

hot place

cold place

expansion valve

3

2

Advanced HP Coalition

Webinar Update - March 4, 2019

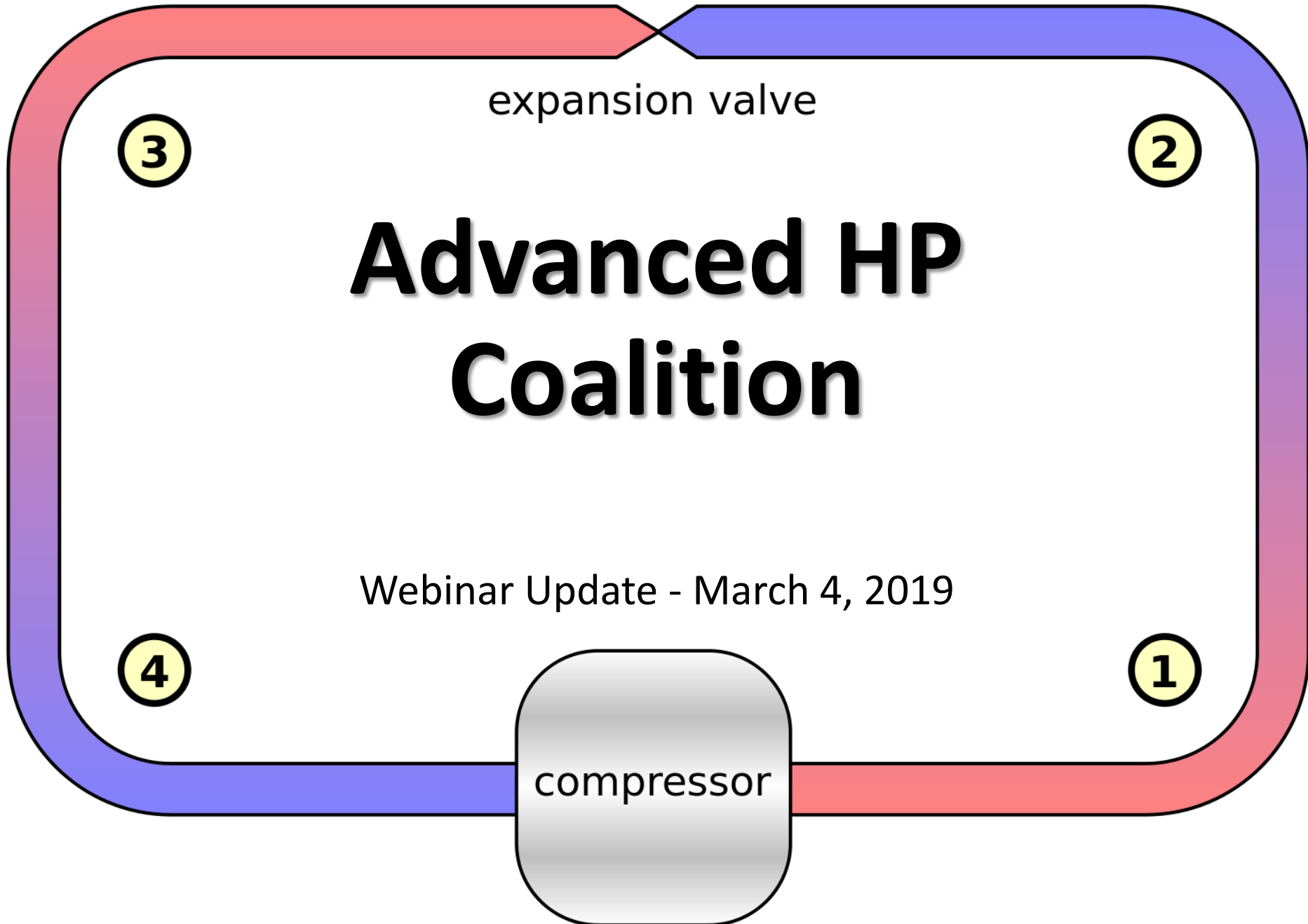
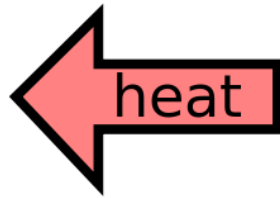
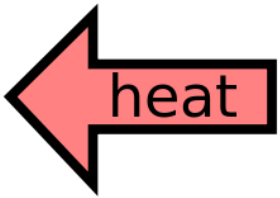
4

1

compressor

heat

heat



“Coalition of the Willing”*



*We are not a formalized organization

New members are welcome

Acknowledgment

We all have lots of **other** work
that needs to get done.

Today's Agenda

- Overview for new folks
- Group Updates (aka committees)
 1. Test Procedure
 2. Equipment Roadmap Specification
 3. Design and Installation
 4. Consumer and Installer Understanding
- Discussion Topics
 - Connected HVAC data vs. lab testing?
 - What would help us collaborate more effectively?
 - Other?
- Next Gathering
 - Renewable Heating and Cooling Workshop

UC Davis Workshop Highlights

- What we know
 - HSPF and SEER are poor proxies
 - We don't really know what the right solution is
 - Increased pressures for in Demand Responsiveness & Decarbonization
- What is emerging
 - Convergence of multiple technologies will transform current products
 - New Canadian Test Procedure may provide a better performance proxy
- Barrier and Challenges Identification
- Vision and Next Steps Identified

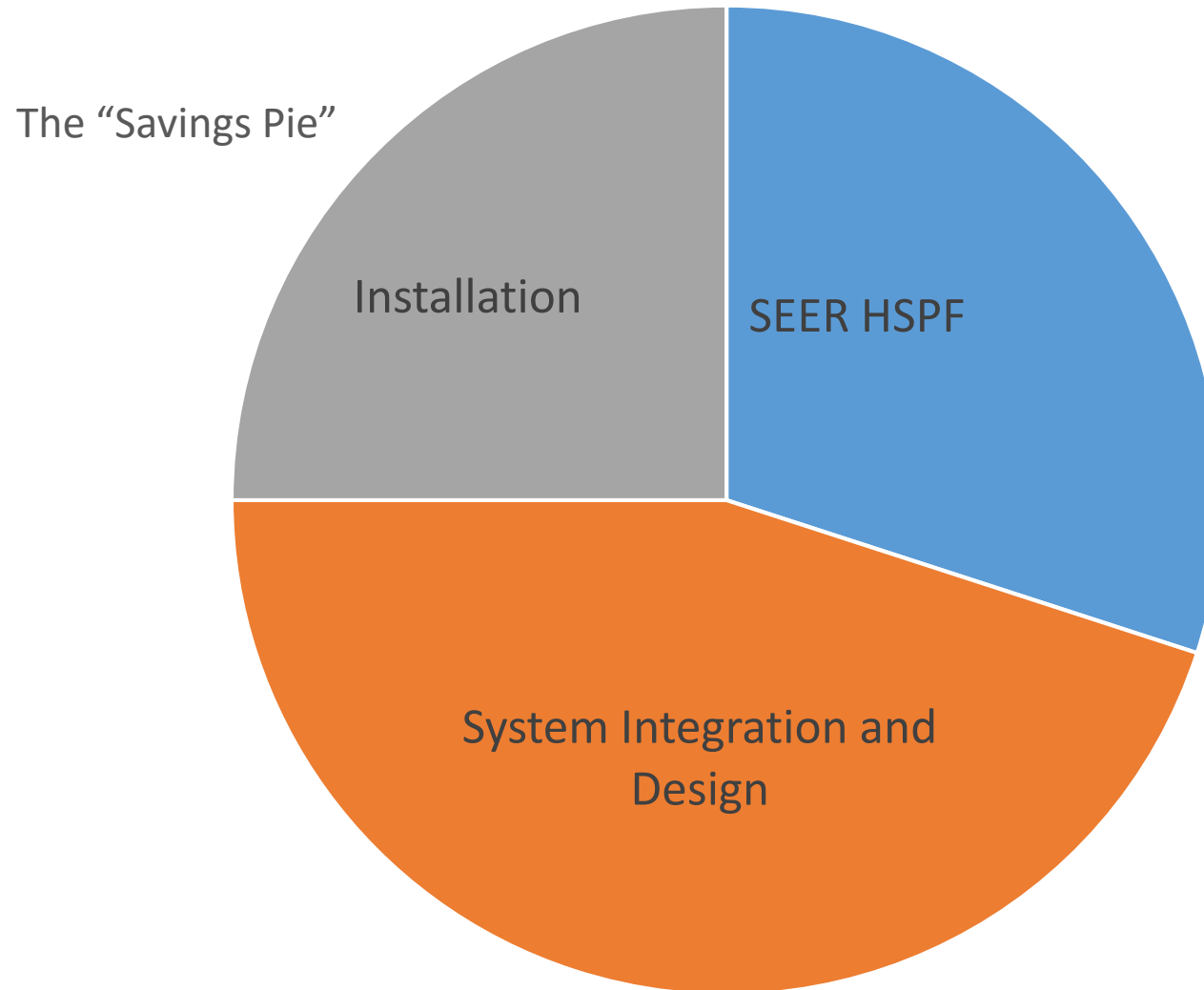
Why a HP Coalition?

1. Share common learnings
2. Pool Resources
3. Convey scale and potential to manufacturers

Why Now?

1. Enormous Potential
2. We Need Real World Performance
 - HPs are not meeting performance expectations
 - CSA EXP-07 Test Procedure is finally done
3. Technology is “rapidly” changing what is possible
 - Variable Capacity Cold Climate heat pumps
 - Advanced HX
 - Refrigerant changes
 - Connected Intelligence

GOAL = Real World Performance



Pie chart is illustrative, not based on specific field and lab testing

How Do We Move the Future to Today?

	Today's Market		Future Market
Technology Capability	Real World SCOP = ~2.2 Min Temp = 5 F	← Barrier Removal	Real World SCOP = 3.2 Min Temp = -20 F Automatically Optimized
Consumer Experience	Expensive Confusing Noisy "Cold Blow" when defrosting		Easily Identified Readily Available Differentiated Dealers
Program Design	SEER/HSPH Spec Driven Install Requirements Post install verification Complicated Evaluation		Clear Criteria Post install data Performance incentives

Group 1 Lab Test Procedure

1. Validate Test Procedure to field performance
2. Secure Funds for Testing EXP07
3. Testing to Characterize 3Rs
 - Repeatability
 - Reproduceability
 - Representativeness
4. Develop Value Proposition
 - Manufacturers
 - Utility / EE Orgs
 - Codes & Standards
5. AEDM Process Application
(alternative efficiency determination method)

Accurate Test Procedure

Christopher Dymond

Gary Hamer

Bruce Harley

Marshall Hunt

David Lis

Joanna Mauer

Mark Modera

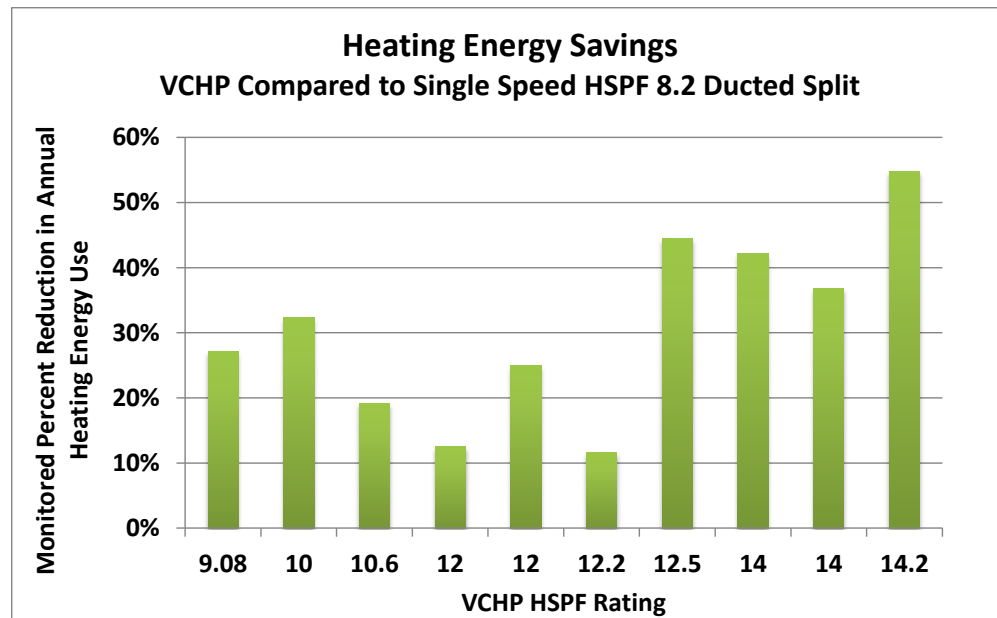
Jonathan Moscatello

Reinhard Radermacher

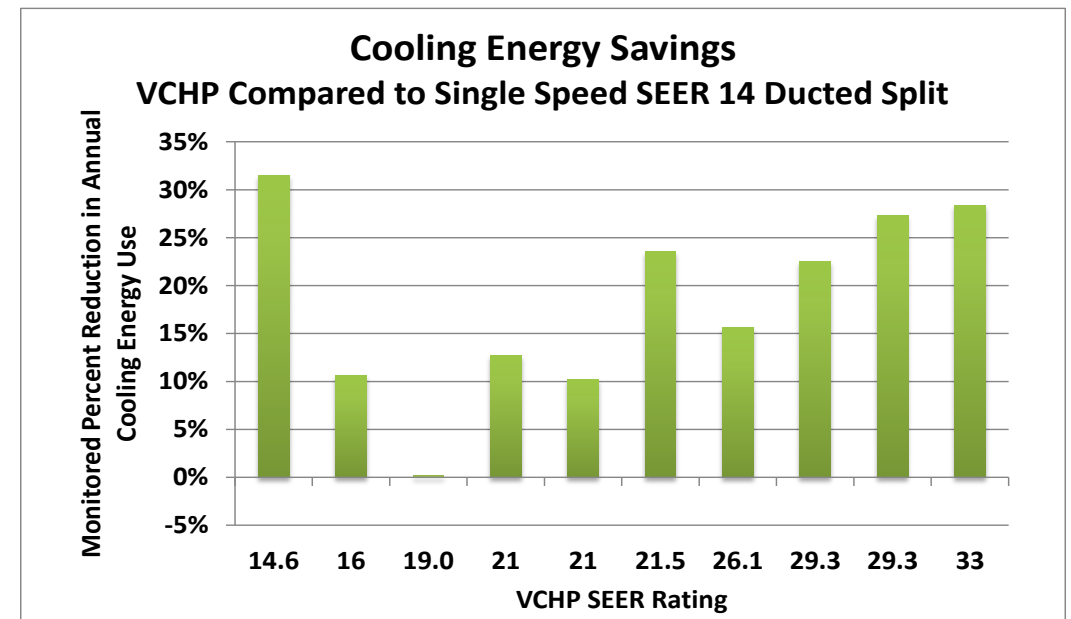
Mvuala Suami

SEER and HSPF are Poor Proxies

HSPF



SEER



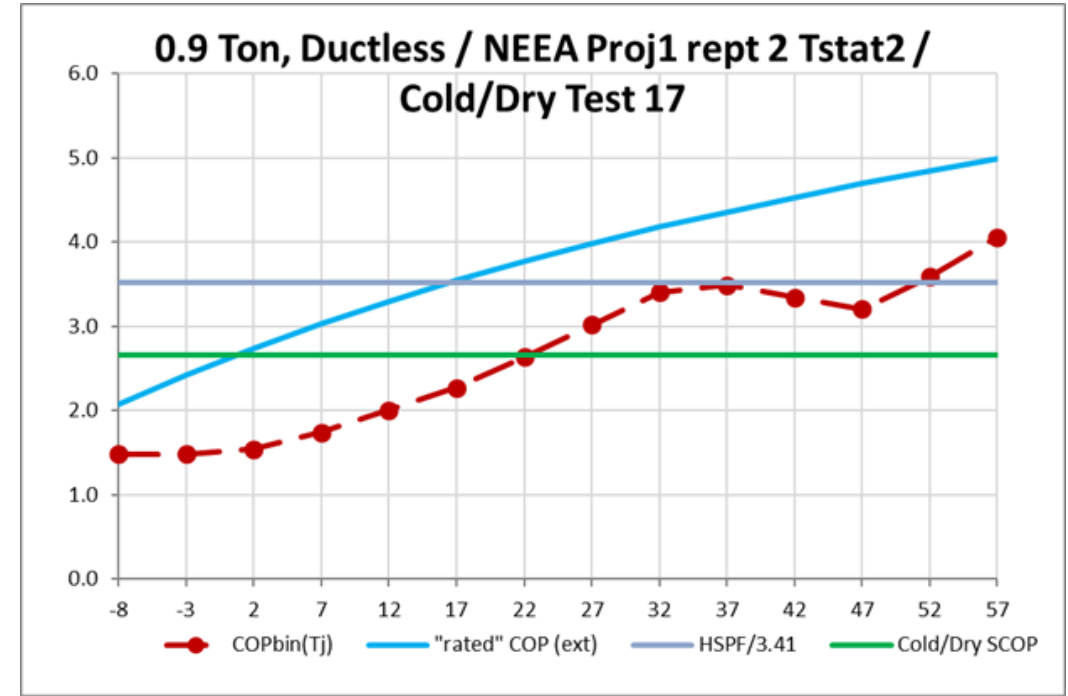
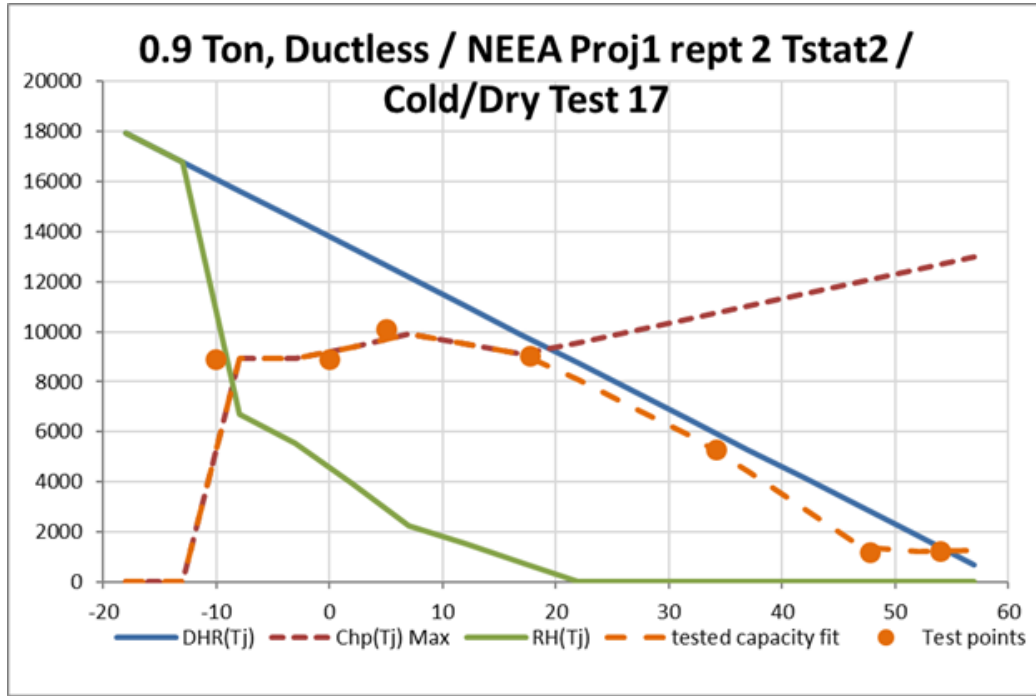
California Central Valley Laboratory Houses

Available Reports:

<http://www.etcc-ca.com/reports/variable-compressor-speed-heat-pumps>

<https://www.etcc-ca.com/reports/central-valley-research-homes-evaluation-ducted-and-ductless-configurations-variable>

CSA EXP-07 ----- what makes it different



Indoor room load simulated by test equipment
Heat Pump operates under its own controls

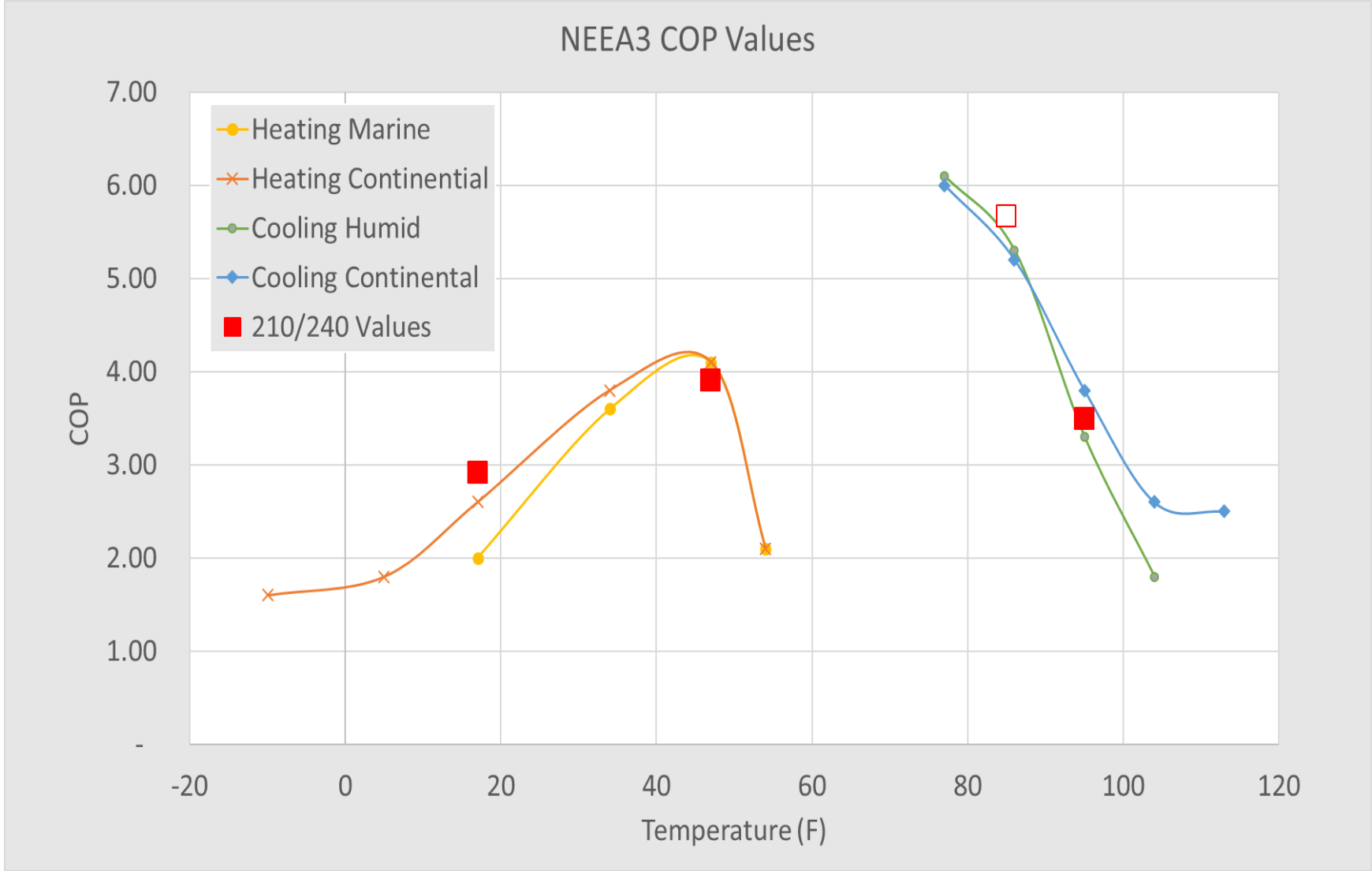
Imposed load is adjusted with outdoor temp

SCOP results better match actual performance

CSA EXP07 Testing Results

[illegible][illegible]

Individual Test Point COP



Climate Weighted SCOP Values

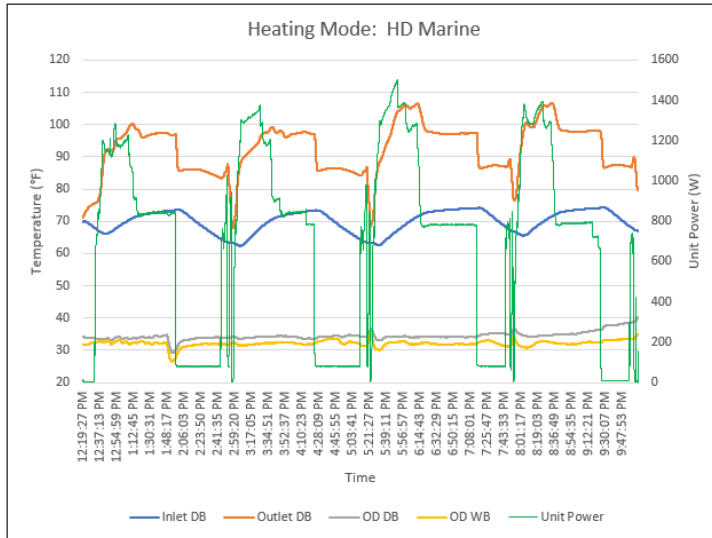
Heating SCOP

Sub Arctic	1.80
Very Cold	2.35
Cold Dry	2.91
Cold Humid	2.63
Marine	3.81
Mixed	3.25
Hot Humid	3.76
Hot Dry	3.61

Cooling SCOP

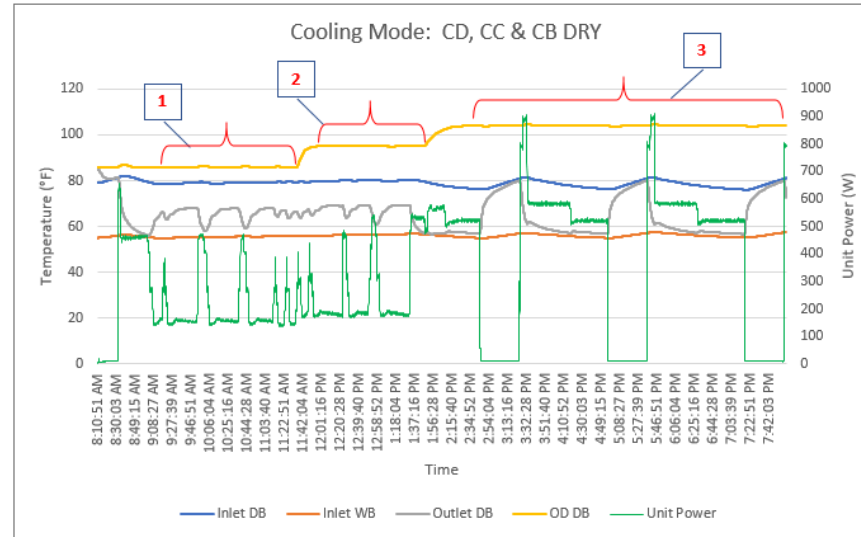
Very Cold	5.04
Cold Dry	4.38
Cold Humid	4.95
Marine	4.12
Mixed	4.83
Hot Humid	5.08
Hot Dry	3.90

Lab Observation Anomalies

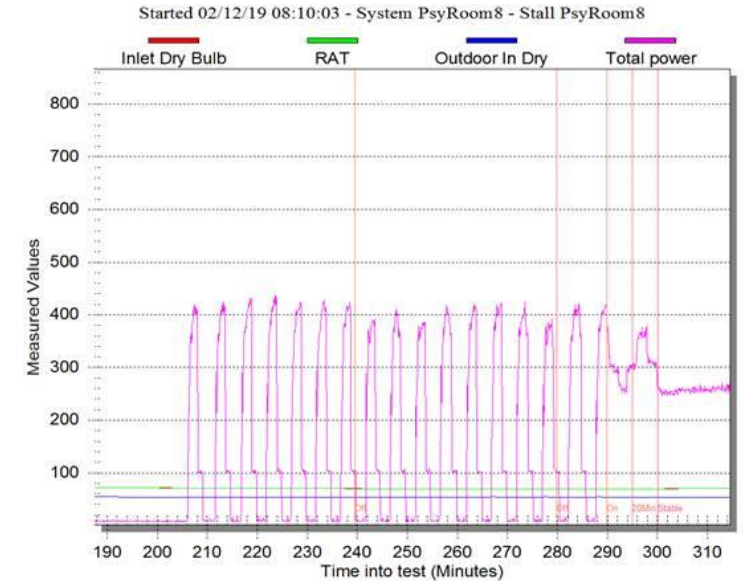


Some machines behave oddly

This makes it challenging to identify when convergence has been achieved



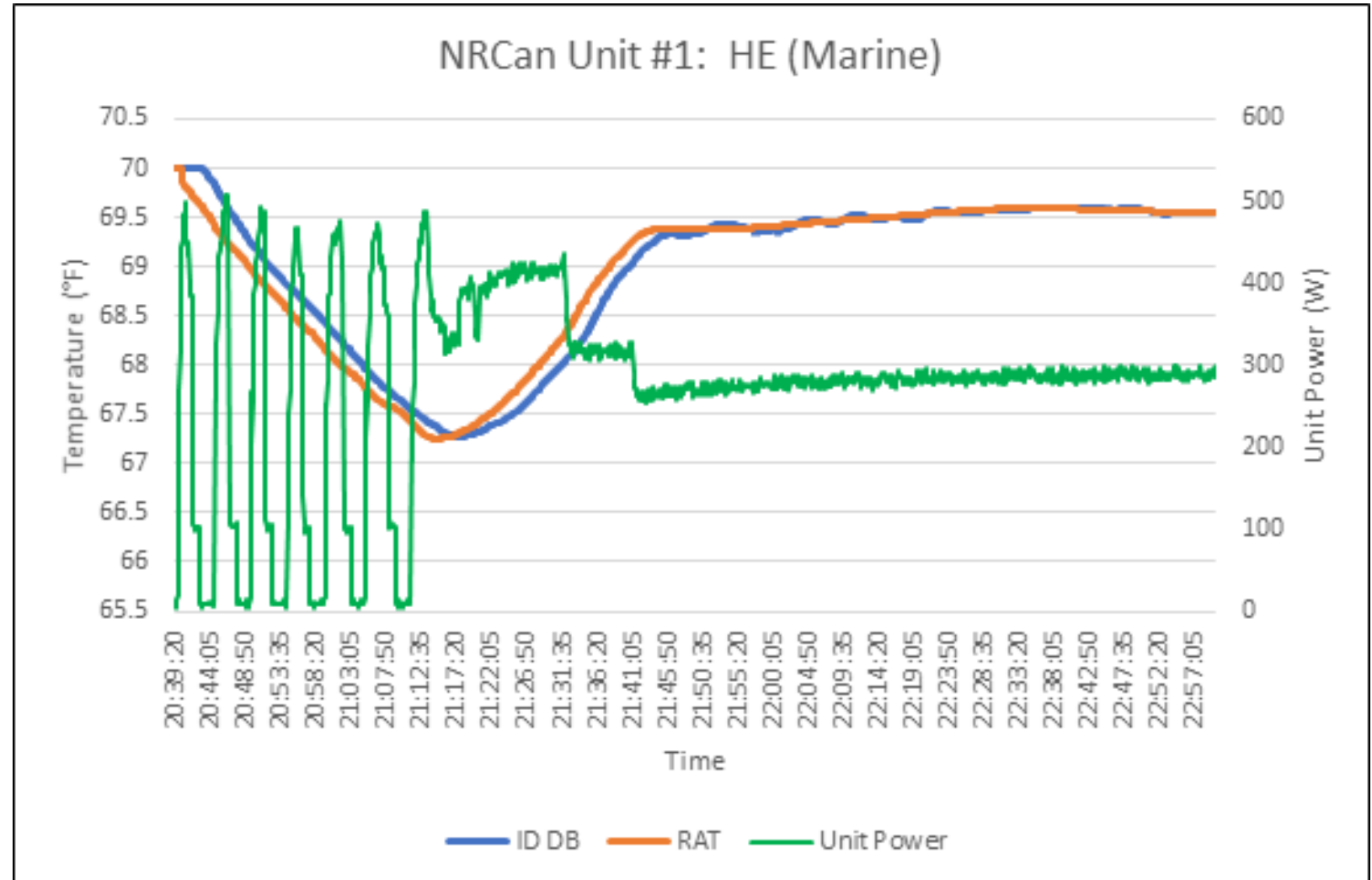
Cooling Convergence is typically quick but some modes are unstable



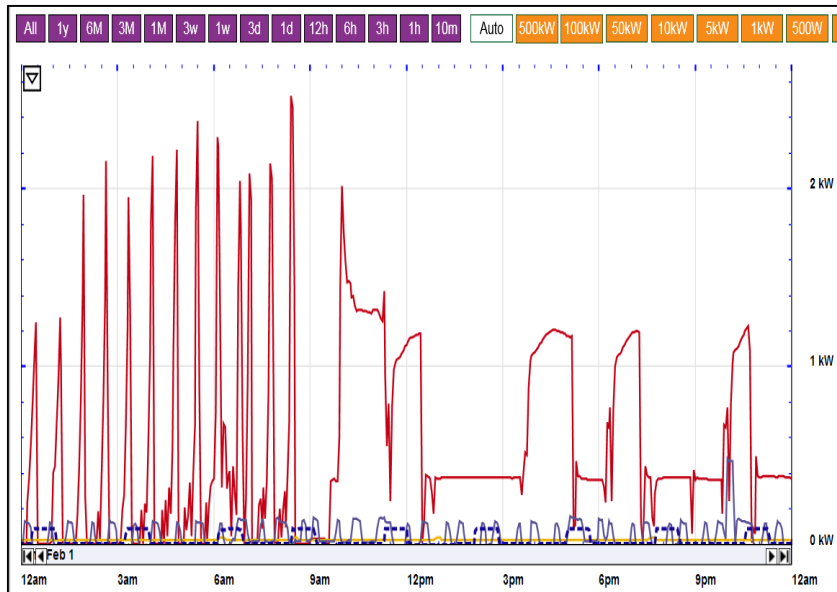
Short cycling for an hour before settling into variable capacity mode

Finding it's “groove”

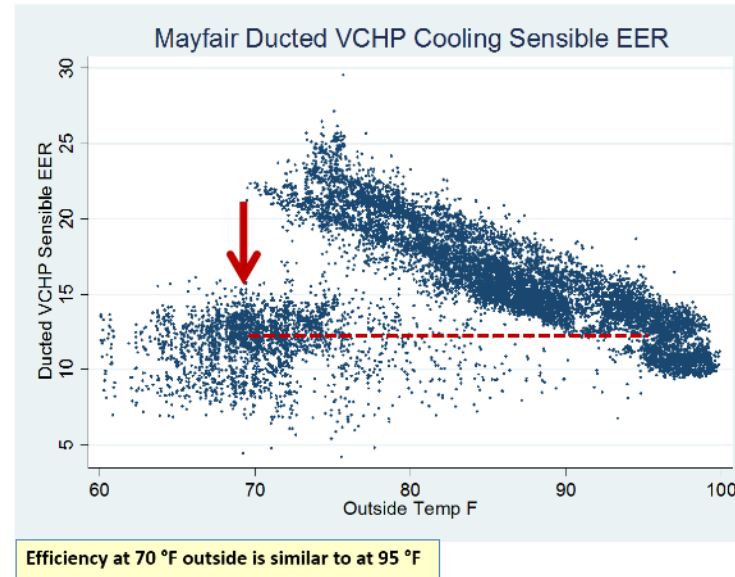
HE (Marine) is a great example of a unit running for an extended period of time (+60 min) before it finds its groove; similar to the step response example I referenced in a previous email (seen below).



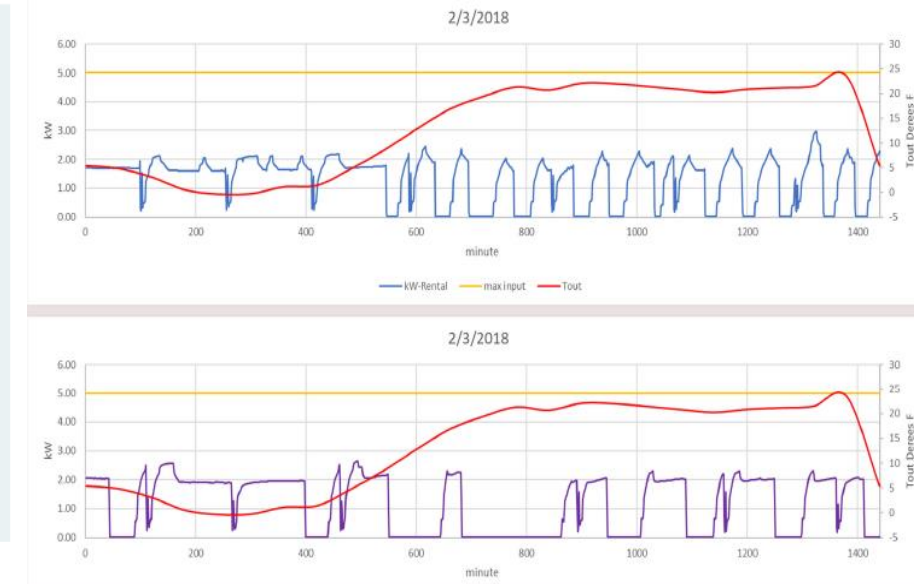
Field Observation Anomalies



Low Load short cycling leads to
annual efficiency loss > 30%



Unexpected Behavior



Cycling at Low Temps

Group 2 Roadmap Specification

1. Define Value Propositions
 - Programs
 - Manufactures
 - Contractors
 - Customers
2. Meet with Manufacturers – Collaborate with Willing
 - What is possible
 - What are major challenges
3. Define Elements of Specs
 - Data Reporting Needs
 - Integrated Controls
 - Performance tiers
 - Product features
4. Socialize and build support

Equipment Roadmap Specification

Jerine ahmed

Mark Alatorre

Nick Dunfee

Christopher Dymond

Todd Greenwell

Gary Hamer

Bruce Harley

Randall Higa

David Lis

Cheryn Metzger

Jonathan Moscatello

Chris Perry

Reinhard Radermacher

Andrea Salazar

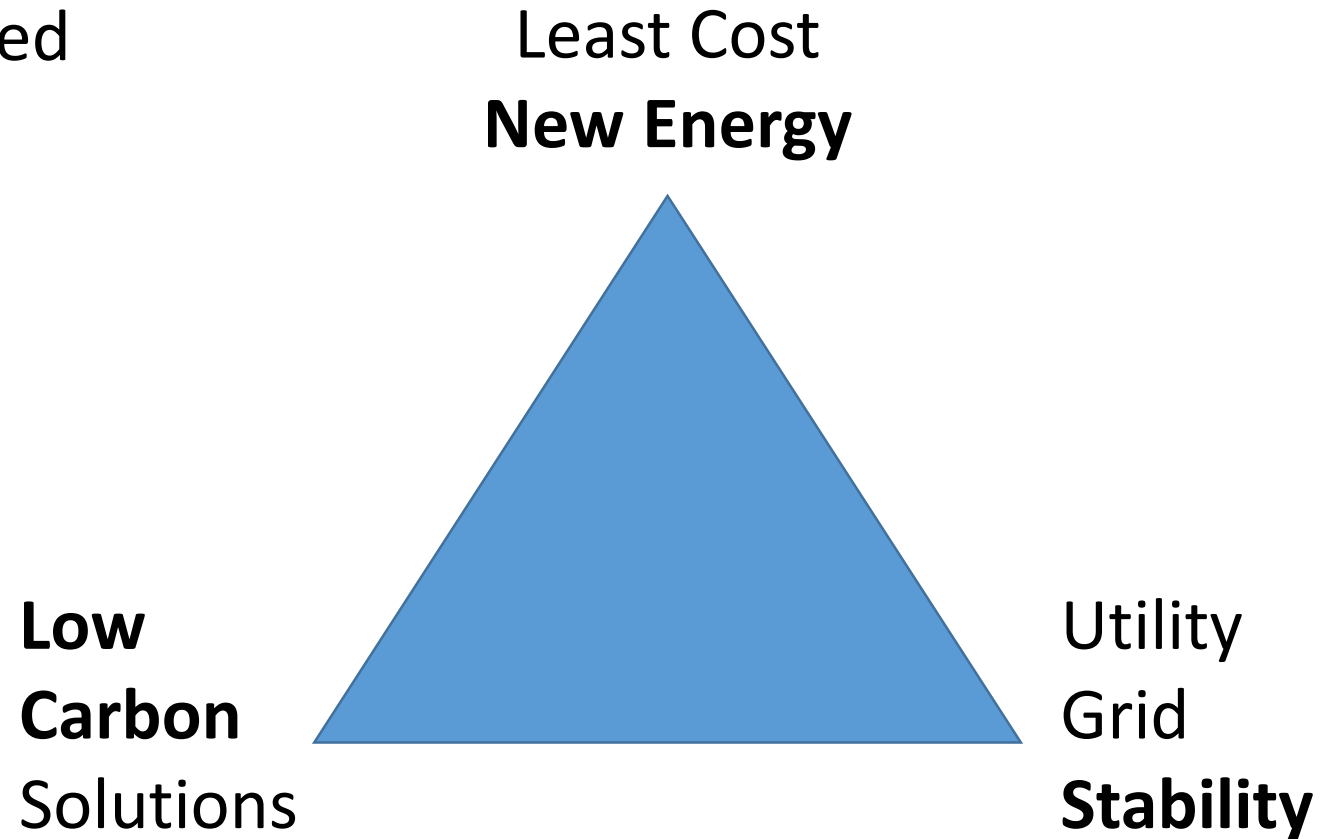
Mvuala Suami

Robert Weber

Jay Stien

Value Proposition - Manufacturer

- We always Need More Power
- Your products have untapped market potential



Top 4 Low-Carbon Solutions

Technical potential of customer side solutions by 2050

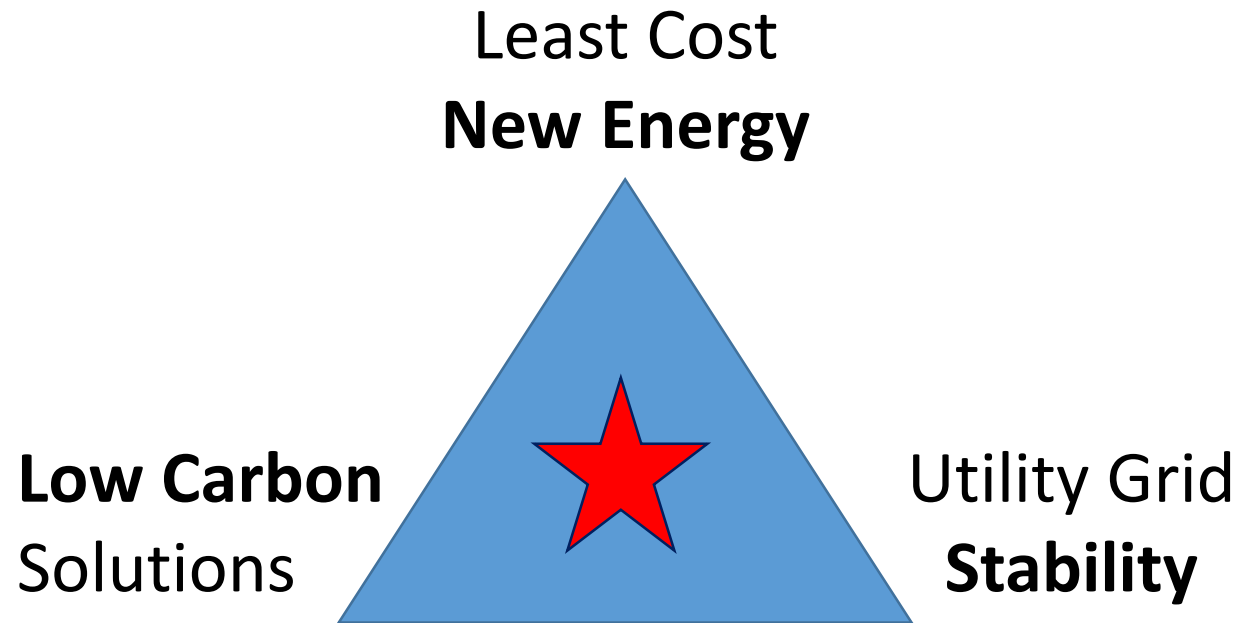
Gas and Electric HPs

Application	Source Energy Use (Quads)		
	2018	2050	Energy Savings
Electric Cars and Trucks	15	3	12
Photovoltaics	-0.2	-9	9
Heat Pumps	11	3	8
LED Lighting	3	1	2

Market Transformation Potential of the ASHP - 2018 ACEEE Paper Excerpt

The ASHP systems are based on a seasonal COP of 2.2 for water heating and 3.3 for space heating sourced by a 50% efficient electrical grid (generation, transmission and distribution losses). 50% efficient is high, but chosen as a proxy for a gas turbine + renewable energy dominated utility grid likely by 2050. The iASHP systems could also be powered on-site by gas. Such systems would need COP values not much higher than 1.1 for water heating and 1.65 for space heating to provide the equivalent source energy reduction. The lighting baseline estimate is adjusted to pre LED conditions NEEA's building stock assessment (NEEA) values, with end state efficacy estimates of 100 lm/W for residential lighting and 150lm/W for commercial. The photovoltaic "savings" are based on a projected 1000 GWp of installed capacity under a solar resource of 1400 kWh/Wp.

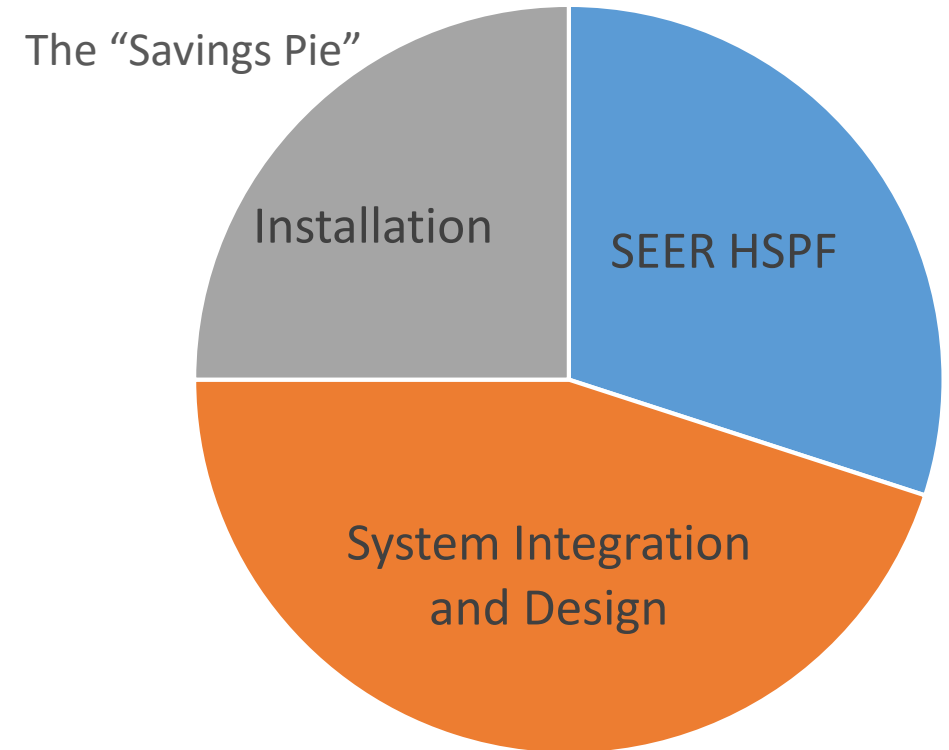
Advanced Heat Pumps



If they had a good “meter”

Our Assumption – Future HPs will

- Be internet connected
- Include machine learning
- Continuous commissioning
- Collect performance data
- Provide contractor feedback



Are your products capable of
real world performance?

Coalition* Plan

1. Work with 3 Manufacturers to Develop a Real World Performance Approach (2019)
2. Publish and Build Support for the Approach
3. Provide Market Support
 - Build Consumer Awareness
 - HVAC Trades Recognition
 - Performance Based Incentives

*A coalition of the willing - We are not a formalized organization

Manufacturer Meetings Being Scheduled

- 5 Major Manufacturers were very interested in collaboration
- 3-5 to visit each manufacturer's Product Manager Team
 - Canada
 - NW
 - NE
 - Midwest
 - California
- NDAs required

Drafting The Roadmap Specification

- Draft just begun --- collaborators welcome
- Features
 - Performance (based on SCOP?)
 - Data Reporting (post install?)
 - Demand Response
 - Comfort Criteria
 - Operating Ranges

Group 3 Design and Installation

1. Create Decision Tree
2. Design use Cases
3. Develop guidance for contractors
4. Develop Installation Specs
5. Refine QA Specs
6. Get Industry Feedback
7. Conduct Q/A on Program Efforts

Design & Install Spec

Mark Alatorre

Suzi Asmus

Mark Baines

Andrew Belden

Nick Dunfee

Christopher Dymond

Bruce Harley

Bruce Manclark

Cheryn Metzger

Mark Modera

Group 4 Installer and Consumer Understanding

1. Market Research – Understand Market Actors
 - Customer
 - Distributor
 - Installer
2. Develop Value proposition for various audiences
3. Establish Heat Pump Association
4. Develop Marketing Campaigns
5. Deploy Marketing Campaign
6. Follow-up and Feedback

Consumer & Installer Understanding

Suzi Asmus

Andrew Belden

Nick Dunfee

Todd Greenwell

Owen Howlett

David Lis

Cheryn Metzger

Jonathan Moscatello

Brenda Pike

David Poderson

Arun Vedhathiri

David Poderson

Andrea Salazar

Discussion 1

Connected HVAC data vs. lab testing?

Discussion 2

What would help us collaborated more effectively?

How to Contribute

1. Attend NEEP Renewable Heating and Cooling Workshop

DATE: Early June?

LOCATION: Boston

2. Join a Subgroup

1. Test Procedure

2. Roadmap Spec

3. Design and Installation

4. Customer and Installer

3. Share your research results

4. Co-fund lab testing

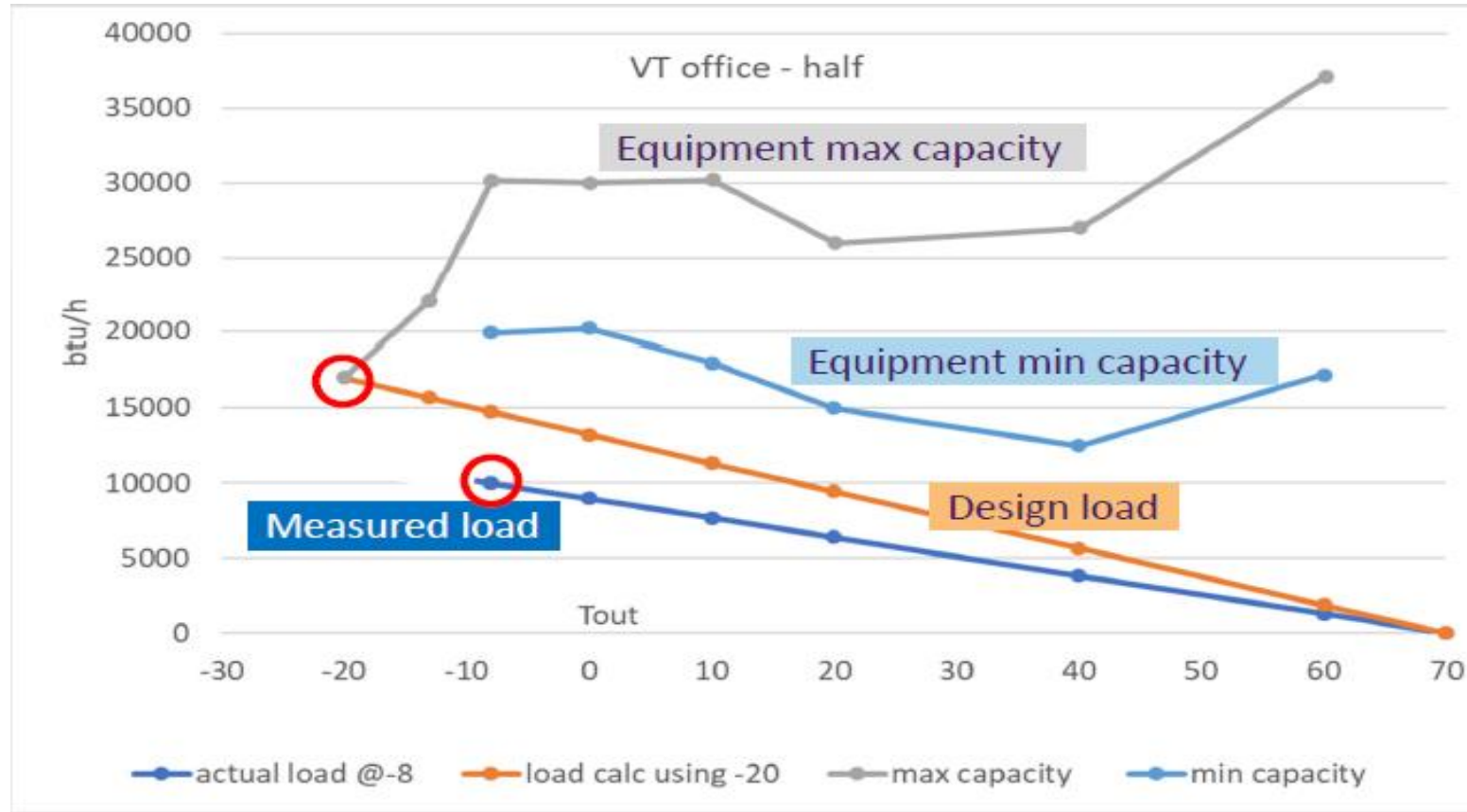
5. Other?

Thank You

Send me an email if you want to be part of the coalition.

cdymond@neea.org

Sizing challenge of low turndown equipment



This example shows that a machine might never operate in between min and max and thus not take advantage of variable capacity benefits