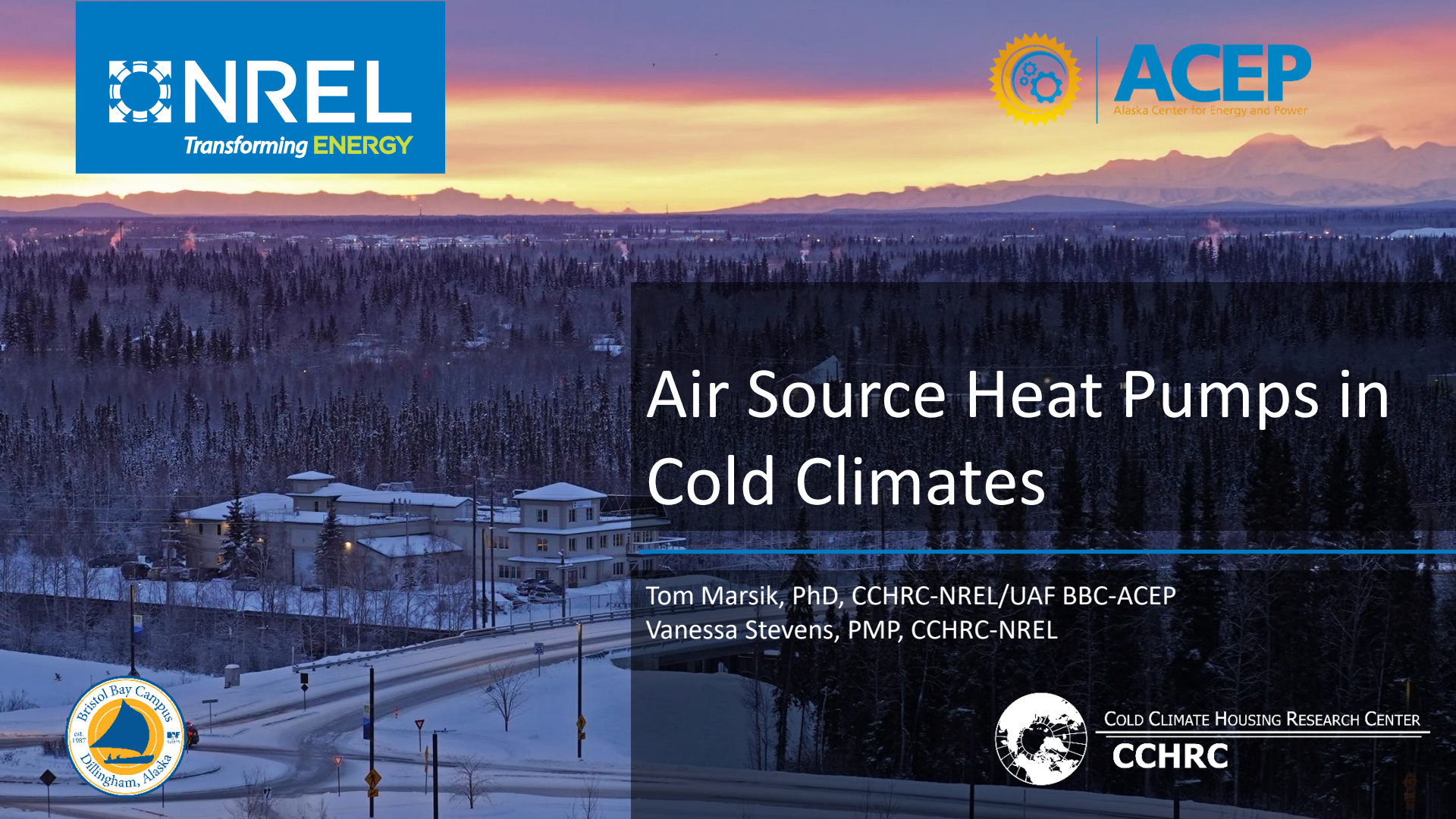

NREL Transforming ENERGY

ACEP Alaska Center for Energy and Power

Air Source Heat Pumps in Cold Climates

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Cold Climate Housing Research Center
CCHRC

Outline

1. Intro to heat pumps
2. Heat pump comparisons
3. Air source heat pump special considerations
4. Air source heat pump performance in Alaska
5. System approach (heat pump + efficient envelope)
6. Main conclusions
7. Additional resources

How does a heat pump work?

Heat sources:

outside air

body of water

ground

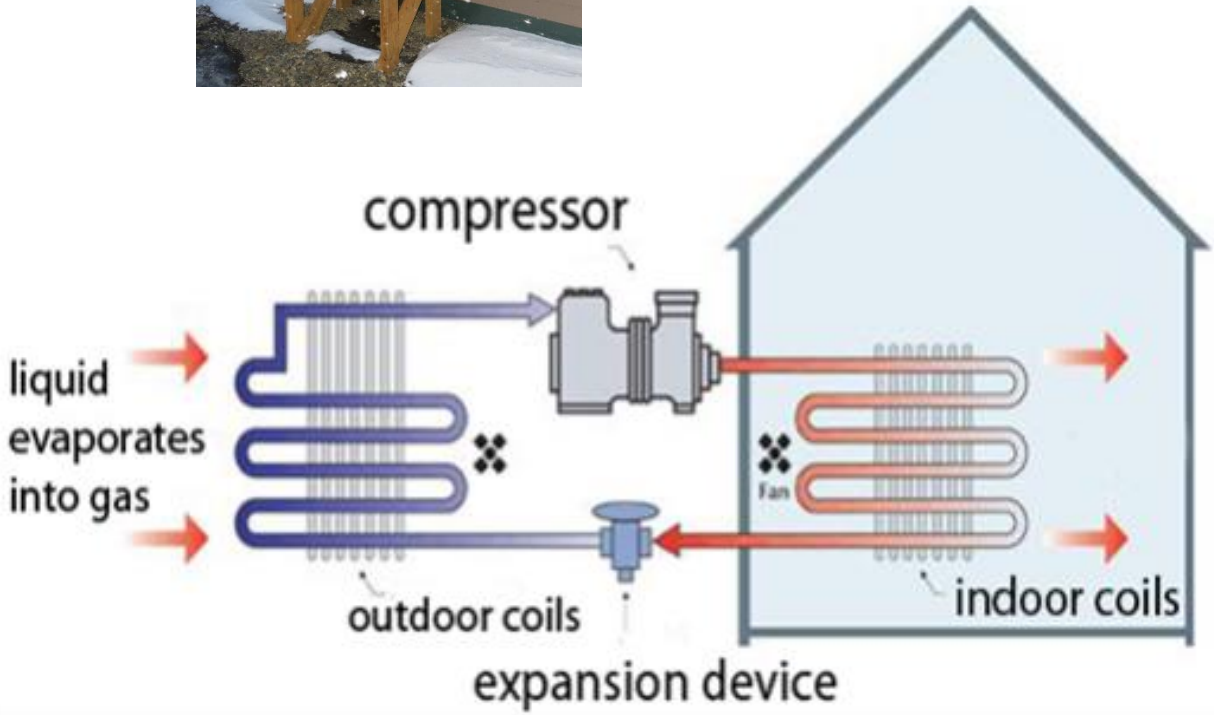


Image courtesy of RETSCREEN.

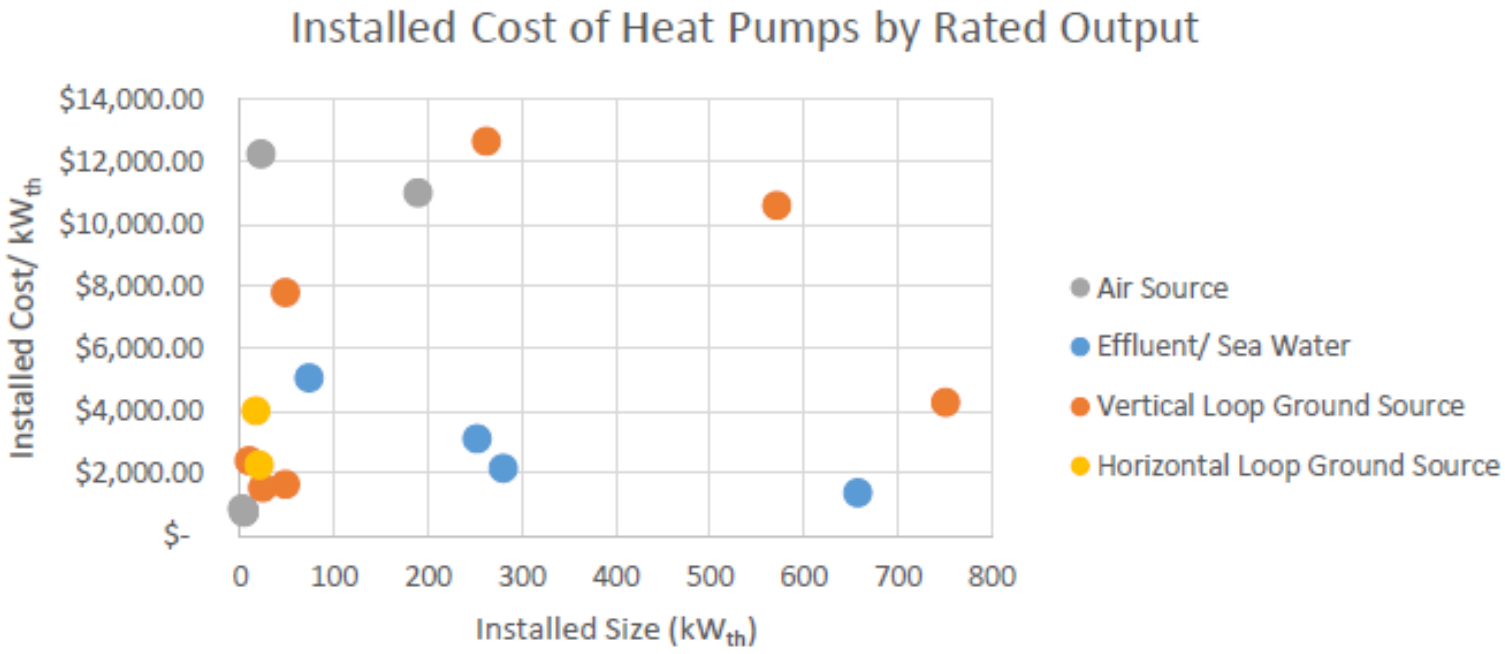
Advantages of Heat Pumps

- Low maintenance
- No combustion
- Partially renewable
- Potential for lower energy costs

"Efficiencies" over 100%

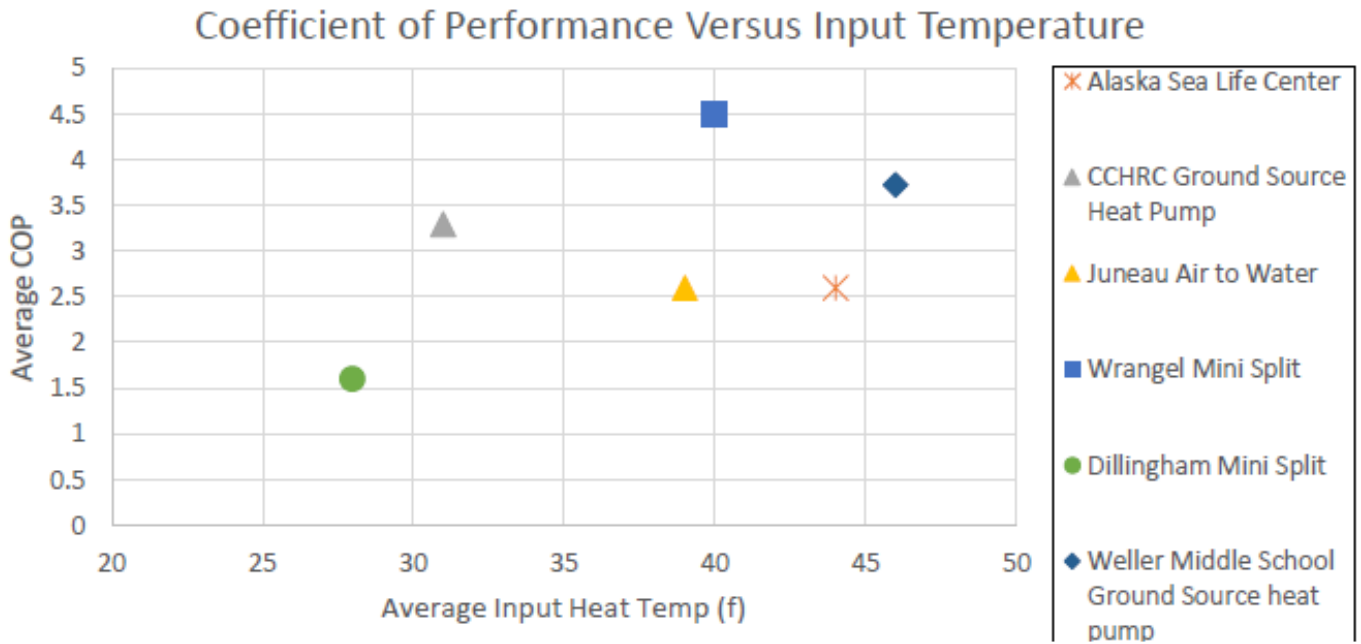
Coefficient of Performance (COP)

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



Comparison by Installed Cost

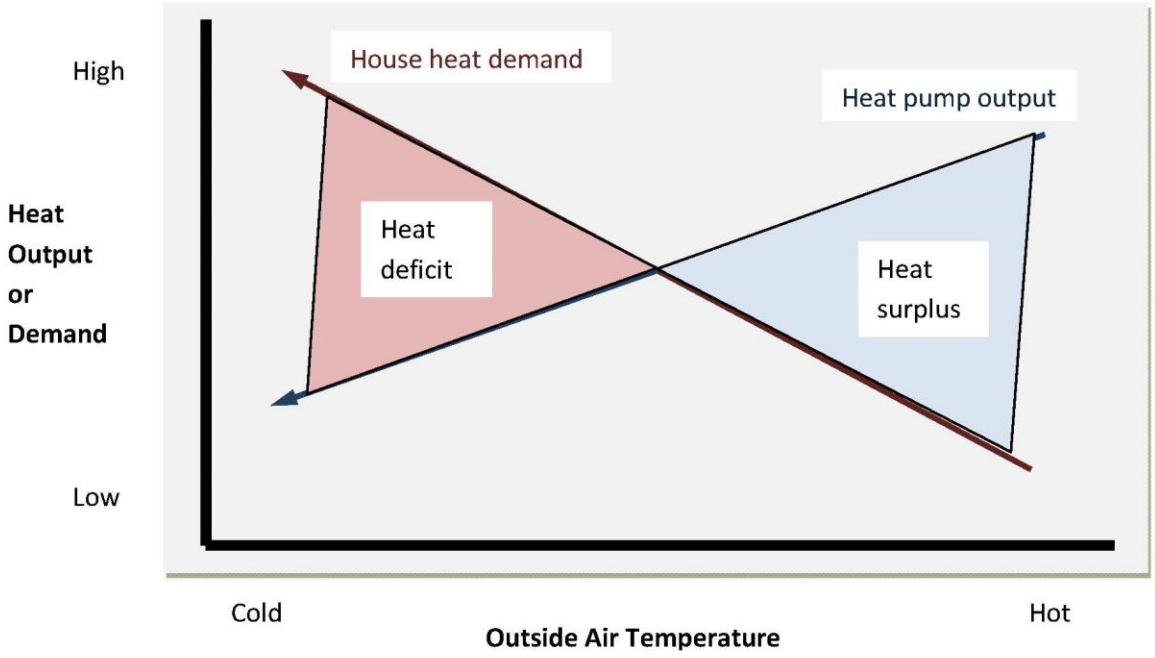
Source: University of Alaska Fairbanks Alaska Center for Energy & Power, Alaska Energy Technology Reports



Comparison by Efficiency

Source: University of Alaska Fairbanks Alaska Center for Energy & Power, Alaska Energy Technology Reports

Air-Source Heat Pumps: Fundamental Challenge



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

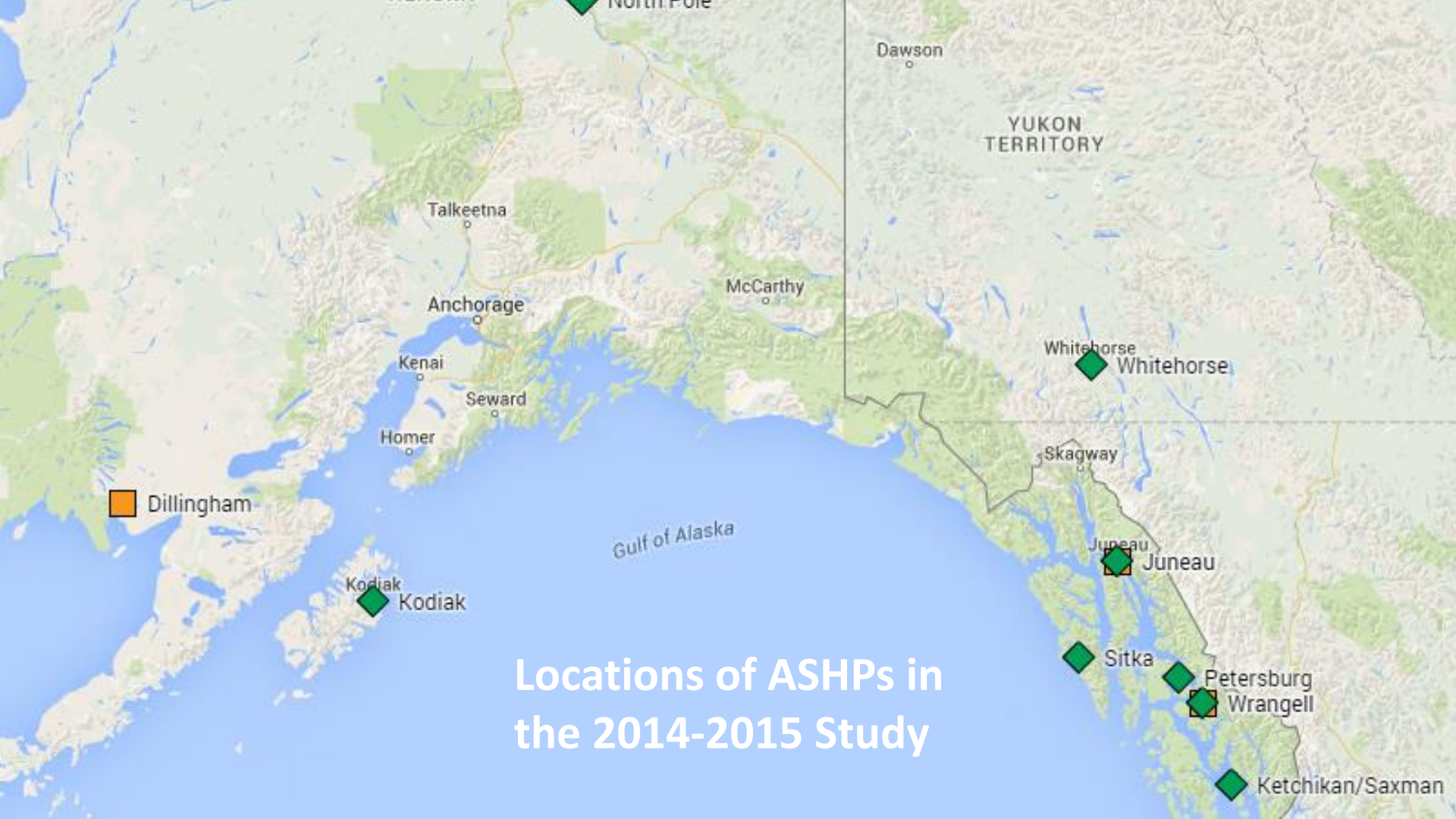
Emerging Energy Technology Fund Grant

Air Source Heat Pump Potential in Alaska: CCHRC, UAF Bristol Bay Campus, Wrangell Municipal Light & Power

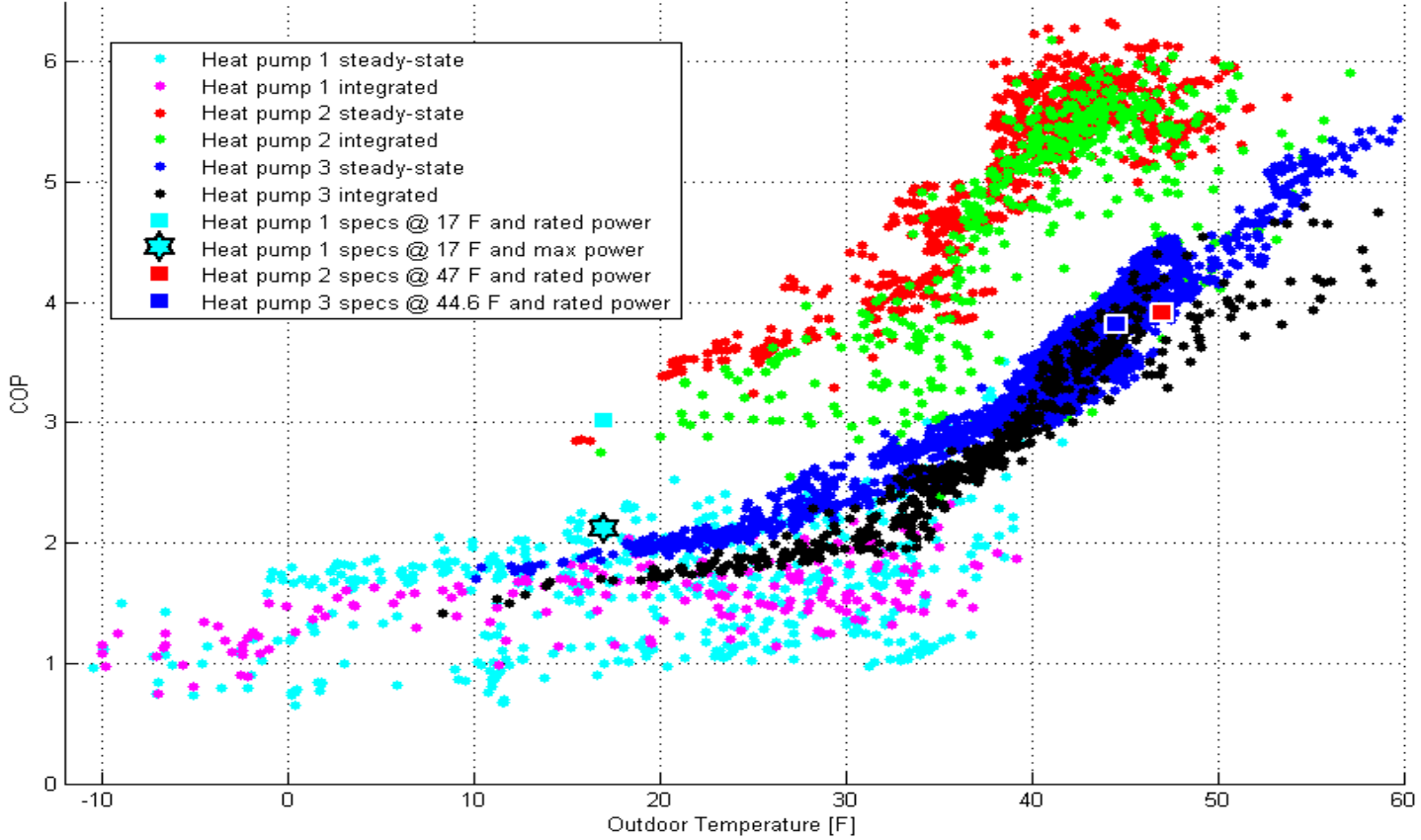
Main Objectives

- Study the field performance of ASHPs in Alaskan conditions
- Study the behavior of ASHPs around cut-off temperatures
- Study the potential of using ASHPs as an electrical demand management tool by replacing resistive heating systems (primarily in Southeast Alaska)

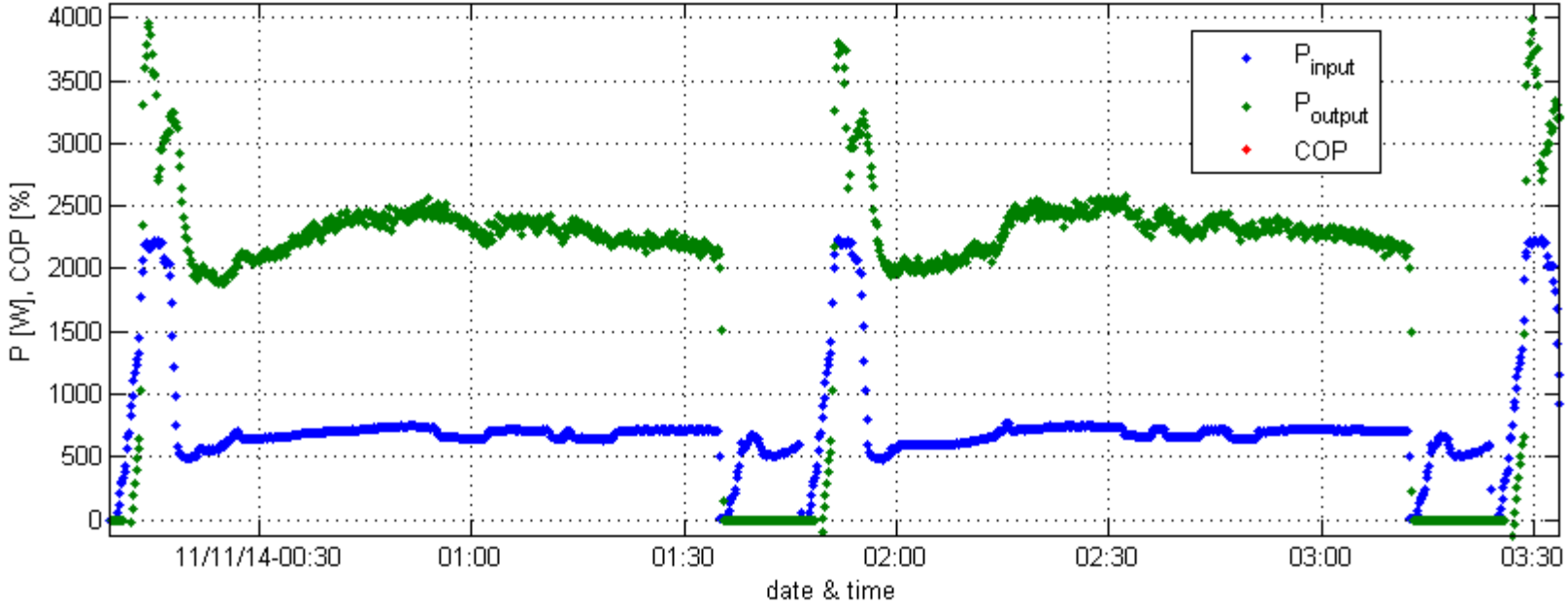
Wrangell City Hall in Southeast Alaska is heated by a heat pump.



Locations of ASHPs in the 2014-2015 Study



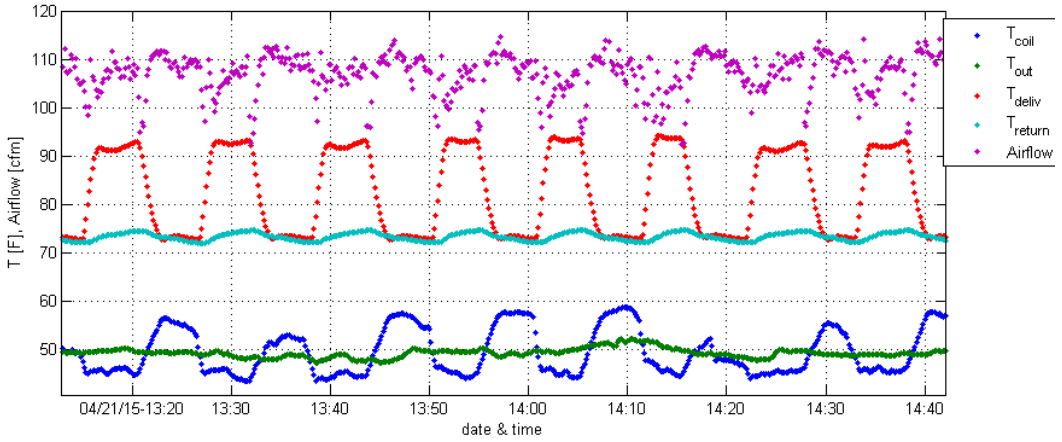
ASHP Detailed Monitoring Results

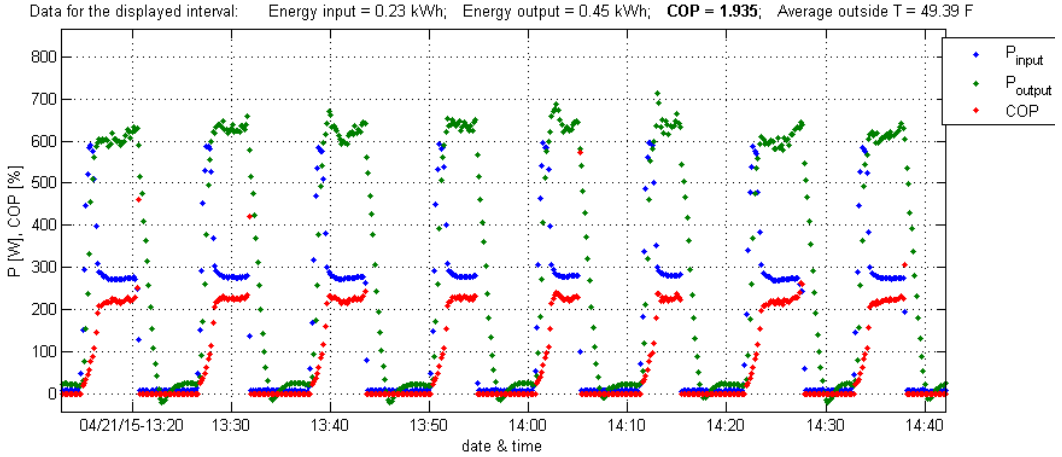


ASHP detailed monitoring – general conclusions

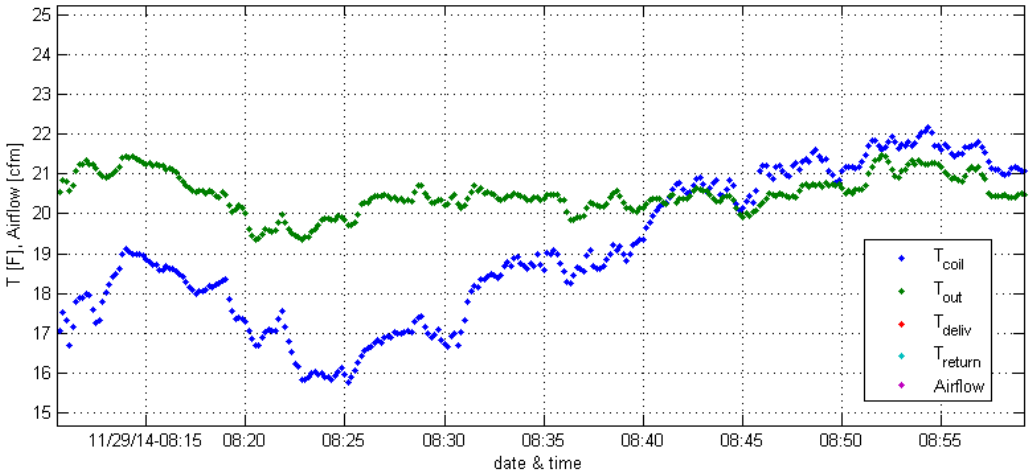
- Manufacturer's specifications do not always correctly reflect field performance
- Most documentation focuses on steady-state performance, but integrated performance data is needed for more accurate representation of cold-climate operation (includes cycling due to defrost)
- Large variations in efficiency among individual models

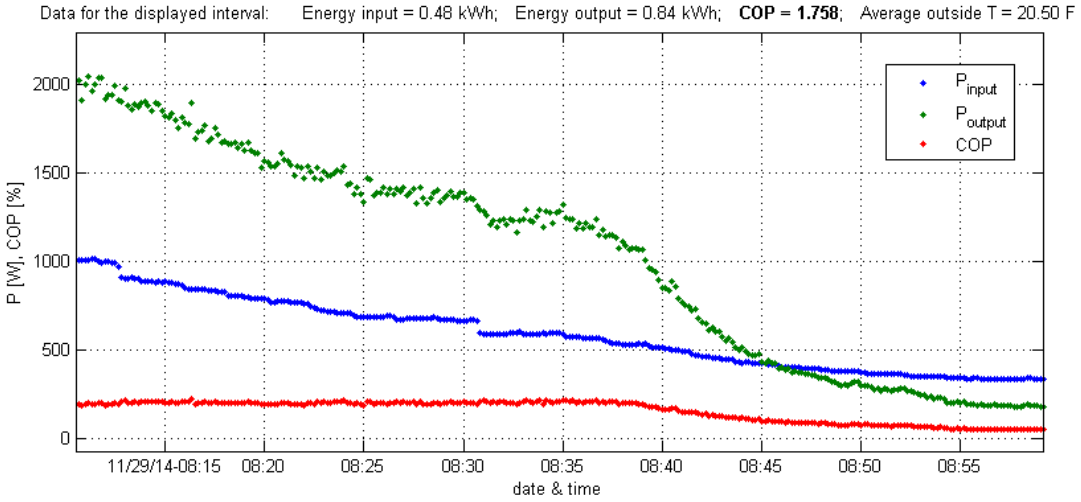
ASHP Short-Cycling in Low-Load Conditions





Rare Occurrence When COP Drops Below 1





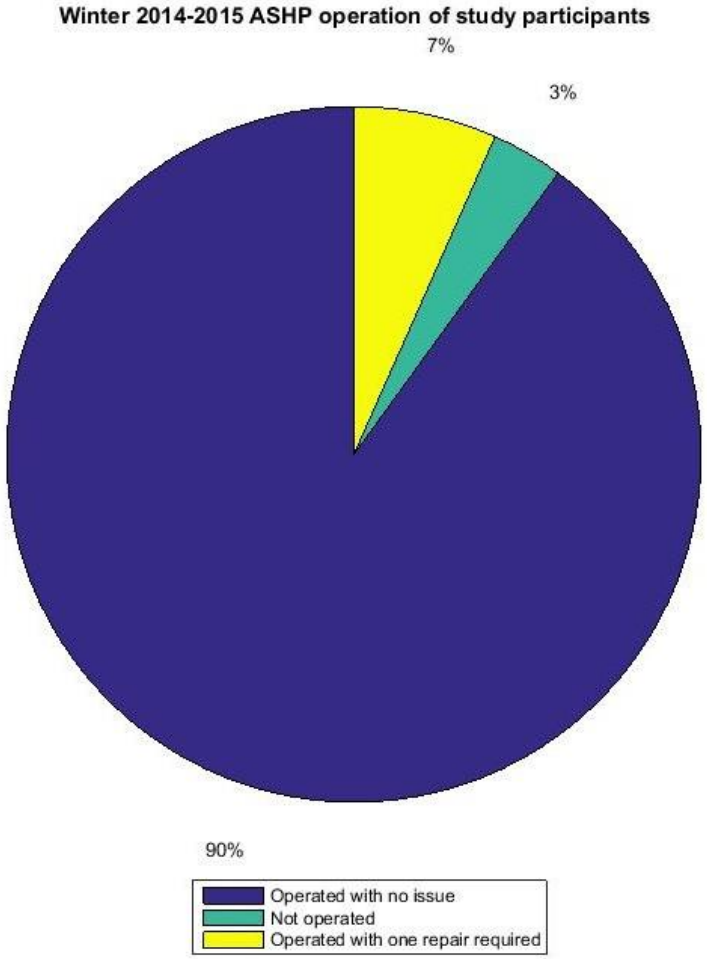
ASHP General Monitoring - Results

30 building owners interviewed about ASHP use

- Commercial/Residential systems
- Ductless/Ducted/Air-to-water ASHP systems
- Retrofit/New Installations

Findings

- 29/30 systems provided adequate or expected heat
- 2 repairs needed, fixed at zero 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)



ASHP General Monitoring - Results

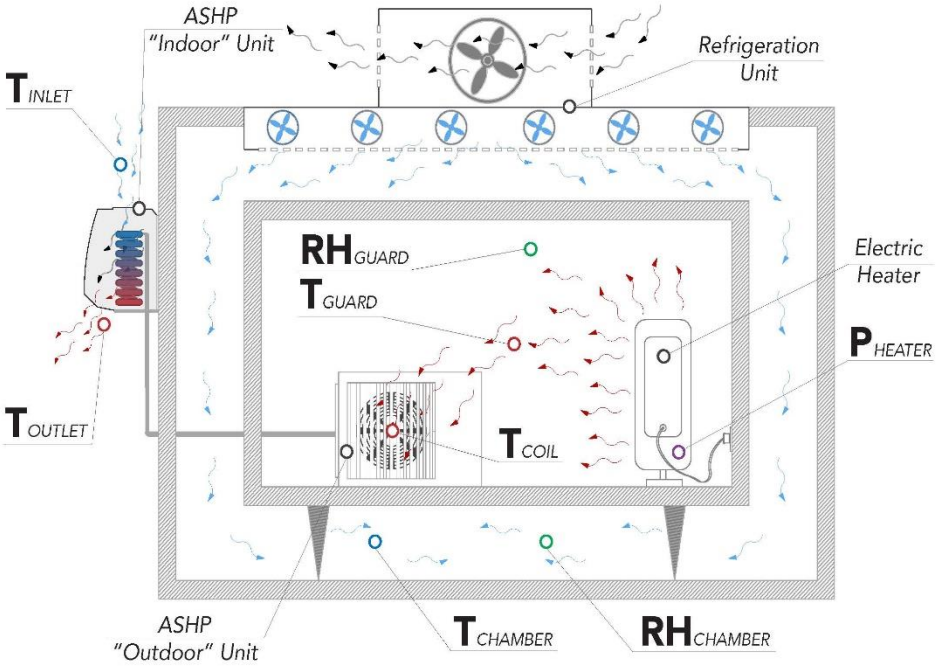
Selected Sites – direct and/or indirect monitoring of ASHP electricity

Main findings

- Limited data does not confirm that ASHPs will always reduce electrical energy use, even when replacing electric resistance heat.
- ASHPs have only a small effect on peak power demand.
- Demand-side management programs should include measures other than ASHPs.

Current Research

Evaluating ASHP performance at different levels of thermal loading



System Approach: Heat Pump + Efficient Envelope

ASHPs – Main Conclusions

- ASHPs can significantly reduce energy use and energy costs when used in appropriate situations and done right.
- More research needed to gain better understanding of ASHP performance in cold climates to guide future deployment.
- System approach yields biggest savings.

Credits

Individuals:

Colin Craven
Robbin Garber-Slaght
Bruno Grunau
Clay Hammer
Jim Rehfeldt
Chris Pike
Erin Whitney
Alan Mitchell
Dirk Baker
Others

Organizations:

Golden Valley Electric Association
Alaska Energy Authority
National Science Foundation
U. S. Dept. of Agriculture
Alaska Housing Finance Corporation
U.S. Dept. of Defense
U.S. Dept. of Energy
Others

Thank you!

Questions ?

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Additional Resources

Alaska Mini-Split Heat Pump Calculator

by Analysis North

https://heatpump.cf

Air Source Heat Pump Installer and Consumer Resources

By Northeast Energy Efficiency Partnerships

https://neep.org/high-performance-air-source-heat-pumps/air-source-heat-pump-installer-and-consumer-resources