Heat pumps in Alaska

House Energy Committee
4/3/25

Michelle Wilber, Grid Edge Research Lead
Dr. Tom Marsik, Professor of Sustainable Energy

ACEP
Alaska Center for Energy and Power

UAF
UNIVERSITY OF ALASKA FAIRBANKS

ACEP

Alaska Center for Energy and Power

Our Mission: Develop and disseminate practical, cost-effective and innovative energy solutions for Alaska and beyond.

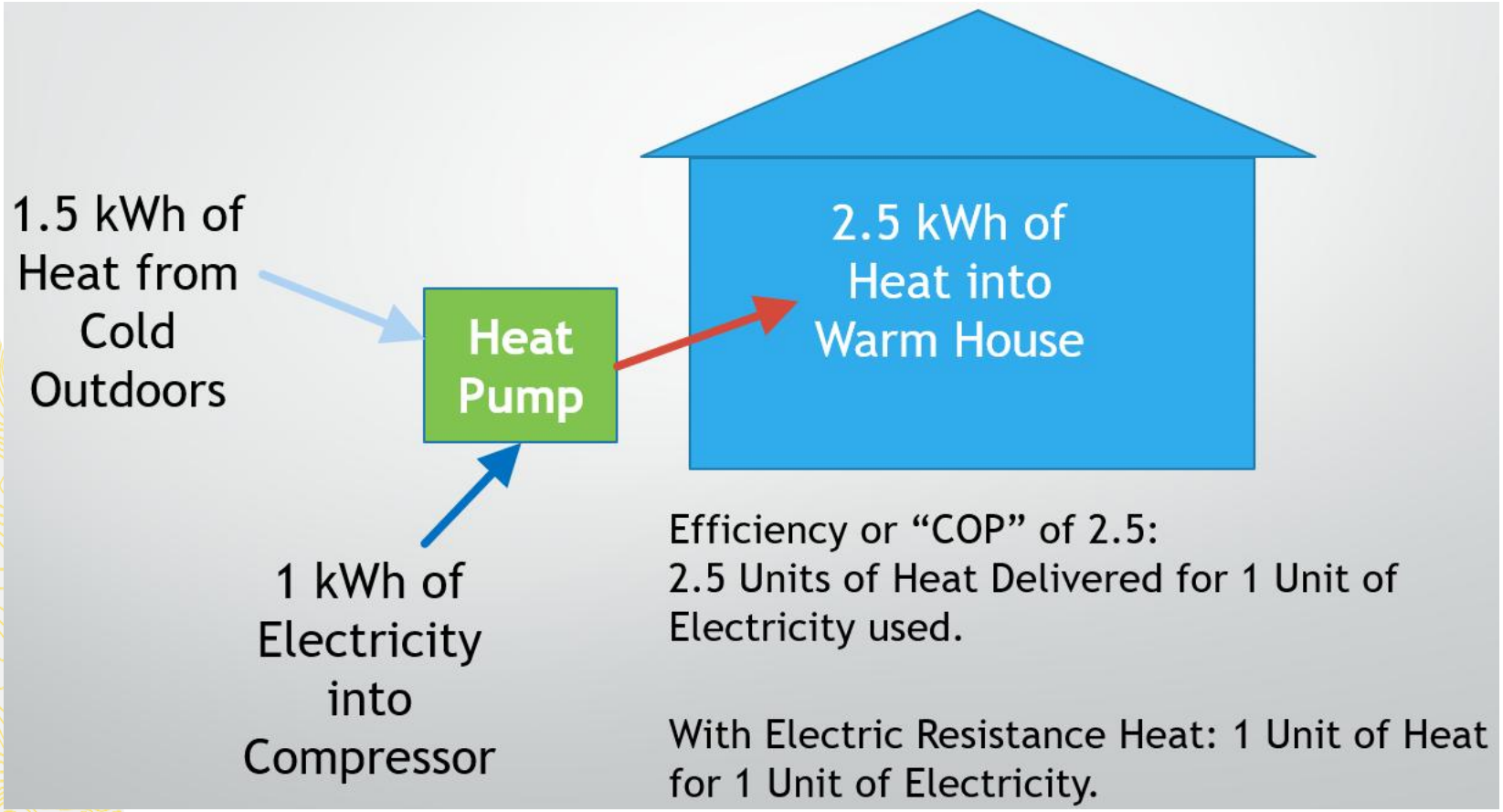
Our Vision: Alaska leading the way in innovative production, distribution, and management of energy.

Asked to touch on:

- Hurdles in front of those wishing to convert to heat pumps
  - Availability of techs for install and maintenance
  - Limitations on local electricity systems that would preclude rapid expansion
- Adaptation and implementation with current heating setups
- Reliability and limitations
- Energy demands and efficiency of heat pumps as an electrified heat source

A Heat Pump is an Efficient Electric Heater

Can Move Heat from the Cold Outdoors to a Warm Home



COP = Coefficient of Performance

ACEP Alaska Center for Energy and Power

UAF University of Alaska Fairbanks

Mini-Split Heat Pump: Outdoor & Indoor Unit

$5,000 and up - Installed, single indoor head.

Mini-Split Heat Pumps

Pros

- Less Expensive to Run than Electric, Propane and Oil Heat
- No Fuel Storage and Handling
- No Combustion in your House
- Low Maintenance
- 2 - 3 x more efficient than Conventional Electric Heat
- Can Provide Air Conditioning

Cons

- $5,000+ Cost, Single Head
- No Domestic Hot Water
- Limited Heat Distribution. Multiple Heads = $$, less effic.
- Reduced Output and Efficiency at Cold Outdoor Temperatures
- May need to upgrade electrical systems
- Not cost effective compared to natural gas in Southcentral at current electric rate structures

Other considerations for individual and community scale deployment: back up heating? Dispatchability? Rates - PCE, incentive rates, etc?

ACEP
Alaska Center for Energy and Power

UAF UNIVERSITY OF ALASKA FAIRBANKS

Availability of techs for install and maintenance

- HEA did do a $500 to installers, $500 to homeowners rebate. Data so far is that we went from 1 to 7 installers (E. Mckittrick)

- “Any refrigeration person who can install and repair an ice-maker or refrigeration unit can install a heat pump - if they wanted to. The refrigeration side of installing a heat pump is simple enough. Most of the labor goes into more carpentry work of building stands, drilling holes, etc.. Somewhat labor intensive.” (P. Kaluza)

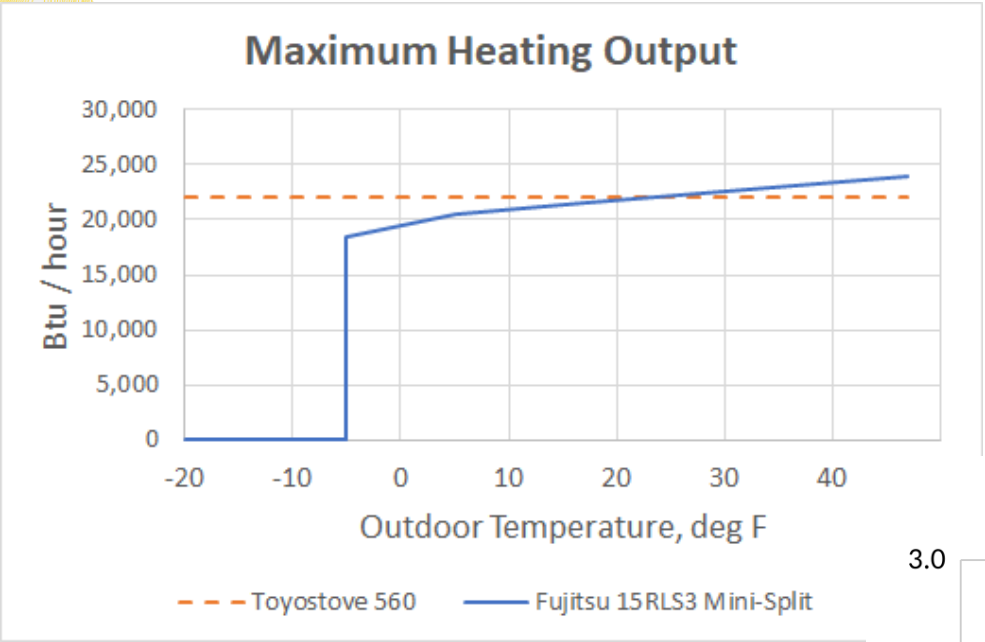
Limitations on local electricity systems that would preclude rapid expansion

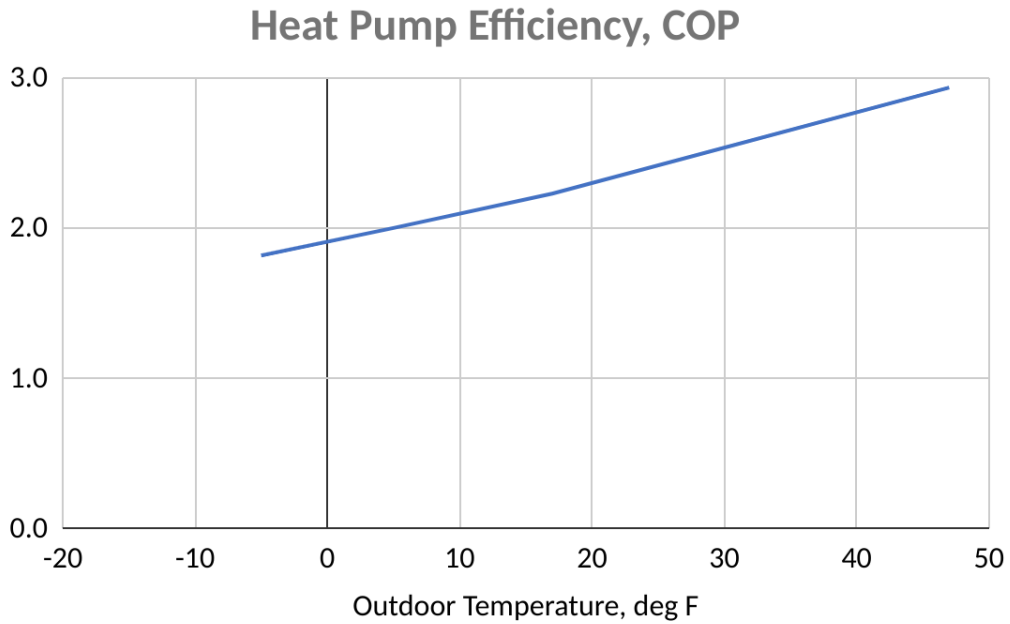
- On railbelt, near term issues will be at the building service level
- Rural microgrids may need to be aware of generation constraints as well as distribution constraints
- By increasing load there is more space for adding renewables in the future, decreases natural gas use even more

Adaptation and implementation with current heating setups

- Many types of heat pumps (air-to-water, centralized air source, etc) but most cost effective is mini-splits
- Automatic integration with existing systems is a challenge - generally requires homeowner to manually turn heat pump off when back-up heating is preferred - this is an active area of research

Reliability and limitations: Output and Efficiency affected by Outdoor Temperature





ACEP
Alaska Center for Energy and Power

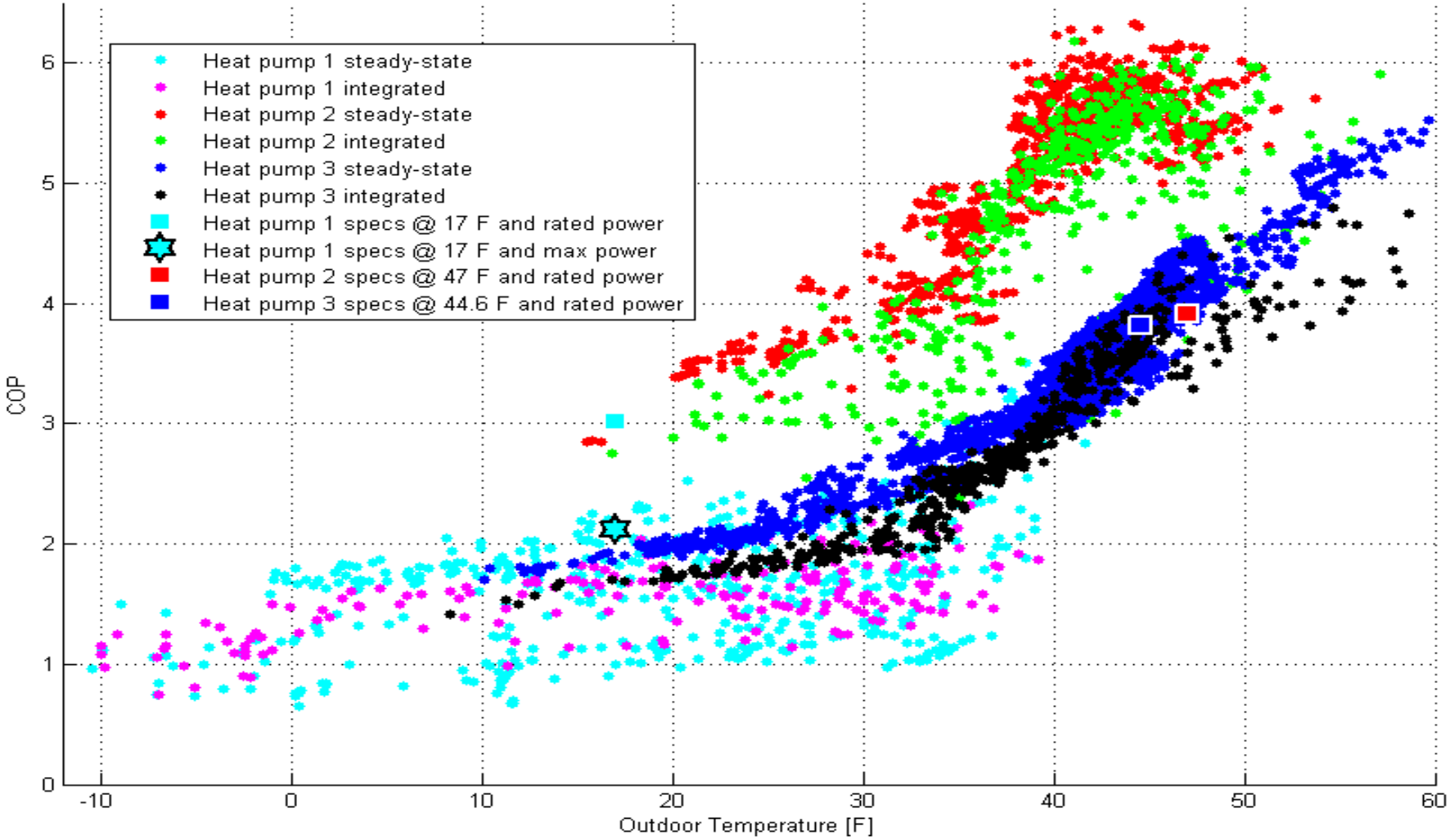
Energy demands and efficiency of heat pumps as an electrified heat source For Southcentral Alaska:

- A heating season **COP of 2 is break even** in gas usage with an 80% efficient gas heating system (weighted average of power pool gas generation plants is 7.96 MCF/MWh - E. Mckittrick, 5% loss)

- **Actual Air Source Heat Pump seasonal COPs 2.3 - 2.6** in AK (turned off at 5F, some heat pumps in Southcentral could obtain this for full heat load) (https://heatpump.analysisnorth.com/) - leads to 13-20% gas savings for heating

- Save Natural Gas, but don't pencil out economically against natural gas with current rate structures - policy could help!

ASHP detailed monitoring - results



Specification COPs are plotted along with the field-measured COPs to provide a general reference point. However, the field-measured COPs are only representative of product performance under the specific measured conditions and are not comparable to rated product performance.

ACEP Alaska Center for Energy and Power

UAF UNIVERSITY OF ALASKA FAIRBANKS

System approach (heat pump + efficient envelope) achieves biggest savings

Heat pumps can save 13-20% gas, efficiency 30%+ (Home Energy Rebate Program Impacts Report)

Questions?

Thanks to:
NREL
CCHRC
Alan Mitchell, Analysis North
Phil Kaluza
Ingemar Mathiasson, Northwest Arctic Borough
Andy Romanoff, AK Heat Smart
for their resources and expertise

Good stuff that we have no time to cover after here

Resources

Heat Pump Calculator: https://heatpump.cf

Alaska Mini-Split Heat Pump Study: http://analysisnorth.com/pages/projects.html

Department of Energy Heat Pump Page: https://www.energy.gov/energysaver/heat-and-cool/heat-pump-systems

Cold Climate Housing Research Center Heat Pump Page: http://www.cchrc.org/heat-pumps

NEEP Cold Climate Heat Pump Resources
Product List:
https://neep.org/initiatives/high-efficiency-products/emerging-technologies/ashp/cold-climate-air-source-heat-pump

ACEP
Alaska Center for Energy and Power

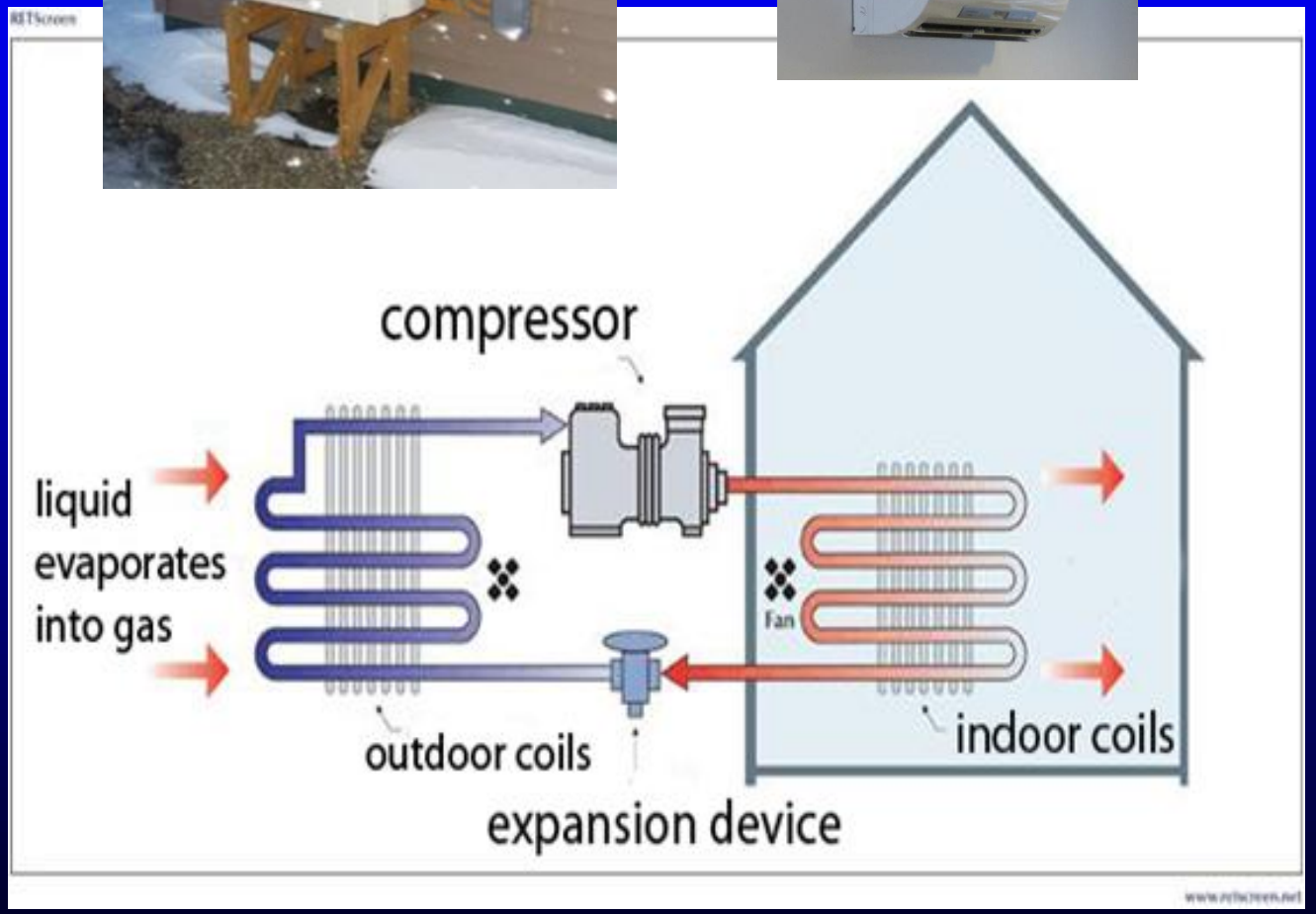
UAF UNIVERSITY OF ALASKA FAIRBANKS

Some Heat Pump Lingo:

- **COP** - Coefficient of Performance - Energy Output / Energy Input
- **HSPF** - Heating System Performance Factor - seasonal average (Region IV)
  - **NEW HSPF2, Region V**, (Northern half of the US - still warmer than AK, but better)
  - **NEW Energy Star** - Cold Climate Certified
- 1 Ton = 12K (12,000 btu). Rating is for cooling. (15-20,000 Btu heating)
- Capacity Ratings: NEEP site: https://ashp.neep.org
  - It's a Wild Wild West for efficiency and output ratings. Consumers need to be smarter than the marketing departments. Mostly self-certified rating system.
  - Manufacturers “Rated” output? - I look for the 5 deg. Max Capacity Rating to compare outputs.

Heat Pumps Do Not Generate Heat, They **Move** It

How does a heat pump work?



Heat sources:

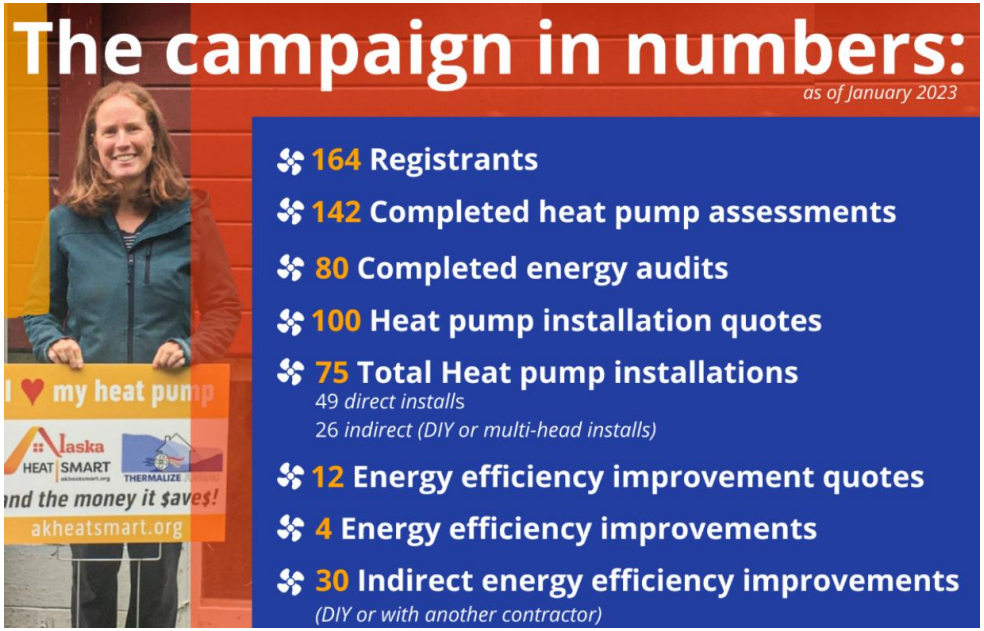
Outside air

Body of water

Ground

Alignment and Impact: Thermalize Juneau had the following outcomes:

THERMALIZE JUNEAU



Increased building efficiency and acceleration of building electrification

164 registrants in Thermalize Juneau 2021

Reduced cost of building decarbonization

- $400 rebate achieved, after 40 installations
- 3% discount for efficiency retrofits after 5 installations (not achieved by thermalizers)
- Return the Rebate program
- Local bank financing option

Reduced consumer energy burdens

- Pre-campaign modeling predicted 50% decrease in EUI from ductless heat pump (DHP) installation
- Similar predictions from heat pump assessments and energy audits

Increased community resiliency

- 3 new jobs
- Smaller dependence on fuel oil & advancement toward renewable energy goal

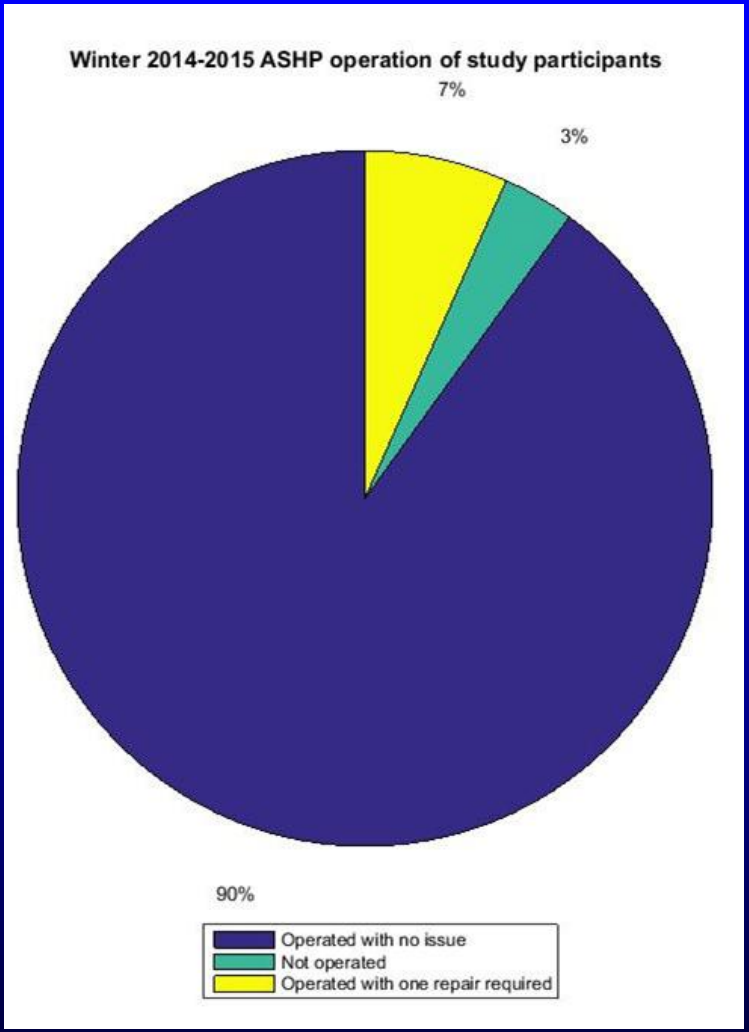
ASHP general monitoring - results

The study interviewed thirty building and homeowners about ASHP use in the winter 2014-2015:

- Mix of ductless ASHPs, forced air ducted ASHPs, and air-to-water systems
- Mix of commercial and residential systems
- Some retrofit appliances, some new installations

Findings:

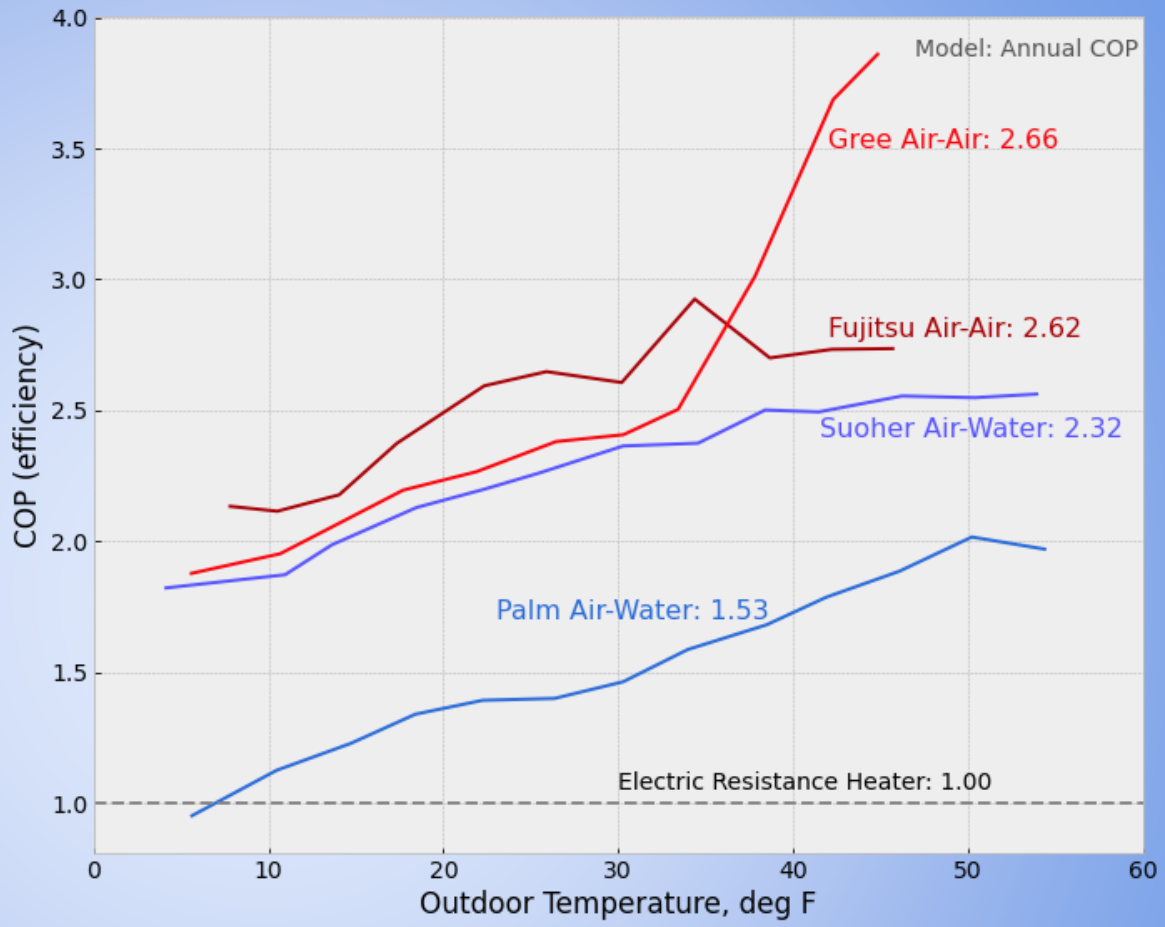
- **29** out of 30 systems provided adequate or expected heat.
- **2** repairs needed, both fixed at no cost to the building owner
- **11** people performed maintenance on the system
- **12** people used their back-up heating system (29 had back-up heat available)



Measured Heat Pump Efficiency

Four Heat Pumps

Phil Kaluza Duplex
Seward, Alaska



Advantages of heat pumps

Wrangell City Hall in Southeast Alaska is heated by a heat pump.

- Low maintenance
- No combustion
- Partially renewable
- Potential for lower energy costs
- Efficiencies (COPs) over 100%

Heat pump efficiency (Coefficient of Performance):

$$COP = \frac{heat\ delivered\ by\ the\ heat\ pump}{electricity\ supplied\ to\ the\ heat\ pump}$$

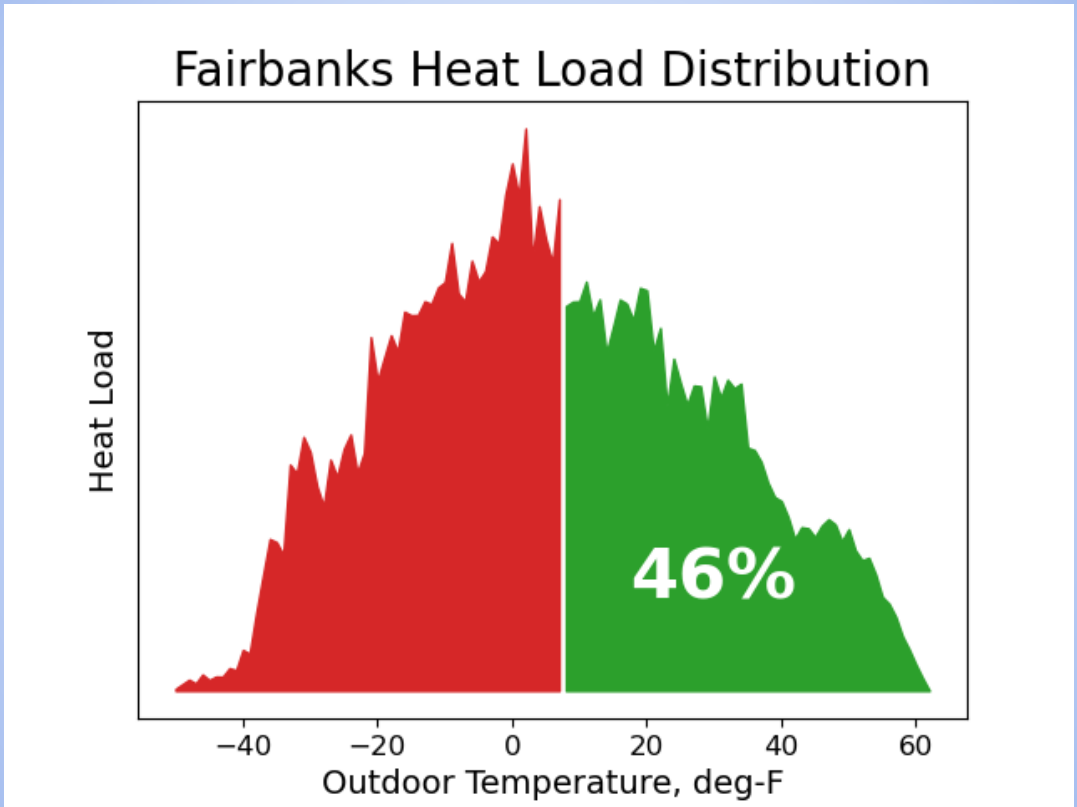
Lowest Temperature where Heat Pump Operation is Economical

Electricity Rates: $0.30 / kWh (GVEA March , 2024)
Fuel Price: $4.45 / gallon

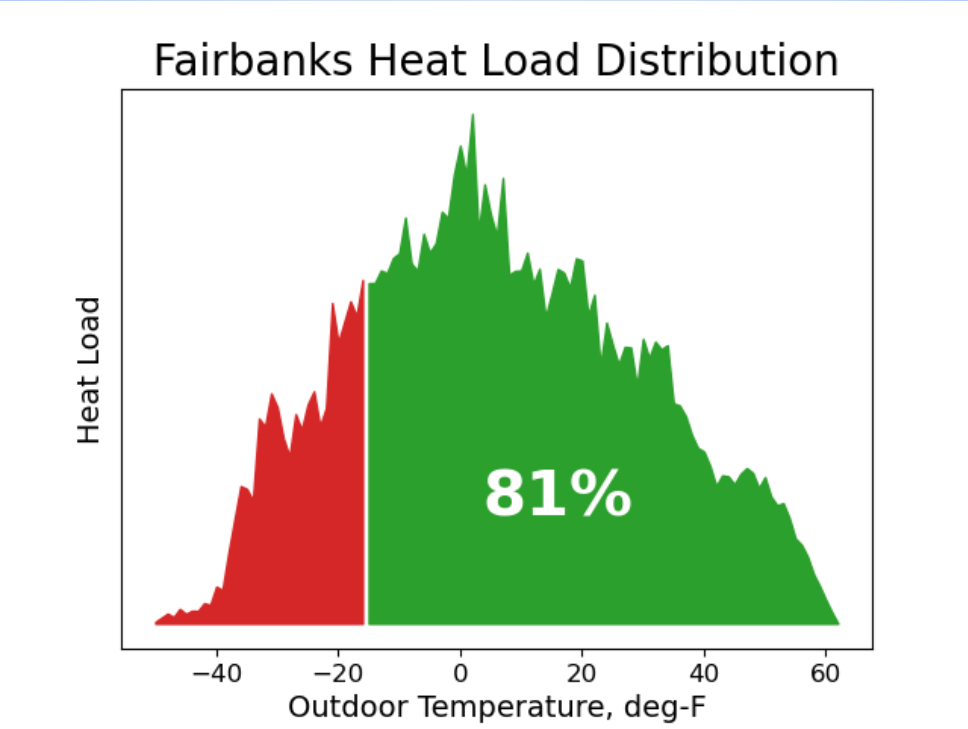
Heat Pump Electricity Cost = Oil Heater Fuel Cost at **8 °F**

COP (Efficiency) = 1.95

Heat Load occurring above Outside Temp of 8 °F



Heat Load occurring above Minimum Heat Pump Operation Temperature, -15 °F



ASHPs – Special Considerations

- Need for a backup heat source in cold climates
- What is the source of electricity and its efficiency?
- Air-to-air versus air-to-water
- For air-to-air: ducted versus ductless
- External thermostat vs. built-in thermostat for ductless
- Outside air cutoff temperature