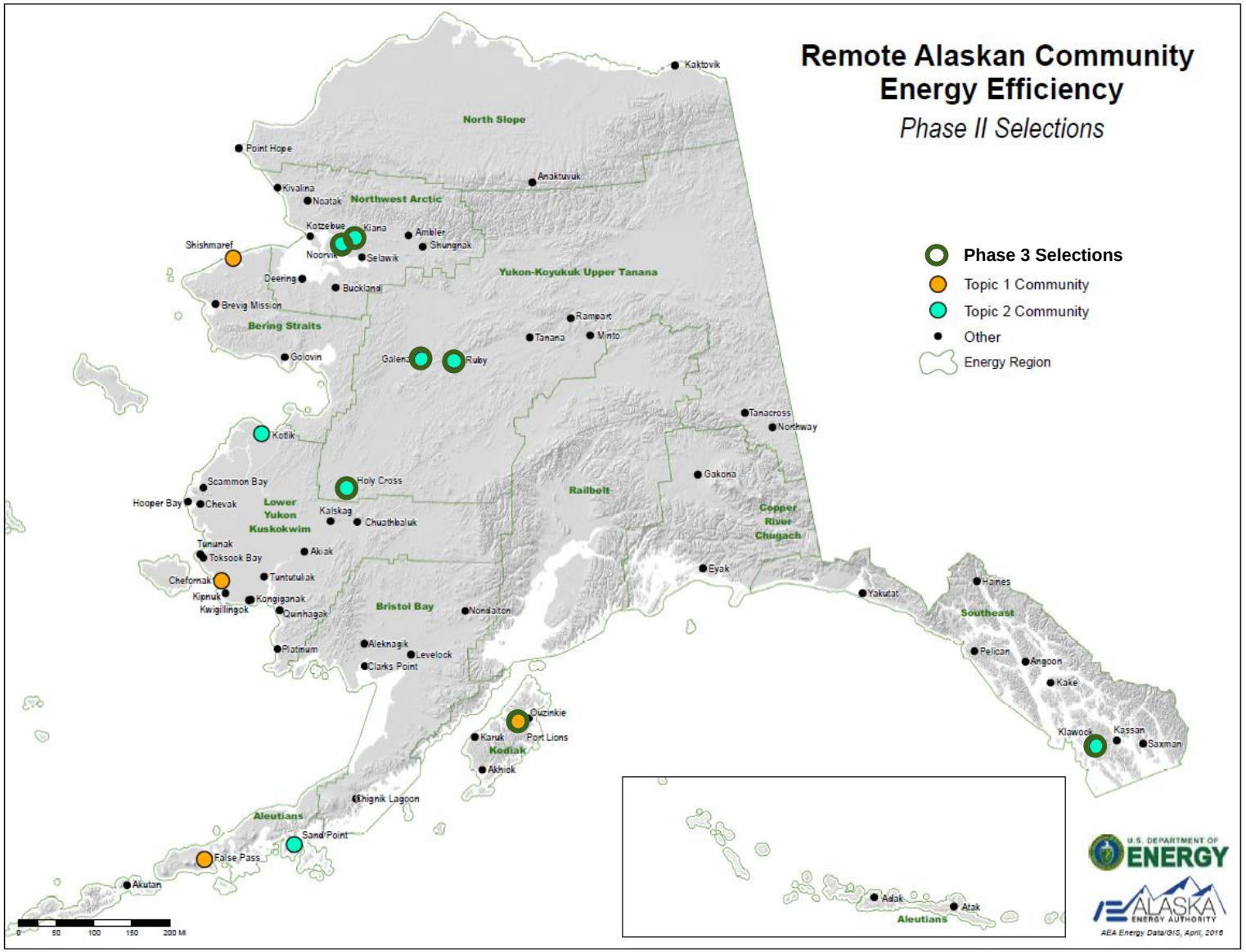
Remote Alaska Communities Energy Efficiency Peer Network

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Webinar Operations

- All participants have been automatically muted.
- If you have a question during the presentation, please type it into the Question panel on the right side of your computer screen. We will pose the question at the end.
- Please check the RACEE website after 4/15/17 for a link to the recording and transcription of this webinar.

http://energy.gov/eere/racee-competition-peer-exchange-network

- DOE plans to collect information for announcement on the next Peer Network call.
  - This can include useful information on funding and project ideas and opportunities
  - Email your input to Fletcher.Souba@ee.doe.gov for April's Webinar.

Welcome to the RACEE Peer Network

- The RACEE Peer Exchange Network is intended to provide a fundamental benefit to the 64 communities that pledged to reduce per capita energy usage by 15% by 2020.

- It will consist of three components:
  - RACEE website
  - Monthly technical webinars
  - In-person meetings
    - For, example, the RACEE Competition Summit at end of RACEE Phase 3

- For more details, see the RACEE Website:

http://energy.gov/eere/racee-competition-peer-exchange-network

RACEE Peer Exchange

- The goal of the network is to empower Alaskan communities and native Alaskan villages to develop effective tools to advance the use of reliable, affordable, and energy efficient solutions that are replicable throughout Alaska and other Arctic regions.

- The Department leverages the existing convening power of the AEA and other regional energy efficiency organizations to form the Peer Exchange Network to build a community of energy efficiency information sharing and action by peer exchange through webinars, and events.

Future Webinar Topics

- **Community Experiences with Air Source Heat Pumps**:
  - Dr. Tom Marsik (Univ. of Alaska, Fairbanks) & Ingemar Mathiasson (Northwest Arctic Borough)
- **Indoor Air Quality Issues and How to Avoid Problems**
- **Biomass Heat Recovery Systems**
- **Water/Sanitation Efficiency in Alaska Communities**
- **Heat Recovery Systems and Benefits**
- **Diesel Part 1: Efficiency**
- **Diesel Part 2: Transition from 2-Stroke to 4-Stroke Engines**
- **Line Loss Mitigation**
- **AKEnergySmart - More about Renewable Energy in Alaska**

Air-Source Heat Pumps

- Performance in Alaska -

Tom Marsik
University of Alaska Fairbanks Bristol Bay Campus
tmarsik@alaska.edu

Vanessa Stevens
Cold Climate Housing Research Center
vanessa@cchrc.org

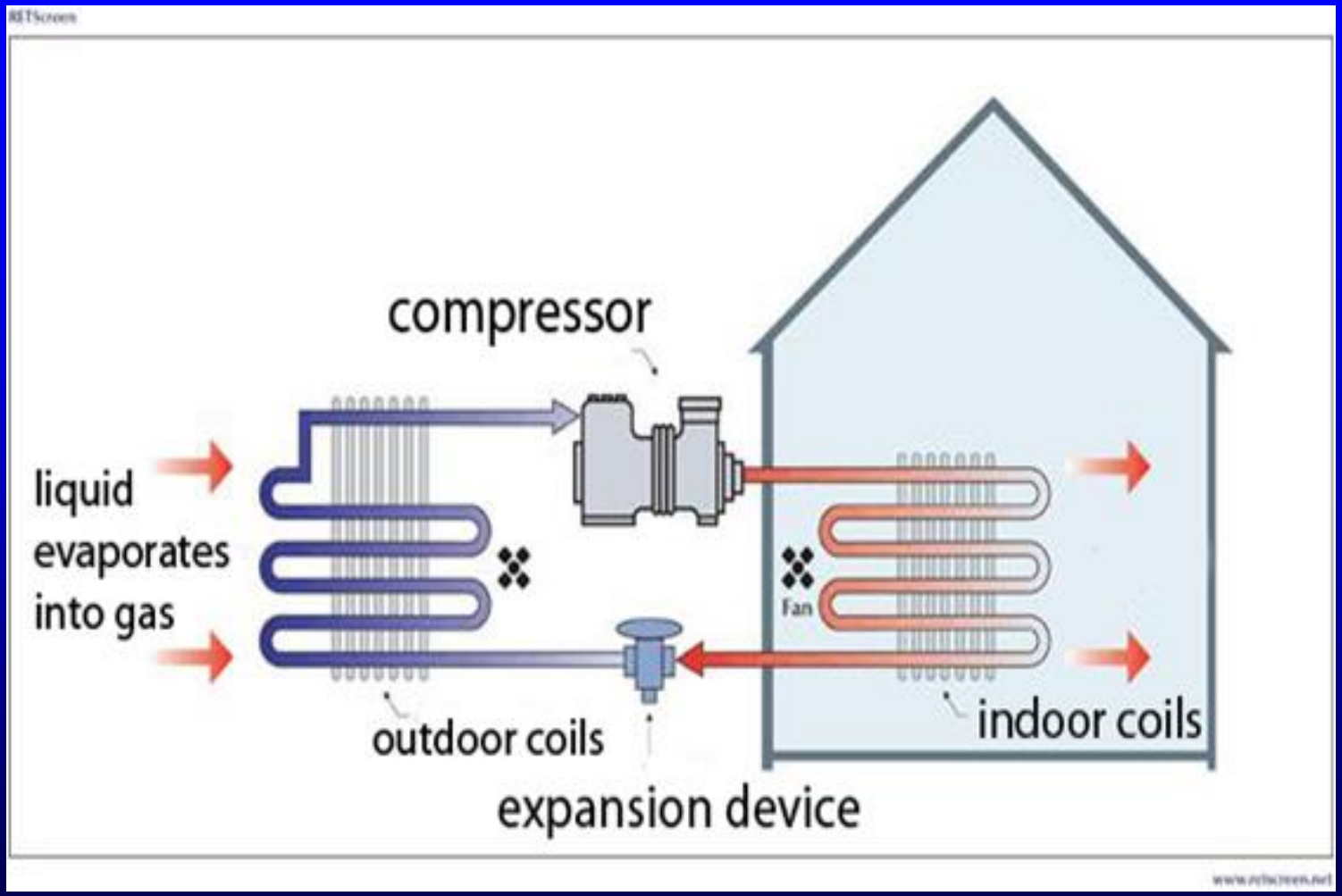
Remote Alaskan Communities Energy Efficiency (RACEE)
Peer Exchange Network Webinar, March 2017

Support by State of Alaska, National Science Foundation, and National Institute of Food and Agriculture, U.S. Dept. of Agriculture

Outline

- Heat pump intro
- Heat pump comparisons
- Air-Source Heat Pump (ASHP) special considerations
- Emerging Energy Technology Fund ASHP project
- System approach (heat pump + efficient envelope)
- Main conclusions

How does a heat pump work?



Heat sources:

Outside air, Body of water, Ground

Advantages of heat pumps

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

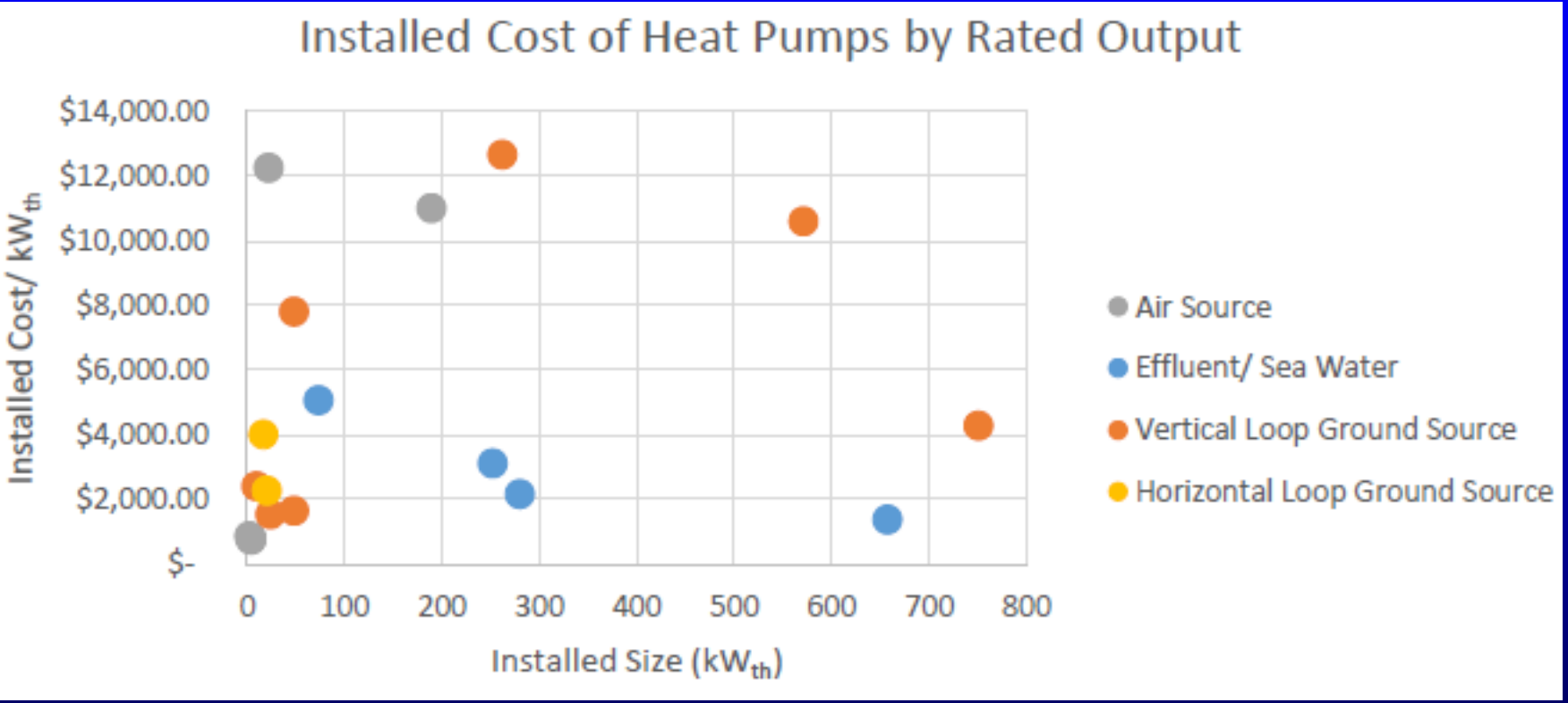
- Low maintenance
- No combustion
- Partially renewable
- Potential for lower energy costs
- Efficiencies (COPs) over 100%

Heat pump efficiency (Coefficient of Performance):

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

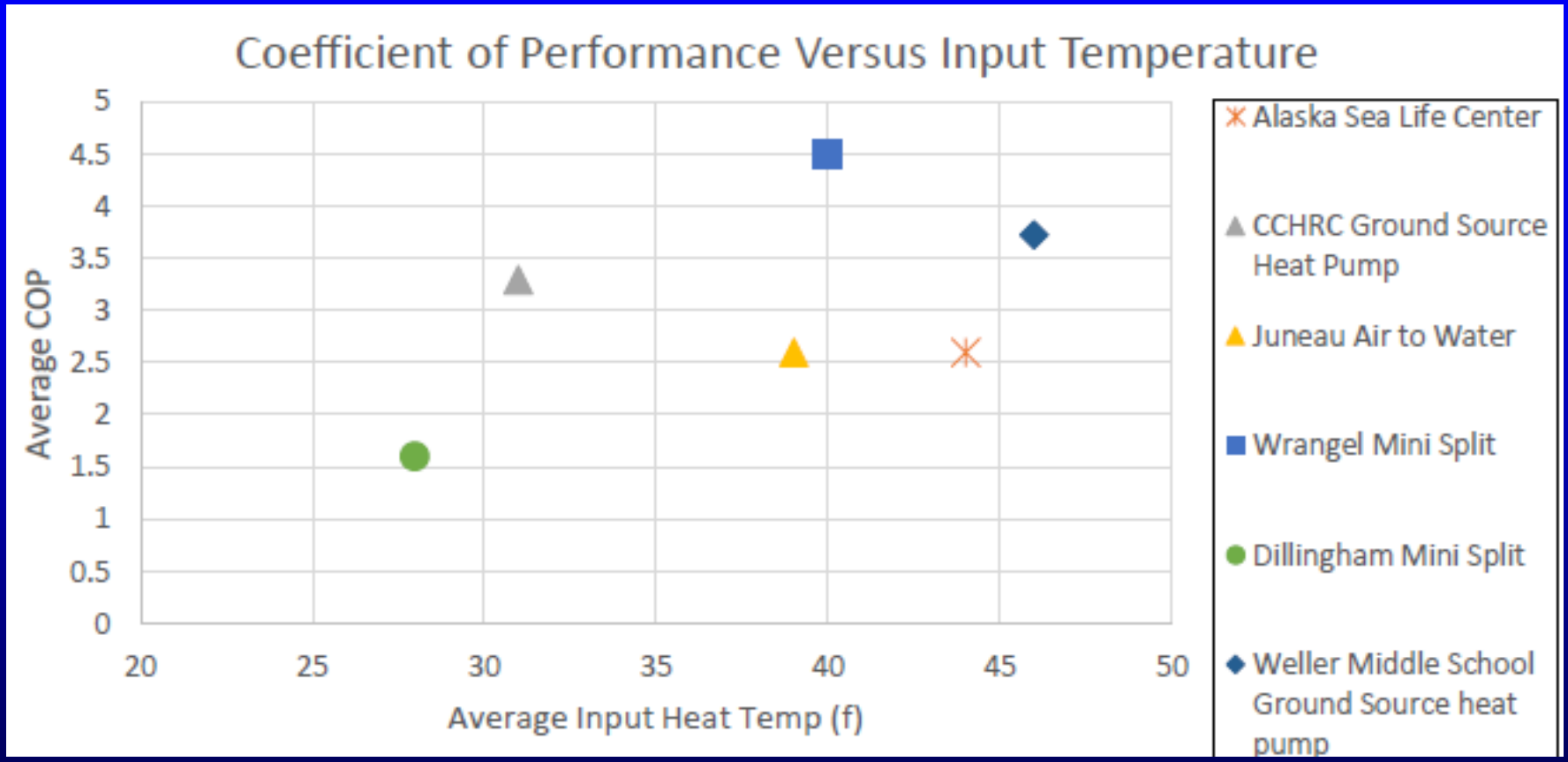
Note: Heating Seasonal Performance Factor (HSPF) = 3.41 × seasonal COP

Comparison by installed cost



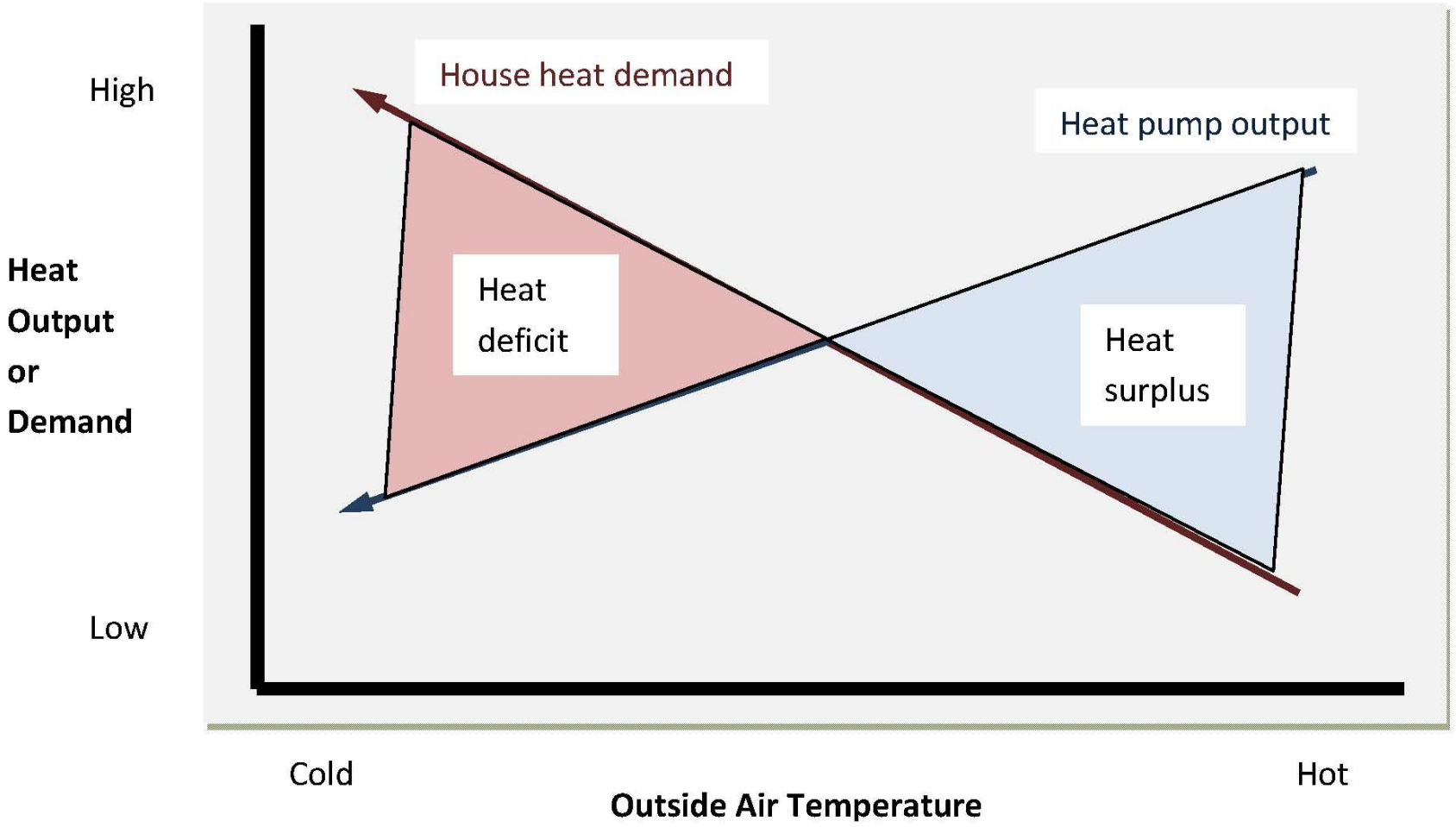
Source: ACEP, Alaska Energy Technology Reports

Comparison by efficiency



Source: ACEP, Alaska Energy Technology Reports

Air-Source Heat Pumps (ASHPs): 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 -

Partnership of:

CCHRC

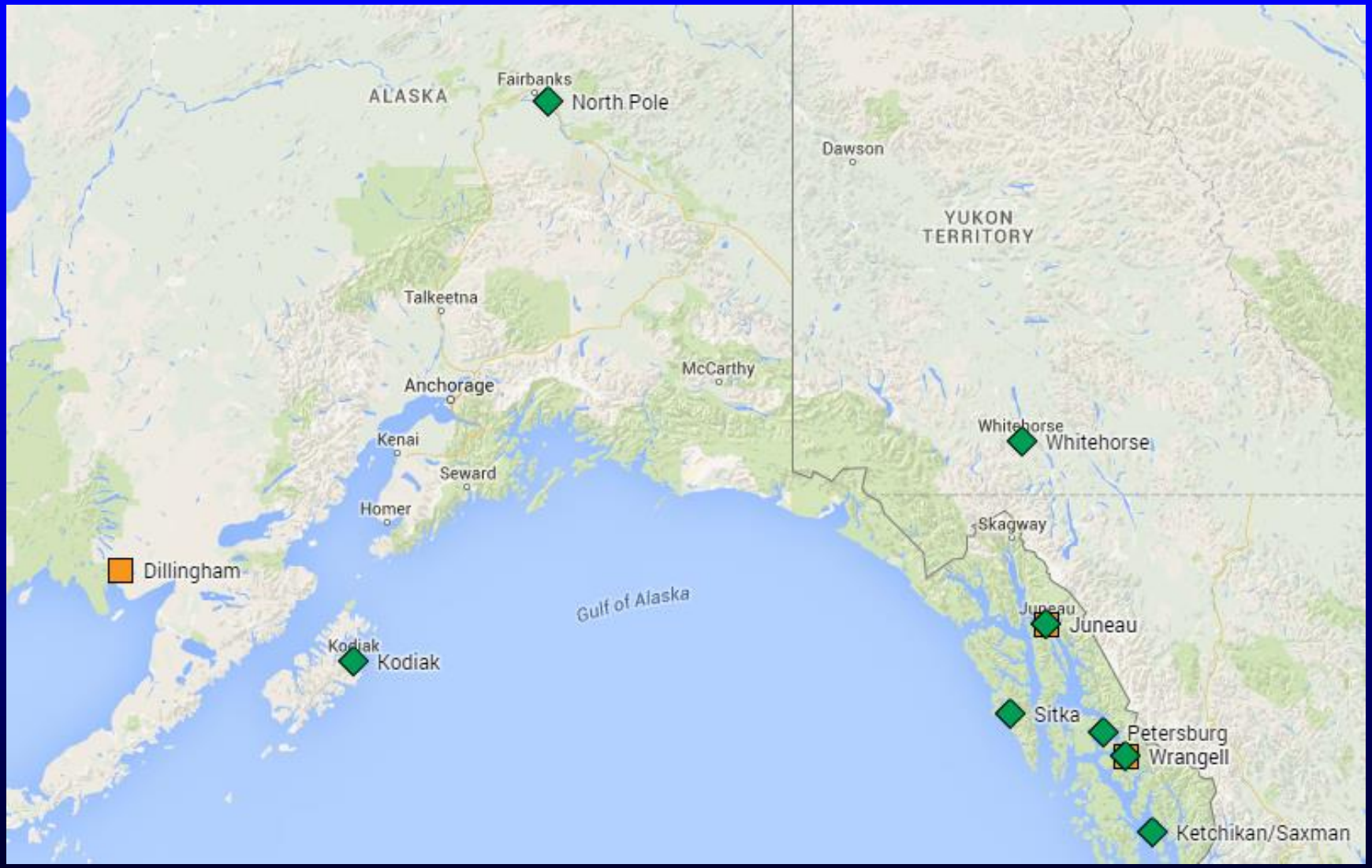
UAF Bristol Bay Campus

Wrangell Municipal Light & Power

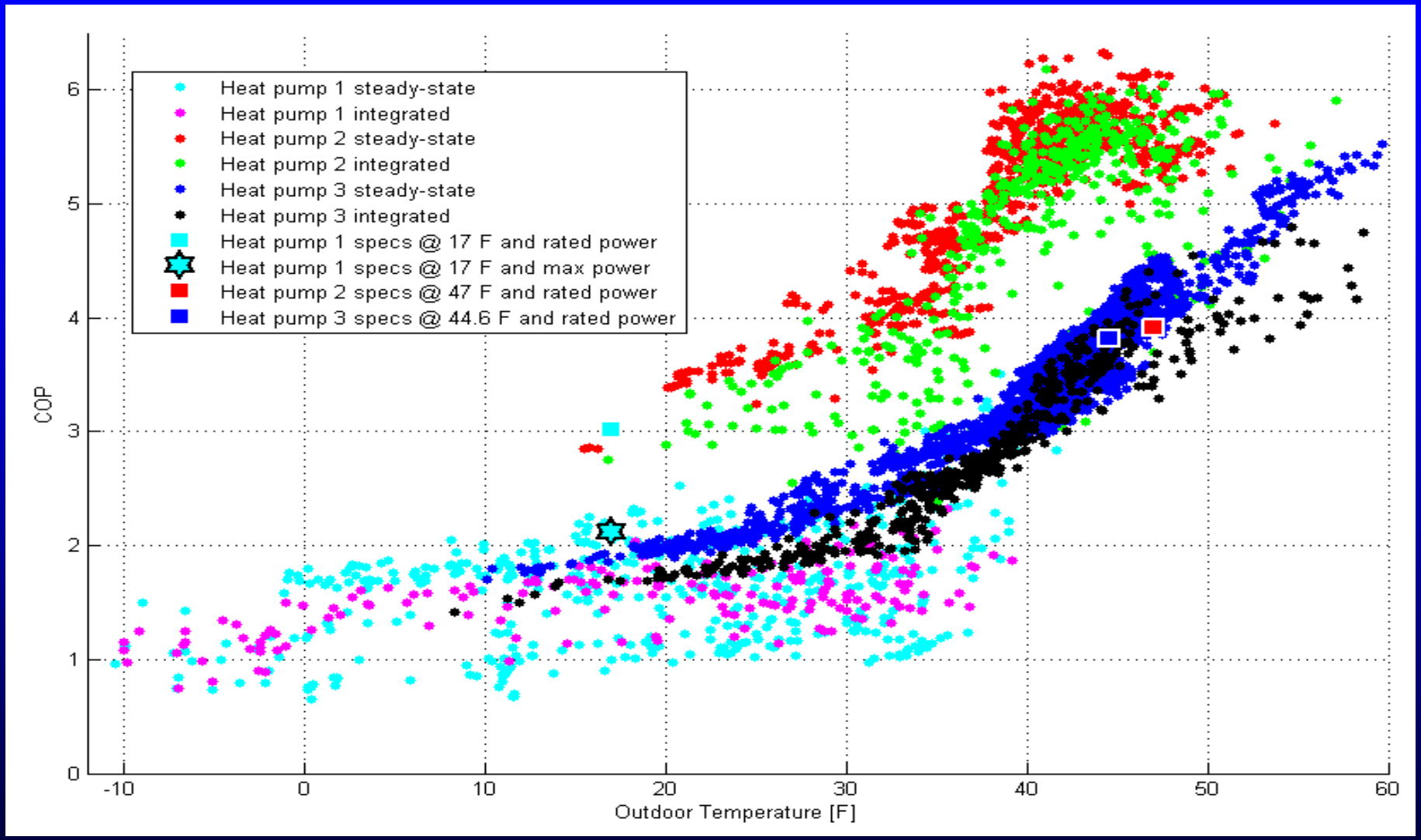
Main Objectives

- 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 on south-east Alaska)

Locations of ASHPs in the 2014-2015 study



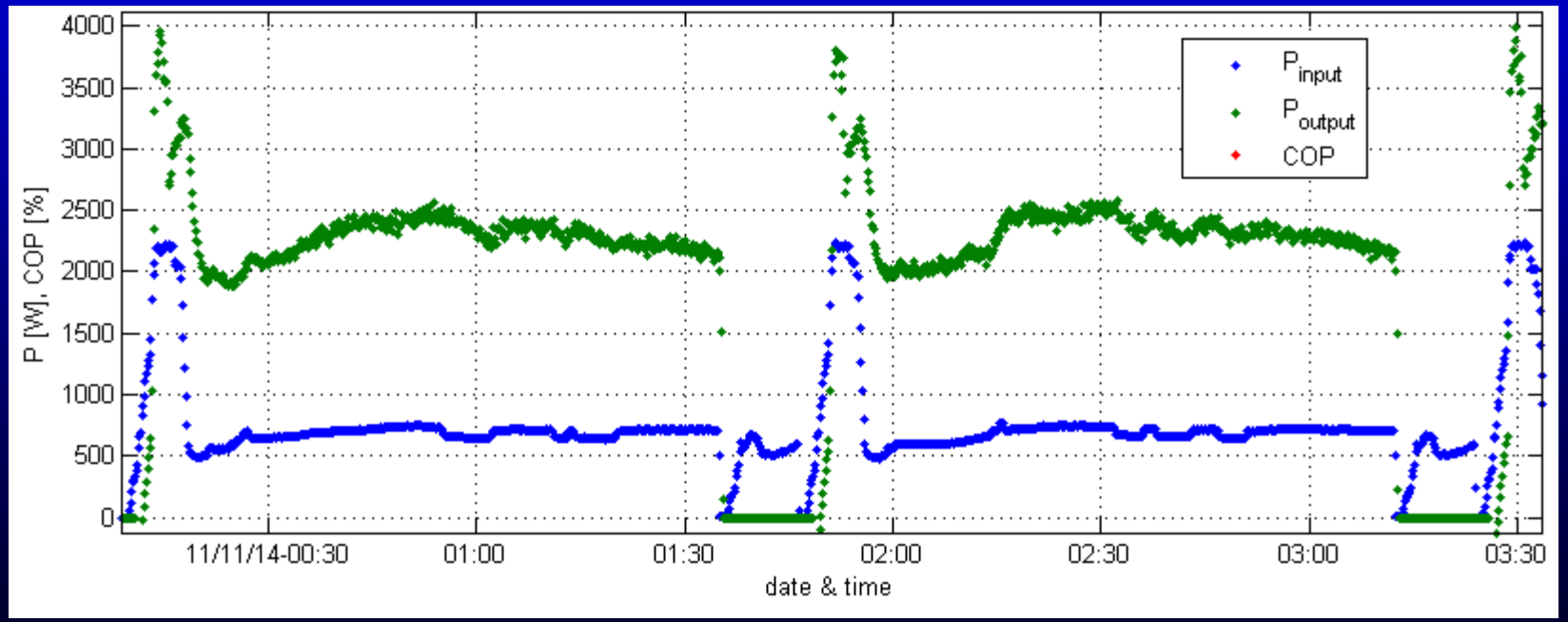
ASHP detailed monitoring - results



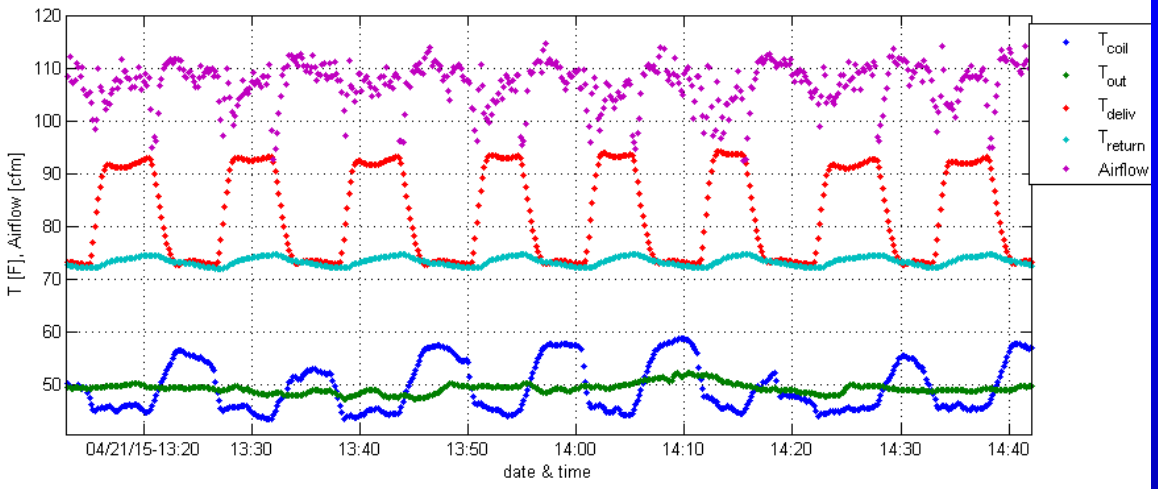
ASHPs detailed monitoring – general conclusions

- Manufacturer's specifications are not always correct
- 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

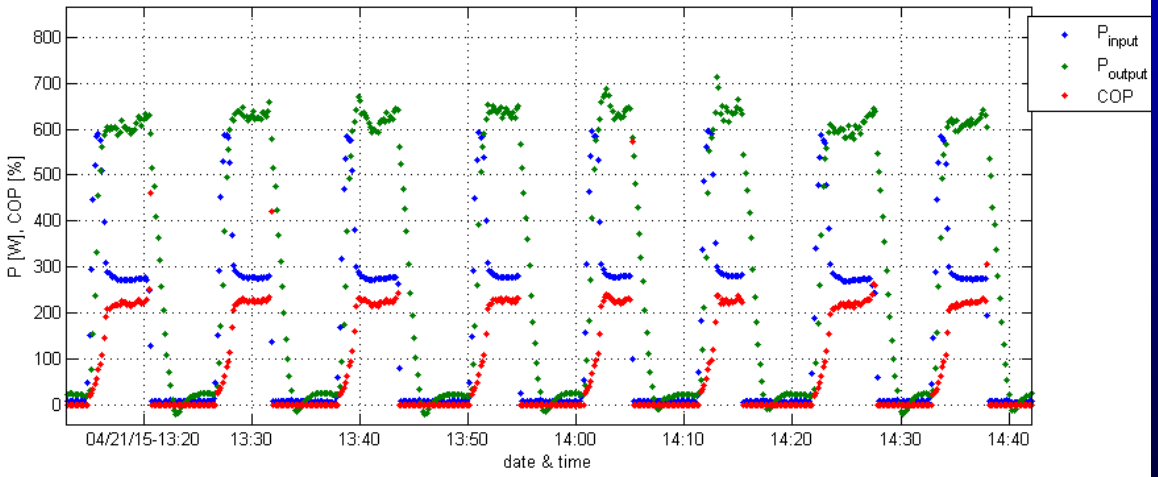
Cycling due to defrost



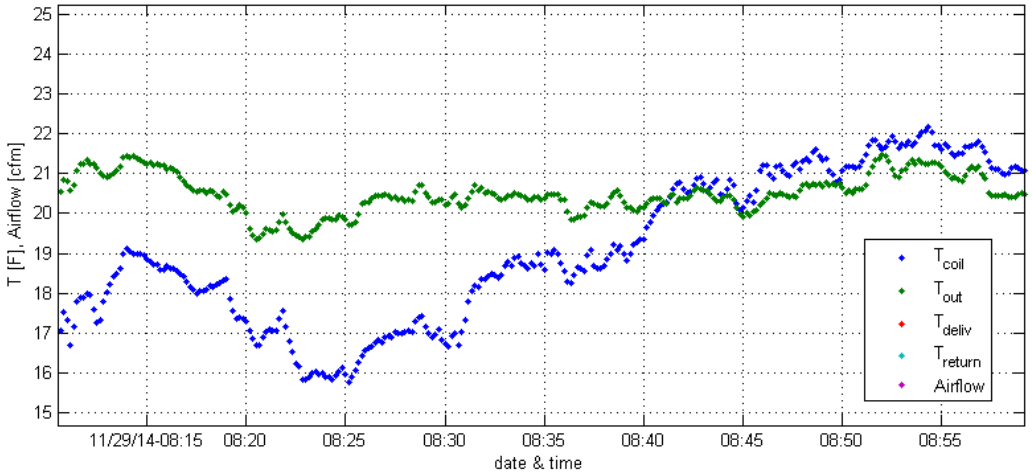
ASHP short-cycling in low-load conditions

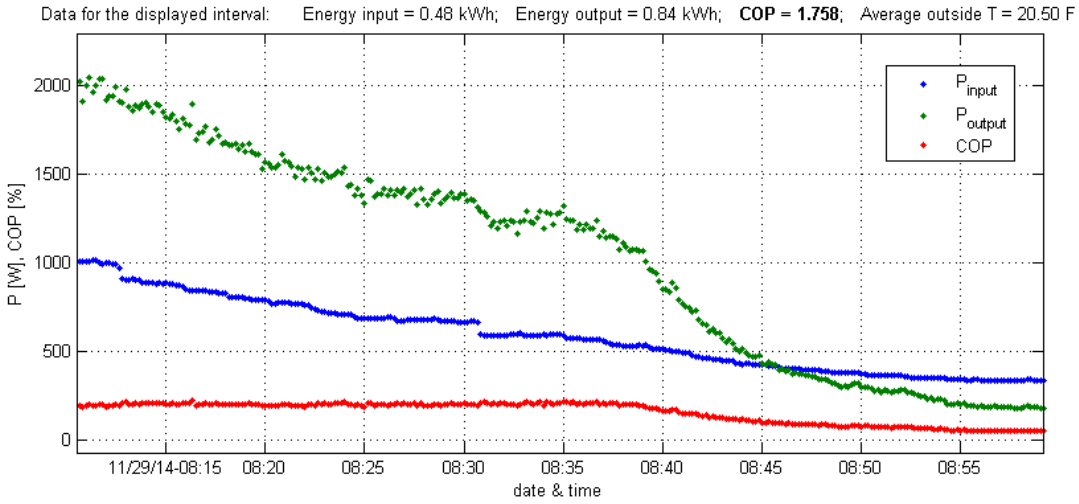


Data for the displayed interval: Energy input = 0.23 kWh; Energy output = 0.45 kWh; **COP = 1.935**; Average outside T = 49.39 F



Rare ASHP situation when COP drops below 1





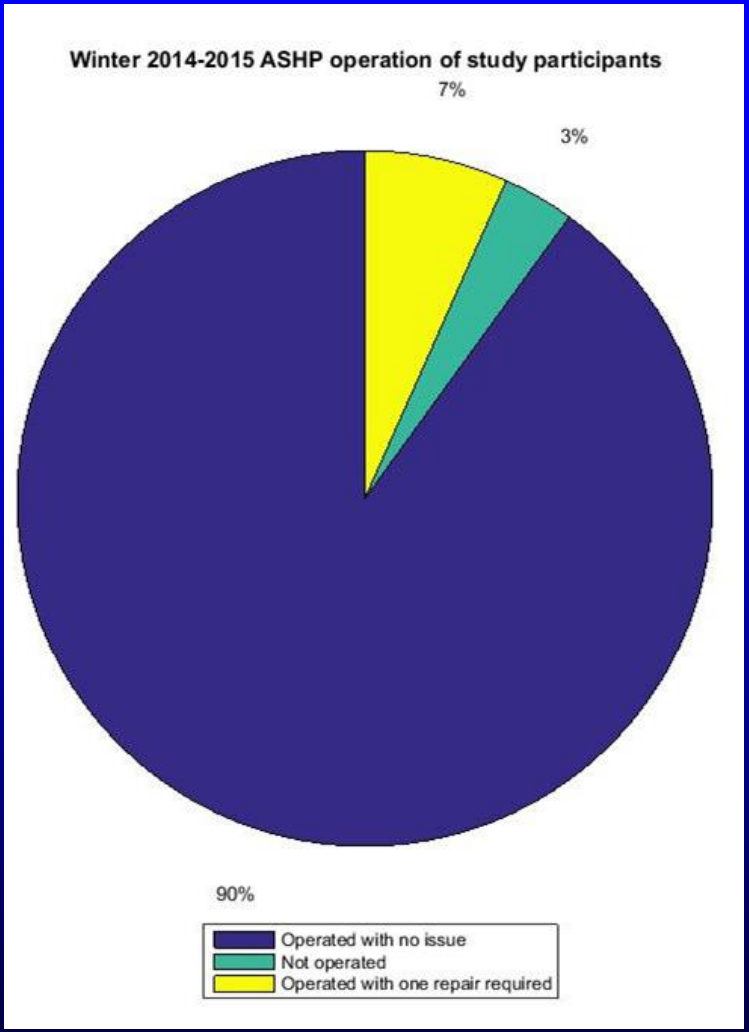
ASHP general monitoring - results

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)



ASHP general monitoring – cont'd

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

Main findings:

- Limited data does not confirm that ASHPs will 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.

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 a better understanding of the performance of current ASHPs to be able to inform decisions regarding operations and future installations in Alaska.
- System approach yields biggest savings.

Credits

Individuals:

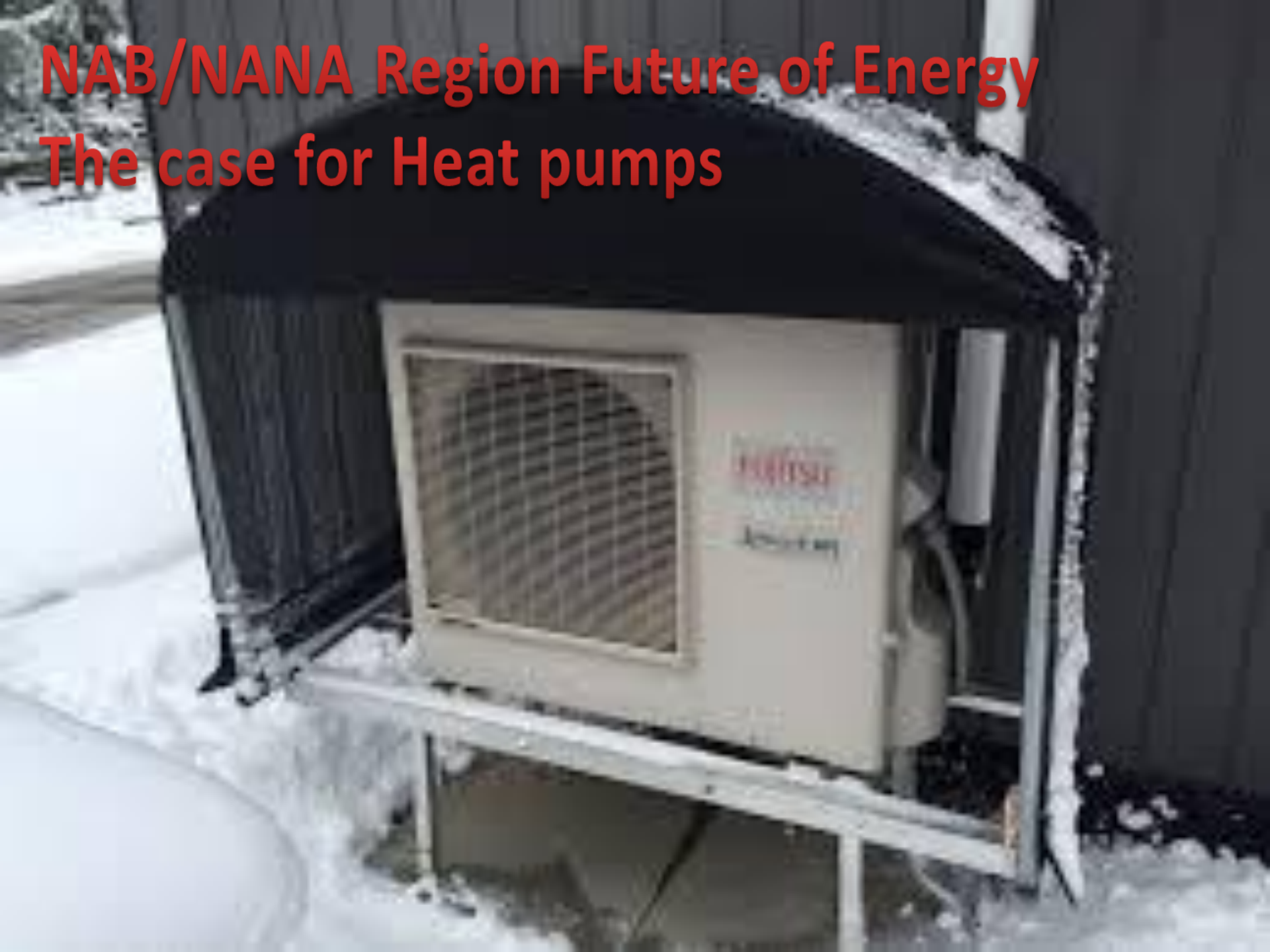
Colin Craven
Robbin Garber-Slaght
Bruno Grunau
Clay Hammer
Jim Rehfeldt
Chris Pike
Erin Whitney
Alan Mitchell
Dirk Baker
Others

THANK YOU!

Organizations:

Alaska Energy Authority
National Science Foundation
U. S. Dept. of Agriculture
Alaska Housing Finance Corporation
Alaska Center for Energy and Power
Others

NAB/NANA Region Future of Energy
The case for Heat pumps

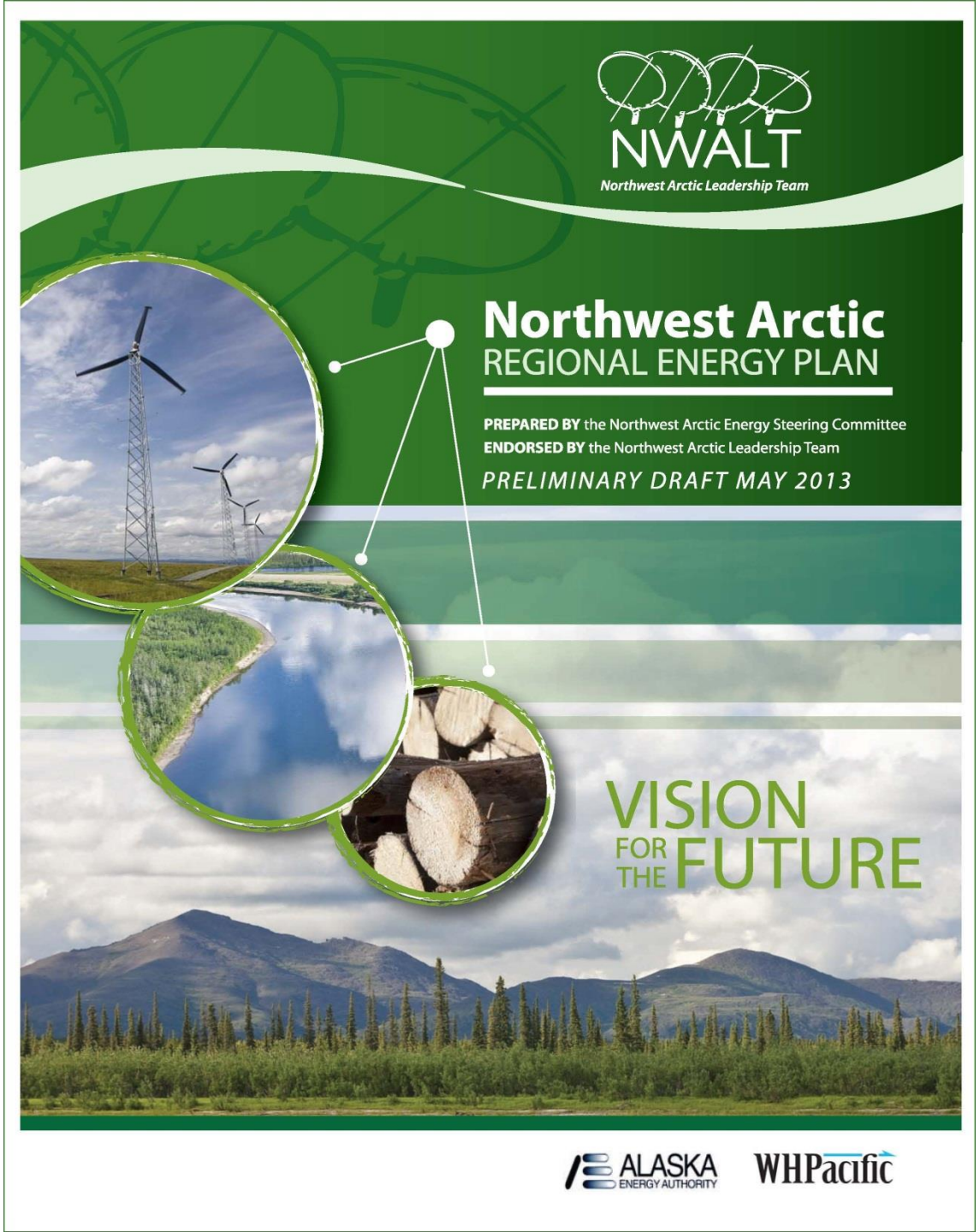


Energy planning background

Started in

2008-2009

Current version 2016 Available @ Nwabor.org



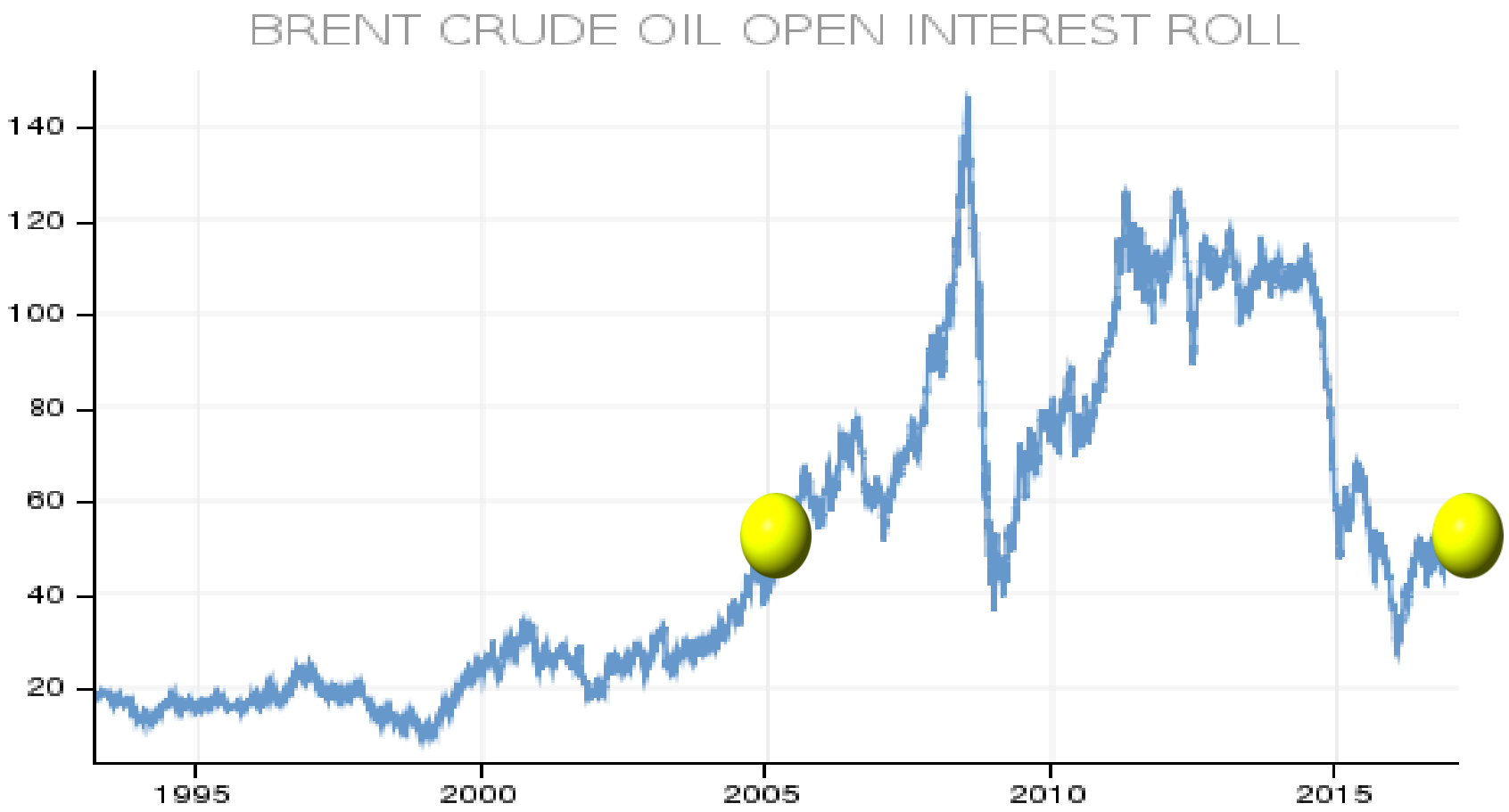
Energy Plan Vision

- **The vision is for the Northwest Arctic region to be 50 percent reliant on regionally available energy sources, both renewable and non-renewable, for heating and generation purposes by the year 2050.**

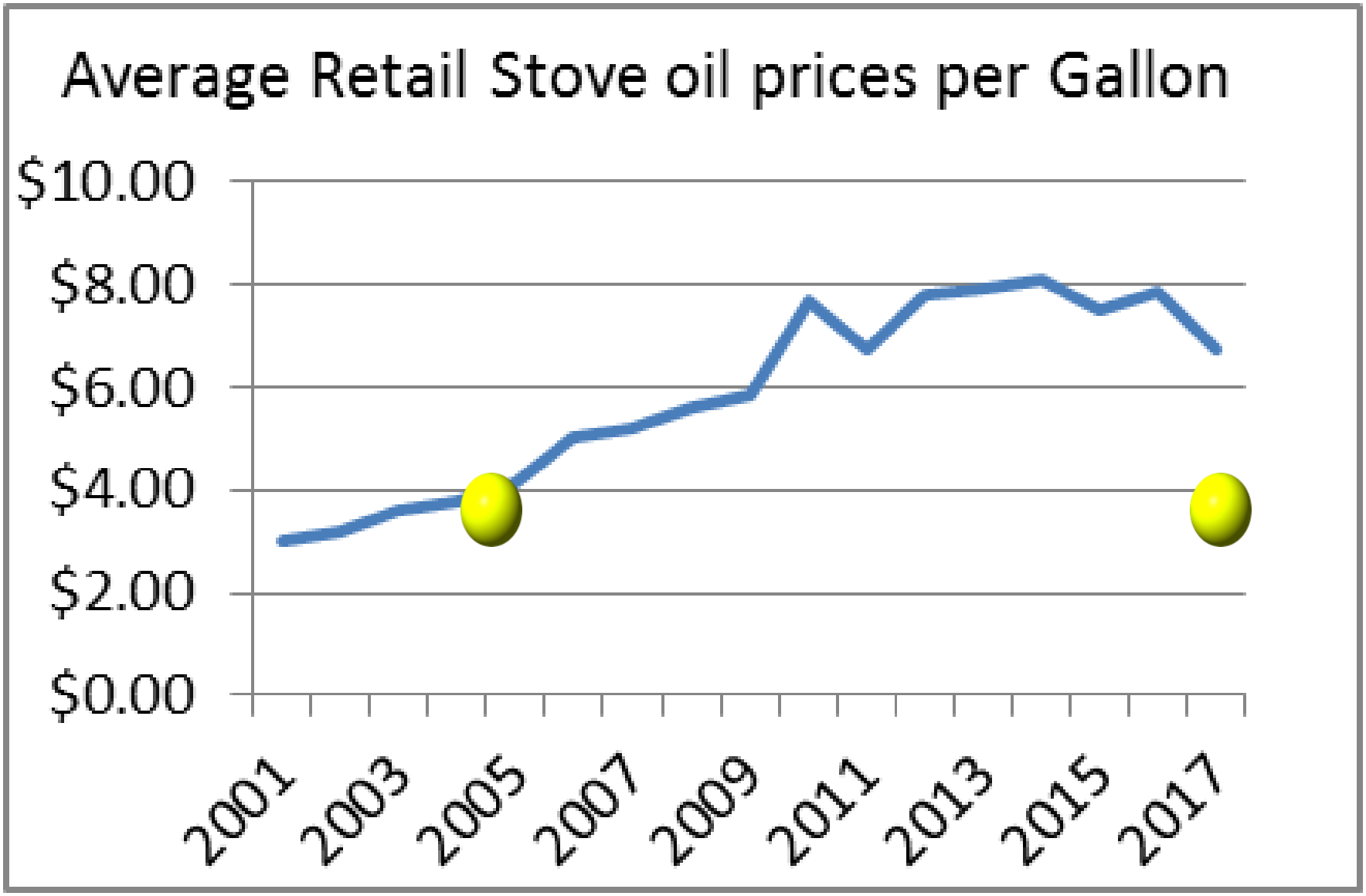
The progression is planned as follows:

- **10 percent decrease of imported diesel fuels by 2020 On track**
- **25 percent decrease of imported diesel fuels by 2030**
- **50 percent decrease of imported diesel fuels by 2050**

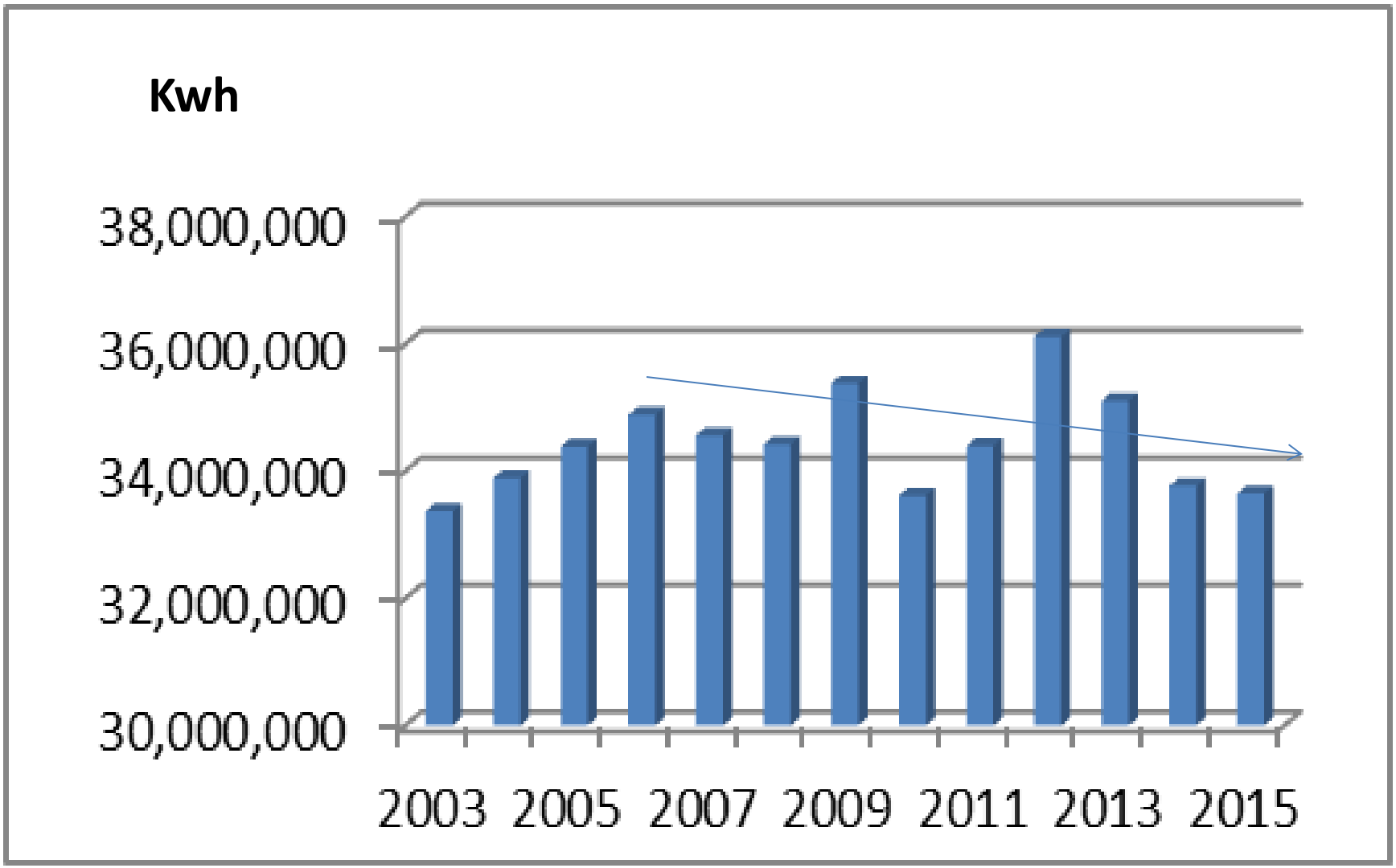
Historical Oil Prices



Regional Average Retail Stove oil prices over time



Electric usage Region wide



Regional Priorities 2017

- **Bulk Fuel Buying & Logistics & Storage (Regional approach)**
- **Regional funding Strategy (JAA or COOP)**
- **Upgrades of Bulk fuel farms and power plants**
- **Energy Education (Energy Smart)**
- **Heat Pumps**
- **Solar Energy**
- Interties
- Transportation
- Community Efficiency programs
- **Wind energy systems**
- **Biomass/Waste to Heat**
- **Hydro electric**
- **Combined Heat and power**
- **District energy distribution**

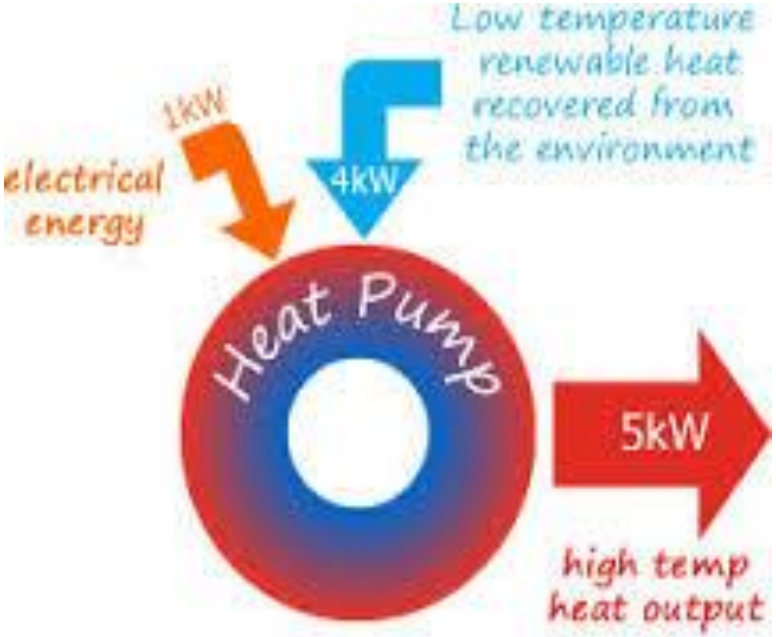
CIAP (Coastal Impact Assistance Program)

Energy Projects

Completed

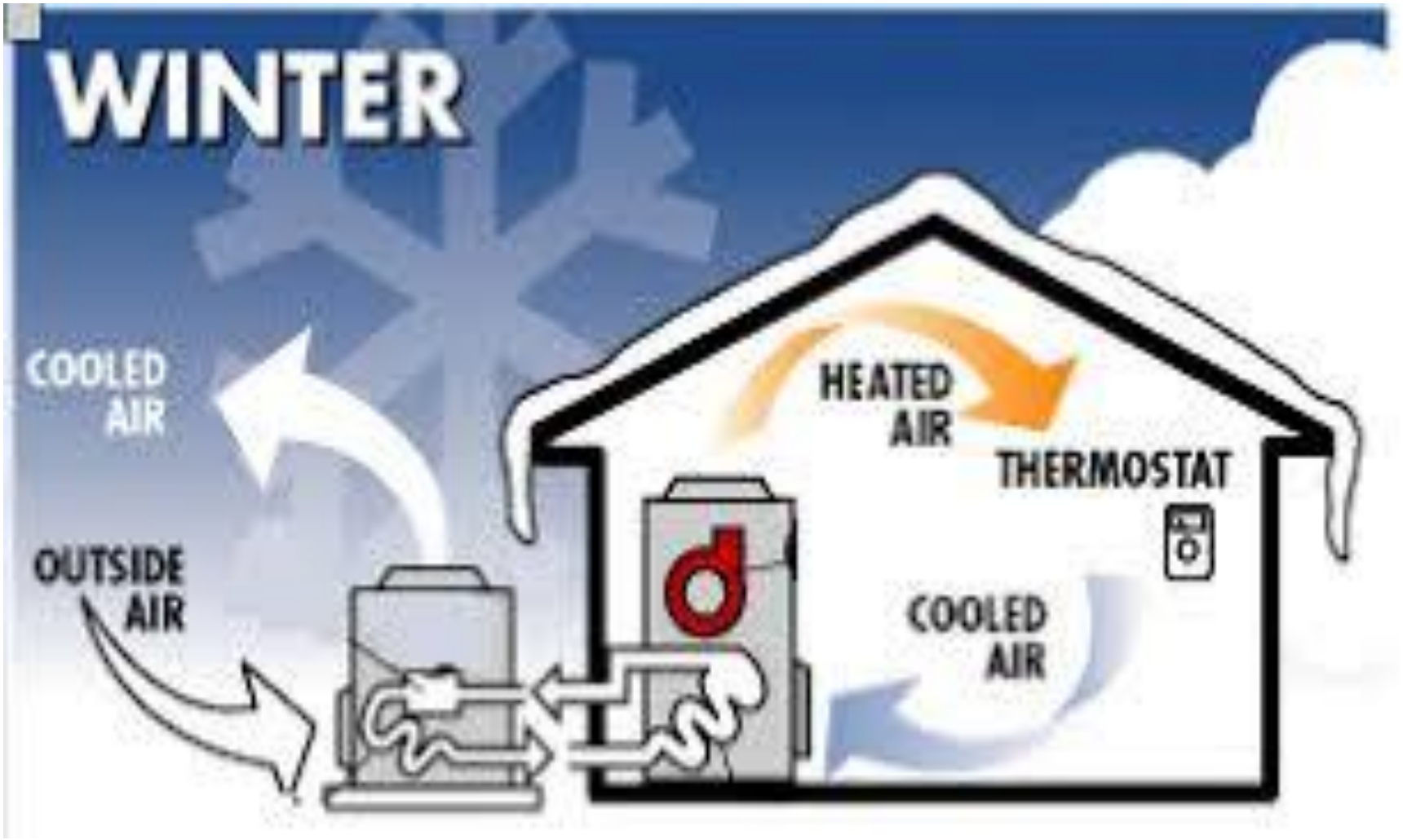
- 2010-11 TED and ECO Smart meter project
- 2011-16 Solar PV for all water plants
- 2016 Utility size Solar 23kw for Noorvik
- 2016- Air to Air Heat-pump pilot project
- 2016 -17 Hydroponic Van project

Introducing Heat pumps

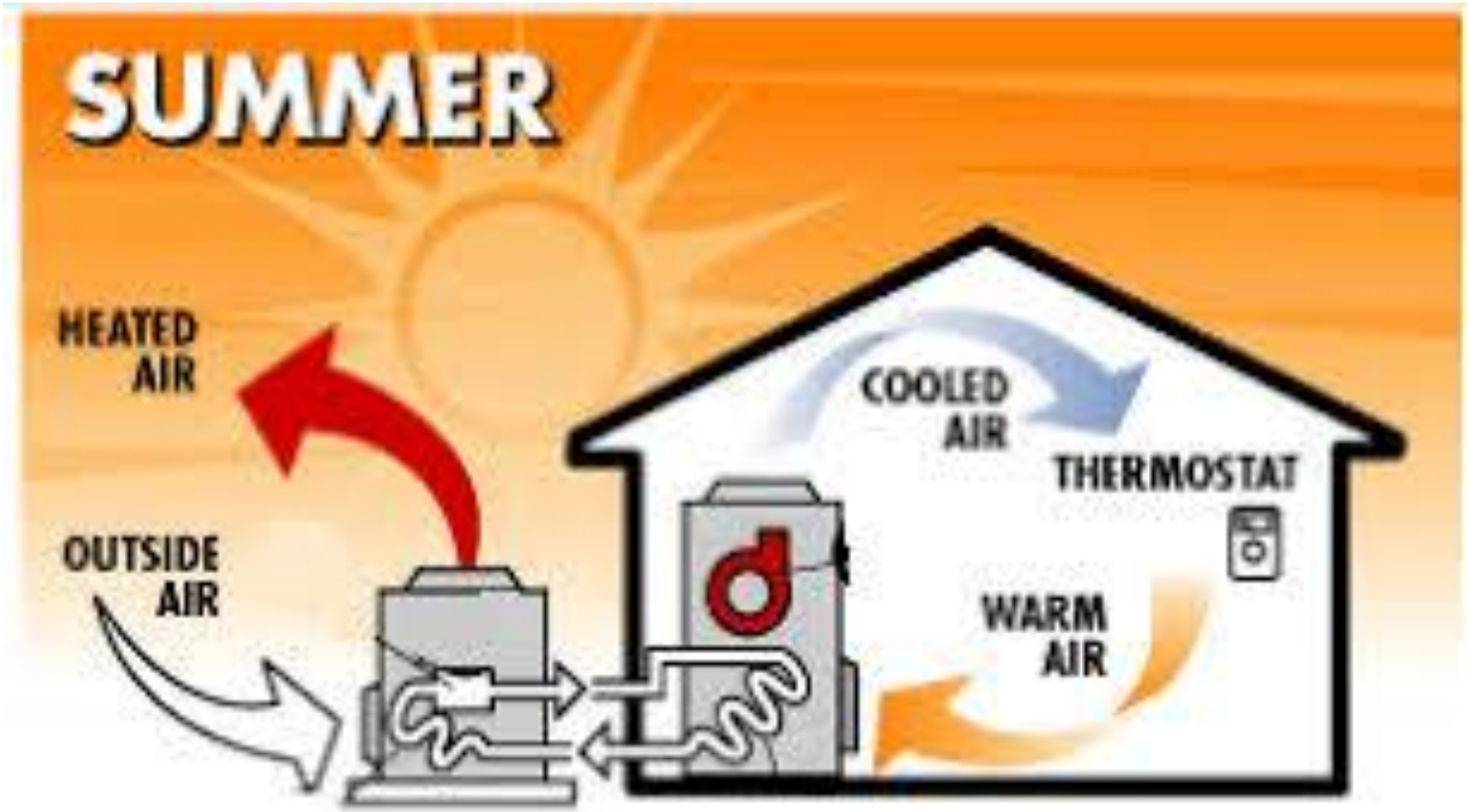


An example of COP

Winter cycle for Heating



Summer cooling cycle



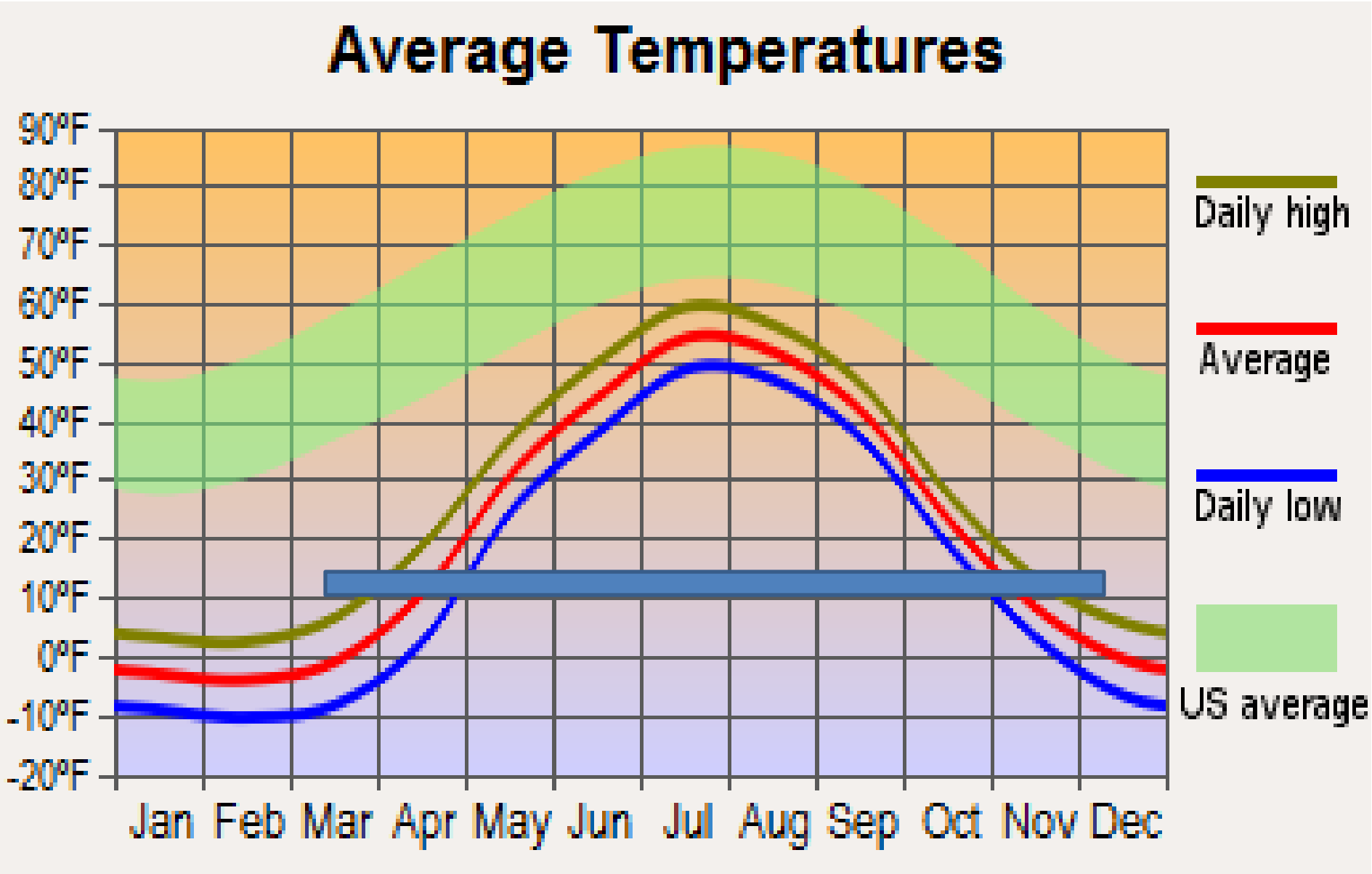
Heat pump Advantages

- **Low-cost heat** – The cost of heating with a heat pump is similar to heating with natural gas or wood. This is typically half the cost of heating with oil, kerosene, electric baseboard or propane to compare heating costs of different heating systems.
- **Low-cost air conditioning** – Today's best heat pumps are twice as efficient as typical air conditioners.
- **Comfort** – With advances in controls, heat pumps can maintain very constant temperatures.
- **Safety** – Because heat pumps are electrically powered, there is no risk of combustion gas leaks.
- **Air quality** – Heat pumps filter air as they heat/cool/dehumidify it.
- **No CO2 emissions** – Cleaner environment and resilience to Global Warming.

Heatpump disadvantages

- **Cold temperature performance** –
- As outdoor temperatures drop, so does the efficiency of an air-source heat pump.
- COP needs to be utilized above +10 F
- At this time they will not work below -20F.

Kotzebue Yearly Temp.



Heat pump Cost and Value (Initial Calculations)

Noatak, Ambler or Shungnak

- **Cost of a 19 Seer/11 HFPS Ductless Heat-pump would be approximately $ 5,000.00**

Comparison to Toyostove Diesel Heat
@ $10.00/G and 60 MBTU

- @ $ 0.20/Kwh savings over **6 months** compared to Diesel could be up to **$ 3,865.00**
- This is using the first 500 Kwh under PCE.

- @ $ 0.70/Kwh savings over **6 months** compared to Diesel could be about **$ 1,136.00**

	Gas/G	Stove Oil/G	Kwh (PCE)	Kwh (501-
Kotzebue	$5.15	$5.04	$0.18	$0.45
Ambler	$9.10	$9.50	$0.21	$0.61
Kobuk	$8.00	$7.50	$0.21	$0.60
Shungnak	$8.25	$8.25	$0.21	$0.60
Kiana	$6.00	$5.50	$0.20	$0.57
Noorvik	$5.83	$5.42	$0.20	$0.57
Selawik	$7.50	$8.28	$0.20	$0.52
Buckland	$6.80	$6.80	$0.20	$0.48
Deering	$4.50	$4.25	$0.32	$0.71
Kivalina	$4.85	$4.40	$0.20	$0.56
Noatak	$9.99	$8.99	$0.21	$0.75

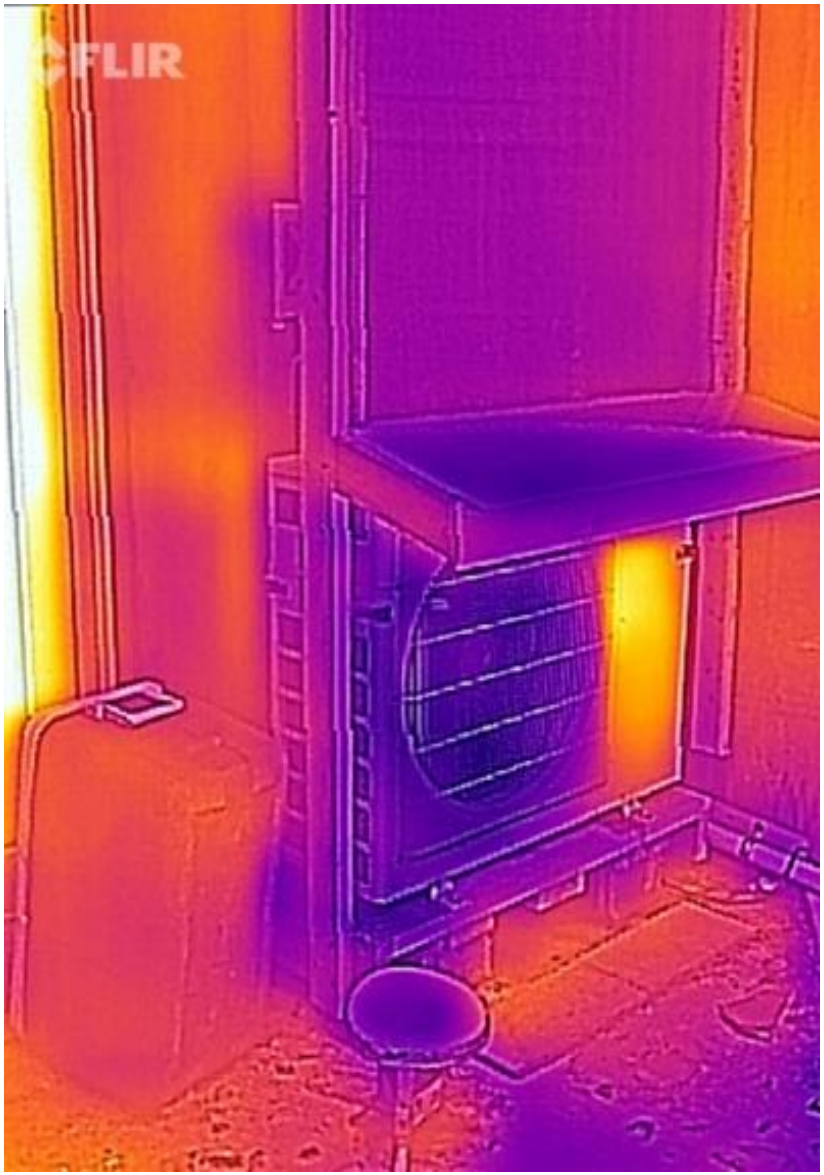
Panasonic CU-4E24RBU - 24,000 BTU

Ductless Heat Pump System - Wall Mounted - 19.2 SEER - 11 HSPF

13 Air to Air Heat-pump installations Pilot Project- CIAP Funded.

Outdoor unit open

Thermal Pics.



A warm room will now welcome us
when we come to work in the morning. Thank you!
Janet Mitchell, Administrator
Kivalina City Council

First one is the bedroom and the next is in the living room. Thanks .
Went home and the floor was nice
and warm.
Daisy Weinard, General Manager
Ipnatchiaq Electric Company

Cooling tent for Meat

Results so far

The units was operated
September-October 2016

Keep in mind the savings calculated
are for the Households
and City Buildings

Untapped PCE 2014

Utility	PCE Eligible kWh Region wide 2014 Residential		left over		Community		left over	%	
AVEC	Facilities	used	available	value	Facilities	used	available		value
Ambler	486000	309006	176994	$98,904.25	227640	204139	23501	10.32376	$13,132.36
Kiana	726000	432836	293164	$132,187.65	321720	218384	103336	32.11986	$46,594.20
Kivalina	510000	396682	113318	$50,075.22	337680	118477	219203	64.91442	$96,865.81
Kobuk	210000	147719	62281	$38,346.41	118440	55951	62489	52.76005	$38,474.48
Noatak	702000	606078	95922	$63,711.39	477120	223474	253646	53.16189	$168,471.67
Noorvik	804000	649954	154046	$69,166.65	525840	366173	159667	30.36418	$71,690.48
Selawik	1074000	797514	276486	$113,635.75	719040	550009	169031	23.50787	$69,471.74
Shungnak	378000	290358	87642	$53,961.18	225960	137886	88074	38.9777	$54,227.16
	0		0	$0.00	0		0		$0.00
Buckland	588000	448460	139540	$35,136.17	380520	32283	348237	91.51608	$87,686.08
Deering	282000	152943	129057	$57,559.42	119280	108793	10487	8.791918	$4,677.20
Kotzebue	6276000	3716281	2559719	$692,659.96	2719080	1621262	1097818	40.37461	$297,069.55
		Kwh	4088169			Kwh	2535489		
		Value $		$ 1,405,344.06				value $	$948,360.73

This is 2,044 Kwh and $ 700.00/household that is not claimed

Ambler House Results

- Month Usage Cost/Kwh Total
- August ,, No Heat pump $ 0.247 $ 0
- Sept. 304 Kwh $ 0.286 $ 86.88
- Oct. 342 Kwh $ 0.304 $ 104.10
- Pump operated until 1th November

- Cost per Kwh increases the more the Heat-pump is used.
- Stove oil is $ 9.50/Gallon
- October was heated by an equivalent cost of 11 Gallons But AVEC used 24.4 G to produce the 342 KWh

Noatak House Results

Month	Usage	Cost/Kwh	Total
August	489 Kwh	$ 0.254	$ 22.82
Sept.	765 Kwh	$ 0.453	$ 165.30
Oct.	930 Kwh	$ 0.519	$ 274.93

- Pump operating on and off through winter.

- Cost per Kwh increases the more the Heat-pump is used.
- Stove oil is $ 8.99/Gallon
- October was heated by an equivalent cost of 30.6 Gallons
- But AVEC used 66.4 G to produce the 930 KWh

Kivalina City results

- Month Usage Cost/Kwh Total
- August ,, No Heat pump $ 0.222 $ 0
- Sept. 161 Kwh $ 0.217 $ 35.08
- Oct. 466 Kwh $ 0.210 $ 97.93
- Pump operated until 20th November

- Cost per Kwh decreases the more the Heat-pump is used as long as there is PCE available.
- Stove oil is $ 4.40/Gallon
- October was heated by an equivalent cost of 22 Gallons
- But AVEC used 33.3 G to produce the 466 KWh

Kiana City results

Month	Usage	Cost/Kwh	Total
July	114 Kwh	$ 0.211	$ 24.06
August	170 Kwh	$ 0.222	$ 35.90
Sept.	590 Kwh	$ 0.201	$ 118.51
Oct.	939 Kwh	$ 0.193	$ 181.47

- Pump operated until 1 th November

- Cost per Kwh decreases the more the Heat-pump is used as long as there is PCE available.
- Stove oil is $ 5.50/Gallon
- October was heated by an equivalent cost of 33 Gallons
- But AVEC used 67 G to produce the 939 KWh

Return on investment @ Ambler

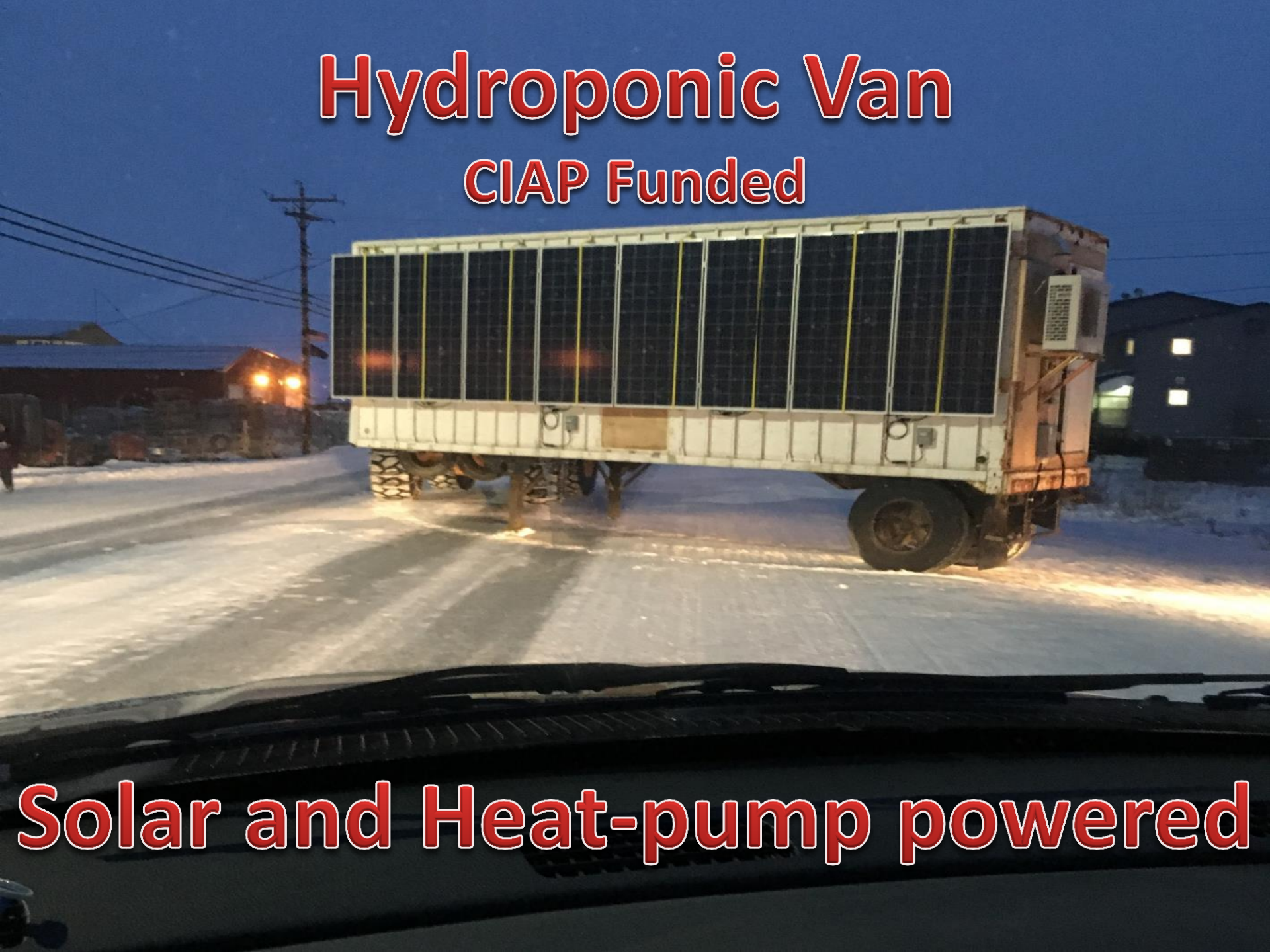
- **2-5 year payback**
- **Benefit to cost ratio of 2 to 6, depending on cost of electricity and Diesel fuel.**
- **$22,500.00 savings/ Household @ $ average $ 1,500.00/year over 15-year lifetime.**
- **150 Gallons of Diesel not needed per Household/year**
- **Total amount of Diesel not needed for 81 Households over 15 Years; 182,250 Gallons**
- **Total savings on project for 81 Households,**

  $ 1,822,500.00

Regional Return on investment

- Assume 2000 Households region wide
- Savings/household and year.
  @ a conservative $ 1,000.00 average
- Payback average 4-5 years
- 15 year lifespan on equipment.
- Total savings for the Region as a whole
- $ 30,000,000
- 4.5 Mil gallons of Diesel not needed for heating.

- And we can also use it for Community buildings


Hydroponic Van
CIAP Funded
Solar and Heat-pump powered

eco-friendly
CO_2 hot water solution

HOMEOWNERS ENJOY:

A better supply of hot water
Low environmental impact
Lower monthly utility bills
Whisper quiet operation
Cool climate performance down to -15F

Sun Bandit® Solar Hybrid Energy Systems

Sun Bandit® is a revolutionary new way in which solar is used to heat water. This innovative new technology utilizes PV technology to deliver clean, reliable hot water by putting the free energy of the sun to work for you

30%

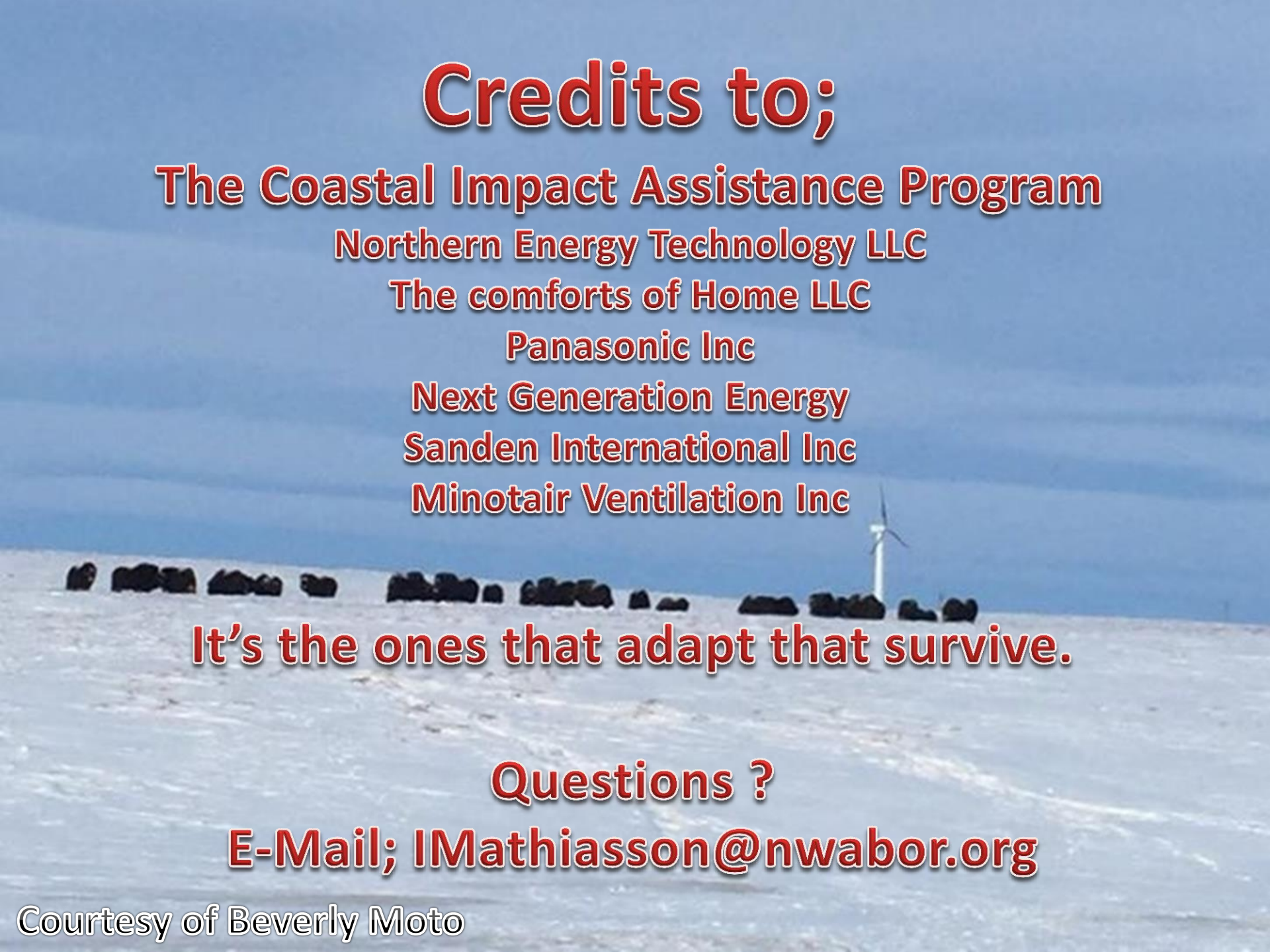
Tax Credit

Minotair Heat exchanger

The MINOTAIR is a multifunction unit:

- **Ultra efficient Air Exchanger!**
- **HEPA Filtration!**
- **Dehumidifier – without the heat!**
- **Self-contained Heat Pump!**
- **Even serves as thermostat/humidistat for your furnace, air conditioner and central humidifier!**

Inside the Hydroponic Van


Credits to;
The Coastal Impact Assistance Program
Northern Energy Technology LLC
The comforts of Home LLC
Panasonic Inc
Next Generation Energy
Sanden International Inc
Minotair Ventilation Inc
It’s the ones that adapt that survive.
Questions ?
E-Mail; IMathiasson@nwabor.org
Courtesy of Beverly Moto