Heat Pump Research Updates from Alaska

Vanessa Stevens
Alaska Center for Appropriate Technology
Heat Pumps in Alaska
January 16, 2025

Members of the NREL Alaska campus work throughout the traditional territories of the Indigenous Peoples of Alaska. Our research center is on the homeland of the Lower Tanana Dene Athabaskans. We thank and respect the First Alaskans for their ancestral and present land stewardship and place-based knowledge.

Contents

NREL at-a-Glance

2,926

Workforce, including

219 postdoctoral researchers

60 graduate students

81 undergraduate students

World-class

facilities, renowned technology experts

More than 900

Partnerships

with industry, academia, and government

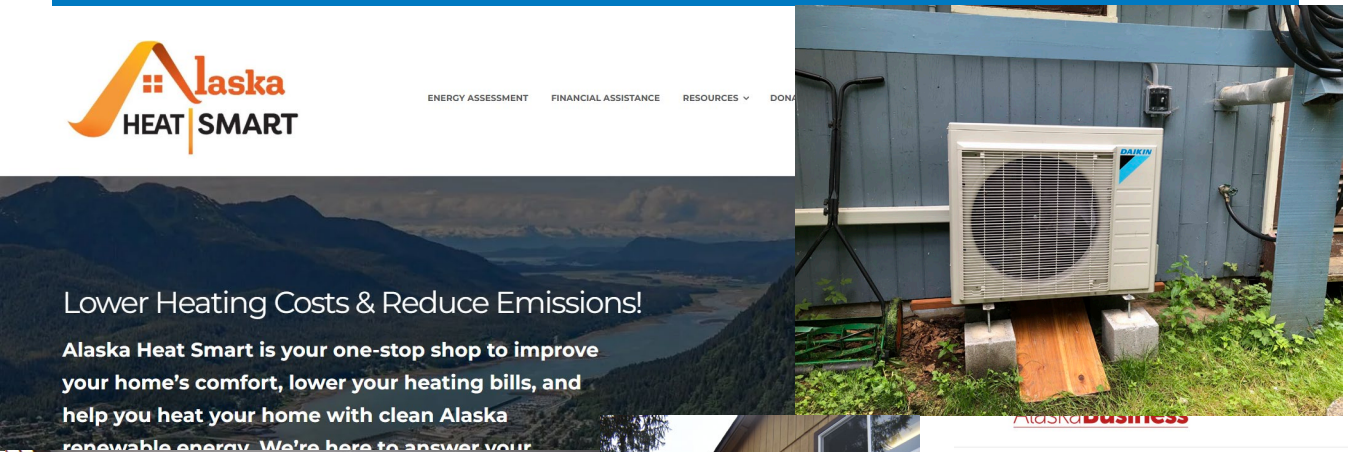
Campus

operates as a living laboratory

Alaska Campus Research Focus Areas

- Air and ground source heat pumps
- Biomass technologies
- Building envelopes and foundations
- Combustion safety
- Energy-water nexus
- HVAC optimization
- IAQ and moisture
- Net zero-ready buildings in cold climates
- Permafrost and building performance
- Renewable electricity to thermal storage
- Social Science Research
- Technoeconomic analyses
- Water and wastewater
- Weatherization

Heat pumps are here!



News

Federal grant to bring heat pumps to households, solar energy to villages in Northwest Arctic

By Alena Nalden
Published: March 5, 2024

Under a newly announced federal grant, every household in the Northwest Arctic Borough would receive a heat pump to alleviate the cost of energy, and every village in the region would have a solar energy system — and an additional source of revenue.

In late February, the U.S. Department of Energy awarded rural and remote communities across the country funds to lower energy costs and support the deployment of clean energy. The Northwest Arctic Borough is receiving around $55 million, with grants funded by the 2021 federal infrastructure law.

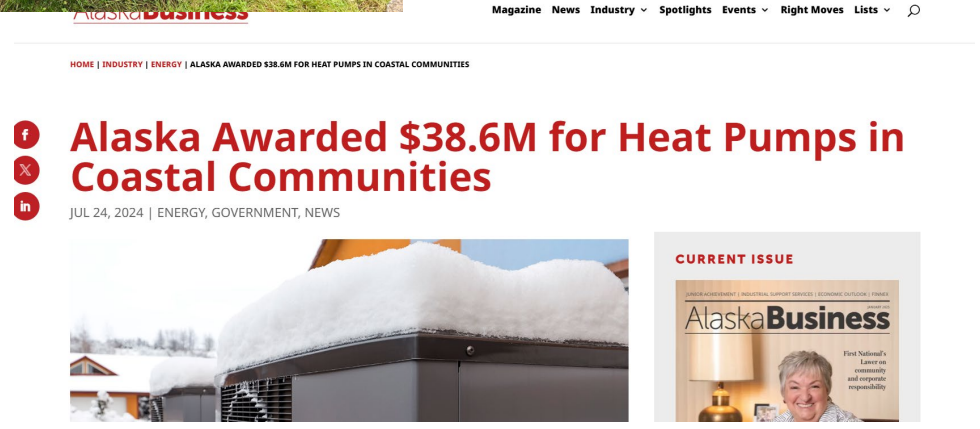


Image credits and screen shots by NREL staff.

At NREL, we evaluate heat pumps using both a climate chamber and the outdoor Fairbanks environment.

Image credits NREL staff.

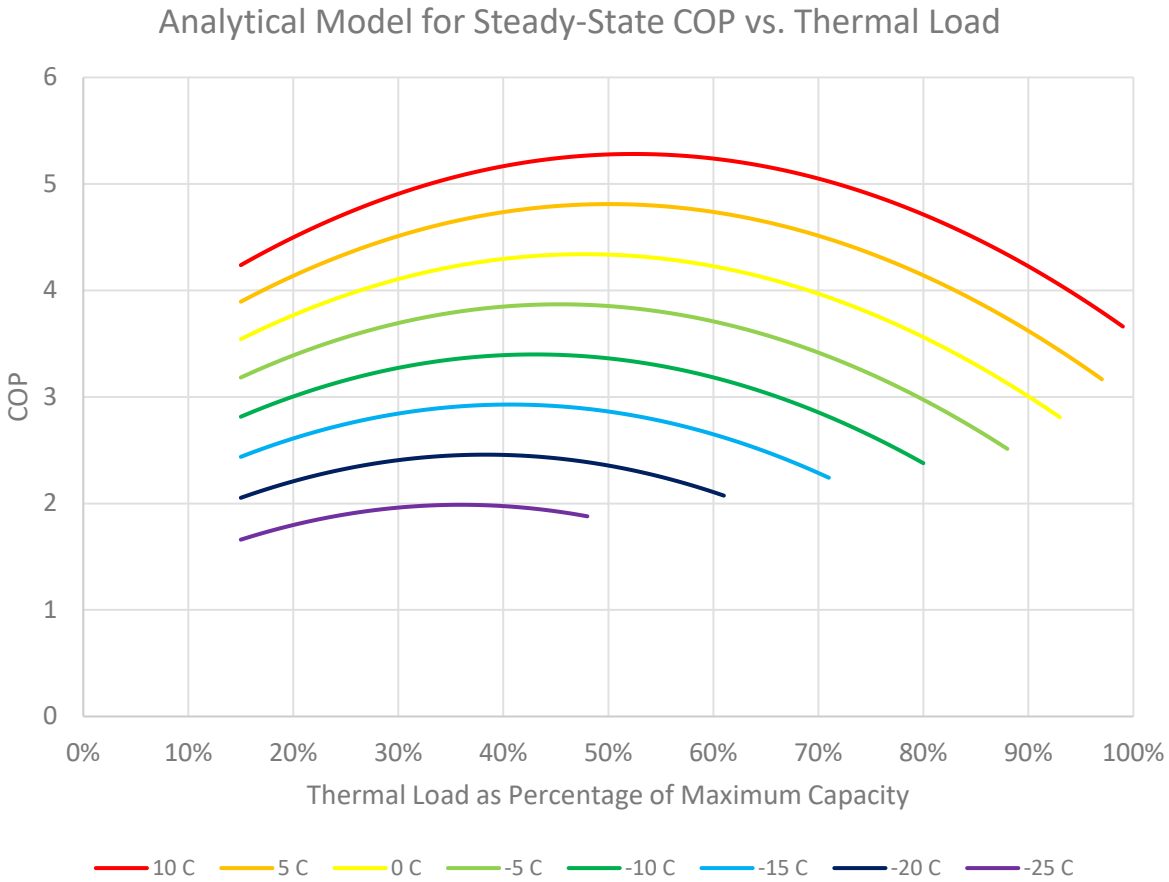
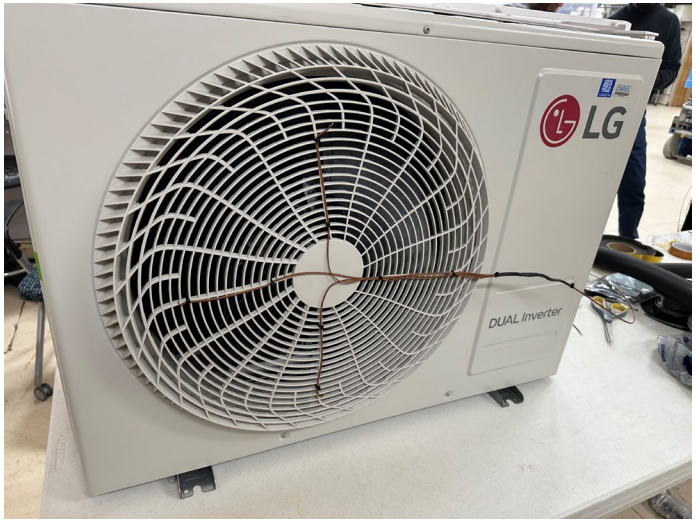

Analytical Model for Steady-State COP vs. Thermal Load
COP
0
1
2
3
4
5
6
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Thermal Load as Percentage of Maximum Capacity
10 C
5 C
0 C
-5 C
-10 C
-15 C
-20 C
-25 C

Image credits NREL staff.

Northwest Arctic Borough Install Testing



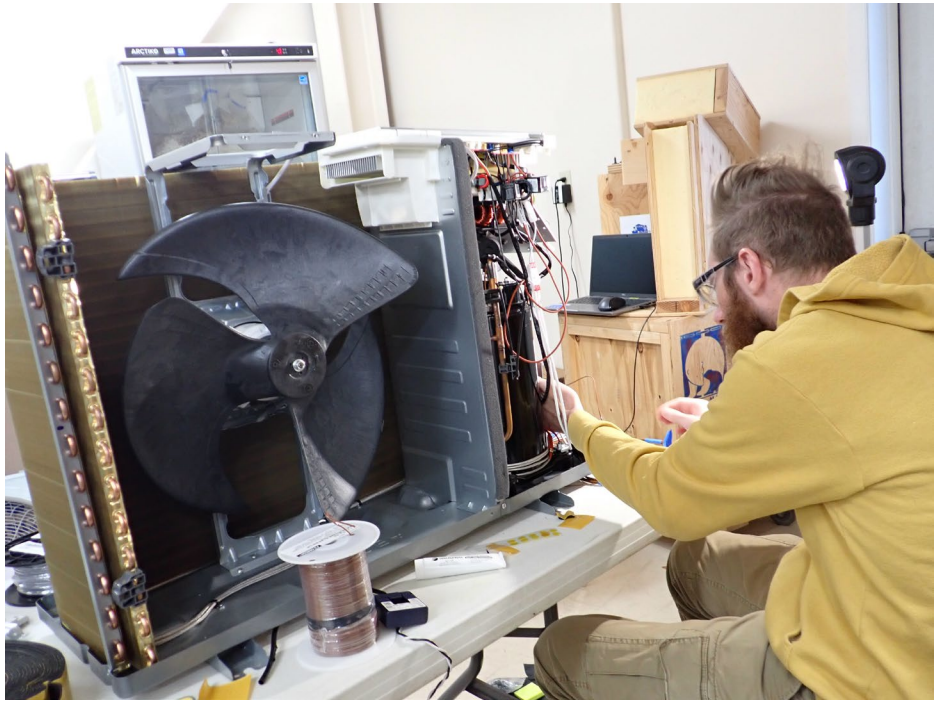


Image credits NREL staff.

Software Improvements

- Base pan heater controls

- Defrost frequency

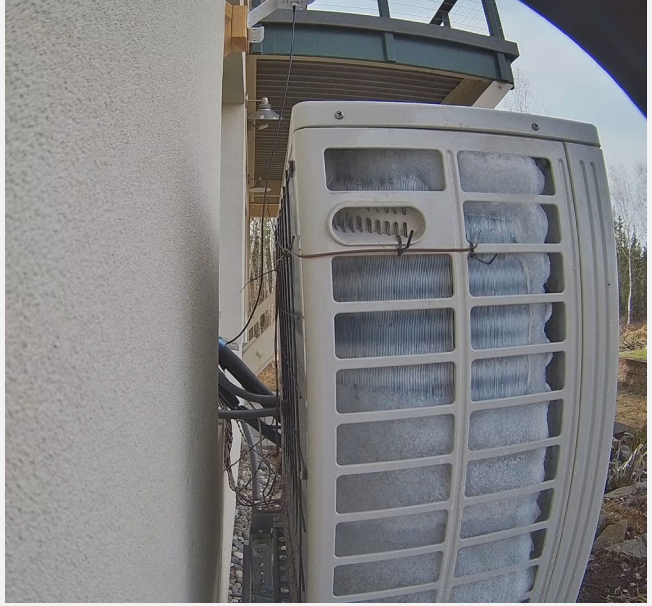
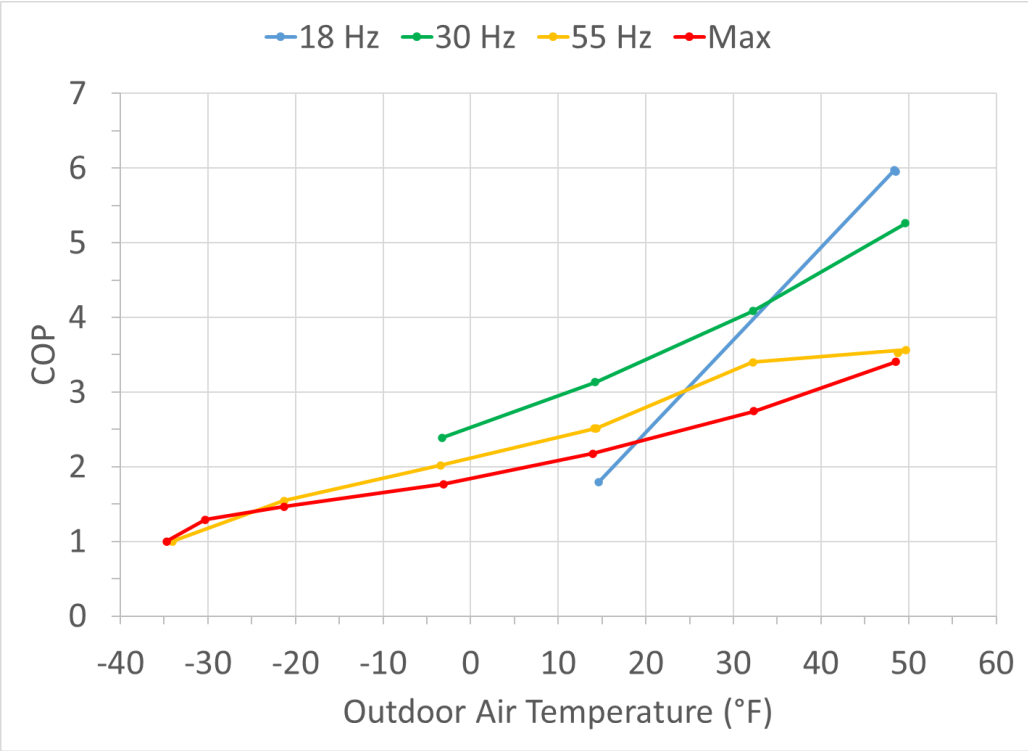


Photo credits NREL staff

Chamber Testing Observations

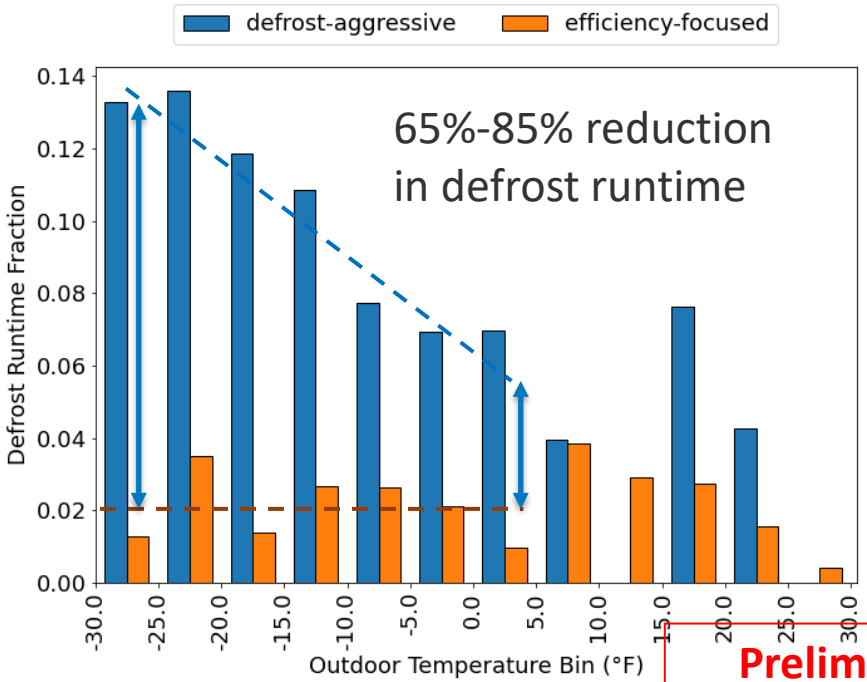
- Generally good COPs and capacity retention.
- COP above 1 down to –35°F.
- 12,000 Btu/h capacity @ –12°F.
- Frequency of defrosts increased at lower temperatures despite dry conditions in chamber.
- 260 W drain pan heater ran 50% of time @ 14°F and 33% of time below –4°F.

Preliminary Results

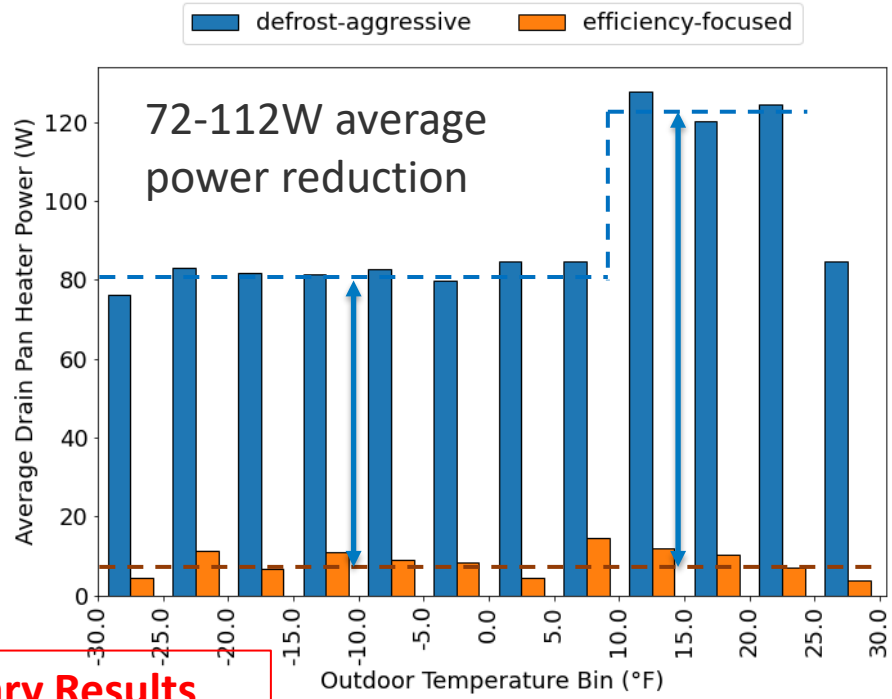


Software Impacts on Defrost and Drain Pan Heater Operation

4-hour minimum runtime between defrosts



Drain pan heater runs only during defrost and the 5 minutes following

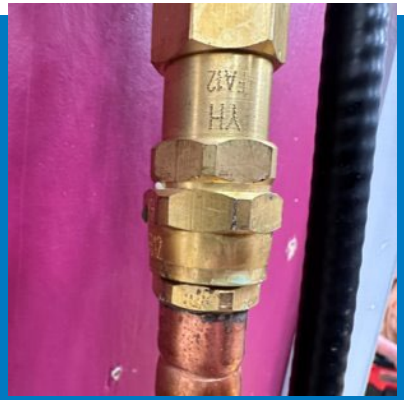


Preliminary Results

Another area of research is focused on improving how easy heat pumps are to install.

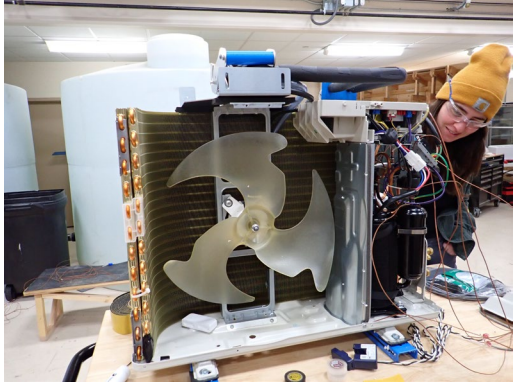
Image credits NREL staff.

MRCOOL



- DIY installation
- Refrigerant leak detection system

Photo credits NREL staff



EcoSnap

- DIY installation
- Wall spacing
- Refrigerant leakage
- Cold temperature installations

Photo credits NREL staff

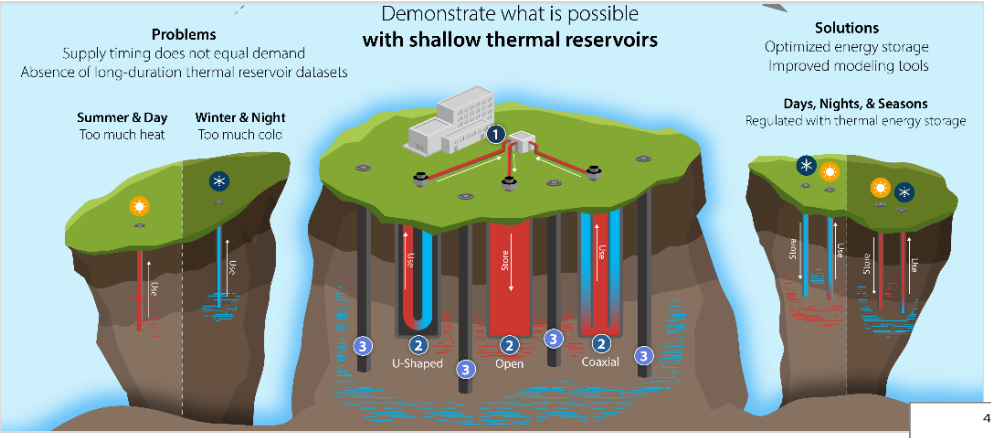
What is next?

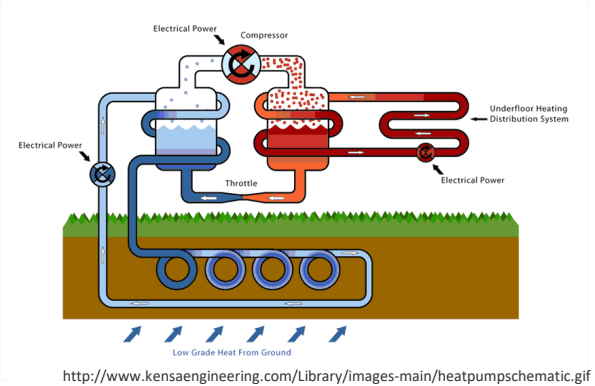
- New refrigerants
- No defrost at all?
  Controls OR hydrophobic surfaces
- Integration with other heating systems
- Thermochemical energy storage
- Monoblock air to water systems

Photo credit NREL staff

Geothermal Heat Pumps in Alaska

Geothermal heat pumps take advantage of the large reservoir of energy in the subsurface

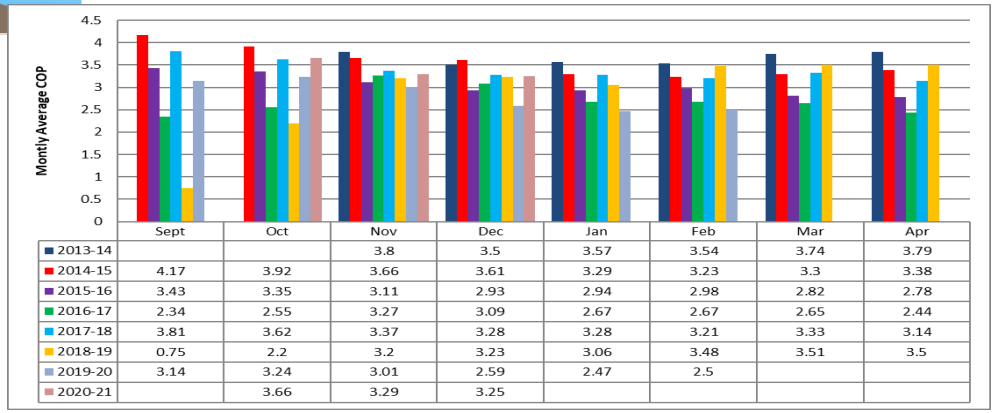




http://www.kensaengineering.com/Library/images-main/heatpumpschematic.gif

The subsurface can act as thermal storage to optimize geothermal in cold soils (NREL is working with the Army to further develop this technology)

Geothermal heat pumps can provide affordable heating and improve grid resilience in Alaska (the CCHRC heat pump has demonstrated high COPs over 8 years).



	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
2013-14			3.8	3.5	3.57	3.54	3.74	3.79
2014-15	4.17	3.92	3.66	3.61	3.29	3.23	3.3	3.38
2015-16	3.43	3.35	3.11	2.93	2.94	2.98	2.82	2.78
2016-17	2.34	2.55	3.27	3.09	2.67	2.67	2.65	2.44
2017-18	3.81	3.62	3.37	3.28	3.28	3.21	3.33	3.14
2018-19	0.75	2.2	3.2	3.23	3.06	3.48	3.51	3.5
2019-20	3.14	3.24	3.01	2.59	2.47	2.5		
2020-21		3.66	3.29	3.25				

Resources

Department of Energy (general information):
https://www.energy.gov/energysaver/heat-pump-systems
Alaska Heat Smart (FAQs, programs, rebates):
https://akheatsmart.org/heat-pumps/
CCHRC youtube (recordings of presentations on heat pumps and other topics):
https://www.youtube.com/@ColdClimateHousing
Alaska Heat Pump Calculator:
https://heatpump.analysisnorth.com/
NEEP Cold Climate ASHP List:
https://ashp.neep.org/#!/product_list/
ASHP Sizing and Selection Toolkit (from Canada):
https://natural-resources.canada.ca/maps-tools-and-publications/tools/modelling-tools/toolkit-for-air-source-heat-pump-sizing-and-selection/23558
NEEA Cold Climate Heat Pump Recommendations:
https://neea.org/img/documents/NEEA-Cold-Climate-DHP-Spec-and-Recommendations.pdf

Thank you

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Publication #

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