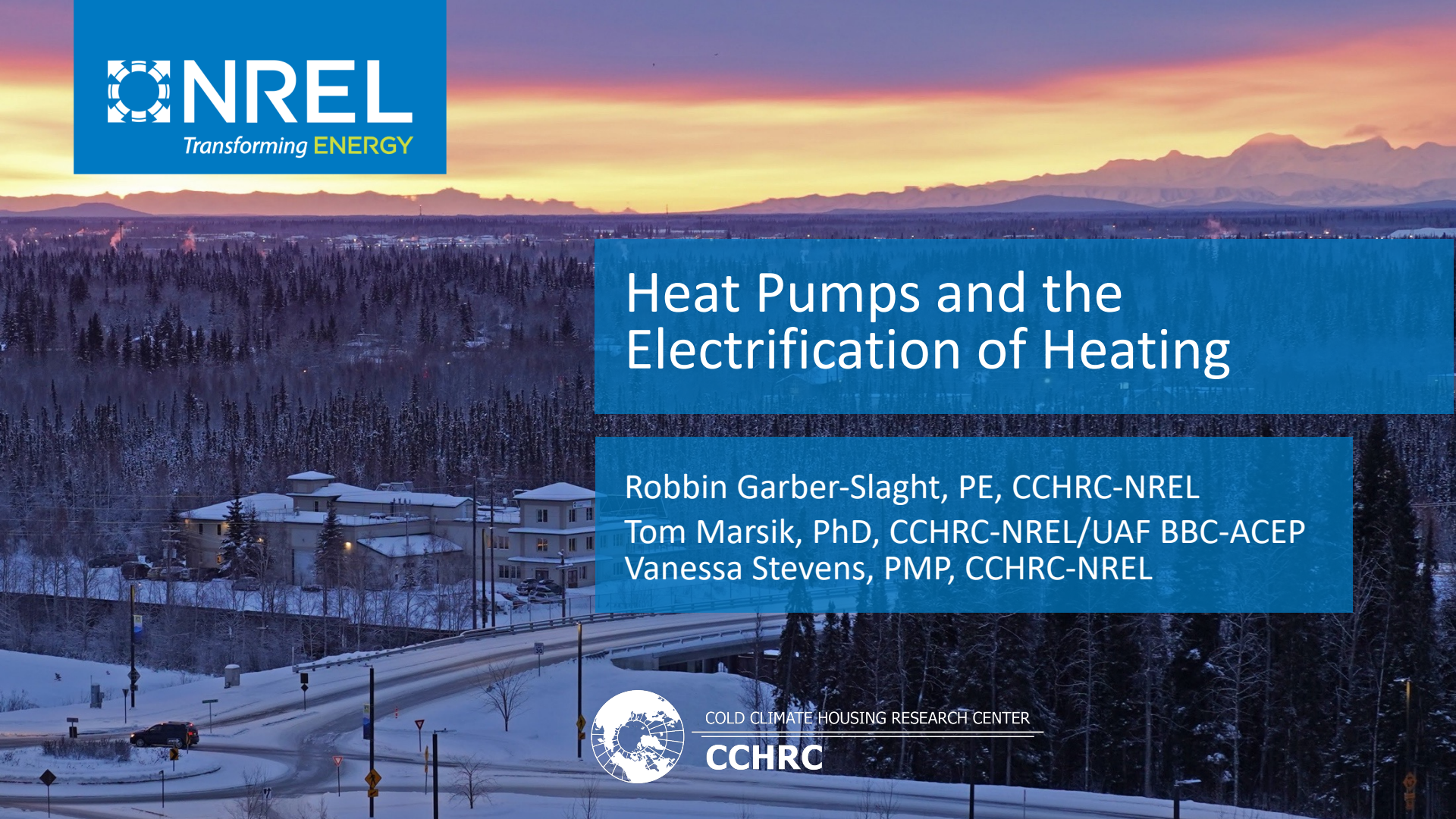

Heat Pumps and the Electrification of Heating

Robbin Garber-Slaght, PE, CCHRC-NREL
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COLD CLIMATE HOUSING RESEARCH CENTER
CCHRC

Advantages of Heat Pumps

- Low maintenance
- No local combustion
- Partially renewable (partially grid tied)
- Potential for lower energy costs
- "Efficiencies" over 100%

Image: Tlingit Haida Regional Housing Authority

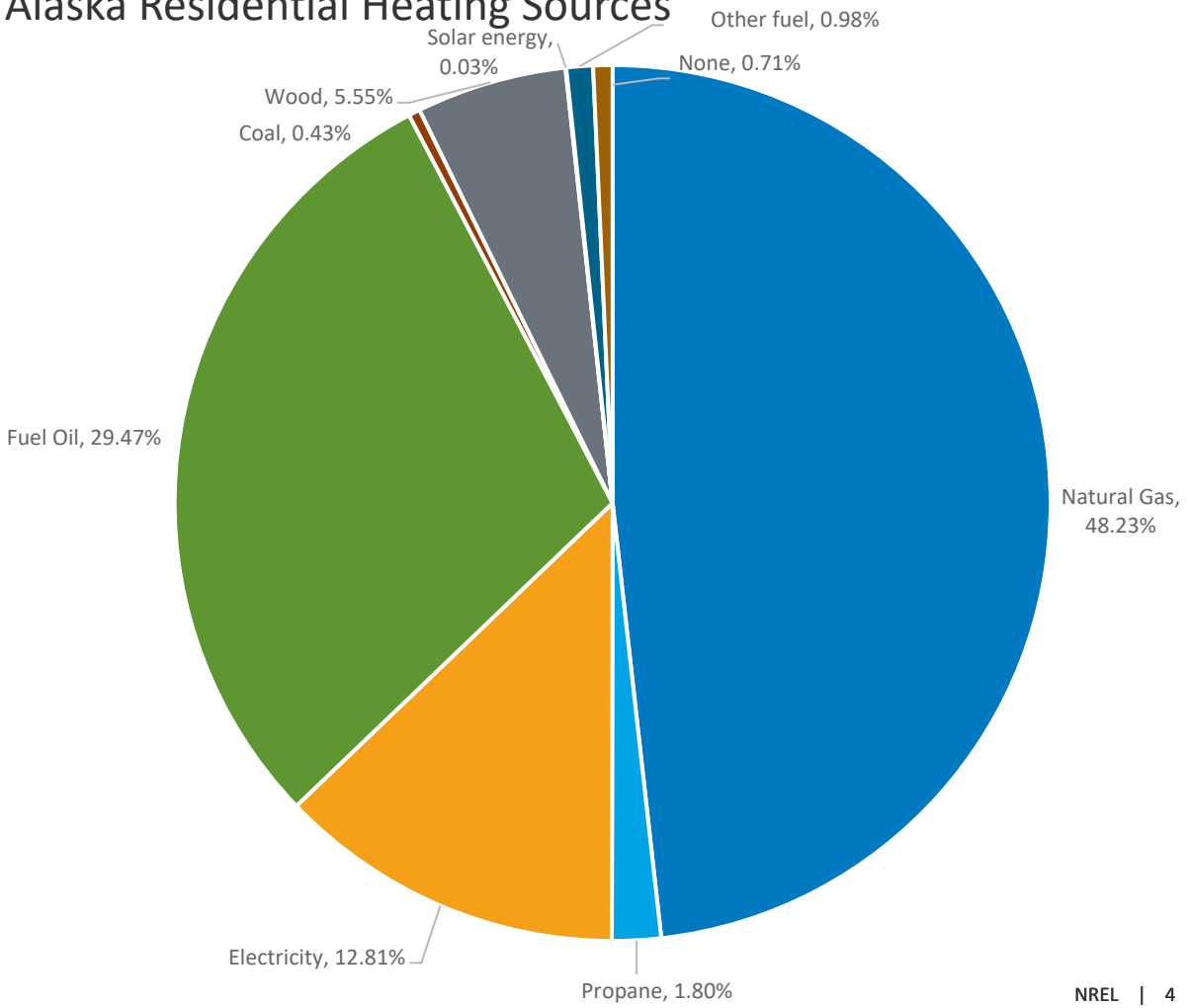
Energy for Space Conditioning

- Space cooling is almost always supplied by electricity
- Space heating is a building energy load usually outside of electrical load

Photo: CCHRC Inc, Molly Rettig

Heating Energy - Alaska

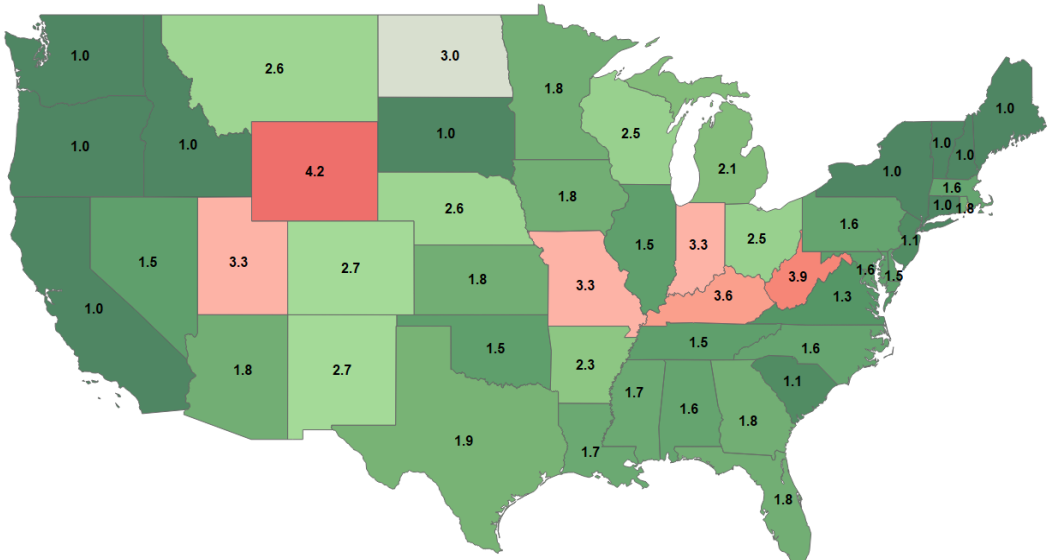
- 70 to 80% of building energy load in Alaska is heating!
- About 81% of residential heating is supplied via on-site combustion of fossil fuels



Data Sources:
Wiltse, Nathan, Dustin Madden, and By Valentine. "Energy Efficiency Of Public Buildings In Alaska Metrics And Analysis." Cold Climate Housing Research Center, 2014. http://cchrc.org/media/Energy_Efficiency_of_Public_Buildings_in_Alaska_Metrics_and_Analysis.pdf.
"DP04: SELECTED HOUSING CHARACTERISTICS - Census Bureau Table." Accessed July 25, 2022. https://data.census.gov/cedsci/table?q=dp02,dp04,B22010,B17017&g=0400000US02&y=2019

Carbon and Energy Cost Impacts of Electrification of Space Heating with Heat Pumps in the US

With current grid technology how does electrification using air source heat pumps compare to natural gas furnaces?



Minimum seasonal heat pump COP required for CO2e neutrality in each US state, compared with an 80% AFUE natural gas furnace.

Graphic from: Walker, Iain, Brennan Less, Nuria Casquero-Modrego, and Nuria Casquero-Modrego. "Carbon and Energy Cost Impacts of Electrification of Space Heating with Heat Pumps in the US," 2022. https://doi.org/DOI: 10.1016/j.enbuild.2022.111910.

Walker, Iain, Brennan Less, Nuria Casquero-Modrego, and Nuria Casquero-Modrego. "Carbon and Energy Cost Impacts of Electrification of Space Heating with Heat Pumps in the US," 2022. https://doi.org/DOI: 10.1016/j.enbuild.2022.111910.

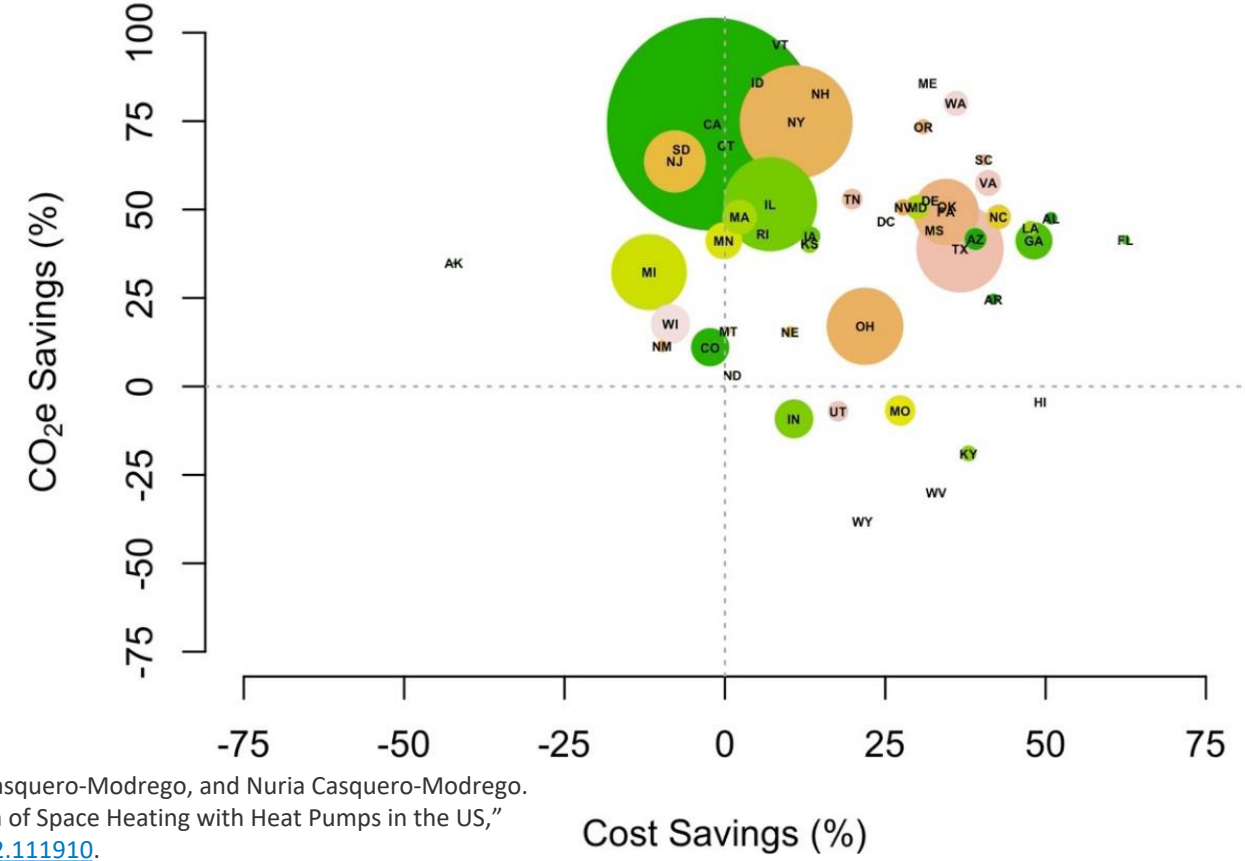
Impacts of the Replacement of Gas Furnaces with Heat Pumps

Percent savings for CO2e and energy cost in each US state, when replacing a 80% AFUE furnace with a seasonal COP 3 heat pump.

Heat pumps can significantly reduce CO2e depending on the grid (coal states do not do well)

While Alaska achieves some CO2e savings, there is significant extra consumer cost

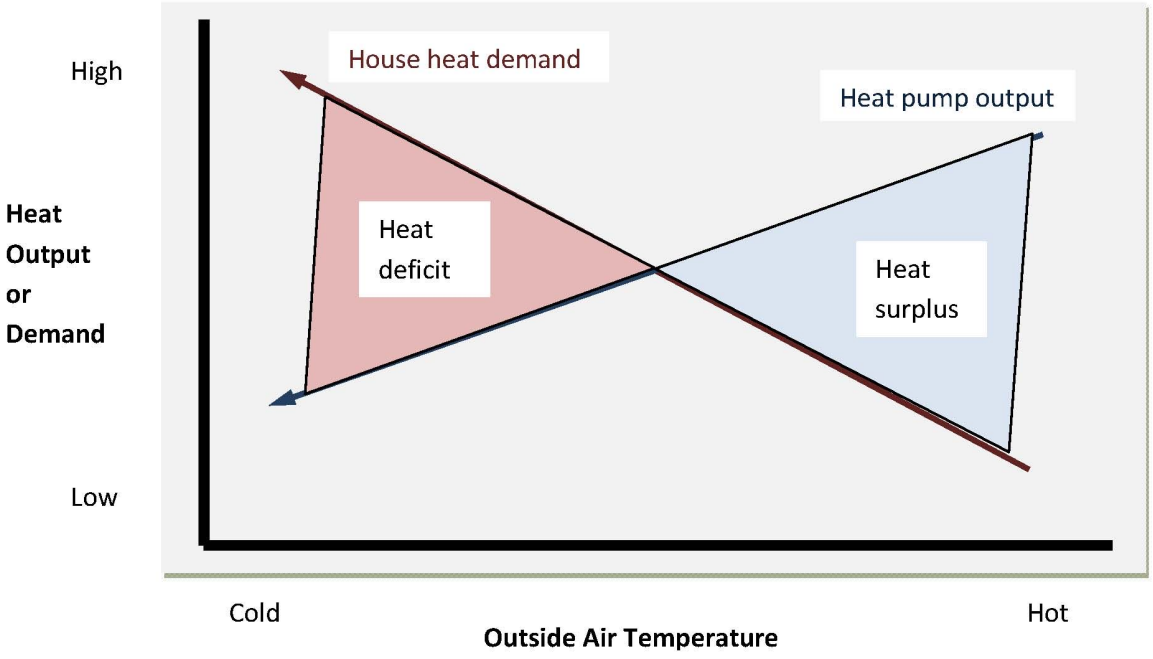
Hawaii has a CO2e negative impact and high consumer savings, cooling is not factored into this study



Graphic from: Walker, Iain, Brennan Less, Nuria Casquero-Modrego, and Nuria Casquero-Modrego. "Carbon and Energy Cost Impacts of Electrification of Space Heating with Heat Pumps in the US," 2022. https://doi.org/DOI: 10.1016/j.enbuild.2022.111910.

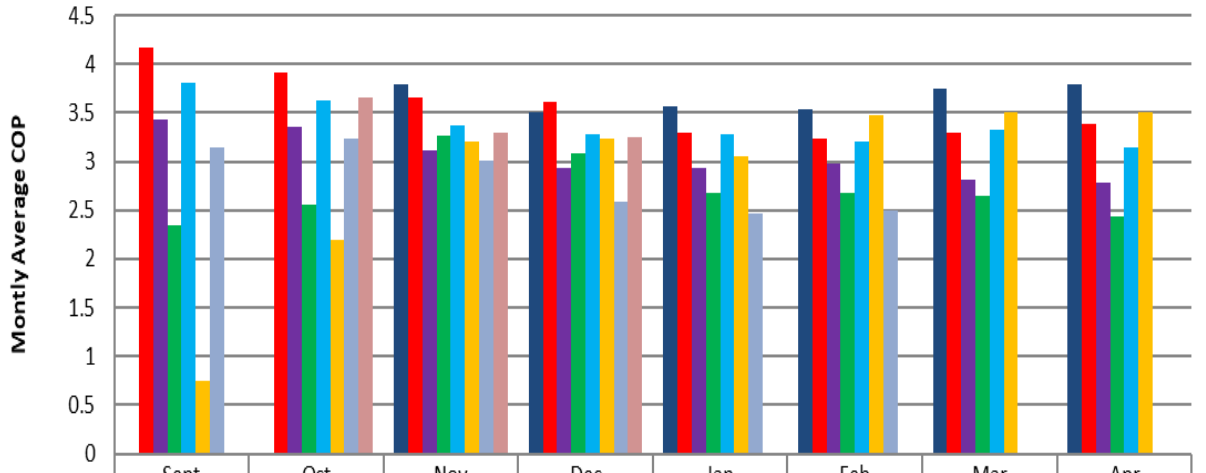
Air-Source Heat Pumps challenges:

- Heat output and efficiency degrade with colder temperatures
- Need a backup heat source in cold climates
- Outside air cutoff temperature (-18C)
- Defrost cycles lower efficiency
- Low temperature delivery makes retrofits of boiler systems difficult



Ground-Source Heat Pumps challenges:

- Efficiency degrades with colder ground temperatures
- High installation costs
- Low temperature delivery makes retrofits of boiler systems difficult



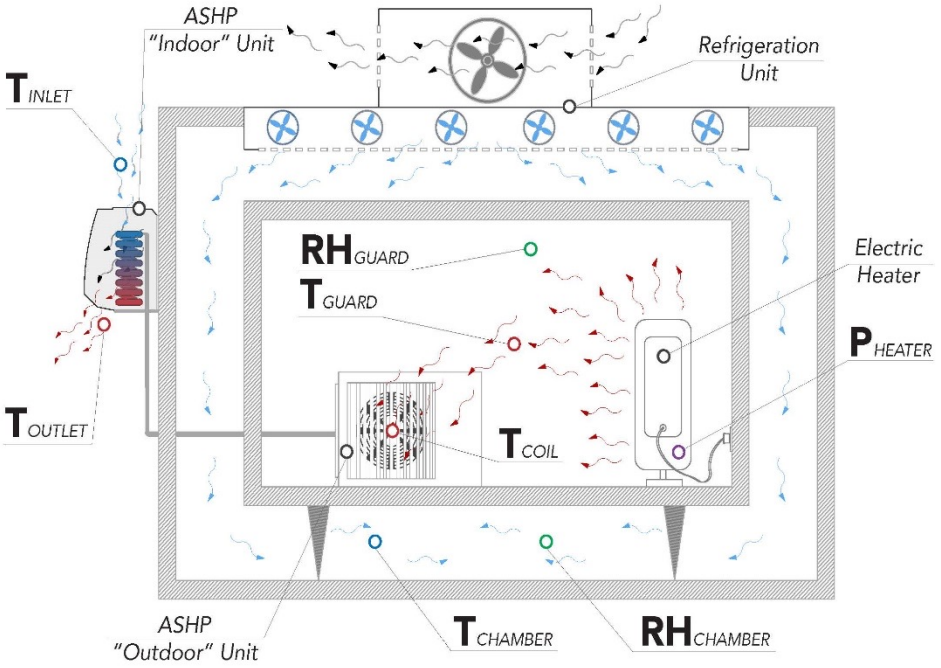
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
2013-14			3.8	3.5	3.57	3.54	3.74	3.79
2014-15	4.17	3.92	3.66	3.61	3.29	3.23	3.3	3.38
2015-16	3.43	3.35	3.11	2.93	2.94	2.98	2.82	2.78
2016-17	2.34	2.55	3.27	3.09	2.67	2.67	2.65	2.44
2017-18	3.81	3.62	3.37	3.28	3.28	3.21	3.33	3.14
2018-19	0.75	2.2	3.2	3.23	3.06	3.48	3.51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

Demonstration GSHP efficiency in Fairbanks, Alaska

Current NREL Research

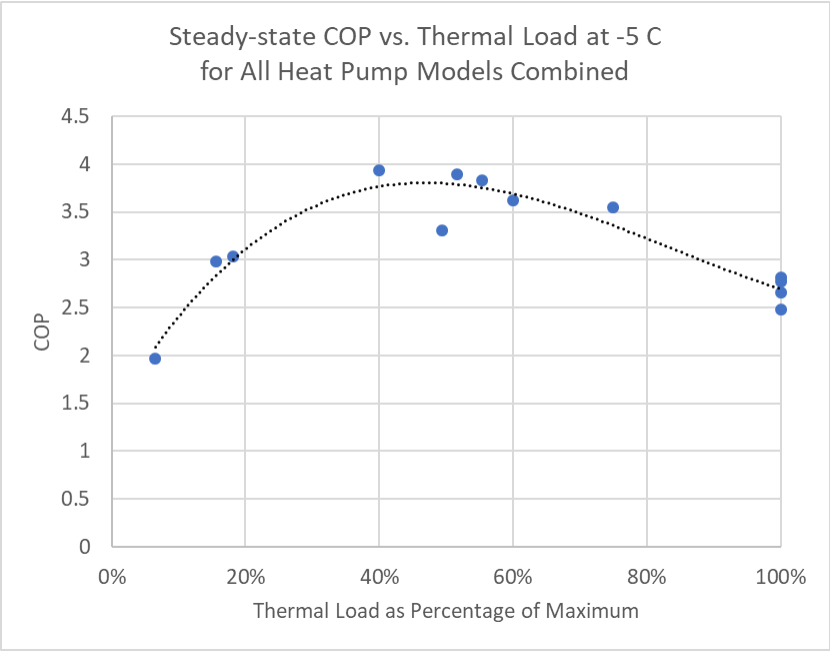
Evaluating ASHP performance at different levels of thermal loading

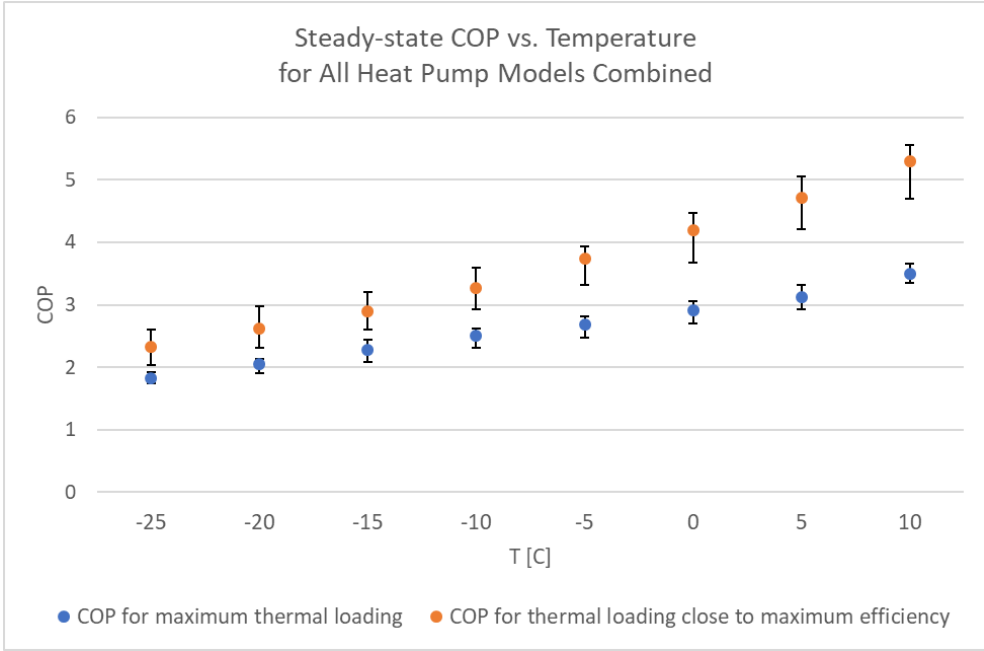
Image: NREL



Current NREL Research

Evaluating ASHP performance at different levels of thermal loading





Current NREL Research

Oak Ridge National Lab study

- Evaluating a ducted air source heat pump prototype for cold climates in Fairbanks
- CCHRC first studied an ORNL heat pump in 2017; it operated efficiently at -30°F
- This new cold climate heat pump is designed to operate efficiently down to -10°F and lower
- This prototype is close to market ready

Image: NREL

Current NREL Research

Developed by **Alaska Heat Smart, Renewable Juneau**, and **AEL&P** and the first of its kind in Alaska, the **THERMALIZE JUNEAU** pilot program seeks to:

- **INSTALL** ductless heat pumps in participating Juneau homes and businesses
- **IMPROVE** energy efficiency of participating Juneau homes and businesses
- **GROW** and support local clean energy jobs
- **PIONEER** a repeatable framework for other communities to try!

Current NREL Research

Currently in the second year of the project:

- 40 complete ductless heat pump installations
- 3 home retrofits complete
- 79 home audits completed, with 1 to go
- 3 post audits lined up
- Workforce development classes completed for realtors (6 attendees) and builders/homeowners (41 attendees)

THERMALIZE JUNEAU

Image: Alaska Heat Smart.

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Thank you

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Transforming ENERGY

What is a heat pump?

Air source heat pumps **use outside air as their energy source.**

Ground source heat pumps **use the ground or bodies of water as their energy sources**

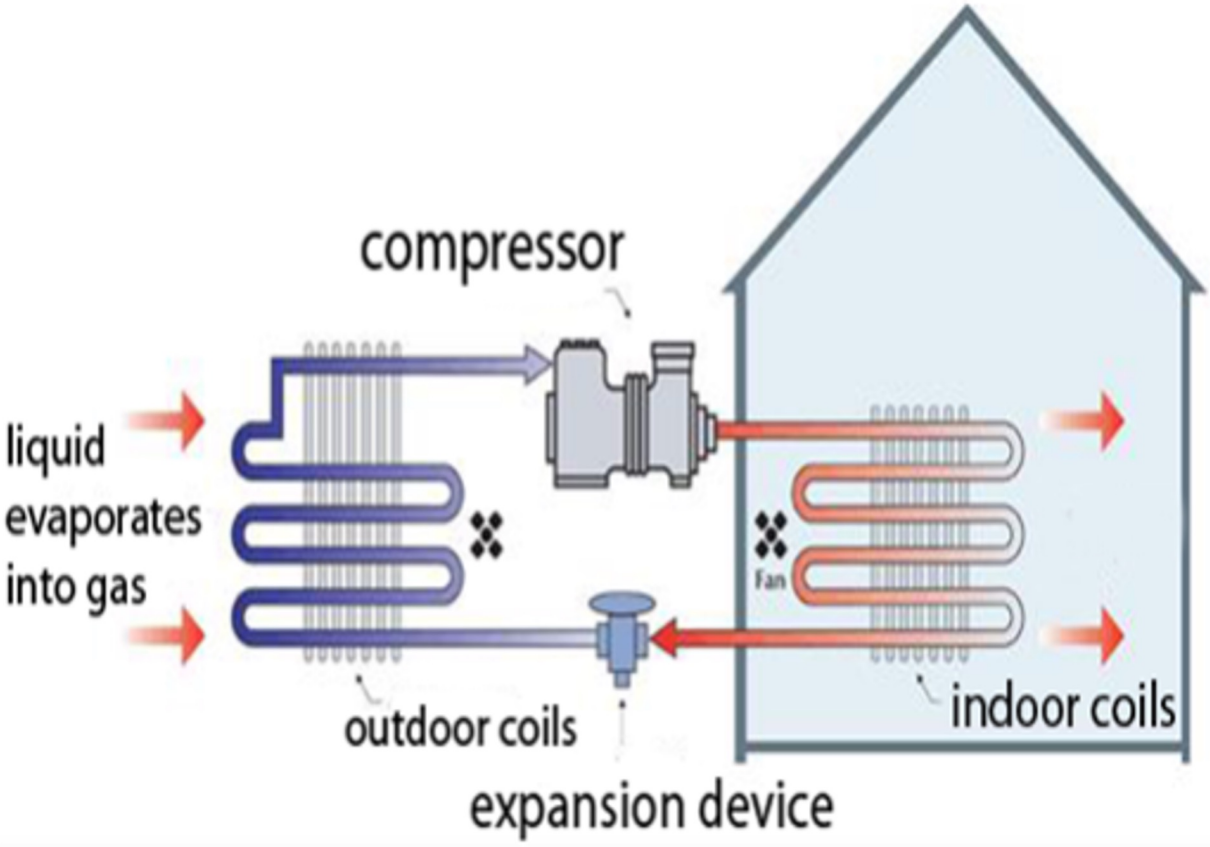

Image: RETSCREEN