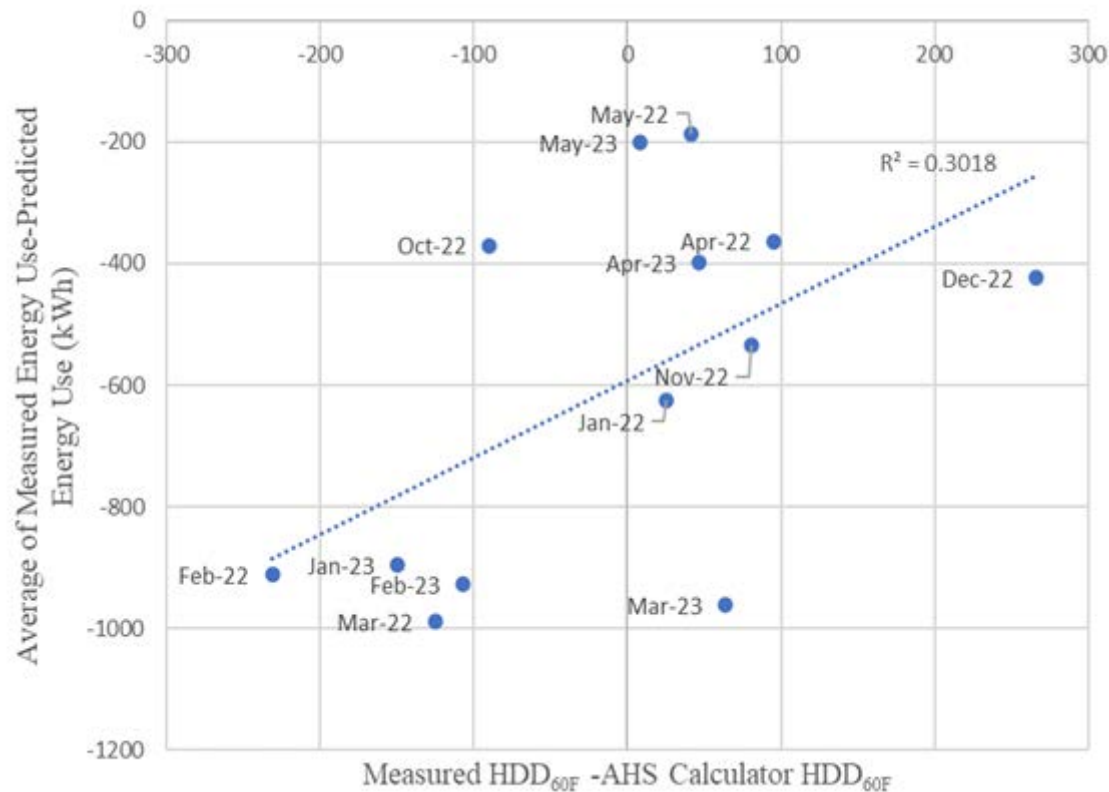


Energy Use

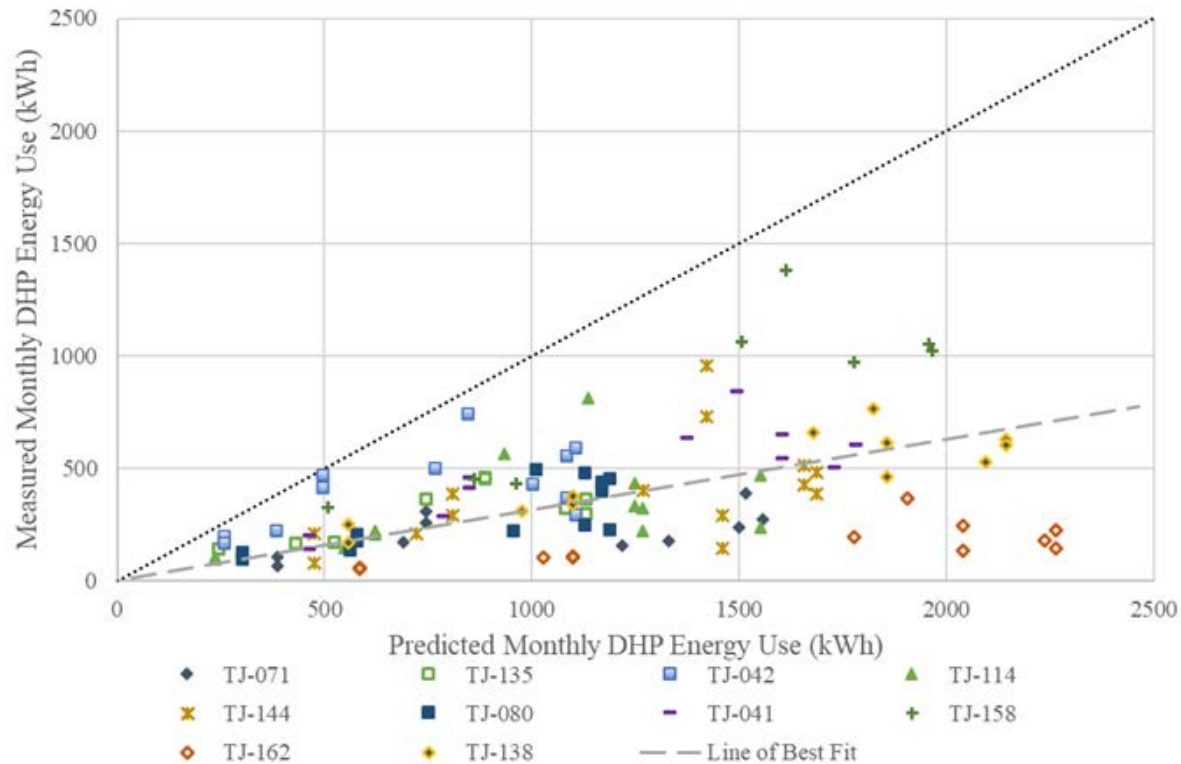
Measured values for heat pump energy consumption lower than predicted values.



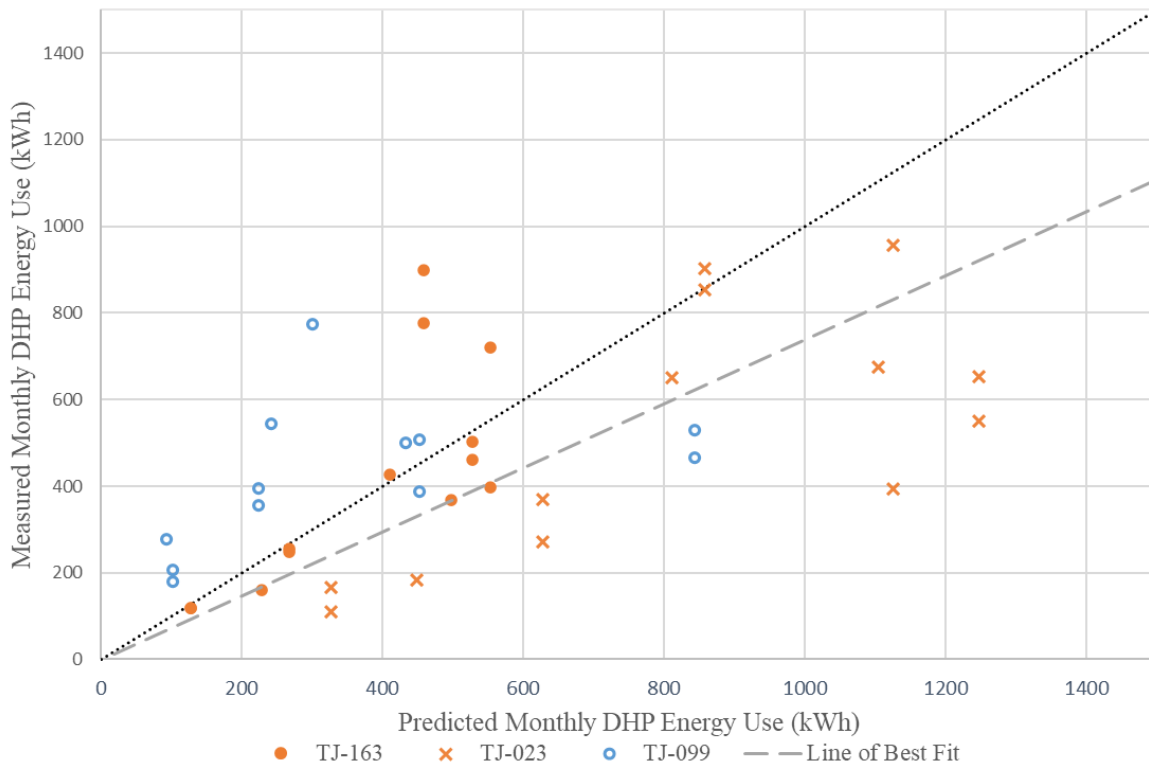
Heating degree days were examined to rule out warmer than average temperatures.



Households with a DHP and non-electric fuel for heating.

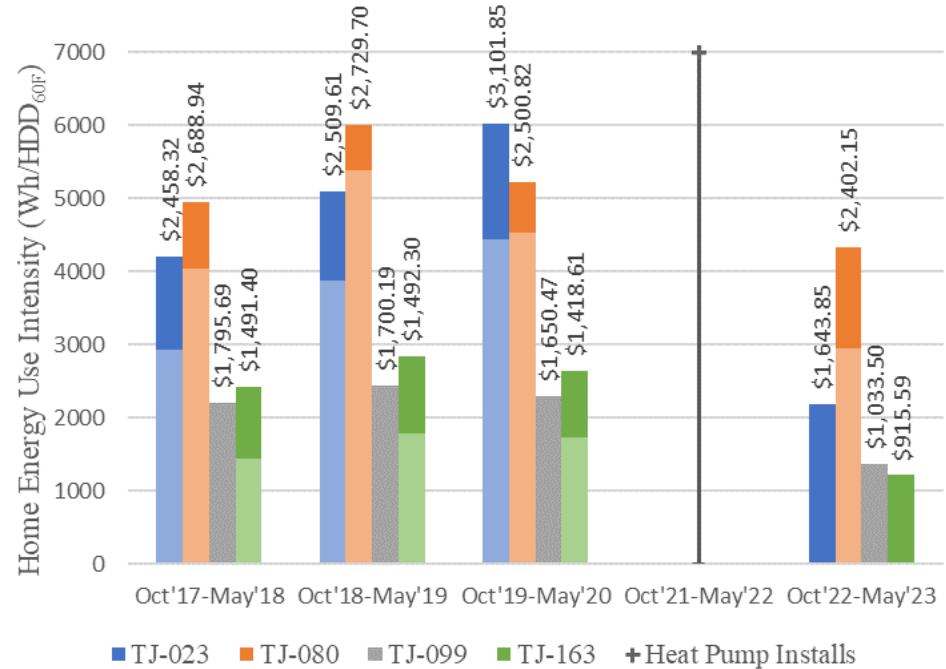


Households with only electric heating sources after DHP installation.



Whole-house energy use pre- and post-DHP installation

- Calculated heating season whole house energy use based on utility bills.
- Four participants provided reliable utility bills for the entire period
- Energy use was normalized per 1,000 HDD



Sense Meter Reliability

Analysis of the Laboratory Evaluation Results

Heat Pump	Total Energy (kWh)		Percent Difference
	Sense Meter	WattNode	
Fujitsu RLS3H	6.41	6.25	2.61%
Daikin LV	5.11	5.00	2.15%
Panasonic Exterios	4.82	4.74	1.63%
Daikin Aurora	8.28	8.06	2.80%
TOTAL	24.62	24.05	2.38%

- Sense meter evaluated in the lab with different heat pumps and compared to a WattNode WNB-3Y-208P connected to a Campbell Scientific CR1000X
- Researchers compared readings between Sense and TWACS data in homes with both.
 - 6 homes total
 - 1 sense meter didn't identify the DHP
 - 4 had minor inconsistencies
 - 1 had severe variations

Conclusion

- 14 DHPs operated reliably through two heating seasons
- Only 1 of the 14 monitored DHPs experienced a maintenance issue
- The four homes saw annual energy use and cost decreases
- Sense meters provided reliable energy use data in lab as well as field



References

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Juneau Empire. (2018, February 12). City sets goal to be 80 percent renewable by 2045. Juneau Empire. Retrieved October 16, 2021. Available at: <https://www.juneauempire.com/news/city-sets-goal-to-be-80-percentrenewable-by-2045>

Q & A

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