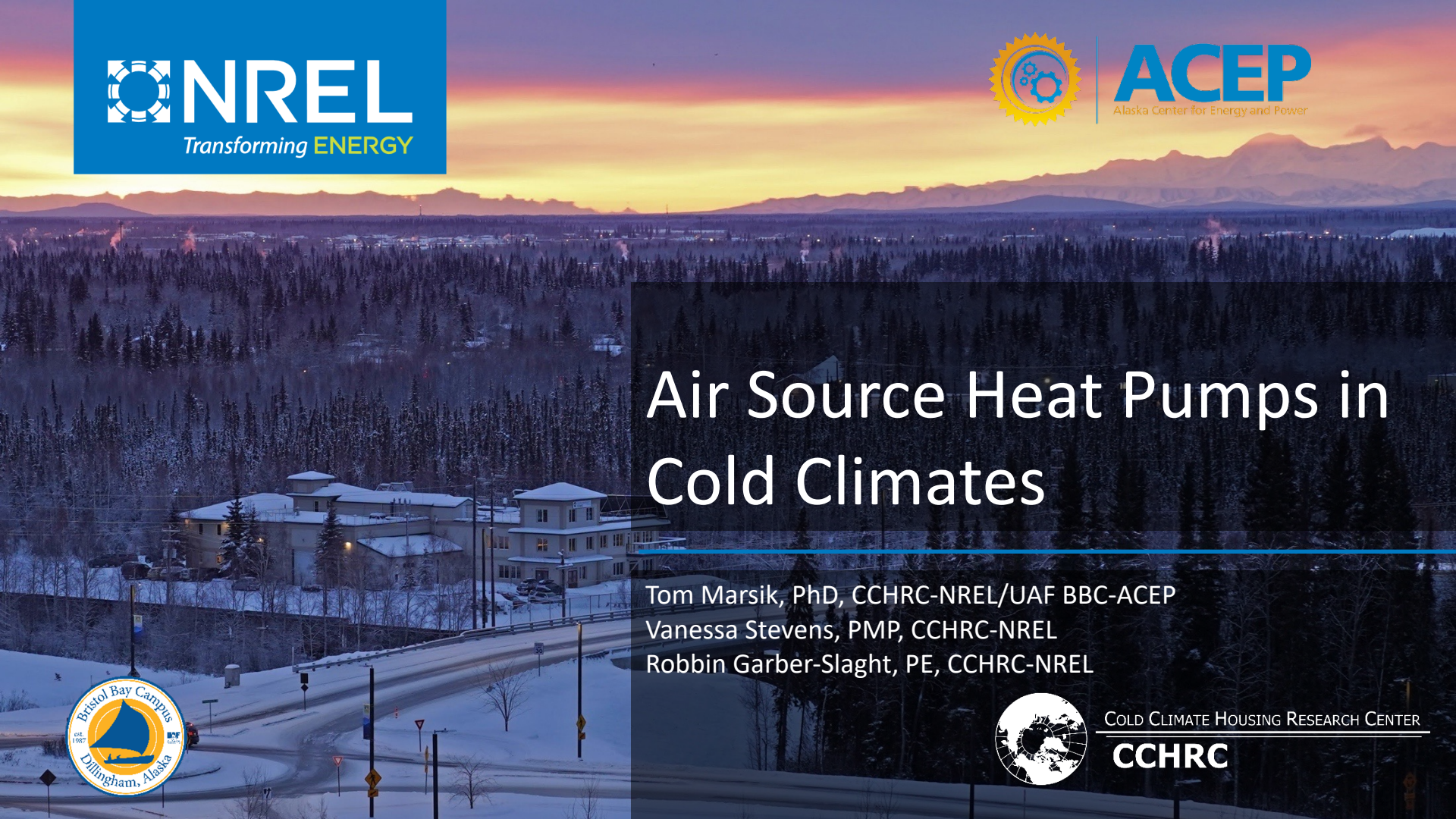

NREL
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ACEP
Alaska Center for Energy and Power

# Air Source Heat Pumps in Cold Climates

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Bristol Bay Campus
Dillingham, Alaska

Cold Climate Housing Research Center
CCHRC

# How does an air source heat pump work?

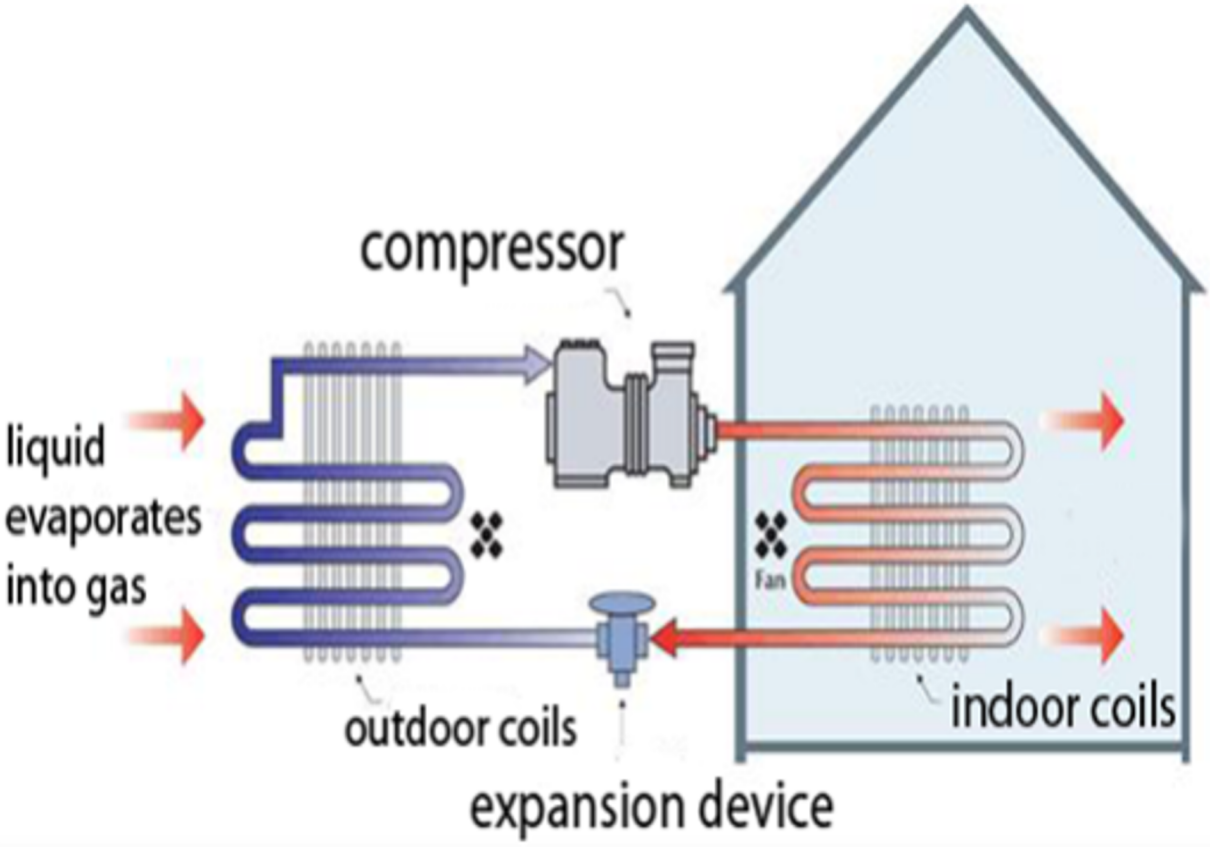



*Image courtesy of RETSCREEN.*

# Advantages of Heat Pumps

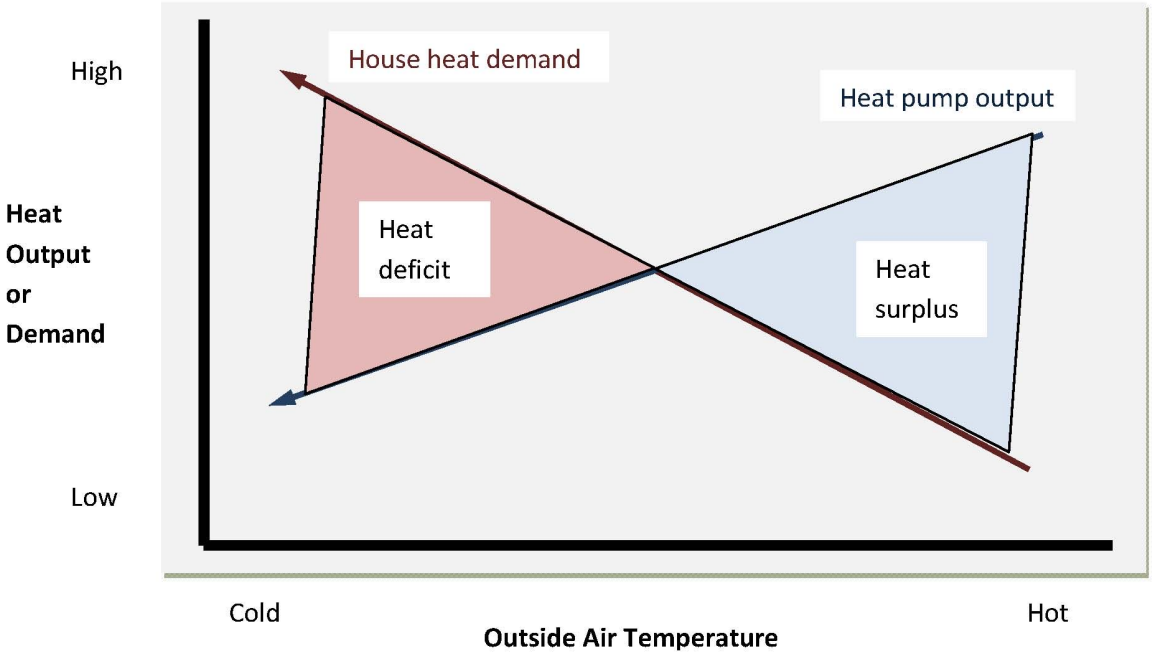

- Low maintenance
- No combustion
- Partially renewable
- Potential for lower energy costs

"Efficiencies" over 100%

# Coefficient of Performance (COP)

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

# 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
- Outside air cutoff temperature

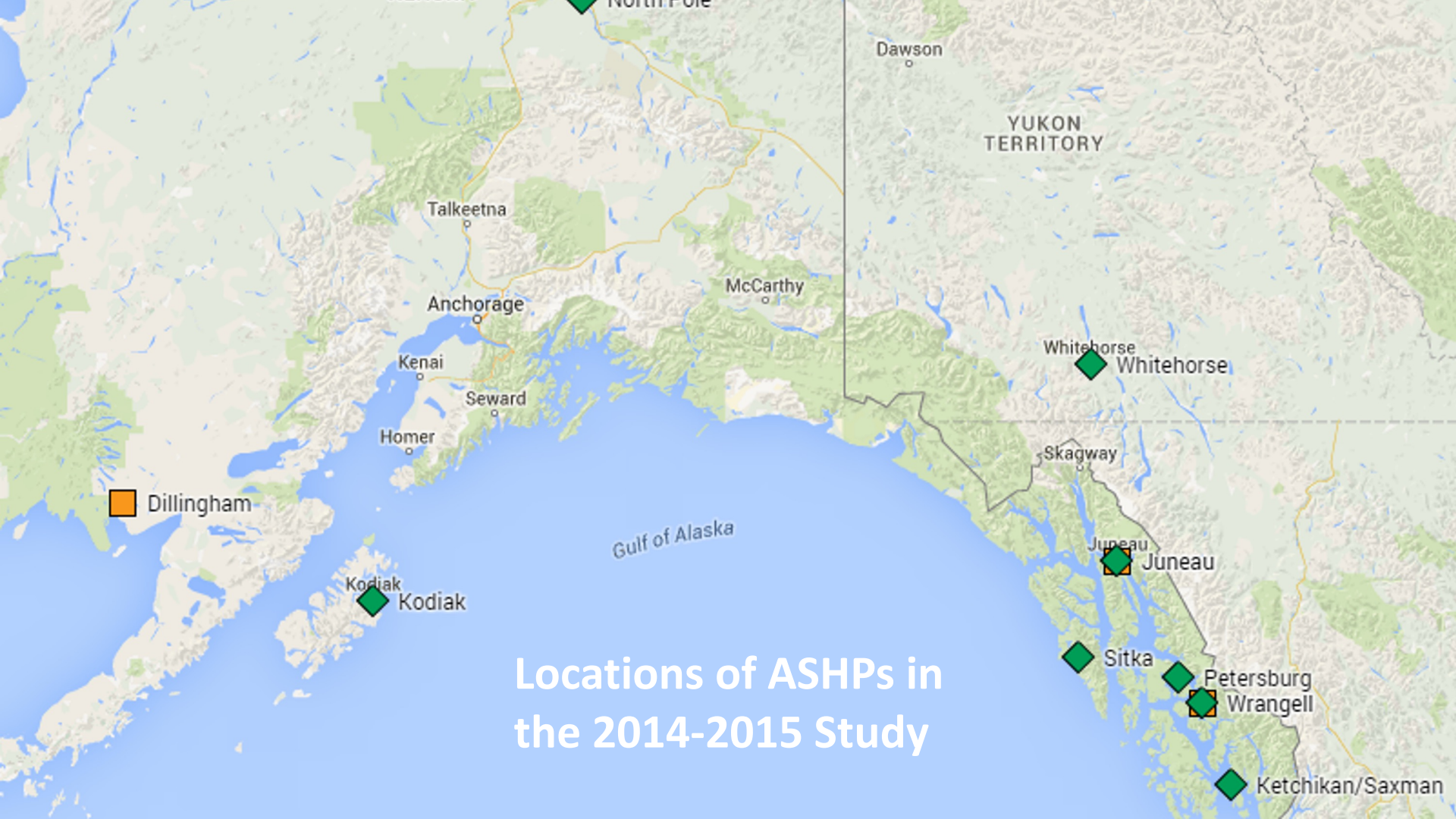
# Emerging Energy Technology Fund Grant

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.*


Dawson
YUKON TERRITORY
Talkeetna
McCarthy
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Homer
Whitehorse
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Skagway
Dillingham
Gulf of Alaska
Juneau
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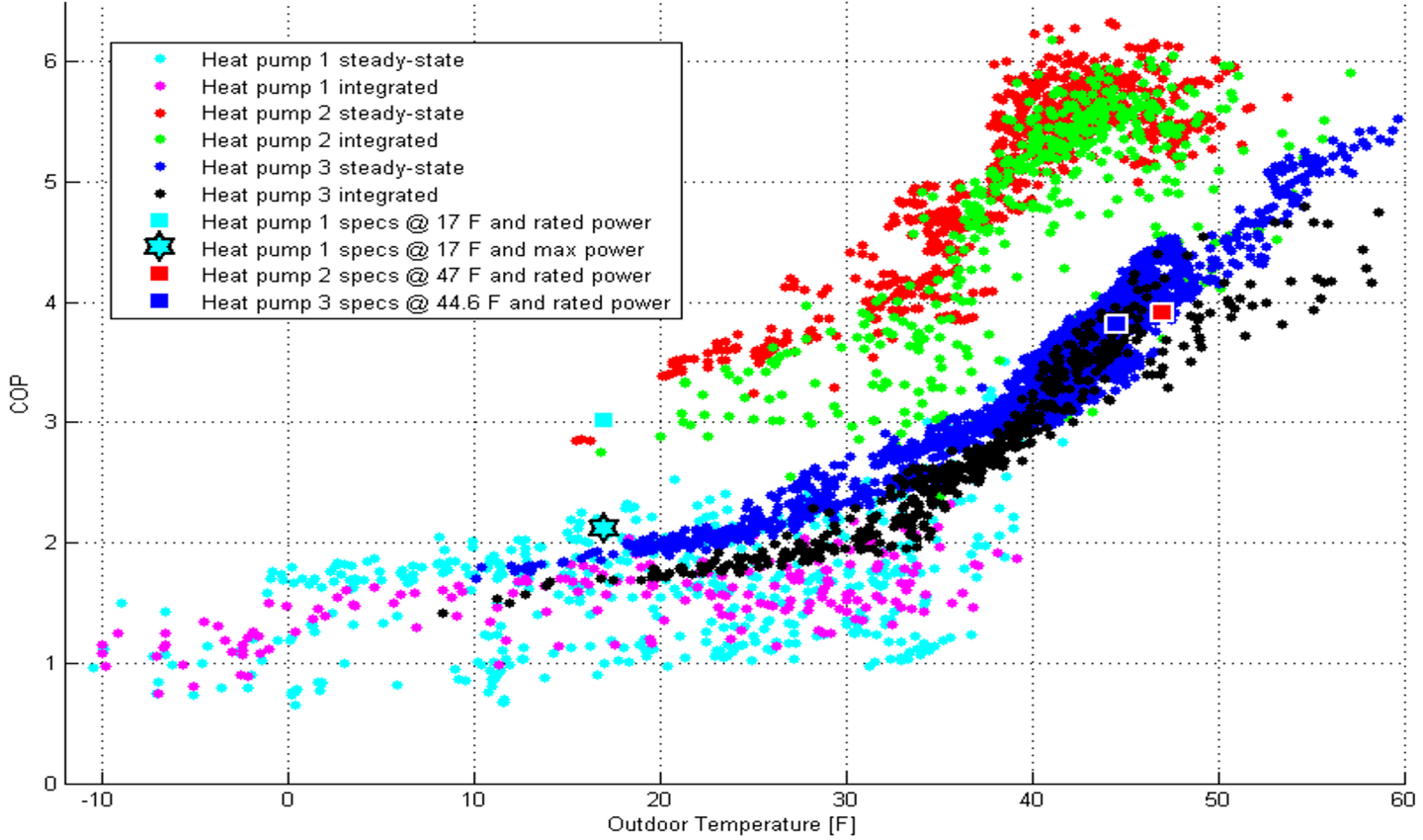
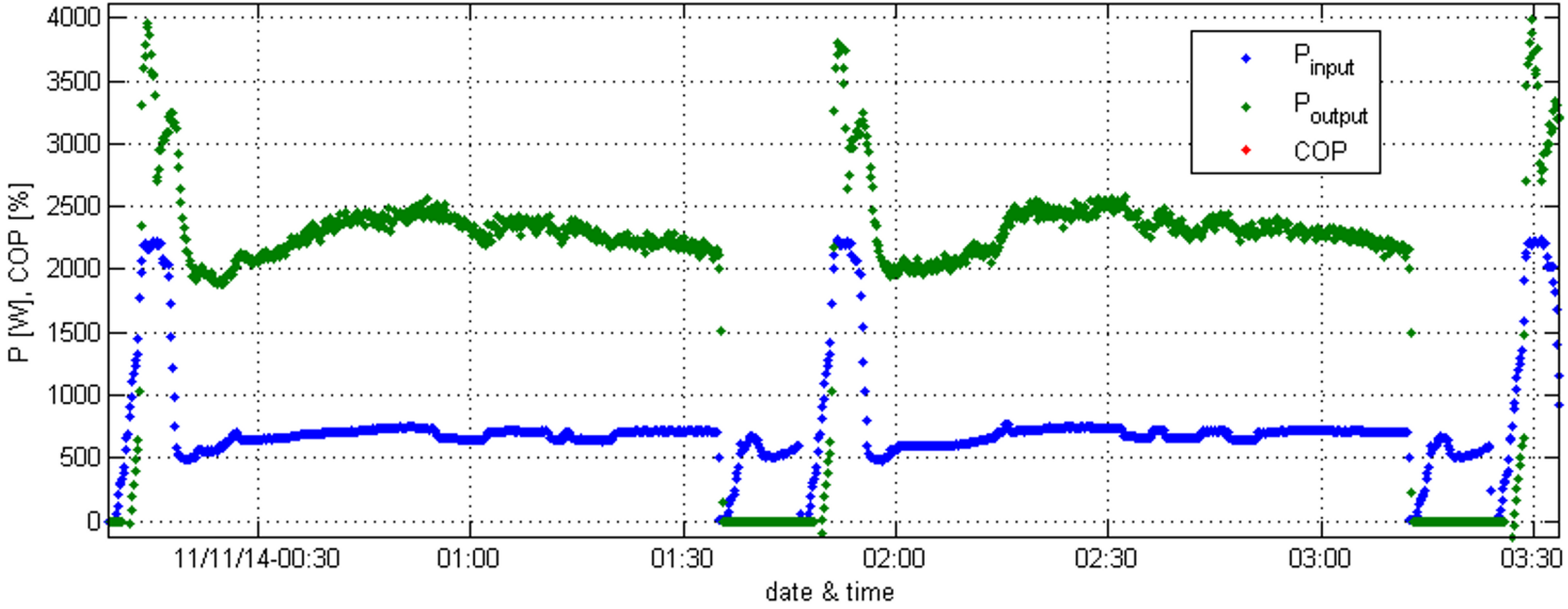
Kodiak
Kodiak
Sitka
Petersburg
Wrangell
Ketchikan/Saxman
Locations of ASHPs in the 2014-2015 Study




# 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 General Monitoring - Results

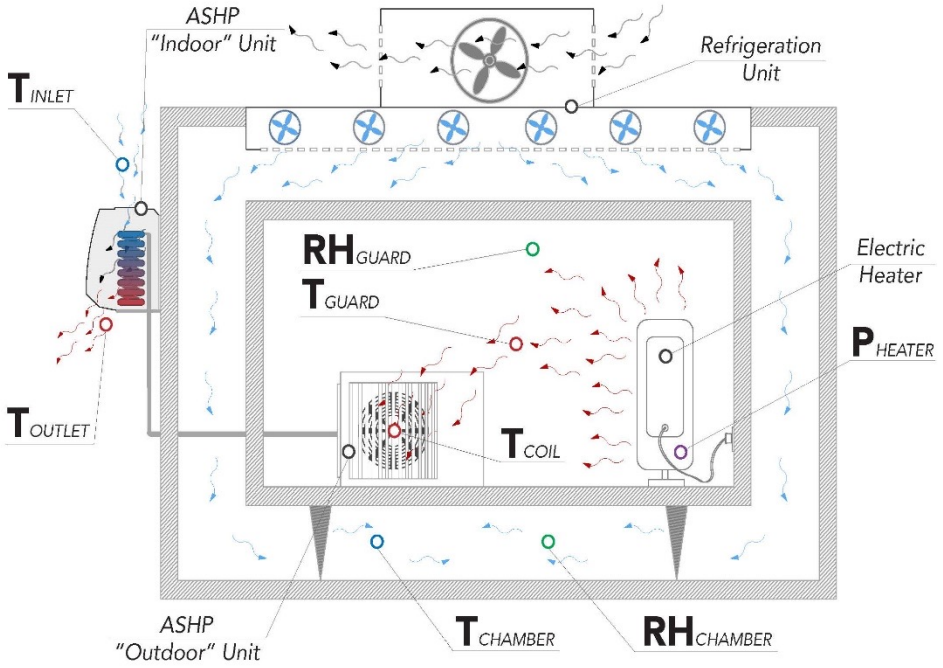
Selected Sites – direct and/or indirect monitoring of ASHP electricity

**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



# Current Research

## Oak Ridge National Lab study

- Evaluating an ORNL prototype for cold climates at CCHRC
- 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

# Current Research

## Helping Alaska Heat Smart implement Thermalize Juneau campaign

- First thermalize campaign in Alaska
- Economies of scale to implement heat pumps and other energy efficiency measures
- Study energy savings and homeowner satisfaction

# 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
Bruno Grunau
Clay Hammer
Jim Rehfeldt
Chris Pike
Erin Whitney
Alan Mitchell
Dirk Baker
Others

**Organizations:**

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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