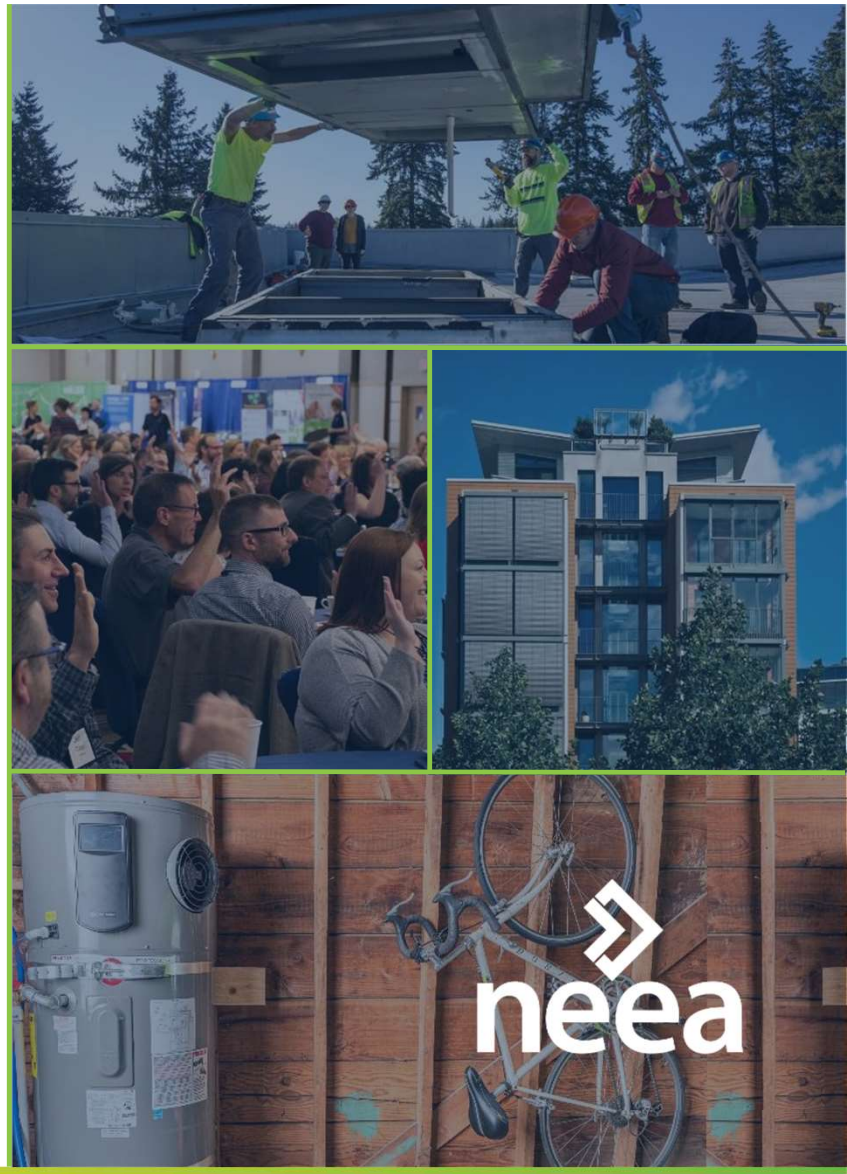
Products Coordinating Committee

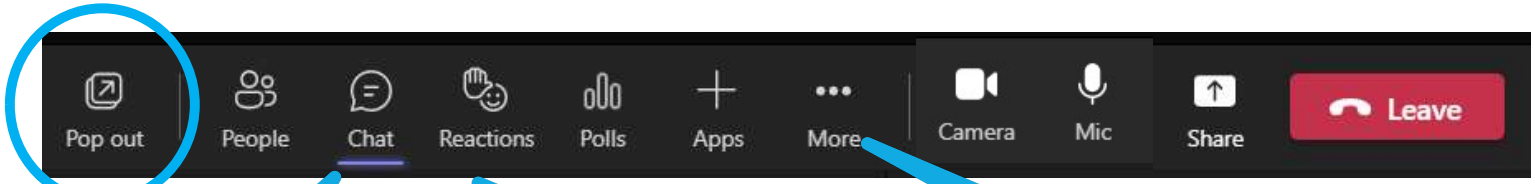


Q2 2024 Meeting

Day 1
Monday, June 24, 2024
12:30 – 4:10 pm, Pacific Time

This meeting will be recorded and transcribed

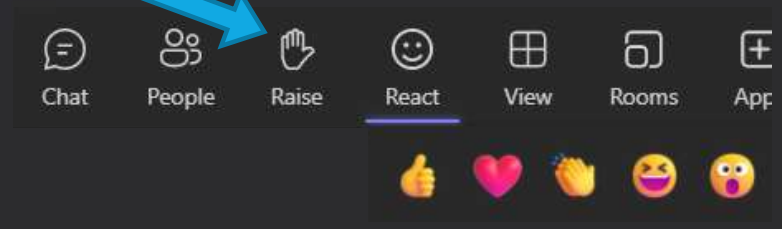
Tools for Today: Engaging on Teams



The chat is not captured in the recording.

Do you have any accessibility challenges with this technology today?

Comments/Questions?
Please raise your virtual hand or chime in
Chat & reactions also welcome



"…" More includes:

- ✓ Settings: mic & video
- ✓ Background effects

Heads up:

"Spotlighting" Speakers

Collective Role – Working Together

- Share your organization's activities
- Come prepared to actively participate
- Be transparent
- Identify any potential conflicts/challenges
- Flag any potential opportunities to leverage
- Be present in the conversation and stay flexible

AGENDA

All times Pacific

12:30 -1:00 pm (30 mins)	**Welcome, Agenda, Packet Review & Introductions**
1:00 - 2:30 pm (90 mins)	**Regional Priority Topic** • **Advanced Heat Pumps** – *Coordination on planned or ongoing field studies/pilot studies/data collection*
2:30 – 2:40 pm	***BREAK***
2:40 – 4:00 pm (80 mins)	**Regional Roundtable**
4:00 – 4:10 pm (10 mins)	**Recap, Next Steps, Adjourn**

Packet Review & Informational Updates

- Tier 1: Agenda Items
  - ✓ *Memo: Coordination on planned or ongoing field/pilot studies/data collection (pg.5)*
  - ✓ *Memo: Heat Pump Measure Development updates by Regional Technical Forum (pg. 6)*
  - ✓ *Memo: Coordinating Committee Assessment (pg. 7-8)*
  - ✓ *Q3 Regional Priority Topic Check In; Heat Pump Water Heater (pg. 9)*
- Activity Reports
  - ✓ *Heat Pump Water Heater (pg. 12-15)*
  - ✓ *Advance Heat Pump (pg. 16-20)*
  - ✓ *Retail Products Portfolio (pg. 21-24)*
  - ✓ *High-Performance Windows (pg. 25-28)*
- Tier 3: Additional Resources *(links on pg. 3)*

  Committee materials (charters & recent meeting resources, functional newsletters (Market Research & Eval, Emerg Tech, Codes + Standards + New Construction)

Introductions

- **Name**
- **Organization**
- ***And…***

xx

AGENDA

All times Pacific

12:30 -1:00 pm (30 mins)	**Welcome, Agenda, Packet Review & Introductions**
1:00 - 2:30 pm (90 mins)	**Regional Priority Topic** **Advanced Heat Pumps** – *Coordination on planned or ongoing field studies/pilot studies/data collection*
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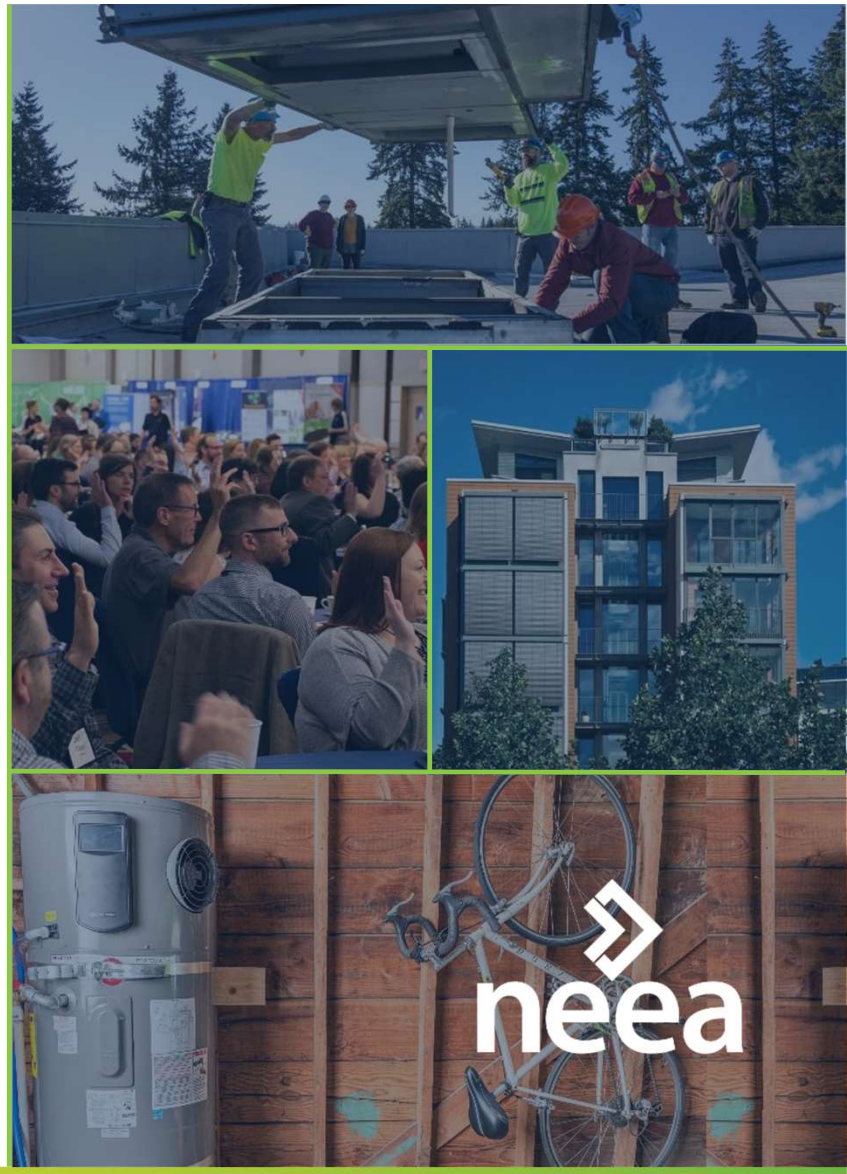
4:00 – 4:10 pm (10 mins)	**Recap, Next Steps, Adjourn**

Advanced Heat Pumps

Committee Presentation on planned or ongoing field studies/pilot studies/data collection

6/24/2024



Desired Outcomes

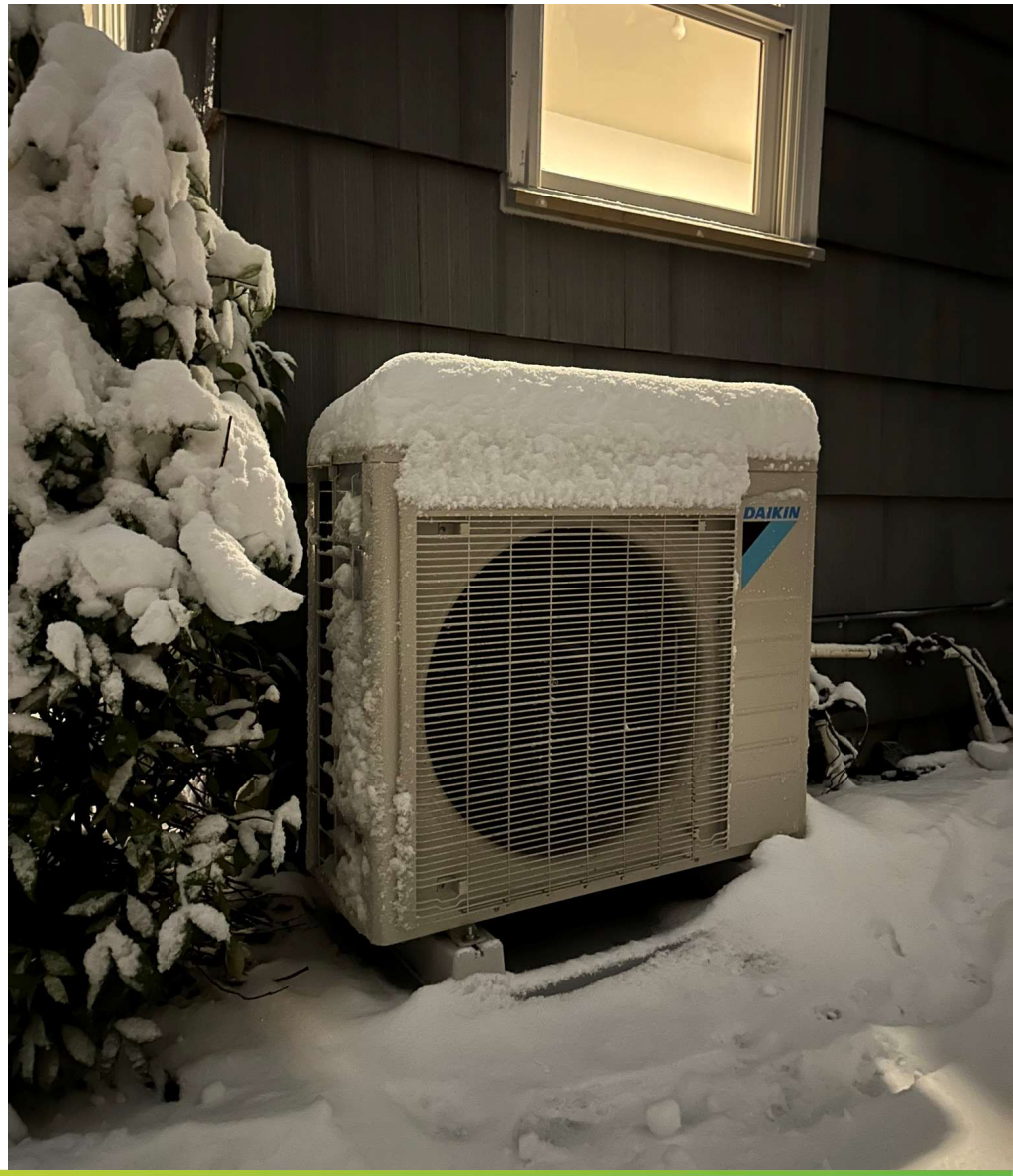
- Build awareness of regional research and findings
- Uncover duplicative efforts
- Gain input from peers
- Open opportunities for collaboration or co-investment

Today's Presenters and Topics

ORG	PRESENTER	TOPIC
Chelan	Josh Mitchell	Heat pump update
Avista	Leona Haley	Hybrid and cold climate heat pump pilot
Emerald PUD	Tyler Boehringer	Measure Cost Effectiveness Calculator
Energy Trust	Andrew Shepard	Heat pump research
BREAK	BREAK	BREAK
PSE	Will Dixon	Heat pump research
Tacoma Power	Rich Arneson	Heat pump research
BPA	Nathan Kelly	High Performing Heat Pumps
NEEA	Christopher Dymond	Low Load Efficient lab research Cold climate room HP field research

Keeping on Track

- Speakers: Keep brevity in mind
- Audience: Questions in chat. (Identify which speaker or org your Q is directed towards)
- Follow up questions at the end if time allows

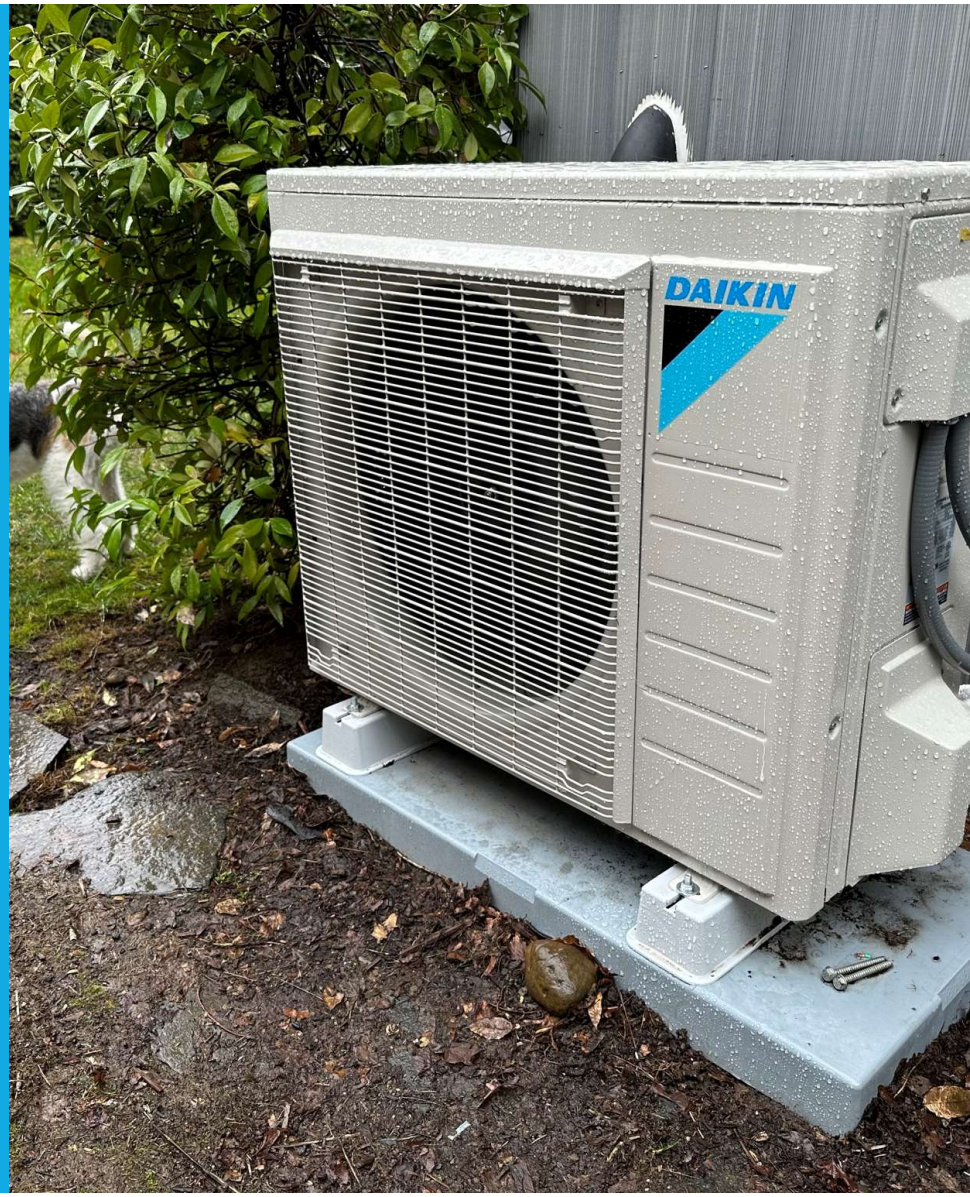


 |

Chelan PUD

Josh Mitchell

josh.mitchell@chelanpud.org



Chelan Co PUD Heat Pump Update

6/24/2024

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Current State of HP Affairs

- Rebate offering of **$3500/$4000**(variable)
  – How do we come up with these numbers?

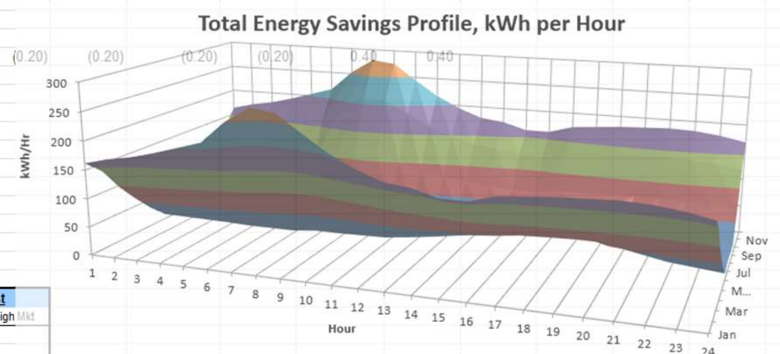
Program:	31	Variable Speed Heat Pumps with PTCS Single Family - Existing PTCS Conversion of Electric FAF to Heat Pump Baseline: Electric Forced Air Furnace w/ Air Conditioning				
Quantity	140	PUD rate schedule	Residential, Sch. 1			
Units	Each	Retail rates, $/kWh	$ 0.0270	Incentive Rate = $0.680 per kWh		
Energy savings per unit, kWh/Unit	5,885	Retail demand charge, $/kW	$ -			
Energy savings w/o take-back, MWh/Yr	823.84	Retail rate increase	0.2%	(0.80)	4	(0.20)
Take-back / rebound effect	0%	Discount rate, PUD	7.0%	292.80	31	0.40
Cost per unit	$9,622.17	Discount rate, Customer	7.0%	-0.273%		
Total installed cost	$1,347,104	Discount rate, Society (7th Pwr Plan)	7.0%	(9.6)		
Financial incentive per unit	$4,000.00	Inflation	2.5%			
Total incentive amount	$560,000	Post mkt forecast escalation, %	3.0%			
Service life, yrs	15	Forward mkt update	12/26/23			
PUD meter and verify costs	$0	Measure's calculated peak kW-Yr	450.6			
First year PUD admin. costs	$0	Local distribution system credit	$66.00	$/kW-Yr		
Customer O&M costs (savings) per Unit	$0.00	Capacity and resource adequacy credit,	$72.80	$/kW-Yr		
Societal benefits (cost) per Unit	$0.00	% of added capacity value (100%=All, 0%=None)	70%			
Environmental benefits (cost) per Unit	$0.00					
$145.93	Levelized Value of Wholesale Energy, $/MWh = NPV (Wholesale Energy+Capacity+Carbon Free) / NPV (Total MWh/Year w Take-Back)					

	Customer			PUD with Rate Impact			Utility's Cost Test			Project's Total Resource Cost		
	Low Rates	Expected	High Rates	Low Mkt	Expected	High Mkt	Low Mkt	Expected	High Mkt	Low Mkt	Expected	High Mkt
Net Present Value (NPV)		-$581,748			$329,628			$534,984			-$252,120	
Benefit Cost Ratio		0.26			1.59			1.96			0.81	
Internal Rate of Return (IRR)		< 0			15%			20.0%			4%	
Payback Begins in Year		Never			6			5			12	
Levelized Value of Energy Savings, $/MWh		$27.37			$145.93			$145.93			$145.93	
Levelized Cost, $/MWh		$104.90			$102.00			$74.63			$179.53	

Total	Wholesale	Carbon	Distribution	Transmission RA
$145.93	$82.08	$10.71	$25.27	$27.87

	0	1	2	3	4	5	6	7	8	9	10
$ nominal	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Retail Rates, $/mwh	$ 27.00	$ 27.05	$ 27.11	$ 27.16	$ 27.22	$ 27.27	$ 27.33	$ 27.38	$ 27.44	$ 27.49	$ 27.54
Forward Annual Flat Rate, $/MWh		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Hourly Market Value, $/MWh		$ 80.82	$ 86.59	$ 87.59	$ 84.20	$ 81.91	$ 81.91	$ 80.71	$ 80.44	$ 79.98	$ 80.09
Energy Savings, MWh/Year		824	824	824	824	824	824	824	824	824	824
Energy Savings, aMW		0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
Value of Wholesale Energy		66,582	71,340	72,162	69,370	67,481	67,481	66,494	66,272	65,892	65,980
Wholesale Energy Carbon Free		5,122	5,576	6,068	6,602	7,181	7,810	8,483	9,212	10,002	10,857
Retail Energy Cost Savings		[illegible]	[illegible]	[illegible]	[illegible]	22,467	22,512	22,557	22,602	22,647	22,693
Local Distribution System Credit		20,818	20,818	20,818	20,818	20,818	20,818	20,818	20,818	20,818	20,818
Bulk Transmission System Credit		22,963	22,963	22,963	22,963	22,963	22,963	22,963	22,963	22,963	22,963

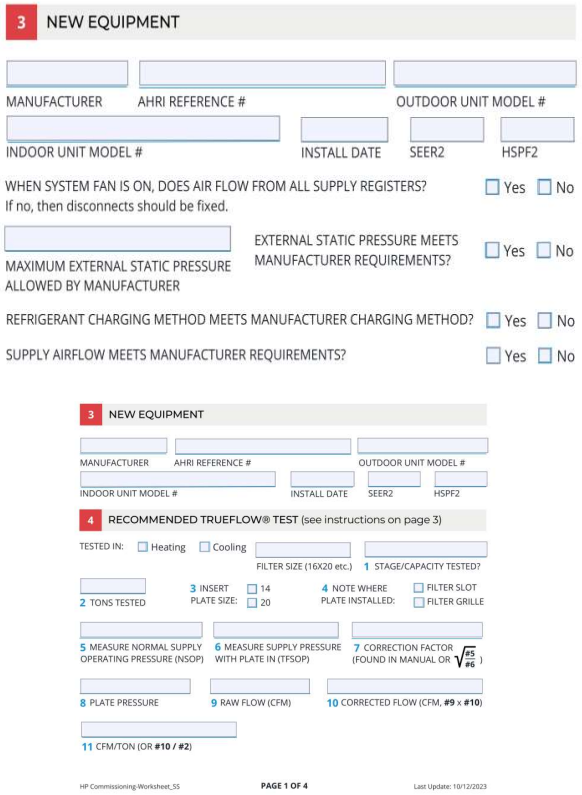
	11	12	13	14	15	16	17	18	19	20
$ nominal	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
Retail Rates, $/mwh	$ 27.60	$ 27.66	$ 27.71	$ 27.77	$ 27.82	$ 27.88	$ 27.93	$ 27.99	$ 28.04	$ 28.10
Forward Annual Flat Rate, $/MWh	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Hourly Market Value, $/MWh	$ 79.87	$ 79.92	$ 79.85	$ 79.78	$ 79.67					
Energy Savings, MWh/Year	824	824	824	824	824	0	0	0	0	0
Energy Savings, aMW	0.094	0.094	0.094	0.094	0.094	0.000	0.000	0.000	0.000	0.000
Value of Wholesale Energy	65,804	65,843	65,780	65,724	65,637	-	-	-	-	-
Wholesale Energy Carbon Free	11,783	12,786	13,870	15,045	16,315	-	-	-	-	-
Retail Energy Cost Savings	22,738	22,784	22,829	22,875	22,921	-	-	-	-	-
Local Distribution System Credit	20,818	20,818	20,818	20,818	20,818	0	0	0	0	0
Bulk Transmission System Credit	22,963	22,963	22,963	22,963	22,963	0	0	0	0	0



Current State of HP Affairs (cont'd)

- Still requiring Commissioning of Systems to PTCS standards

- Heat Pumps are providing over 50% of the savings of our Residential Portfolio



3 NEW EQUIPMENT

MANUFACTURER | AHRI REFERENCE # | OUTDOOR UNIT MODEL #

INDOOR UNIT MODEL # | INSTALL DATE | SEER2 | HSPF2

WHEN SYSTEM FAN IS ON, DOES AIR FLOW FROM ALL SUPPLY REGISTERS? ☐ Yes ☐ No
If no, then disconnects should be fixed.

MAXIMUM EXTERNAL STATIC PRESSURE ALLOWED BY MANUFACTURER

EXTERNAL STATIC PRESSURE MEETS MANUFACTURER REQUIREMENTS? ☐ Yes ☐ No

REFRIGERANT CHARGING METHOD MEETS MANUFACTURER CHARGING METHOD? ☐ Yes ☐ No

SUPPLY AIRFLOW MEETS MANUFACTURER REQUIREMENTS? ☐ Yes ☐ No

3 NEW EQUIPMENT

MANUFACTURER | AHRI REFERENCE # | OUTDOOR UNIT MODEL #

INDOOR UNIT MODEL # | INSTALL DATE | SEER2 | HSPF2

4 RECOMMENDED TRUEFLOW® TEST (see instructions on page 3)

TESTED IN: ☐ Heating ☐ Cooling

FILTER SIZE (16X20 etc.) | 1 STAGE/CAPACITY TESTED?

2 TONS TESTED | 3 INSERT PLATE SIZE: ☐ 14 ☐ 20 | 4 NOTE WHERE PLATE INSTALLED: ☐ FILTER SLOT ☐ FILTER GRILLE

5 MEASURE NORMAL SUPPLY OPERATING PRESSURE (NSOP) | 6 MEASURE SUPPLY PRESSURE WITH PLATE IN (TFSOP) | 7 CORRECTION FACTOR (FOUND IN MANUAL OR $\sqrt{\frac{\#5}{\#6}}$)

8 PLATE PRESSURE | 9 RAW FLOW (CFM) | 10 CORRECTED FLOW (CFM, **#9** x **#10**)

11 CFM/TON (OR **#10 / #2**)

HP Commissioning-Worksheet_SS | **PAGE 1 OF 4** | Last Update: 10/12/2023

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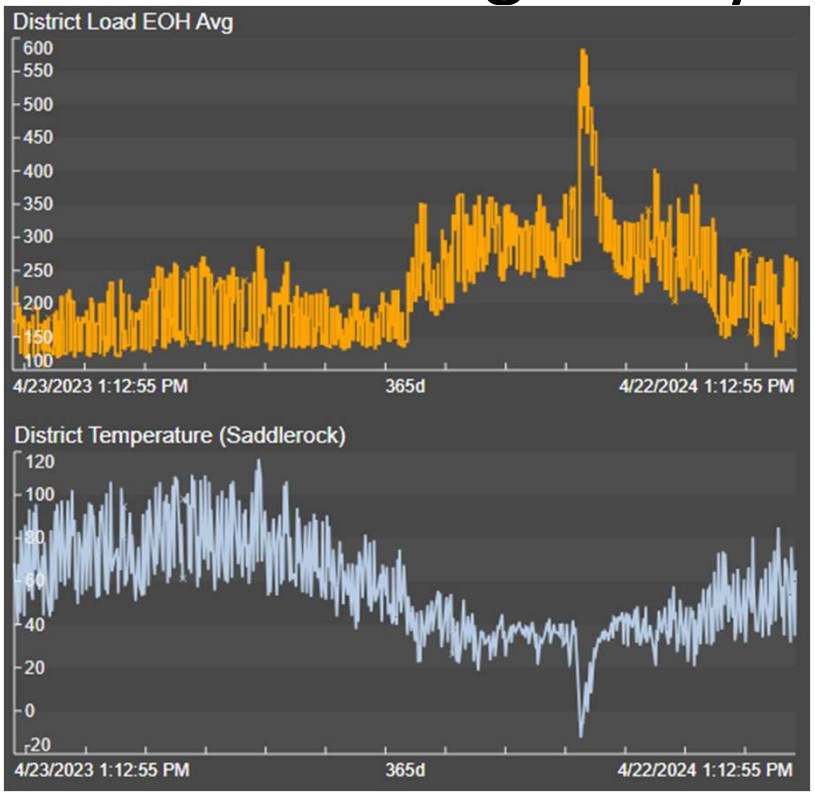
Why Does Chelan want to see a Cold Climate Standard Regionally



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Heat Pump Actual Use Case Study

CHELAN COUNTY POWER P.U.D.

Residential Variable Speed Heat Pump

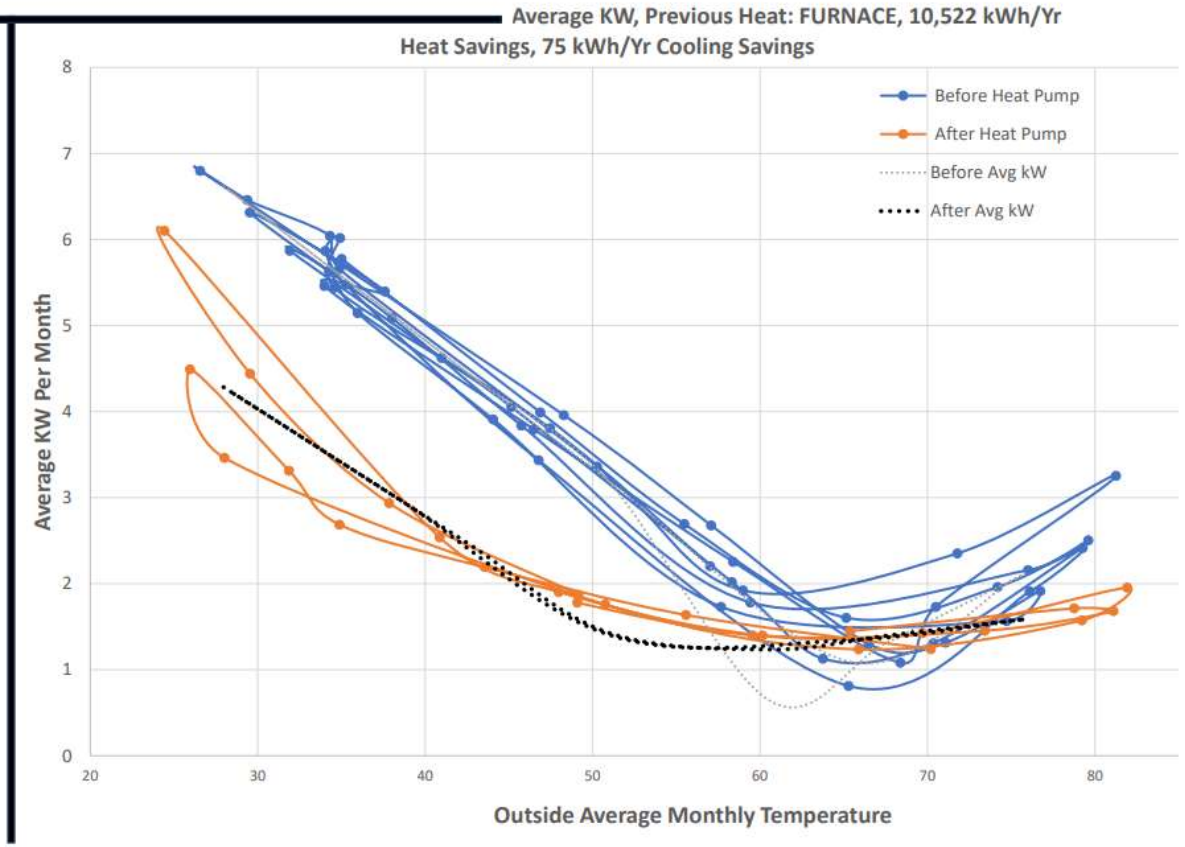
Before and After Energy Use Comparison

- Cory Schramm- Energy Efficiency Intern
- Josh Mitchell- Residential Energy Efficiency Advisor
- Jim White- Senior Energy Efficiency Engineer

Solid Results with Some Installs

Property Number 4

- HP Brand: **American Standard**
  - Indoor: TEM8A0C48V41+TDR
  - Outdoor: 4A6L9048A1
- Thermostat: **American Standard**
  - ACONT850AC52UA
- Sqft: **1,740**
- Heating Savings: **10,522 KWh**
- Cooling Savings: **75 KWh**
- Installer E
- Same Owner



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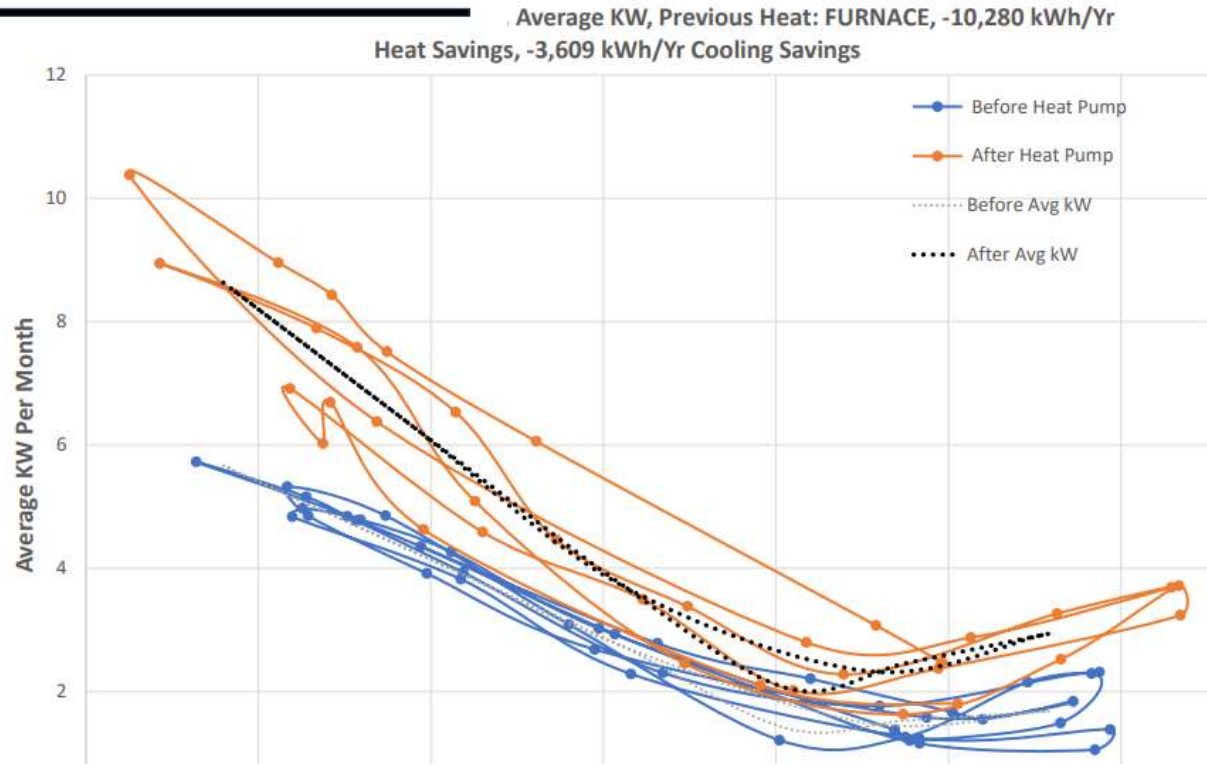
Less with Others

Property Number 22

- HP Brand: **Daikin**
  - Indoor: DV42FECC
  - Outdoor: DZ17VSA361
- Thermostat: **Daikin**
  - Daikin One
- Sqft: **1,360**
- Heating Savings: - **10,280 KWh**
- Cooling Savings: - **3,609 KWh**
- Installer D
- Different Owners



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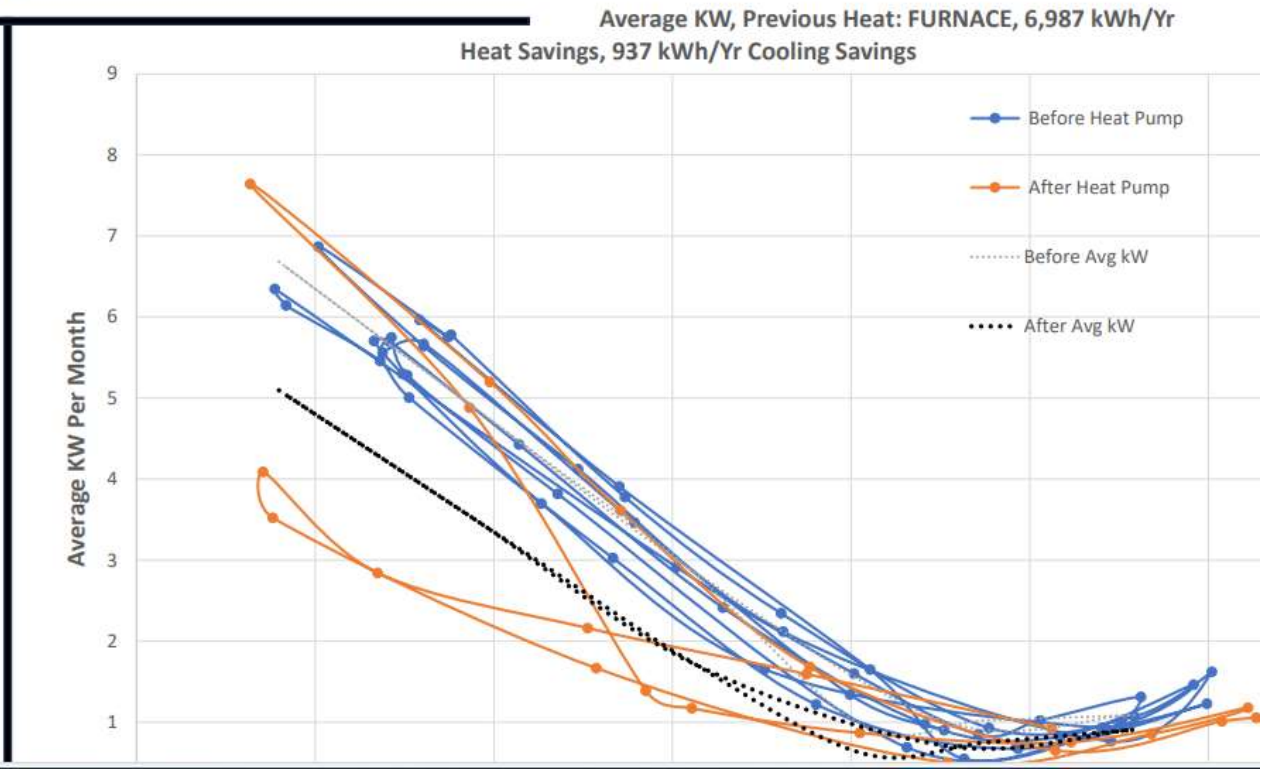
Property Number 22 Continued

Who is going to run a compressor with snow up to their eaves?

Mixed Reviews on Other Installs

Property Number 32

- HP Brand: **Carrier**
  - Indoor:
  - Outdoor: 25VNA848A003
- Thermostat: **Carrier**
  - SYSTXCCITC01-B
- Sqft: **2,736**
- Heating Savings: **6,987 KWh**
- Cooling Savings: **937 KWh**
- Installer A
- Same Owners



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Summary of Findings

- Reviewed 104 Heat-pumps that were installed to PTCS standards during 2020-2022 (That had enough heating load data)
  - Half of these installations increased load on the grid (average increase of 1,000 kWh per year)
  - 8 showed similar savings to deemed, 41 showed nearly triple the deemed savings
  - Surprising amount of the savings came from cooling
- No clear correlation between equipment, installer, thermostat, and savings outcome
  - Chelan PUD's theory is that the lack of savings is related to people's use of emergency heat.
  - Different homeowners, home remodels, etc. also play a role in savings.

What did we do differently?

- Realized we are not ready to pay for capacity of a Cold Climate Heat Pump!!
- We met individually with all Contractors and showed them their installs (good, the bad and the ugly).
- Communicated the importance of proper installation, educating their customers, using proper settings with the thermostat
- Preliminary results are showing improvements in installs done post meeting with contractors

P.U.D.
CHELAN COUNTY
POWER
www.chelanpud.org

Thank you!

Josh Mitchell, Chelan PUD

josh.mitchell@chelanpud.org

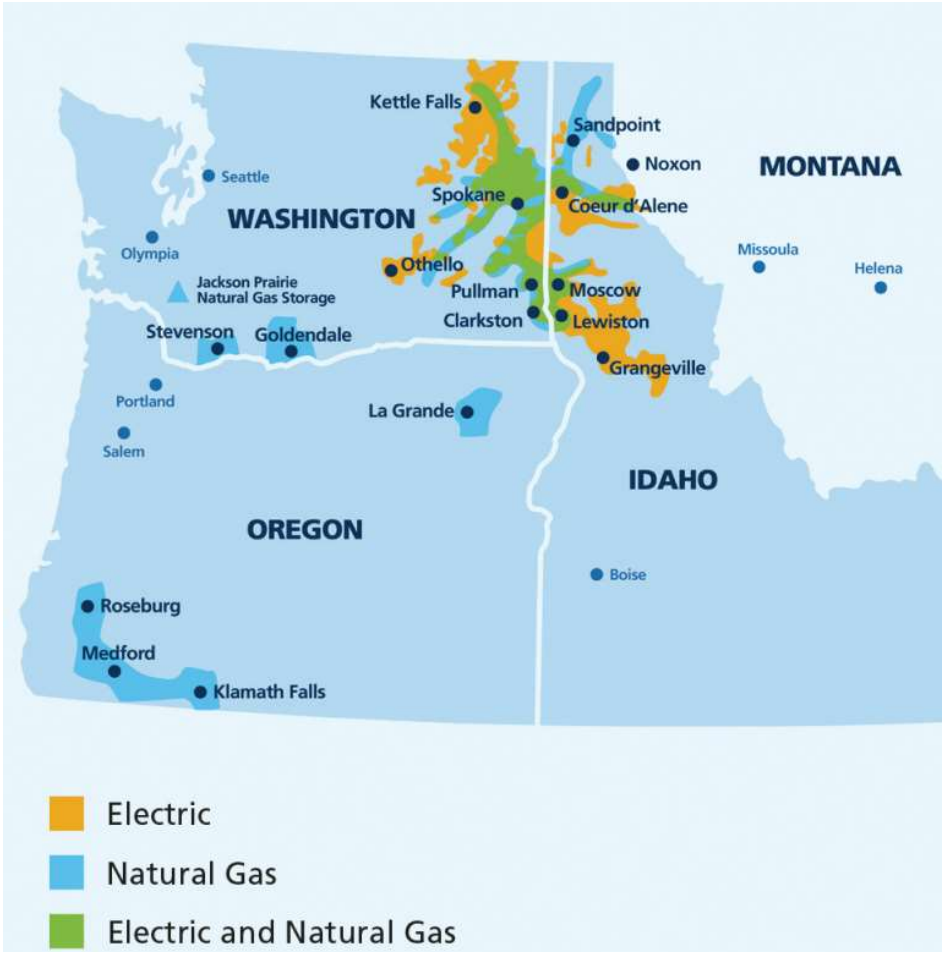
Avista

Leona Haley

Leona.Haley@avistacorp.com

About Avista

- **Celebrating 135 years of service**
- **Headquarters:** Spokane, WA
- **Employees:** 1,700+
- **Service territory:**
  - Washington
  - Idaho
  - Oregon
- **Customers served** (approx.)**:**
  - 408,000 electric
  - 374,000 natural gas



Avista Heat Pump Pilot – Field study

- **Study size:** 12 Homes
  - **Hybrid heat pumps**
    - 3 homes with sufficient insulation, 3 with poor insulation
  - **Cold-climate heat pumps**
    - 3 homes with sufficient insulation, 3 with poor insulation

Avista Heat Pump Pilot – Objectives

Customer

- **Experience**
  - Pre-installation
  - Installation
  - System operation
  - Behavior change

Trade Ally

- **Needs**
  - Promotion
  - Support
- **Installation**
  - Best practices

Weatherization

- **Impacts to**
  - System performance
  - Customer behavior with system operation

Avista Heat Pump Pilot – Eligibility

- **Premise requirements**
  - **Location:** Spokane County Washington
  - **Metering:** Smart meter
  - **Style:** Single-family
  - **Occupancy:** Owner-occupied
  - **Existing HVAC:** Natural gas furnace with central air-conditioning
- **Customer commitment**
  - 2-year pilot term

Avista Heat Pump Pilot – Status

Partners selected	Holliday Heating, Cooling and Electric DNV
Recruitment underway	Leveraged Bidgely tool to identify homes List scrubbed and finalized Recruitment email sent
Installation plan	Complete prior to 2024 heating season

Avista Heat Pump Pilot – Equipment

Heat-Pump

Performance Measurement

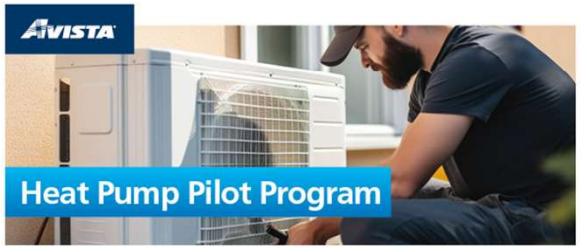
- **HVAC metering**
  - Power
  - Temperature
  - Humidity
  - Air-flow
  - Pressure
- **Whole home metering**
  - 5-minute electric (AMI)
  - Hourly gas (AMI)

Avista Heat Pump Pilot – Customer Participation

- Application
- Pre-installation inspection
- Equipment installation
- Complete surveys
- Allow weatherization (half of the homes)
- Allow monitoring equipment removal

Avista Heat Pump Pilot – Marketing materials

Recruitment Email



Dear Customer,

Could your home benefit from a new heating and cooling system? If so, we're offering you an opportunity to participate in our new Heat Pump Pilot.

We need twelve (12) Avista customers with existing natural gas furnace and central air conditioning equipment in their homes to let us replace those systems with either a new dual-fuel heat pump system or a new premium high-performance heat pump system.

Application

Heat Pump Study Participant Application

Avista is looking for 12 Washington customers to take part in a two-year research study to evaluate the performance of hybrid[1] and cold-climate heat pumps in our service territory. Our goal is to learn how cost-effective these new heating systems are for our region's climate and to determine if they should be added to our customer rebate offerings. Selected participants will receive one of these premium high-performance systems at no cost. To apply, please complete and email the application form below to Leona.Haley@avistacorp.com.

Program Flyer

Get a free HVAC system from Avista for joining our heat pump study.

Are you considering a new heating and cooling system? Avista is looking for 12 Washington customers to take part in a research study to evaluate the performance of hybrid[1] and cold-climate heat pumps in our service territory. If you choose to participate, Avista will replace your existing natural gas furnace and central air-conditioning system with one of these premium high-performance systems.

Avista Heat Pump Pilot – Participation documents

HOLLIDAY
HEATING + COOLING + ELECTRIC

BID PROPOSAL FOR:

HOLLIDAY HEATING + COOLING + ELECTRIC IS PROPOSING THE FOLLOWING SCOPE OF WORK:

Avista Corporation
East 1411 Mission Ave
Spokane, WA 99202

AVISTA

Heat Pump Pilot - Participation Agreement

CUSTOMER INFORMATION

NAME (hereinafter the "Customer") **DAYTIME PHONE NUMBER**

PROPERTY ADDRESS (physical address where equipment is installed) **CITY, STATE, ZIP**

NOTICE: THE EQUIPMENT MUST REMAIN AT THE PROPERTY ADDRESS ABOVE THROUGHOUT THE PILOT TERM.

PROGRAM PARTICIPATION REQUIREMENTS

Customer, residing at the Property Address set forth above (hereinafter the "Property"), elects to participate in the Avista Heat Pump Pilot program ("Pilot"), freely, voluntarily and without duress, and further agrees to the terms and conditions in this Agreement. Avista and Customer are referred to herein individually as a "Party" or collectively as the "Parties".

Avista Heat Pump Pilot – Estimated timeline

- Q3-2024 Installations complete
- Q4-2025 1st year evaluation report
- Q4-2026 Final evaluation report

Thank you!

Leona Haley, Avista

Leona.Haley@avistacorp.com

Emerald People's Utility District

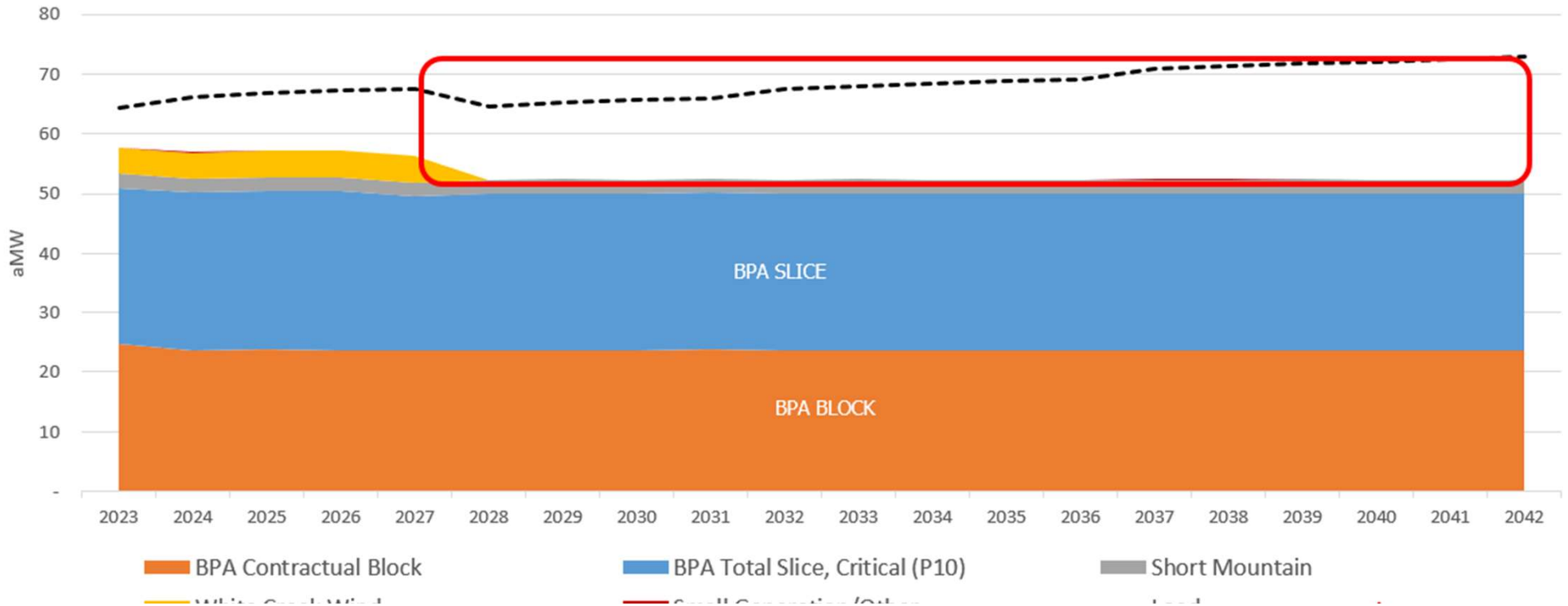
Tyler Boehringer
tylerb@epud.org

Emerald People's Utility District

EE Cost Effectiveness Calculator Development

BPA Slice Customer

- Historic Market Power Prices
- Bigger emphasis on EE



How can we get more EE?
Pay more for it.

- How to justify it?
- EE Savings shapes
- Which measures should we value more?
- Which measures save when we need it?
- How much should we be paying?

We needed:

-Identify measures to focus on
-Determining what we should be paying

LIGHTHOUSE ENERGY CONSULTING

What we got:

-A user-friendly tool
-Data to back our program offerings

Sector
Residential

#	Measure Name	End Use	Building Type	Energy Savings (kWh/yr)	Life (yrs)	Non-Energy Impact ($/yr)	Measure Cost ($)	Incentive ($)	BPA Payment ($)	Avoided Cost Scenario	Avoided Cost Value	NEI	Benefit-Cost Ratios: TRC	UCT	UCT w/ BPA Credit	Participant	Maximum Incentive
1	ASHP Conversion - $2,000	Res SF ASHP Conversion (no CAC)		1,386	13	$0	$3,000	$1,300	$600	Low	$1,736	$0	0.6	1.3	2.5	0.6	$1,736
										Base	$2,821	$0	0.9	2.2	4.0	0.6	$2,821
										High	$3,962	$0	1.3	3.0	5.7	0.6	$3,000

Instructions | Calculator | Measure Value | Assumptions | Avoided Cost Calc | Load Shape Info | 2x12 Shape Detail | Low AC | Base AC | High AC

Thank you!

Tyler Boehringer, Emerald PUD
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Energy Trust of Oregon

Andrew Shepard

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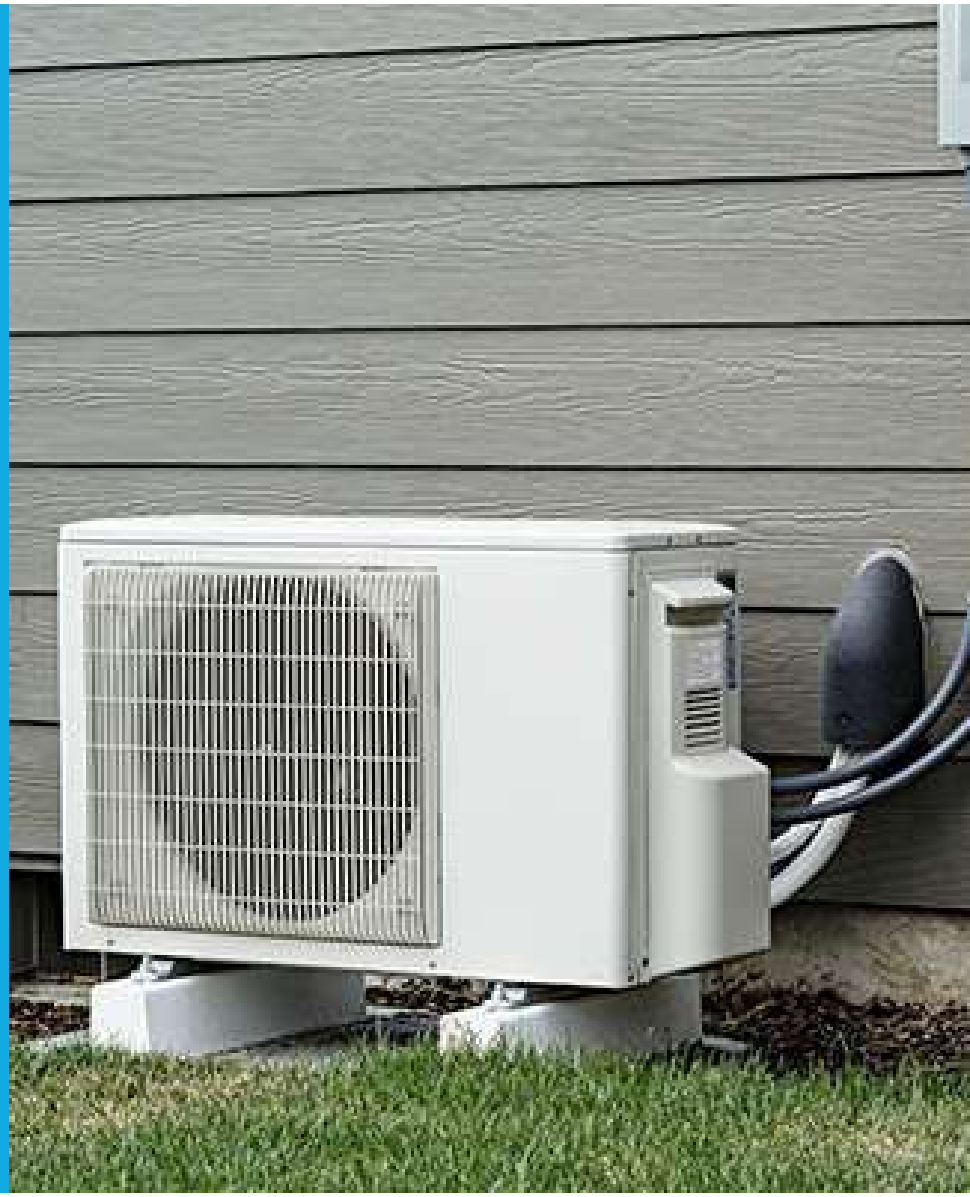
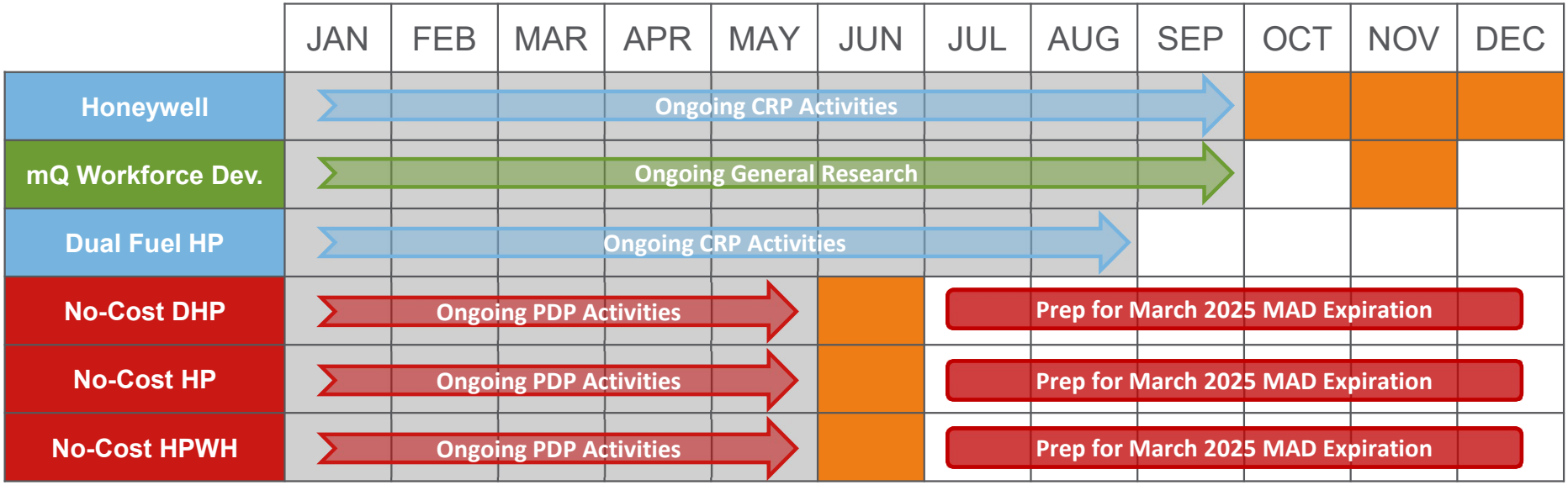


- Energy Trust 2024 Research

2024 R&I Schedule – Active Projects



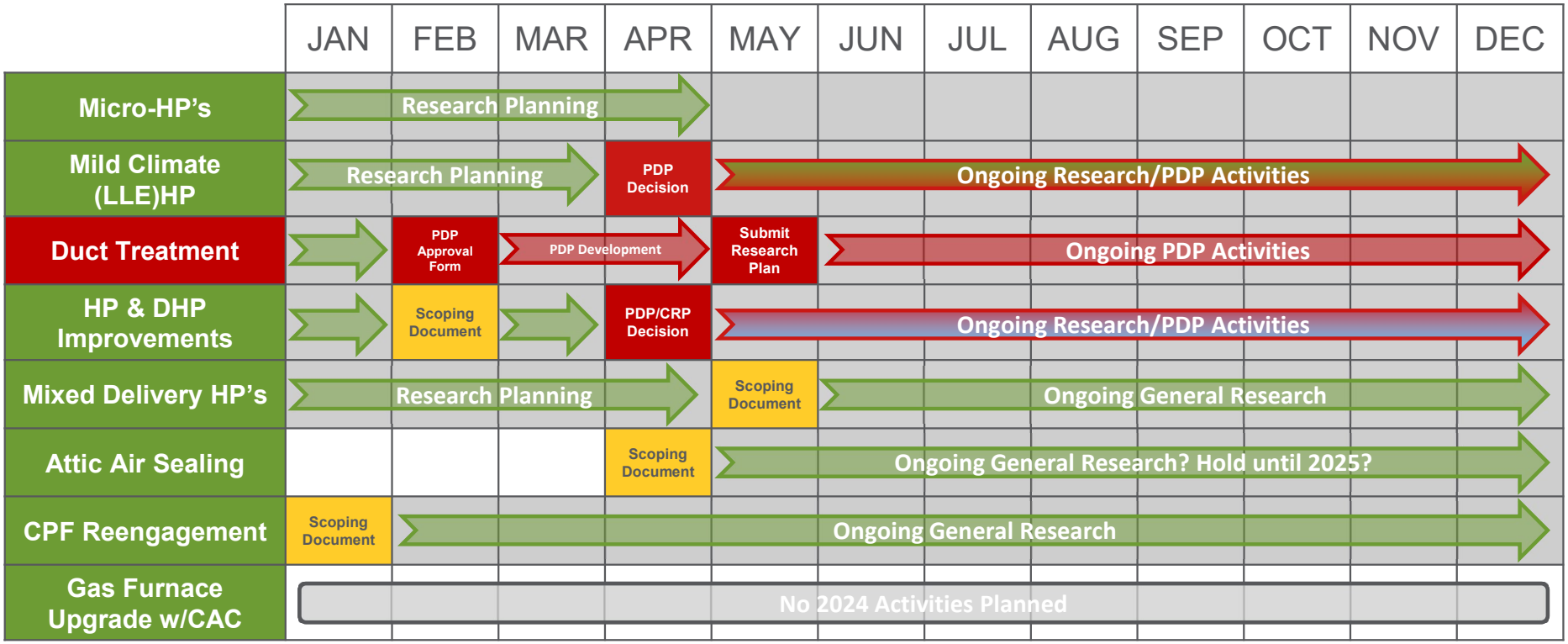
General Research & Planning

Coordinated Research Project

Program Delivery Pilot

Post-Research Summary Memo/Evaluation

2024 R&I Schedule – Pending & In-Progress Activities



General Research & Planning

Coordinated Research Project (CRP)

Program Delivery Pilot (PDP)

Post-Research Summary Memo

HP & DHP Delivery Improvements

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
HP & DHP Improvements	→	Scoping Document	→	PDP/CRP Decision	Ongoing Research/PDP Activities →							

- **Status Update:**
  - HP/DHP Commissioning & Servicing Scoping Memo Submitted 2/29/24
  - Memo circulated with broader ETO team 3/21/24
  - ETO comments/feedback pending
- **Next Steps:**
  - PMC to receive ETO feedback
  - Pending comments/support, develop field research strategies and implementation plan
- **Research Objectives:**
  - Can program improve realized savings of HP/DHP measures through combination of enhanced eligibility screening, increased installation requirements and/or improved on-site data collection & review?
  - Consider recent RTF statements re: HP's refocused on EFAF displacement and upcoming MAD expiration
- **Potential Outcome(s):**
  - Increased realized savings for current HP & DHP offers
  - Foundation for new HP & DHP commissioning incentive
  - Potential increased incentive for projects meeting prescribed screening and installation requirements

Market Segment Served:

- All residential HP & DHP customers
- Prioritization of rental, rural & communities of color

Duct Treatment

- **Status Update:**
  - Duct Sealing PDP Approval Form Submitted 2/29/24
  - Memo circulated with broader ETO team 3/21/24
  - ETO comments received 3/26/24
- **Next Steps:**
  - PMC to review and respond to ETO comments by 4/3/24
- **Research Objectives:**
  - Can Energy Trust fill a gap in duct treatment as a direct service?
  - How can this work be designed to maximize the savings : cost ratio?
  - What does customer acquisition look like?
  - Can this be an enhancement to other HP/Gas Furnace measures?
- **Potential Outcome(s):**
  - Return of duct sealing savings
  - Improved performance of existing and new heat pumps and gas furnaces

Market Segments Served:

- All site-built single family homes
- Emphasis on income-qualified, rental and prioritized communities

Thank you!

Andrew Shepard, Energy Trust of Oregon

andrew.shepard@energytrust.org

Seattle City Light

Lars Henrikson

Lars.Henrikson@seattle.gov

Thank you!

Lars Henrikson, Seattle City Light

Lars.Henrikson@seattle.gov

5 Minute Stretch

Puget Sound Energy

Will Dixon

William.Dixon@pse.com

Thank you!

Will Dixon, Puget Sound Energy

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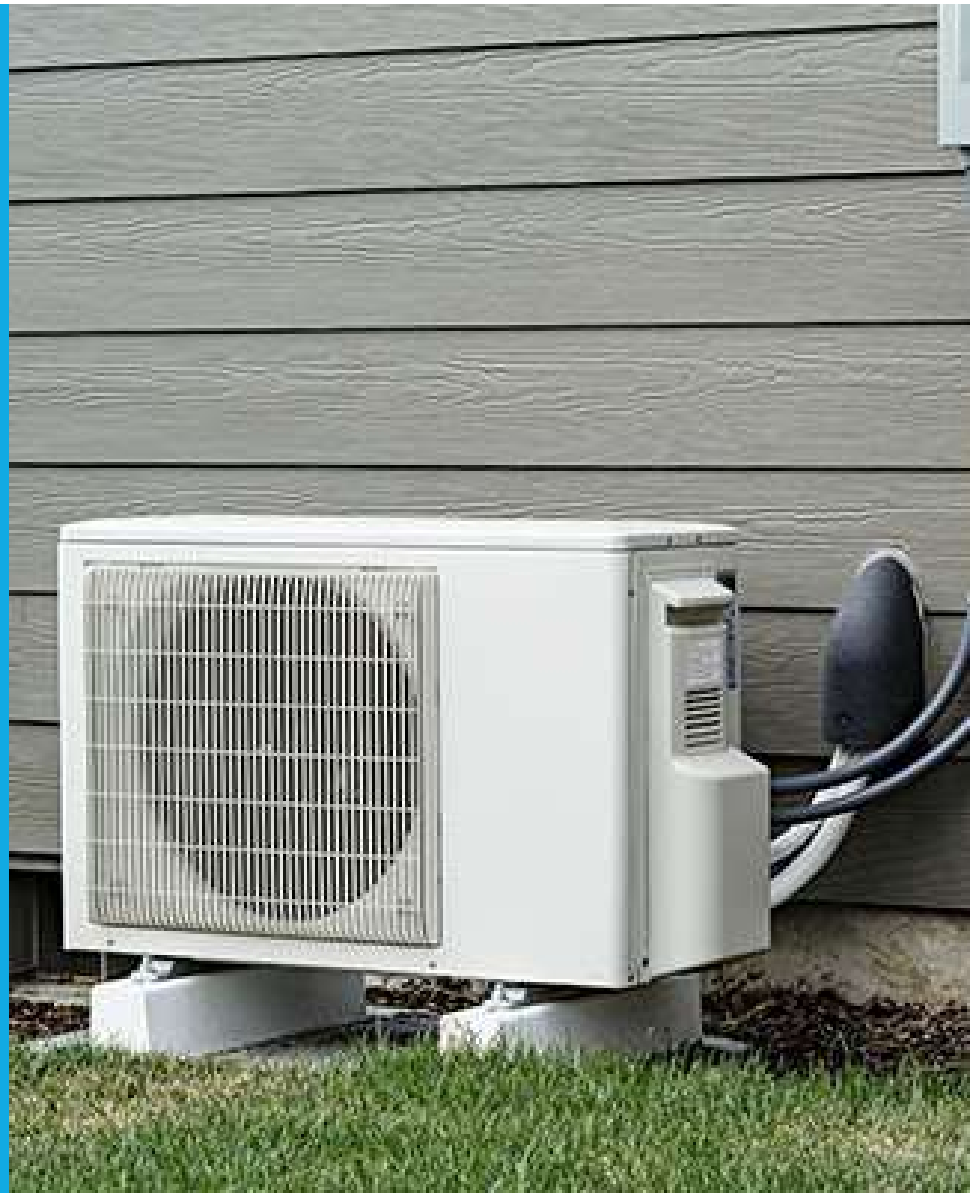
Tacoma Power

Rich Arneson

rarneson@cityoftacoma.org



Tacoma Heat Pump Research

Understanding Drivers of Winter Peak Impacts from Ducted HPs

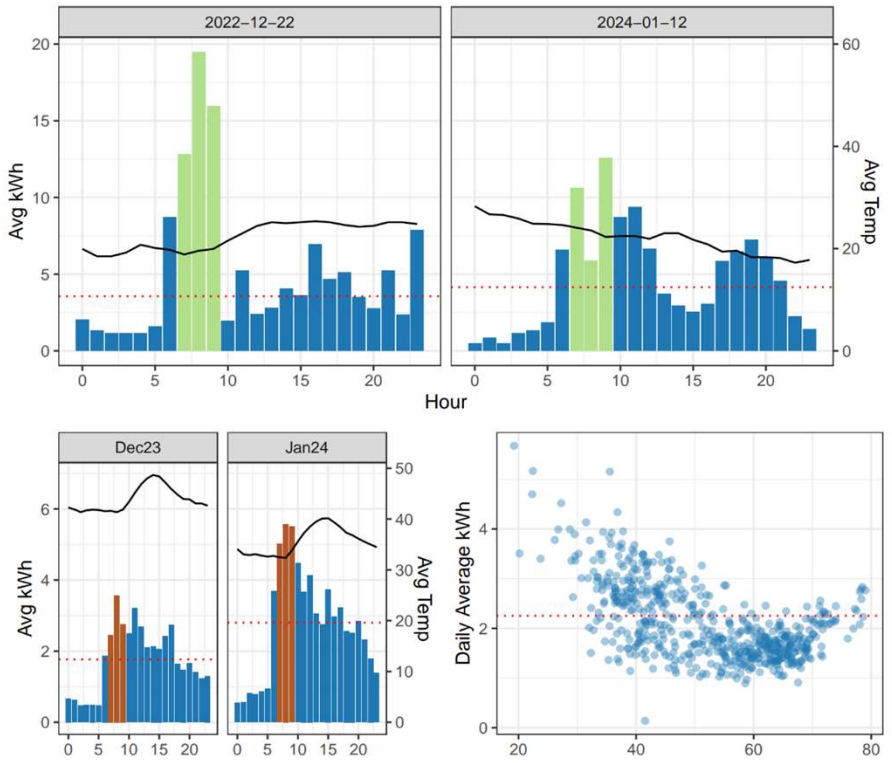
June 20, 2024

TACOMA POWER
TACOMA PUBLIC UTILITIES

Phase 2 Project Objectives

Phase 2 of this project has two objectives, to identify

- What's causing these spikes?
- What are barriers and opportunities for future interventions?



Phase 2 Objectives

- **What's likely causing these demand spikes?**
  - What kind of heating equipment is present in the home?
  - Are there other big loads that could be causing spikes?
  - Thermostat type and set-back settings?
  - HP control settings?
  - What are expected energy vs demand impacts?
- **What are barriers and opportunities for future interventions?**
  - Reasons for thermostat settings
  - Willingness to adjust thermostat settings
  - Willingness to change HP control settings
  - Willingness to install new thermostat
  - Willingness to have thermostat settings changed by program

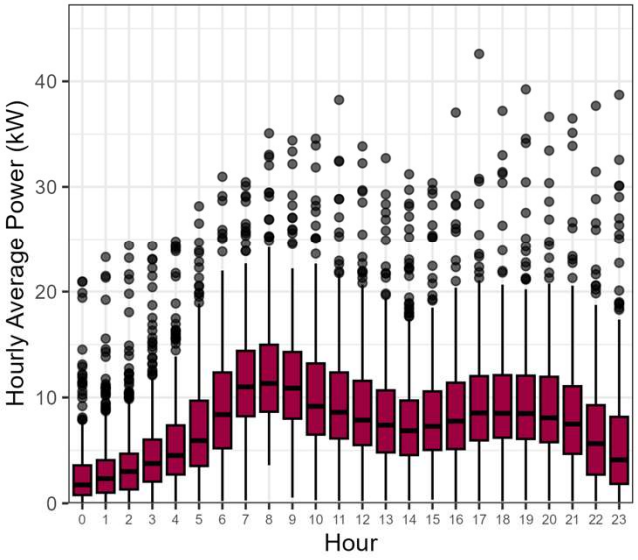
Current Status

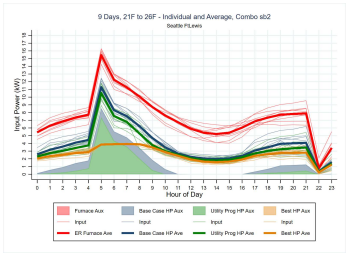
- ✓ Population and sample identified
- ✓ Estimated potential impacts

- _ Find study partners for co-funding
- _ Planning/survey instrument work through the summer
- _ Survey launch in the fall
- _ Onsite visits during the winter (assumes co-funders)
- _ Analysis and report early summer

Load Shapes by Classification

High Spike ~13%
(>5 kW Diff)





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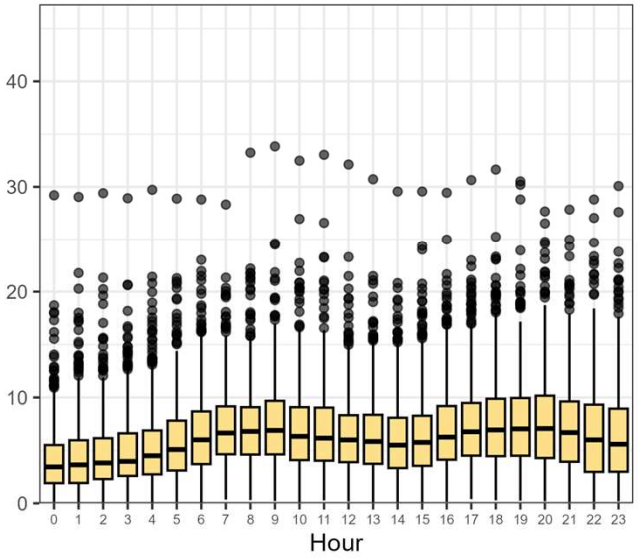
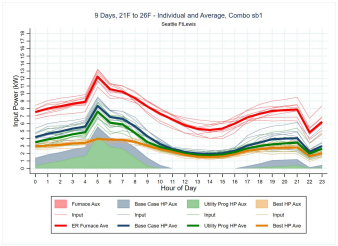
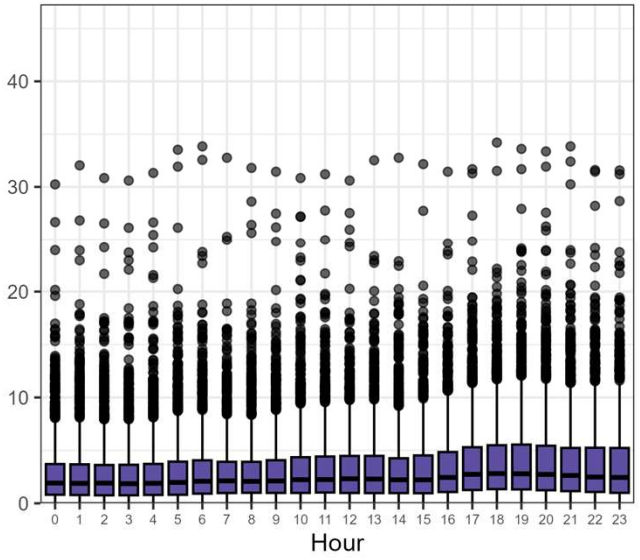
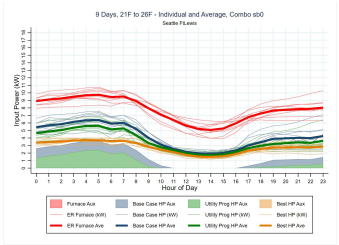




Low Spike ~62%
(< 1.5kW)





Phase 1 Results: Anticipated Outcomes

For every 1,000 HPs, ~1MW coincident peak demand reduction.

Size of Spike	Frequency	Observed Size of Demand Impact (kW)	Expected Peak Reduction
High (>5kW delta)	13%	8.6kW	5.3kW
Medium (>1.5 kW)	25%	2.9kW	1.1kW
Total	**38%**	**4.8kW**	**2.5kW**

- We anticipate ~2.5 kW of impact for sites that mitigate this demand spike.
  - Adjusted from observed to account for the non-heating portion and the reality that only a portion of the heating can be mitigated

Survey vs Onsite Summary

	Survey	On-site	Temperature Loggers
Heating equipment in the home	√	√**	
Other big loads	√	√	
Thermostat type	√	√	
Thermostat settings	√	√*	√**
HP control settings	√	√**	
Comfort	√	√	√
Reasons for thermostat settings	√	√	
Willingness/barriers to adjust t-stat settings	√		
Willingness/barriers to adjust HP controls	√		
Willingness/barriers to use a new thermostat	√		

*** High value and reliability from the data collection approach*

Timeline (Draft)

Task Name	2024												2025											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Phase 1																								
Phase 2 Planning and AMI Analysis																								
Survey Design																								
Conduct survey of customers																								
Reporting: Survey																								
Onsite design																								
Onsite data collection														X										
Reporting: Onsite/Final																								

Full Study Presentation

TACOMA POWER
TACOMA PUBLIC UTILITIES

Heat Pumps are Coming!

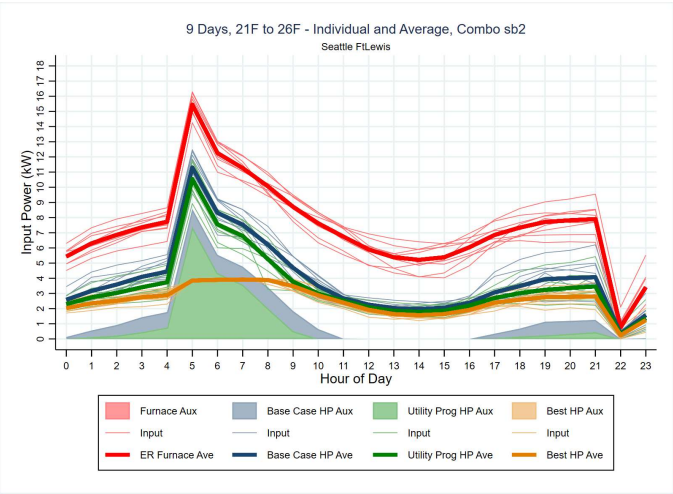
- Legislators of state, region and nation are encouraging heat pumps to mitigate the effects of climate change.

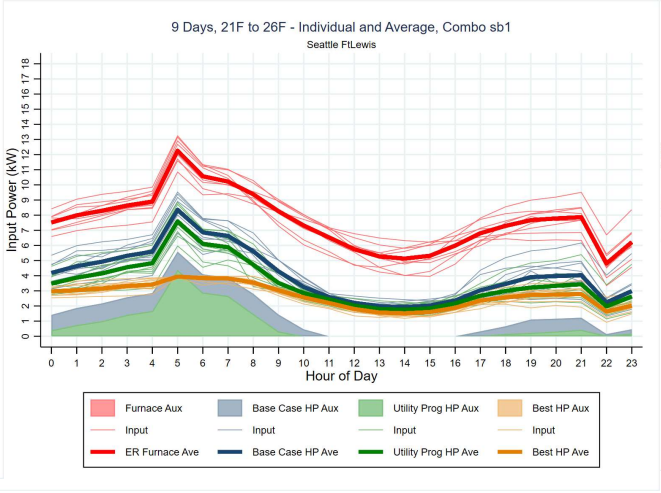
- A large-scale conversion is likely to have impacts on our utility systems, what should we study and prepare for?

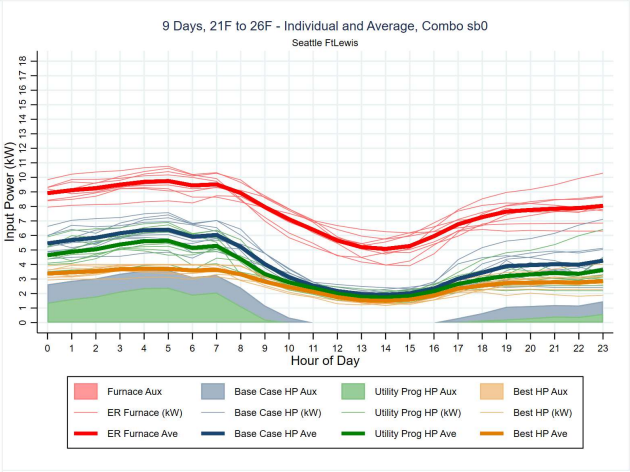
Deep Set-backs = Demand Spikes?

- Early modeling suggests deep set-backs of HPs could lead to large morning peaks (i.e., demand spikes coincident with peak).

- Tacoma wants to learn if this happening in the real world, how often and why.

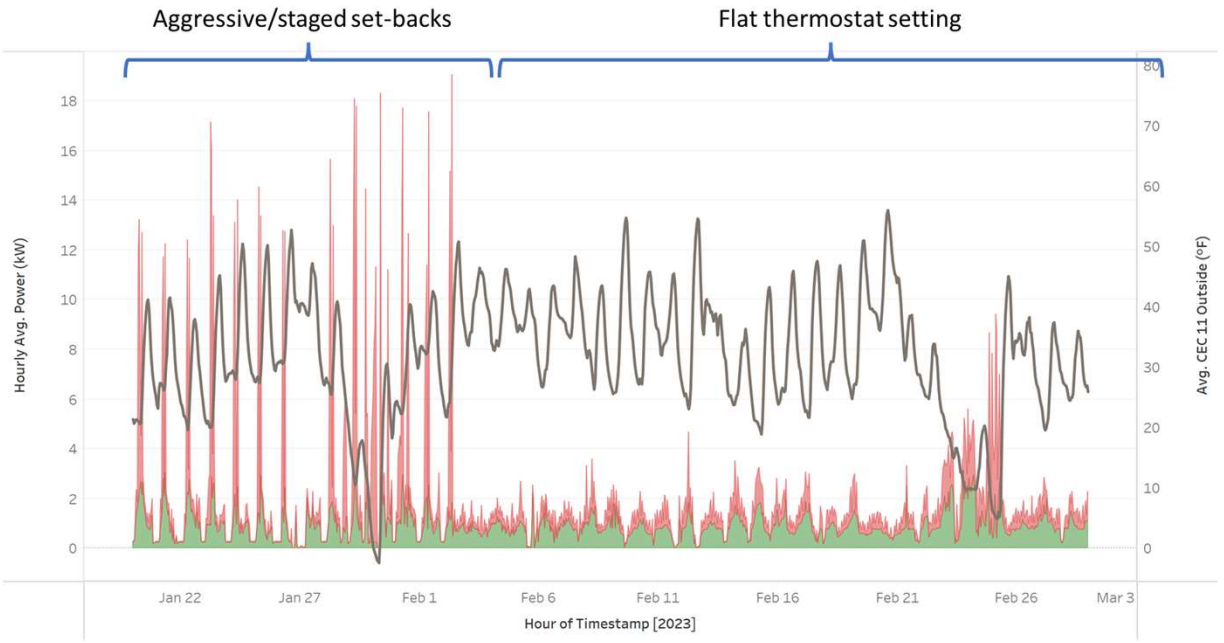






Single Site Example

- BPA study found a HP with aggressive set-backs with large demand spikes, likely due to auxiliary heat to warm the home in the morning.
- Once thermostat setting was stable, these spikes were mitigated.



Tacoma Study Overview

Phase 1: AMI Analysis

Phase 2: Understanding Drivers and Opportunities

(Fall 2024-Winter 2025)

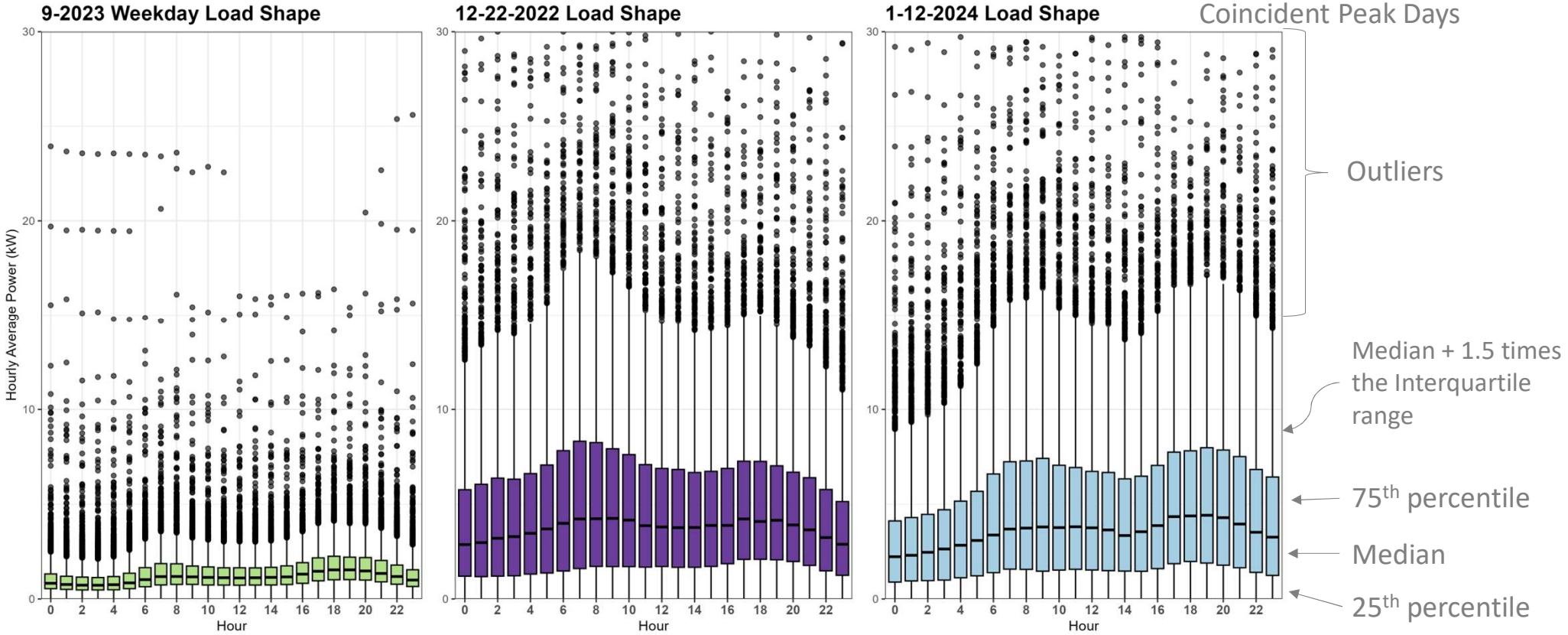
Phase 3: Intervention(s)

(TBD)

- **Real-world evidence of HP demand spikes?**
- **How frequent is it?**
- **How big is the potential kW impact for mitigation?**

Phase I Results – Real World Evidence

Overall, as temperatures fall, usage increases and becomes more variable.

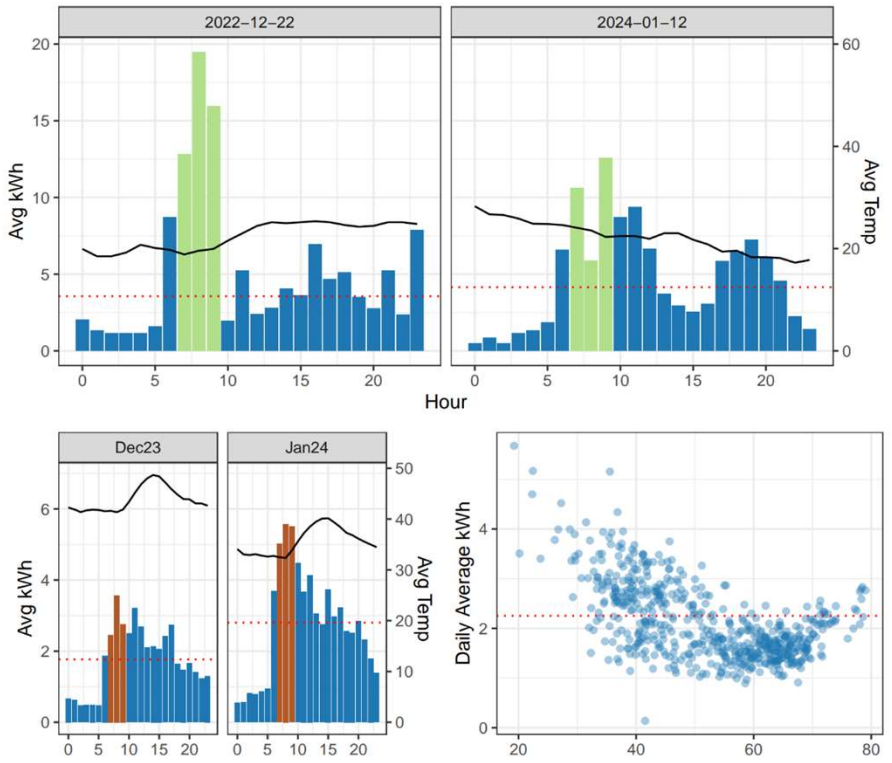


2,901 central HP sites with Tacoma Power AMI data.

Phase I Results – Individual Sites

- Poster child of HP demand spike

- Each site classified based on change in usage from overnight to morning during coincident peak days.
  - High Spike
  - Medium Spike
  - Low Spike



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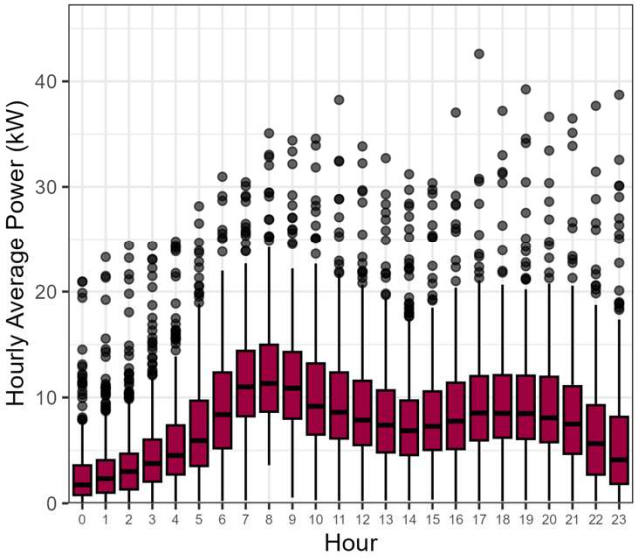

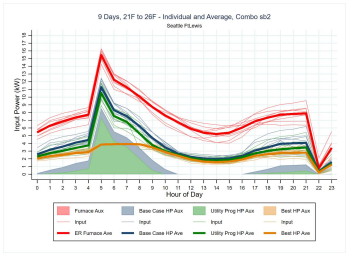

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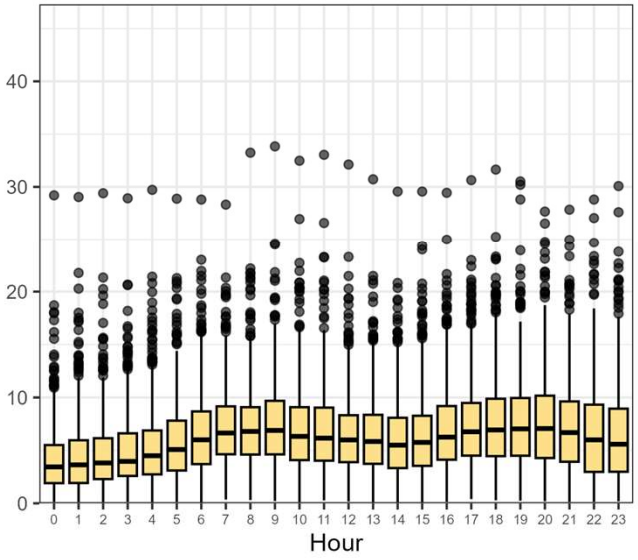

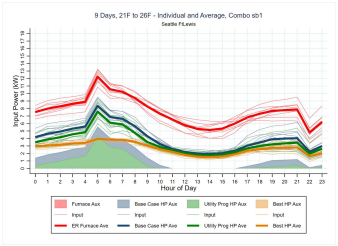

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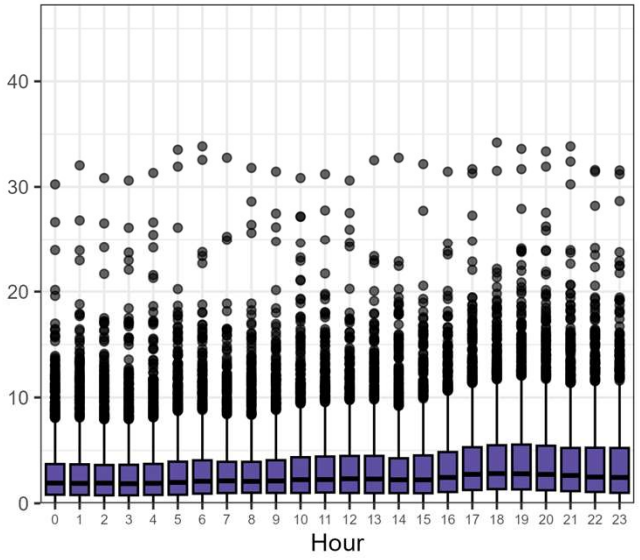

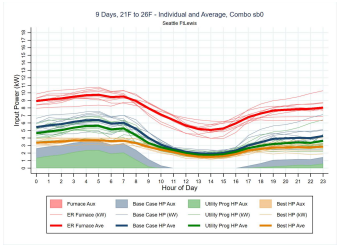

Phase 1: How big might the impacts be?

For every 1,000 HPs, ~1MW coincident peak demand reduction.

Size of Spike	Frequency	Observed Size of Demand Impact (kW)	Expected Peak Reduction
High (>5kW delta)	13%	8.6kW	5.3kW
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We anticipate ~2.5 kW of impact for sites that mitigate this demand spike.

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Tacoma Study Overview

Phase 1: AMI Analysis

Phase 2: Understanding Drivers and Opportunities

(Fall 2024-Winter 2025)

Phase 3: Intervention (TBD)

- **What's causing these spikes?**
- **What are barriers and opportunities for future interventions?**

Tacoma Study Overview

Phase 1: AMI Analysis

Phase 2: Understanding Drivers and Opportunities

(Fall 2024-Winter 2025)

Phase 3: Intervention (TBD)

Future intervention(s) will be based on Phase 2 research.

Intervention options may include:

- Thermostat setback changes
- Adjusting HP controls
- New thermostat
- BYOT thermostat

Phase 2 Objectives

- **What's likely causing these demand spikes?**
  - What kind of heating equipment is present in the home?
  - Are there other big loads that could be causing spikes?
  - Thermostat type and set-back settings?
  - HP control settings?
  - What are expected energy vs demand impacts?
- **What are barriers and opportunities for future interventions?**
  - Reasons for thermostat settings
  - Willingness to adjust thermostat settings
  - Willingness to change HP control settings
  - Willingness to install new thermostat
  - Willingness to have thermostat settings changed by program

Phase 2 Task Overview

1. Complete study planning and additional AMI analysis
2. Conduct survey of customers
3. Onsite data collection
4. Analysis and Reporting

Requires partner funding to proceed

1. Planning + Additional AMI Analysis

- **Finalize Planning**
  - Finalize sample, study tasks and objectives
  - Discuss opportunities with partners
- **Understand daily spike vs coincident peak**
  - Identify those customers with near-daily high demand in the mornings
  - These customers likely have energy savings opportunities
- **Explore the impact of building characteristics on morning spikes**
  - Leverage Tacoma's household characteristic data to explore how important variables such as square footage and vintage affect morning peak patterns.
- **Identify additional sites with spikes of interest**
  - Some heat pumps may spike before or after the coincident peak windows; current metrics may not catch all setback spikes.

2. Conduct Survey of Customers

- **Sample**
  - Expect 25-30% response rate, resulting in ~400 respondents, incentive of $25
  - Sample stratified by high, medium, low; program participant vs non-participant
- **Approach:**
  - Web survey with optional phone follow ups
- **Key survey topics:**
  - Understand all heating equipment, including back up
  - HP satisfaction and comfort
  - Presence and usage of other large loads (water heater, level II EV charger, hot tub, other)
  - Thermostat type
  - Thermostat settings
  - Willingness to make future changes, with and without incentives

2. Survey Sample

- **Tacoma identified ducted heat pump homes with county assessor data, contractor provided lists, and utility program participant lists.**
- **~1,200 with high and medium spikes (key focus)**

Category	# of HP Sites	# HP + AMI	High Spike	Medium Spike	Low Spike
County Assessor Data	10,000	2,677	345	678	1,654
High Performance HP Participants	500	225	18	59	148
High-Capacity HPs	11	11	0	0	0
Contractor List – *estimate*	500	250	33	63	154
Total	**11,011**	**3,163**	**396**	**800**	**1,956**

**Once we have 2024 non-cooling load data, we expect to be able to add approximately 174 high or medium spike participants in the county assessor and high performance HP data sets to the sample.*

3. Onsite Data Collection Approach

- **Sample**
  - Nested sample within survey
  - Sample size will depend on funding availability, 20-100
  - Incentive of $50 for initial visit, $50 to mail back temperature logger
- **Key Topics**
  - Confirmation of all heating equipment, including back up
  - HP Control settings
  - Leave behind temperature logger
  - Presence and usage of other large loads (water heater, level II charger, hot tub, miscellaneous other)
  - Thermostat type
  - Thermostat settings

Requires partner funding to proceed

Survey vs Onsite Summary

	Survey	On-site	Temperature Loggers
Heating equipment in the home	√	√**	
Other big loads	√	√	
Thermostat type	√	√	
Thermostat settings	√	√*	√**
HP control settings	√	√**	
Comfort	√	√	√
Reasons for thermostat settings	√	√	
Willingness/barriers to adjust t-stat settings	√		
Willingness/barriers to adjust HP controls	√		
Willingness/barriers to use a new thermostat	√		

*** High value and reliability from the data collection approach*

Timeline (Draft)

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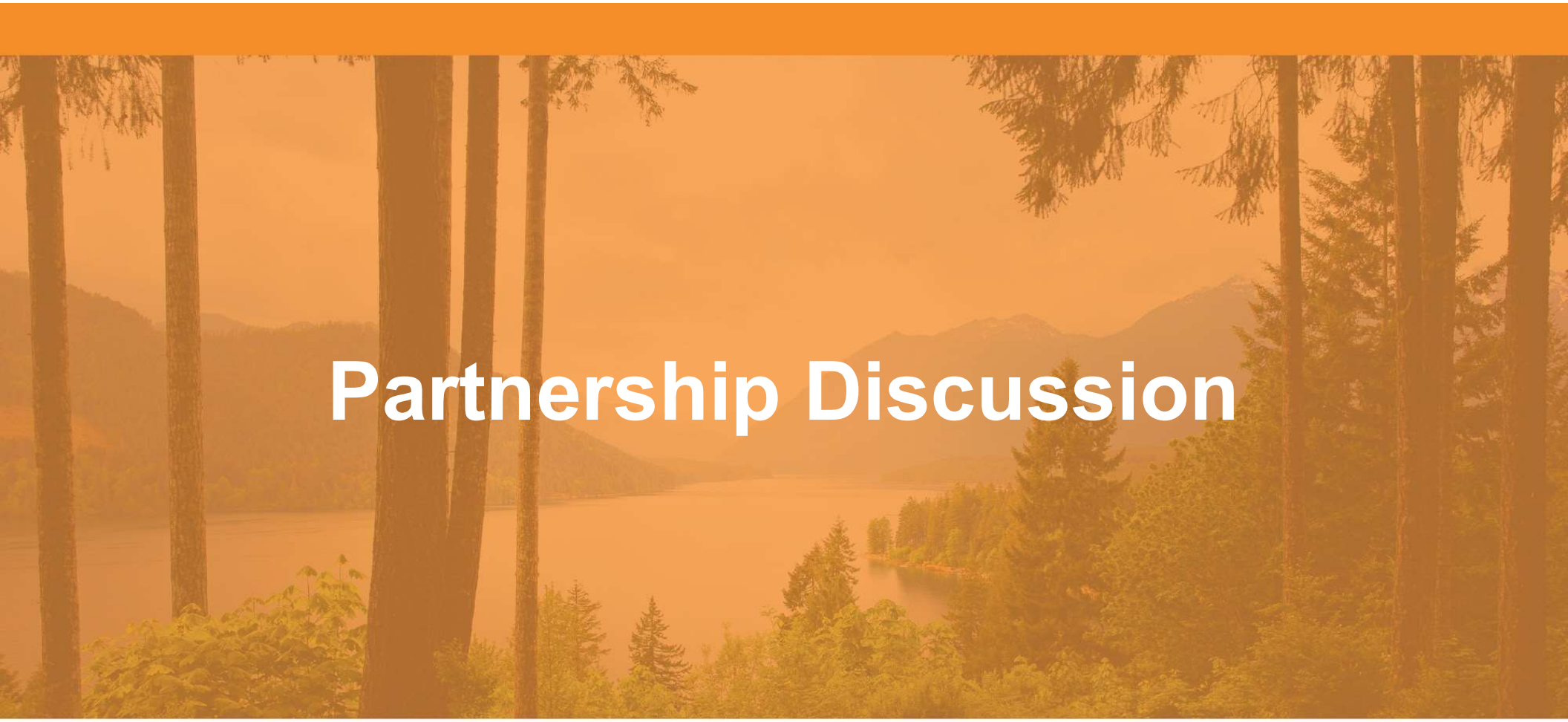


Partnership Discussion

TACOMA POWER
TACOMA PUBLIC UTILITIES

Request for Phase 2 Partners

- **Without research partners, Tacoma is unable to:**
  - Conduct on-site visits.
  - Conduct temperature logging.
  - Develop comprehensive, regionally-valuable instruments, analysis and reporting.

- **Requested funding support:**
  - Funding of on-sites and potentially temperature logging
  - Workplan and Instruments
    - To incorporate partner feedback and ensure their needs are met in study design and instruments
  - Reporting and analysis
    - Study to integrate partner goals into analysis
    - Study to report out on partner goals and ensure report is high quality for region

High-Level Budget Estimates

	Tacoma Budget	Partner Coordination and Onsite Funding*
Phase 1 Work	$36,000	
Study Planning and AMI Analysis	$18,000	$25,000
Design/conduct survey of customers	$54,000	$25,000
Onsite data collection**	$-	$112,000
Temperature	$-	$46,000
Reporting and PM	$25,000	$50,000
	$133,000	**$238,000**

*Approximate, depends on # of partners and their needs

**Assumes 70 on-sites

Questions for Phase 2 Potential Partners

- **What are the research objectives of your organization?**
  - What do you want to learn about cold weather HP operation drivers?
  - Focused on energy or peak?
  - If peak, what type of peak?
- **What decisions are you hoping to inform?**
- **What kind of timeline are you on for finding out the answers to your questions?**

Next Steps

- **Continue with Phase 2, Step 1**
  - Additional AMI analysis
  - Exploratory partnership meetings with external parties (SCL, PSE, NEEA, manufacturers)
- **Meet with internal Tacoma stakeholders for input**
  - Note: due to calendars, unable to meet until late July.
- **Finalize Phase 2**

Thank you!

Rich Arneson, Tacoma Power
rarneson@cityoftacoma.org

Bonneville Power Administration

Nathan Kelly
nckelly@bpa.gov

Product Coordination Council
High Performing HPs

June 24th, 2024

Nathan Kelly
BPA EE Engineering – Residential Tech Lead

Equipment Criteria and Selection Process

- **Save Energy**
  - Efficient operation, both when it's very cold out (the peak) AND at mild/low-load conditions (most of the heating load in many areas in PNW)
  - Some combination of (1) ability to turn down well and (2) very good "low-speed" COP

- **Minimize Winter Peak**
  - High heating capacity maintained at low outdoor temperatures
  - Minimize or Eliminate Resistance Heat

- **Minimize Summer Peak Contribution**
  - Higher EER -> better peak COP

- **Equipment in the Field**:
  - Bosch, Carrier, Daikin, Lennox, Mitsubishi, Fujitsu, and Trane/American Standard

Research Partners, Sites, and Equipment Types

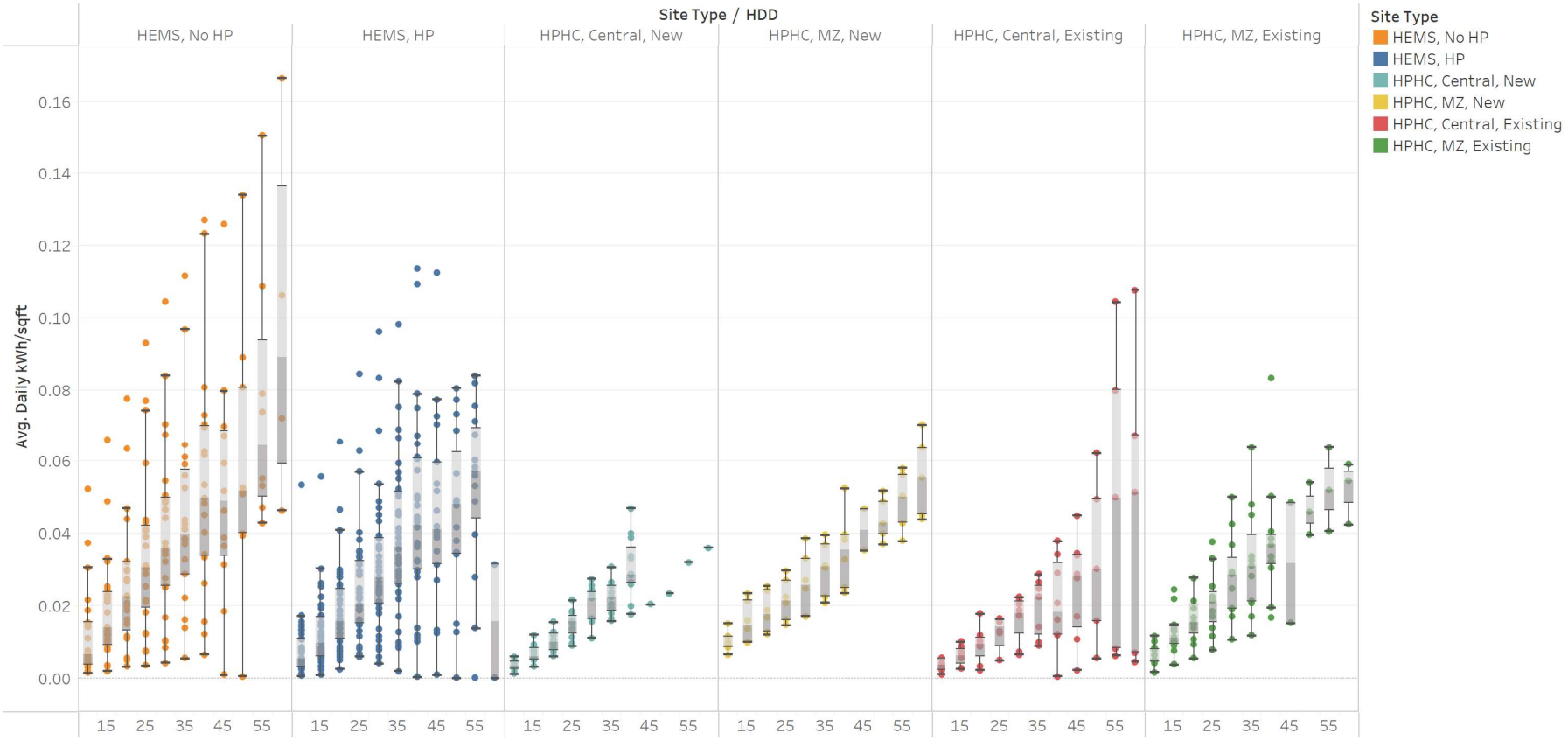
BPA Utilities/ Strategic Tribal Partner	Total Sites	Central Retrofit/New Installs	Central Existing Installs	Multizone Retrofit/New Installs	Multizone Existing Installs
Central Electric Coop	7	0	1	3	3
Inland Power	5	1	4	0	0
Snohomish PUD	5	0	3	0	2
Tacoma Power	17	10	0	1	6
Glacier Electric/ Blackfeet Tribe	2	0	0	2	0
Okanogan PUD/ Colville Tribe	10	0	0	10	0
Yakama Power/ Yakama Tribe	2	2	0	0	0
Total	48	13	8	16	11

Retrofit/New Installs – new equipment installed selected with HP HC HP criteria

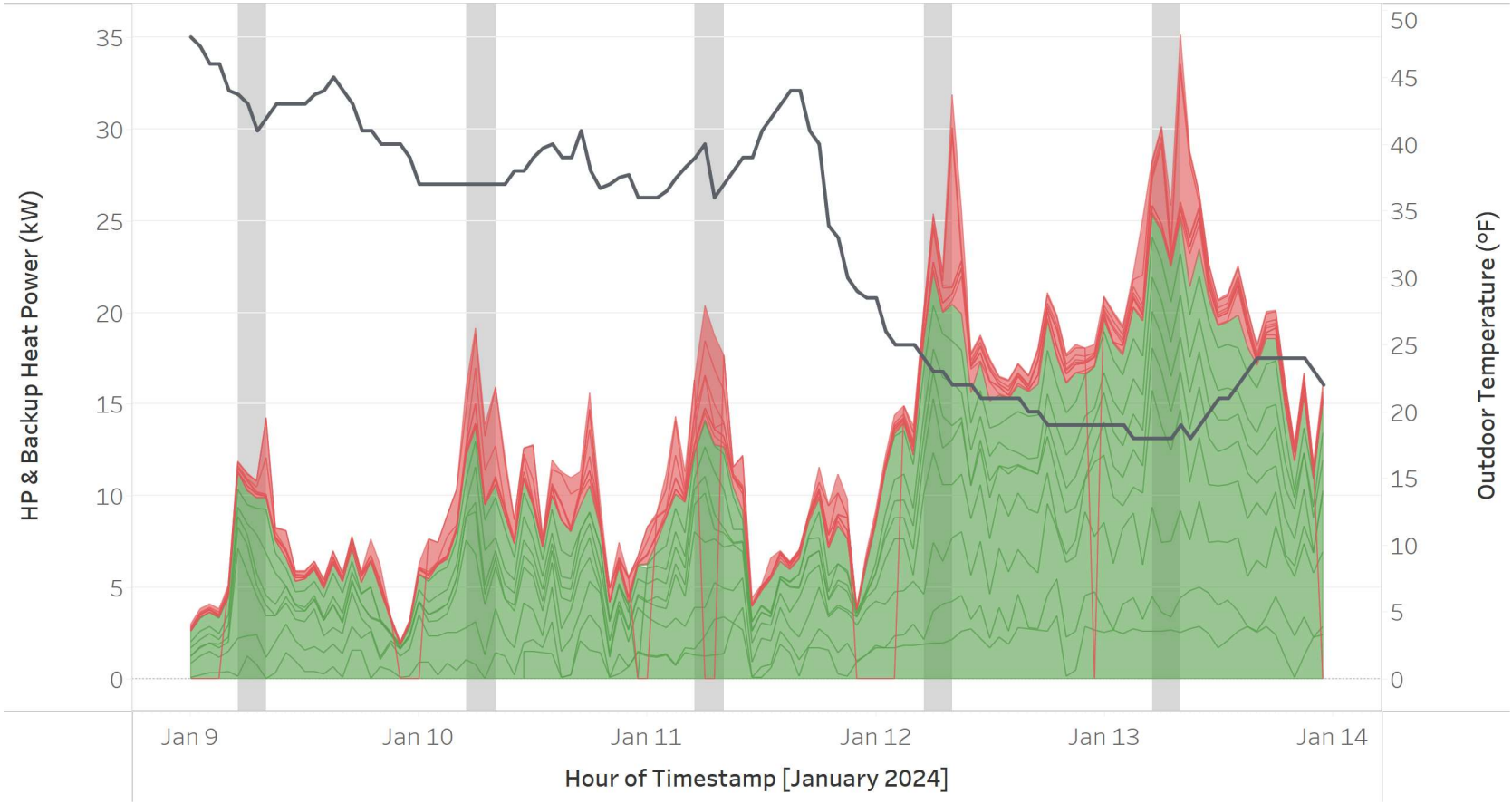
Existing Installs – utility customers with newer equipment which met HP HC HP criteria

Early Findings

HPHC and HEMS – HVAC kWh/sqft vs. HDD



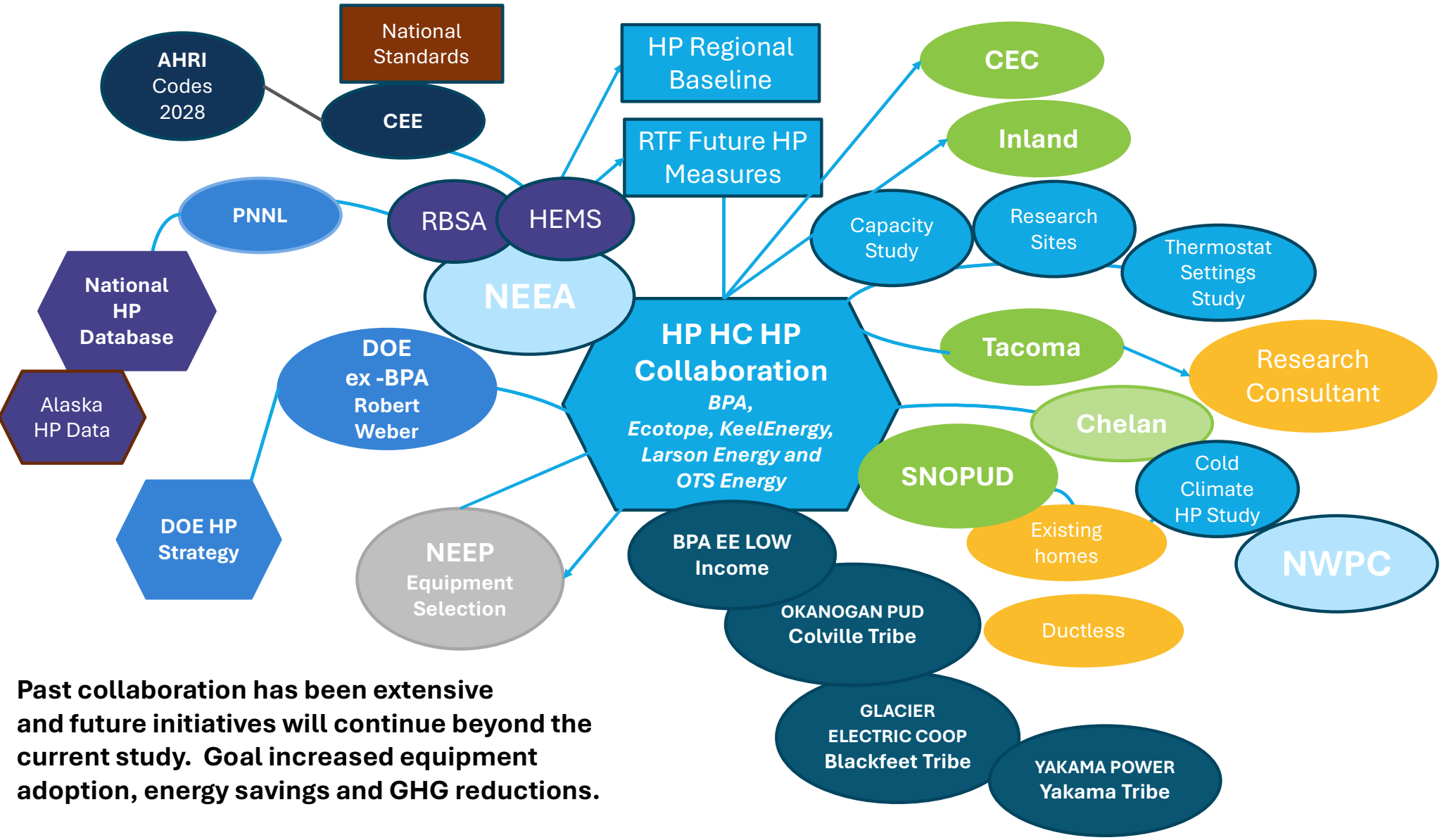
Setbacks 5-8AM



Learnings so far, what to share with industry

- Our “new install,” lower balance point sites have less variation in performance, lower energy during very cold weather
- Standard metrics (box specs) do NOT appear to be predictive, pending deeper analysis
- The strong signals coming out of our study so far:
  - Sizing and “high-capacity” appear to work, with more benefit in colder weather
    - Utilities: set a target balance point!
  - The HPHCs can deliver the heating with little or no electric resistance heat at and around the balance point…
    - …unless the thermostat/setback control decides otherwise!
  - Resistance heat coming out of set-back doesn’t <u>have</u> to happen!

- ALL FINDINGS SO FAR ARE PRELIMINARY!



Past collaboration has been extensive and future initiatives will continue beyond the current study. Goal increased equipment adoption, energy savings and GHG reductions.

Upcoming Research

- Looking for opportunities for research partners for the following topics:
  - MF HPs including
    - Epocha (PTHP with no outdoor unit) and cold-climate Window Heat Pumps (window shaker-style replacements)
  - MF and SF new construction measure including low income
    - Specifically targeting Habitat for Humanity chapters
  - Heat Pump Sizing using historical load data
- Do you have suggestions for research topics?

Thank you!

Nathan Kelly, Bonneville Power Administration

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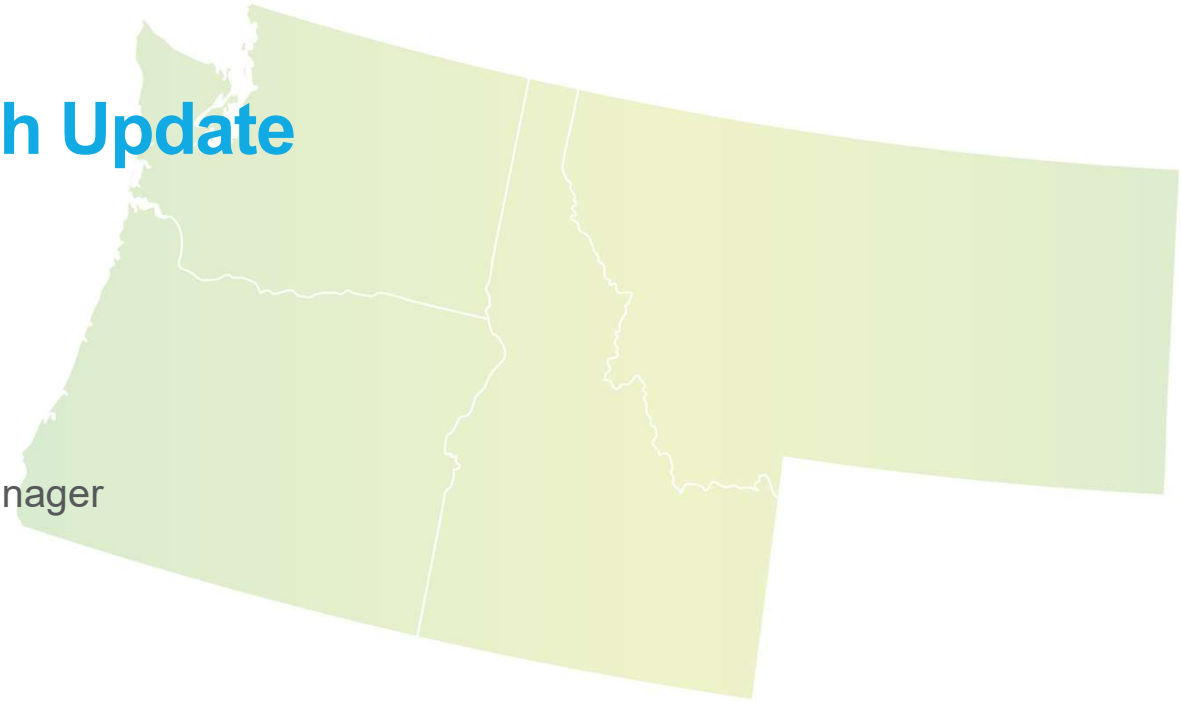
NEEA

Christopher Dymond
Product Manager
cdymond@neea.org

Heat Pump Research Update

LLE Lab Research
Room HP Field Testing
Rating Representativeness



Christopher Dymond, Sr Product Manager

Low-Load Efficient Heat Pumps

Low Load Efficient

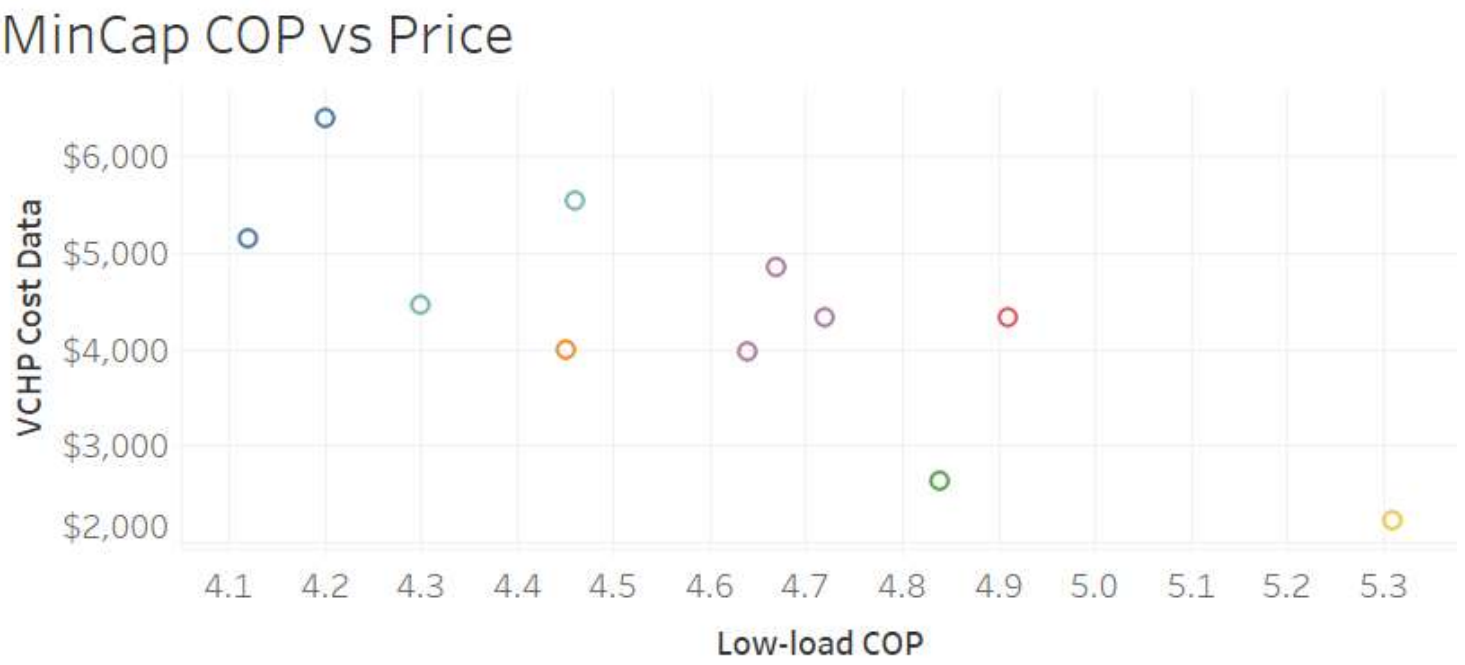
When sized right, a variable speed heat pump spends most of its time running at part load.

VSHPs are 10-50% efficient when running at minimum output than at full output.

NEEA Specification differentiates those that are good at part load:

MinCapCOP47 ≥ 4.5

LLE doesn't appear to cost more



Source: MN CEE/NEEA Variable Speed Heat Pump Product Assessment and Analysis
https://neea.org/resources/variable-speed-heat-pump-product-assessment-and-analysis

Investigations

- ✓ Modeling and Analysis
- ✓ Test Procedure Development and Influence (CVP)
- ✓ OEM Interviews and Virtual Teardown (24 systems)
  - Lab Testing (6 systems)
  - Physical Teardown (3 systems)
  - Analyzing Field Data (BPA, RR and CEE)

Cold Climate Room Heat Pump

Cold Climate Room Heat Pumps

- Key innovation is use of an atomizer to get rid of condensate and melt water without need of melt water system or risk of freezing water dribbling down the side of the building.
- Two new products are entering the market that can operate below 5F
- These systems are available in limited production runs at a cost of $3000-$4000

Midea PWHP

Image courtesy Midea

Specs subject to change

	Outdoor Condition	Capacity (BTU/hr)	Efficiency
Cooling Mode	95 °F (35 °C)	9010	11.81 EER
Heating Mode	47 °F (8.3 °C)	9050	4.05 COP
	17 °F (-8.3 °C)	9060	2.42 COP
	5 °F (-15 °C)	9000	2.0 COP
Min Temp	-13 °F (-25 °C)	5050	1.41 COP
CEER	16		
SEER2	18.76		
HSPF2	10.12		
Indoor Sound Pressure Level	High	Low	Silent
	51 dB(A)	43 dB(A)	26 dB(A)
Unit Weight	130 lbs		

Gradient All Weather Unit

Image courtesy Gradient

Specs subject to change

Electrical Requirement	**Voltage**	**Phase**	**Circuit Amps**
	120 VAC	60 Hz	15 A
Thermal Performance	**Outdoor Temp**	**Capacity**	**Efficiency**
	95 °F (35 °C)	9000 BTU/h	10.0 (EER)
	47 °F (8.3 °C)	9000 BTU/h	4.00 (COP)
	17 °F (-8.3 °C)	9000 BTU/h	2.60 (COP)
	5 °F (-15 °C)	7200 BTU/h	2.35 (COP)
	-7 °F (-21.7 °C)	4900 BTU/h	1.71 (COP)
Weight	125 lbs		
Refrigerant	R32		
Indoor Sound Level	**High**	**Medium**	**Low**
	47 dB(A)	44 dB(A)	38 dB(A)

*Specifications are subject to change.

Cold Climate Room Heat Pump

- New Products Available — Q4 2024
- EPA Interim Test Procedure — Q4 2024
- Tax Credits begin — Q1 2025
- NW Field Testing Project? — Q4 2024 - Q4 2025

Details at RETAC June 27th

Rating Representativeness

“Test the Test”

Load Based Testing

Revealed Lower Performance and Rank Order Changes

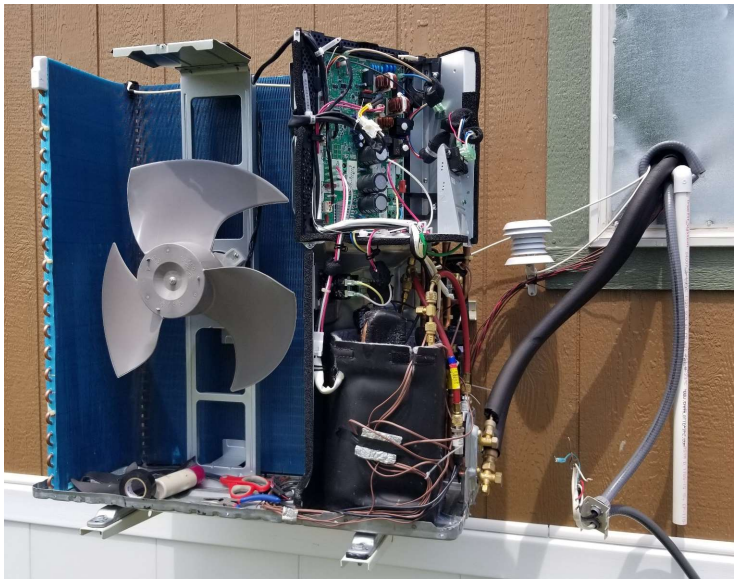
5 systems with same AHRI rating
"appendix M"

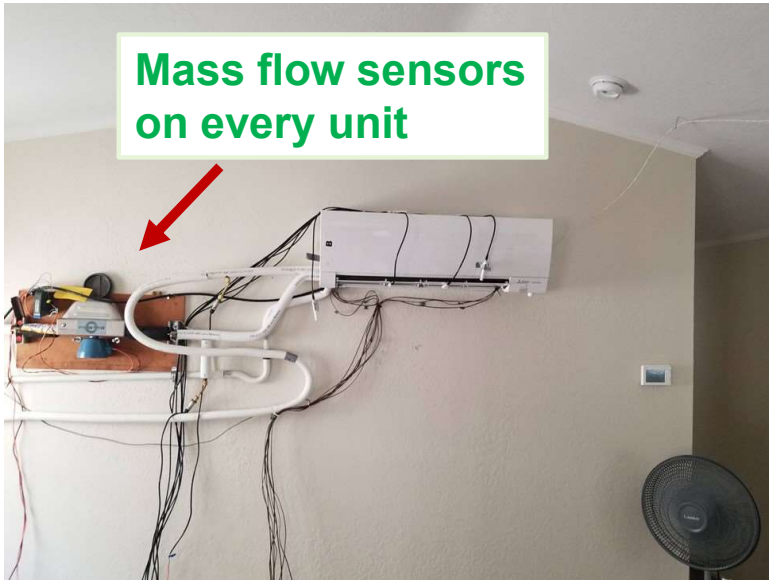
Results vary when tested with EXP07

Better ways of predicting and confirming installed system performance enable accurate product differentiation and increased utility support

System Installation and Instrumentation

- 6 Heat Pumps were field tested, but like a lab installation
  - Over 100 sensors per house, including $\dot{m}$





All units shipped to Lab

UL lab in Plano, TX

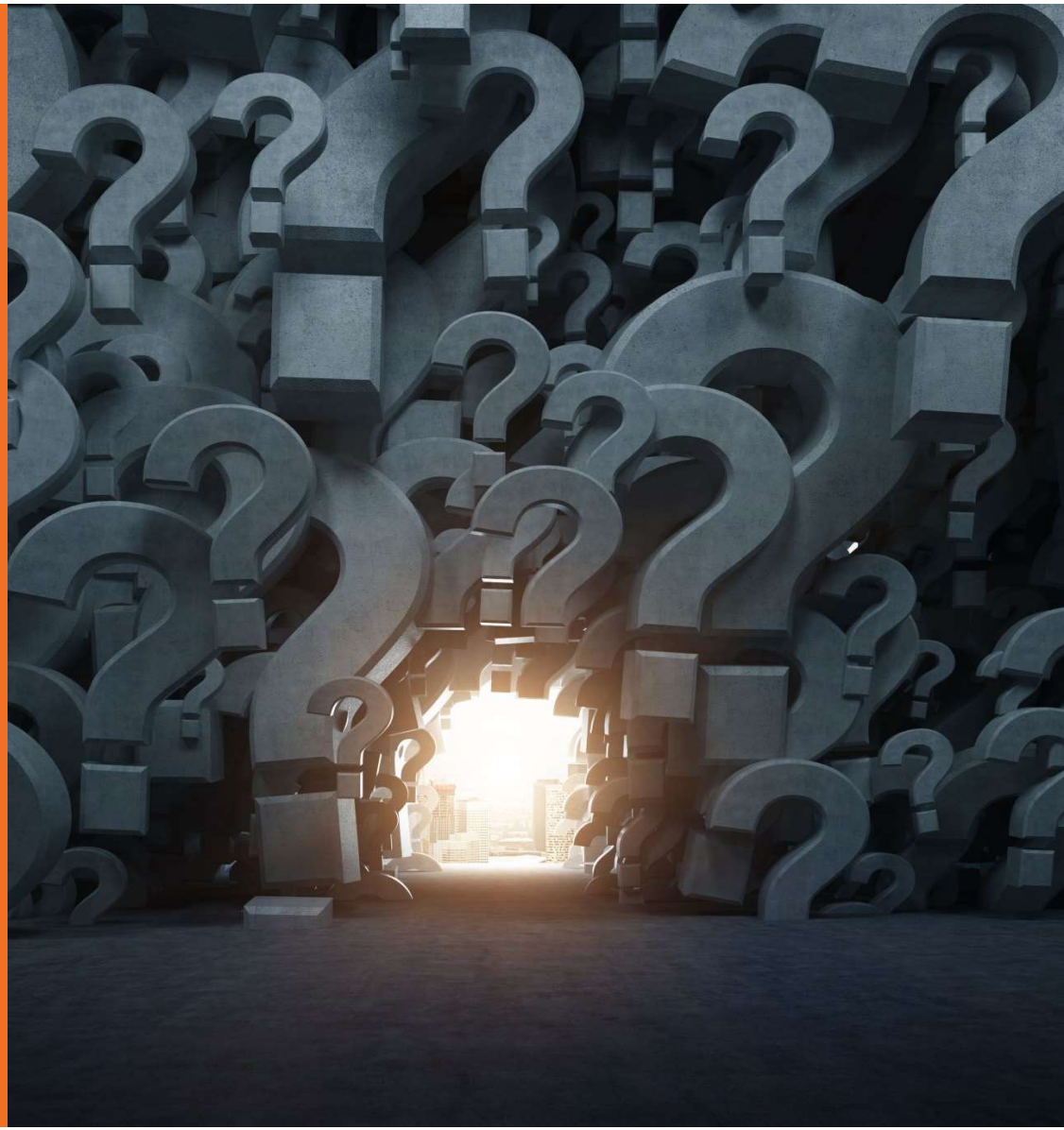
Top Level Findings

- Load based testing is statistically more representative of current M1 test procedure (static testing)
- M1 often overpredicts the performance of the units in both heating and cooling.

	Cooling		Heating	
	SPE:07*	M1	SPE:07	M1
Ducted	13%	9%	11%	17%
Ductless	13%	43%	10%	64%
Combined	13%	22%	10%	36%

* SPE-07 cooling error is from cooling bin-hours used in SPE:07 are skewed to mild hours

Questions and Discussion



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Thank you!

Christopher Dymond, NEEA

cdymond@neea.org

Thank you to all the Presenters

ORG	PRESENTER	TOPIC
Chelan	Josh Mitchell	Heat pump update
Avista	Leona Haley	Hybrid and cold climate heat pump pilot
Emerald PUD	Tyler Boehringer	Measure Cost Effectiveness Calculator
Energy Trust	Andrew Shepard	Heat pump research
BREAK	BREAK	BREAK
PSE	Will Dixon	Heat pump research
Tacoma Power	Rich Arneson	Heat pump research
BPA	Nathan Kelly	High Performing Heat Pumps
NEEA	Christopher Dymond	Low Load Efficient lab research Cold climate room HP field research

Break!

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AGENDA

All times Pacific

12:30 -1:00 pm (30 mins)	**Welcome, Agenda, Packet Review & Introductions**
1:00 - 2:30 pm (90 mins)	**Regional Priority Topic** • **Advanced Heat Pumps** – *Coordination on planned or ongoing field studies/pilot studies/data collection*
2:30 – 2:40 pm	***BREAK***
2:40 – 4:00 pm (80 mins)	**Regional Roundtable**
4:00 – 4:10 pm (10 mins)	**Recap, Next Steps, Adjourn**

Committee Roundtable

Roundtable Focus

(NEEA PMs & PCC members first)

- *Highlights since March*
- *Programmatic updates*
- *Organizational updates*

Please aim for 3-5 min max, thanks!


Let’s wrap it up!

Thank you PCC!

See you tomorrow at 9:30 am

June 25th 2024