Advanced Heat Pump Coalition

Fall Webinar, Nov 30th, 2022

TOPIC: Research Projects Update

Agenda

General Information	**10 minutes**
• Advanced HP Coalition Intro	
• Workgroup Updates	
Project Updates	**60 Minutes**
• 7 presenters	
Questions and Discussion	**15 minutes**

Objective: Increase collaboration

A “Coalition of the Willing”

Goal

To increase research collaboration among energy efficiency organizations that are working to accelerate market adoption of advanced heat pumps

Membership

- ACTIVE = Fund and Guide collaborative activities
- PASSIVE = attend semi-annual webinars, provide feedback

Committees

- Steering Committee
  (NEEA, NEEP, MEEA, CEC, NRCan, EPA, NYSERDA)
- WG #1 – Improved Test Procedure and QPL
- WG #2 – Roadmap Specification and Mfr Engagement

Brightest heat pump minds from organizations such as these:

Workgroup 1 – Improved Test Procedure & QPL

Vision

- The marketplace (Efficiency Programs/manufacturers/contractors) can identify ASHP products that will deliver *actual* performance

Desired Outcomes

- An improved test procedure is developed and validated to show enhanced representativeness of ASHPs
- An Advanced ASHP Qualified Product List (QPL), based on the results of an improved test procedure, is built
- Efficiency Programs use QPL to incentivize adoption of advanced ASHPs that deliver real world performance, increasing savings
- Long term- Federal Standards program ultimately more representative test procedure and rating

Mechanism employed

- Improved Test Procedure
- Qualified Products List

Workgroup 1 – Update

CSA EXP07 has become SPE07:22

- 2022 version is being prepared for publication
- ANSI Accreditation work has begun

Representativeness Project

- Phase 1 – Field testing in Lincoln Nebraska
- Phase 2 – Lab testing at UL in Plano TX, Q2 2023
- NEEP is project manager
- DNV is prime contractor, support from University of Nebraska

Publications

- 2020 EXP07 Interim results
- 2022 Purdue University Reports (various)
- Why Metrics Matter Report

Workgroup 2 – Roadmap

Vision

- Heat pump capabilities that enhance in-field performance are well supported by utility programs and provide additional value to the HVAC industry

What is a “Roadmap Specification”

- It is not program specification
- It includes MT fulcrum items
- It leverages industry direction

Desired Outcomes

- Manufacturers have clear understanding of what Utilities need
- Widespread utility program support exists for the features specified

Workgroup 2 – Update

2022 Activities

- Roadmap Document Updated (living document)
- Many discussions on what elements can become product differentiators
- Workgroup serves as a forum for sharing and a sounding board for research ideas

Publications

- None to date

Workgroup 3 – Best Practices

Workgroup has been disbanded

Work continues through the CEE Quality Installation Project

- Multiple Technical working groups
- Alice Rosenberg is project lead

Publications & Outcomes

- Defined areas of focus
- Best Practices Gap Analysis Report completed – TRC, 2021
- 10 workforce development Presentations at Spring 2022 AHPC Webinar

Fall 2022 Webinar Presentations

Presentations

• Representativeness Project	Jennifer McWilliams	DNV
• Advanced Refrigerants	Sam Yana Motta	ORNL
• NEEP Sizing & Selection Tool	Dave Lis	NEEP
• ASHP Integrated Controls Strategies	Karen Fenaughty	FSEC
• Hybrid HP Tools	Jeremy Sager	NRCan
• GSHP and ASHP Research	Martin Kegel	NRCan
• Features and Capabilities	Christopher Dymond	NEEA
• E4theFuture – CCHP	Christine Amero	Cadmus
• Hot Air Forum	Amber Wood	ACEEE

Questions will be answered after all presentations have been given

Type them into comments or hold them for the end

ACEEE
Smart Energy. Clean Planet. Better Lives.

Hot Air Forum

Hot Water Forum

HOT WATER FORUM AND HOT AIR FORUM

March 7–9, 2023 | San Diego, CA

Photo Credit: San Diego Tourism Authority

2023 Hot Water Forum & Hot Air Forum

SAN DIEGO, CA
MARCH 7-9, 2023

DoubleTree by Hilton San Diego | San Diego, CA

The inaugural **Hot Air Forum (HAF)** is an addition to the ACEEE Hot Water Forum. It will focus on both technical and program implementation details of decarbonizing space conditioning.

Thank You

Special thanks Midwest Energy Efficiency Alliance for hosting a website

Presenter Guidelines

Introduction – 1 Slide

- Introduce yourself and your organization/company
- Contact information

Project Update 3-4 Slides

- What are you doing that you want to share
- Challenges, next steps, other information
- Collaboration opportunities

5 minutes
per presenter

You will get a
30 second warning
at 4 minutes.

All presenters should
join webinar 10 minutes
early

WHEN TRUST MATTERS

Heat Pump Rating Representativeness Project

Jennifer McWilliams

30 November 2022

Objectives

Phase 1

- Observe/gather data of HP performance in a controlled field installation

Phase 2

- Conduct lab-based test procedures on Air Source Heat Pumps
  - Canadian EXP07 Standard and AHRI 210/240
- Assess the representativeness of the test procedures

Findings from the research will inform the future adoption or evolution of voluntary and/or regulatory Air Source Heat Pump test procedures and performance metrics.

Test Site: Mobile Homes in Lincoln, Nebraska

3 rented mobile homes for 1 year

- Mobile home rental in Lincoln, NE
- 6 heat pumps (3 ducted, 3 ductless) to be tested
- Each home has 1 ducted and 1 ductless heat pump
- Heating and cooling tests using one heat pump at a time alternating on a weekly basis

Images Courtesy: Prof. David Yuill

Calibration

Conductance

- Thermal loss close to EXP07 load line
- Target UA is 199 W/K. Measurements ranged from 160 to 169 W/K.

Capacitance

- Similar to average furnished home
- Target thermal capacitance is 317 Wh/K. Measured capacitance ranged from 282 to 298 Wh/K

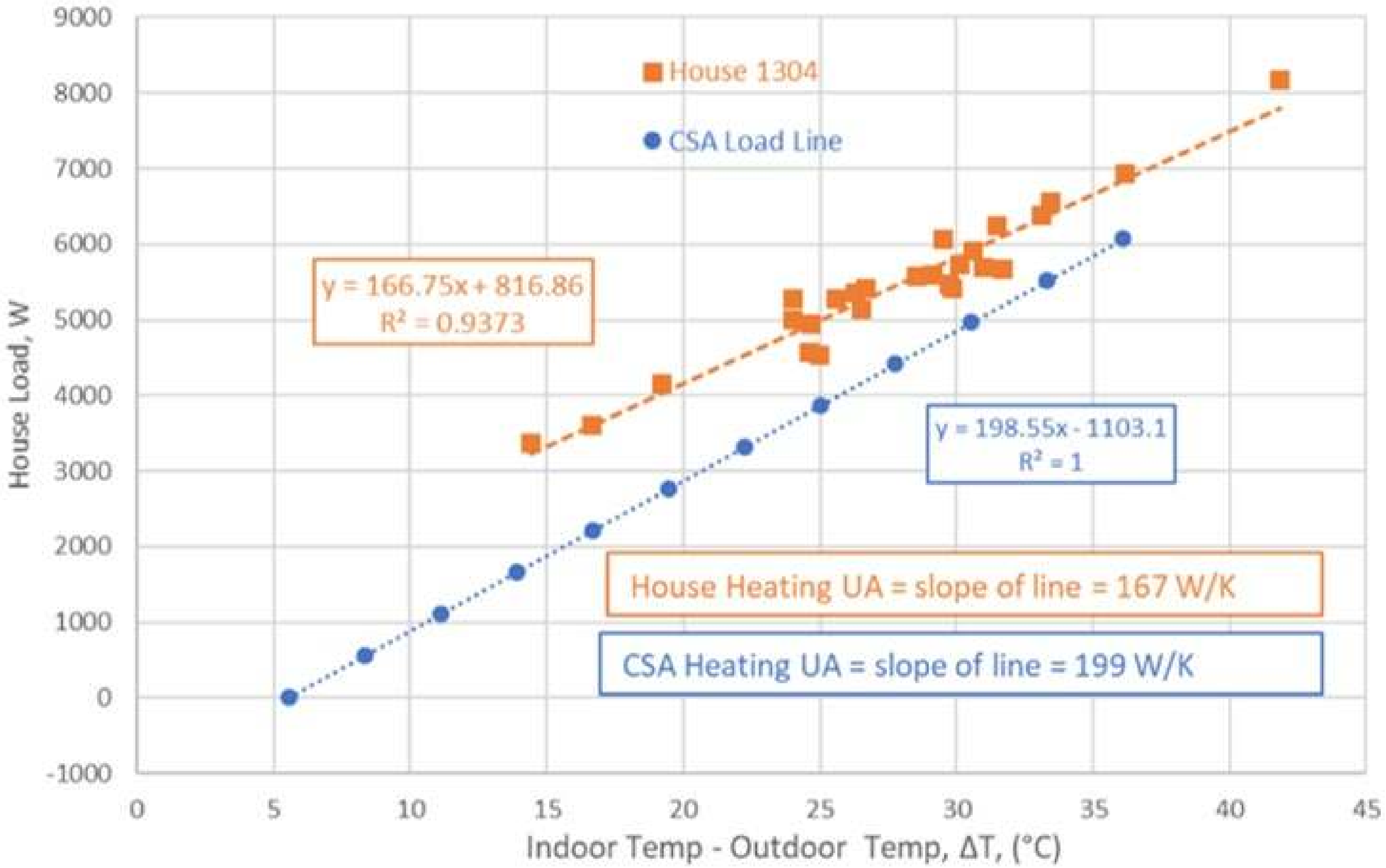
Air Tightness

- Homes as tight as possible
- Blower door test results ranging from 3.1 to 3.9 air changes per hour at 50 Pascals.
- The leakage impact on heating and cooling load is integrated into the overall UA value of each house.

Conductance modifications

Capacitance modifications

Conductance Test Results at one House



Data Collection

- Electrical power usage
- Indoor/Outdoor temperature
- Supply and Return temperatures
- Air flow measurement
- Humidity
- Refrigerant temperature and pressure
- Refrigerant mass flow
- Local wind speed and direction

Evaluating Effectiveness of Integrated Controls to Optimize Ductless Heat Pump Use in Existing Homes

Karen Fenaughty

FSEC, Research Institute of University of Central Florida

MaGrann ASSOCIATES NYSERDA FSEC™ neep UCF

Introduction

- Field demonstration of 12 New York homes retrofit with ductless air-source heat pump (ASHP) systems
- ASHP configurations ranged from simple mini-split to multi-split system with seven fan coils
- Existing central fossil fuel systems remained in service (forced air or hydronic)
- Integrated controllers installed to further reduce fossil fuel heating system use without impacting comfort
- Energy monitoring: 1-minute time steps
- Additional electric heating sources were monitored if they could be isolated

Integrated Control

- Disables the Fossil fuel system unless:
  - Outdoor changeover temperature (15°F or 23°F) disables the ASHP
  - Droop (4°F or 5°F) delta T between main living area and remote room(s)

Ecobee, Google Nest, or Honeywell Central T-Stat

Honeywell (Resideo) D6

Honeywell (Resideo) T10+smart sensor

Flair Puck Pro

Daikin's DKN Cloud WiFi Adapter

Research Method

- Flip-flop design
  - Baseline: ASHP and fossil fuel systems operated independently by occupant
  - Integrated Control: Programmed by contractor, occupant able to adjust set points and schedules
- Data filtered for like-temperature range in both periods
- Weather normalized to TMYx (2006-2021) with linear regression modeling
- Evaluated total heating energy use changes, as well as for electricity and fossil fuel independently
- Energy saving predictions are limited to the daily average temperatures used for modeling
- Savings predictions are not seasonal nor directly comparable from site to site

Findings

- 7 of 11 sites had reduced fossil fuel use during IC
- All 4 sites with greater fossil fuel use had expansive ASHP installations
- 23°F changeover used at 3 of 4 sites increased fossil fuel use where baseline had little to none
- Electricity use was higher with integrated control, as expected, at 8 of the 11 sites

Site #	Compressors/Fan Heads	Change over Temp. (°F)	Temp. Range (°F)	Modeled FOSSIL FUEL Use Prediction (kBtu/range)			Modeled ELECTRICTY Use Prediction (kBtu/range)		
				Baseline	Integrated Control	Savings	Baseline	Integrated Control	Savings
1	2/2	15	26-62	2,159	968	55%	4,687	4,843	-3%
2	1/1	15	25-68	29,437	28,438	3%	6,739	6,961	-3%
3	1/2	15	24-74	48,406	40,552	16%	3,025	2,819	7%
4	1/1	15	35-61	46,903	30,315	35%	3,448	5,033	-46%
5	1/1	15	21-61	16,354	14,606	11%	4,835	3,538	27%
6	Not evaluated								
7	1/3	15	24-50	40,677	24,119	41%	6,574	5,820	11%
8	2/6	23	21-55	-	397		15,266	19,883	-30%
9	2/4	15	22-38	36,701	47,849	-30%	1,834	2,378	-30%
10	2/5	23	27-55	228	3,758	-1549%	17,386	21,518	-24%
11	1/5	23	39-57	42,607	27,284	36%	4,864	5,604	-15%
12	2/7	23	15-56	-	501		19,474	22,687	-16%

- Insufficient data at Site 6
- Particularly limited temperature range at sites 9 and 11

UCF

Conclusions

- Integrated control may or may not decrease fossil fuel use
  - With near complete ASHP retrofit, systems are perhaps already operated by occupants to greatly limit fossil fuel use
  - Outdoor changeover should be carefully selected according to climate
- Caveats
  - Results are case-study in nature, with only temperature ranges evaluated rather than entire winters
  - Data during colder days were not always available for both conditions, limiting observations during the ASHP/legacy switchover

Recent Development on Refrigerants with Low Global Warming Potential

Oak **R**idge **N**ational **L**aboratory

Samuel F. Yana Motta

Nov 30th 2022

ORNL is managed by UT-Battelle LLC for the US Department of Energy

Content

1) **Introduction**
    a. Drivers for change (regulations)
    b. Short-term vs Long-term Mapping
2) **Applications: Option to replace current Refrigerants**
    – Summary of current refrigerants and their replacements
    – Options for Water heaters
3) **Refrigerants options for A/C heat pumps and heat pump water heaters**
4) **Final Comments**
5) **Q&A**

Regulations: Specific to the USA market

Kigali Amendment

Steps	Date
Baseline	2011-2013
1st step	2019 – 10%
2nd step	2024 – 40%
3rd step	**2029 – 70%**
4th step	2034 – 80%
Plateau	2036 – 85%

HFC consumption and a 15% HCFC consumption (in CO_2-equivalents) are included in the baseline

- Almost every region (Europe, Asia, America) is following the path defined by the Kigali Amendment.
- Year 2029 marks a step reduction in consumption (CO2e).
- The expectation is to go to lower GWPs by that date.

EPA AIM

Steps	Date
Baseline	2011-2013
1st step	***2022 – 10%***
2nd step	2024 – 40%
3rd step	**2029 – 70%**
4th step	2034 – 80%
Plateau	2036 – 85%

- EPA also regulates using SNAP. Example: SNAP 23 allows R-32, R-454B, R-454A, R-454C, and R-457A for residential and light A/C
- The HFC allowance program affects both production and imports. Allowances were established for 2022 and 2023, similar to the quota process used for R-22.

CARB California

New Equipment	GWP Limit	Date
Domestic Refrigerators	**150**	2021
Comm Refrig. (+50lb)	**150**	2022
Small A/C (Window,,…)	750	2023
A/C Chillers	750	2024
Larger A/C (RAC, Comm)	750	2025
Comm. A/C (VRF)	750	2026

- California is pursuing GWP limits similar to EU F-Gas.
- The more aggressive measures use GWP<150. The expectation is for others to follow.
- They worked with the whole industry. GWP limits implemented step-by step.

GWP<150 seems to be the long-term target

Timelines for various refrigerant transitions related to regulations

	Current	2022-2023	2024-2028	2029-2033	2034-2035	2036+

Drivers

- **Kigali Amendment**: Baseline 2011-13; Reduction of -40% by 2024, **-70% by 2029**, -80% by 2034, -85% by 2036
- **US EPA AIM**: Baseline 2011-13; Reductions of -40% by 2024, **-70% by 2029**, -80% by 2034, -85% by 2036
- **EU F-Gas**: Baseline 2009-12; Reductions of -69% by 2024, -76% by 2027, **-79% by 2030**

Technologies

Air Conditioning R-410A
- R-32 and R-454B in A/C
- GWP<150: R-290 (small Sys), R-1234yf, R-1234ze, R-454C, R-455A, R-457A →

Refrigeration R-404A
- Interim replacements: R-448A, R-449A,…
- Long term: Trans-C CO2, **Water-Cooled R-290**, R-454C, R-455A, R-457A →

Water Heaters R-134a
- Interim replacements: R-513A, R-515B,…
- Long term: CO2, **R-290**, R-1234ze, R-1234yf ,… →

Chillers, HTHPs R-123, R134a
- Low pressure chillers (R-123) and High Temperature Heat Pumps (R-245fa): R-1233zd, R-514A, R-1336 →
- Medium pressure centrifugal chillers: R-1234ze →

Roadblocks, Breakthrough?

- **Roadblock 1**: Safety Standard & Building Codes
- **Roadblock 2**: Availability of optimized components/equipment
- **Highly flammable Hydrocarbons (propane, isobutane)** are limited to small-charge or secondary-fluid systems (efficiency penalty)

Current Refrigerants and the leading Replacements

Higher Pressure

Current Refrigerant	Class 1	Class 2L	Class 3
R-410A GWP=2,088 Residential & Commercial AC Reversible Heat Pumps Scroll Chillers  	R-466A GWP=733 (new Sys)	R-32 GWP=675 R-454B GWP=466	**R-290 GWP=3 (Small charge)**
R-404A GWP=3,922 Commercial refrigeration 	R-448A GWP=1273 (retrofit) R-449A GWP=1397 (retrofit) **R-744 GWP=1 (Transcritical)**	R-454C GWP=148 R-455A GWP=148 R-457A	**R-290 GWP=31 (water-cooled, Self-contained)**
R-134a GWP=1,430 Domestic & Commercial Refrigeration Heat Pump Water Heaters Centrifugal chillers 	R-513A GWP=631 R-515B GWP=293	R-1234yf GWP = 4 R-1234ze GWP = 7	**R-600 GWP=1 (refrigerators)** **R-290 GWP=3 (HP water heaters)**
R-114 GWP=10,000 Centrifugal chillers High Temperature Heat Pumps Organic Rankine Cycle 	R-1233zd GWP=1 R-1336 GWP= 1 R-514A GWP=2		

GWP values are based on IPCC AR4 (used by most regulations)

Natural refrigerants shown in bold-green fonts

Air Conditioning Heat Pumps

Application	ASHRAE Name	ASHRAE Class	GWP (AR4)	Composition (%)	Replaces	Cap	Eff	Comments
Residential AC Commercial AC (Rooftops, VRF)	R-32	A2L	675	R32 (100%)	R410A	110%	105%	~30-35°F higher discharge temperature than R410A.
	R-466A	A1	733	R32/R125/CF3I (49%/11.5%/39.5%)	R410A	99%	101%	~15°F lower discharge temperature than R32. Thermal stability under evaluation. Not a long term replacement
	R-454B	A2L	466	R32/R1234yf (68.9%/31.1%)	R410A	97%	101%	~15°F lower discharge temperature than R32. Not a long term replacement
	R-454C	A2L	148	R32/R1234yf (21.5%/78.5%)	R22, R407C, R410A	62%	95%	Potential long term replacement due to GWP<150. It will require significant redesign of the system

Replacements with GWP<750) are considered short term - Options with GWP<150 could be long term
Propane is limited to low-charge equipment with charge below 150g (example: window A/C)

Heat Pump Water Heaters

ASHRAE Name	ASHRAE Class	GWP (AR4)	Capacity	Efficiency	Comments
R-513A	A1	631	100%	97% to 100%	Interim replacement. Useful due to class A1
R-515B	A1	293	73% to 75%	99% to 101%	Significant lower GWP and class 1. It may be useful during transition time.
R1234ze	A2L	1	73% to 75%	99% to 101%	Need re-design due to lower capacity. Good efficiency.
R1234yf	A2L	1	95% to 98%	95% to 97%	Close performnace, It can be improved with optimization
R290	3	1	146% to 148%	100% to 104%	Good performance. Needs redesign/optimization of the system to maintain charge below 150g

All performance values are relative to R-134a
Interim replacements such as R-513A are a very close match to R-134
Most long-term replacements are flammable class 2L or 3 – They will have charge restrictions

Final Comments

- A large amount of research on flammability of class 2L refrigerants has been done in the past 10 years to serve as a basis to develop safety standards. Their implementation in building codes should happen by 2024-2025.

- Class 3 refrigerants such as Propane (R-290) have potential to produce good performance, but they are limited by current standards to 150g/system. Propane will need to use more compact heat exchangers to reduce the charge, and optimized compressors to fulfil its potential.

- The training of personnel along the distribution chain, ending with a proper installation of flammable refrigerants will be needed in the future.

Tools to support effective Air-source heat pump sizing

- Dave Lis, Director, Technology and Market Solutions
- Fall 2022 AHPC Webinar

High performance systems

+ Quality design/sizing

+ Quality installation

= Realized ASHP performance

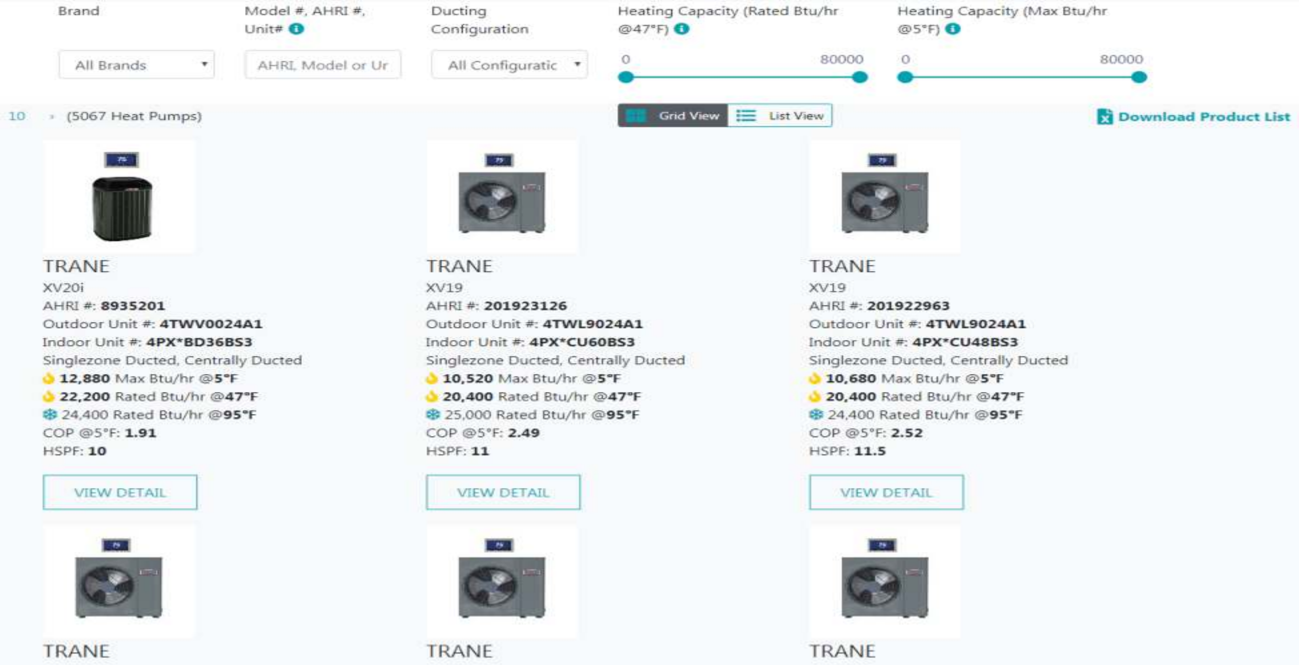
Sizing ASHPs in Cold Climates is a challenge

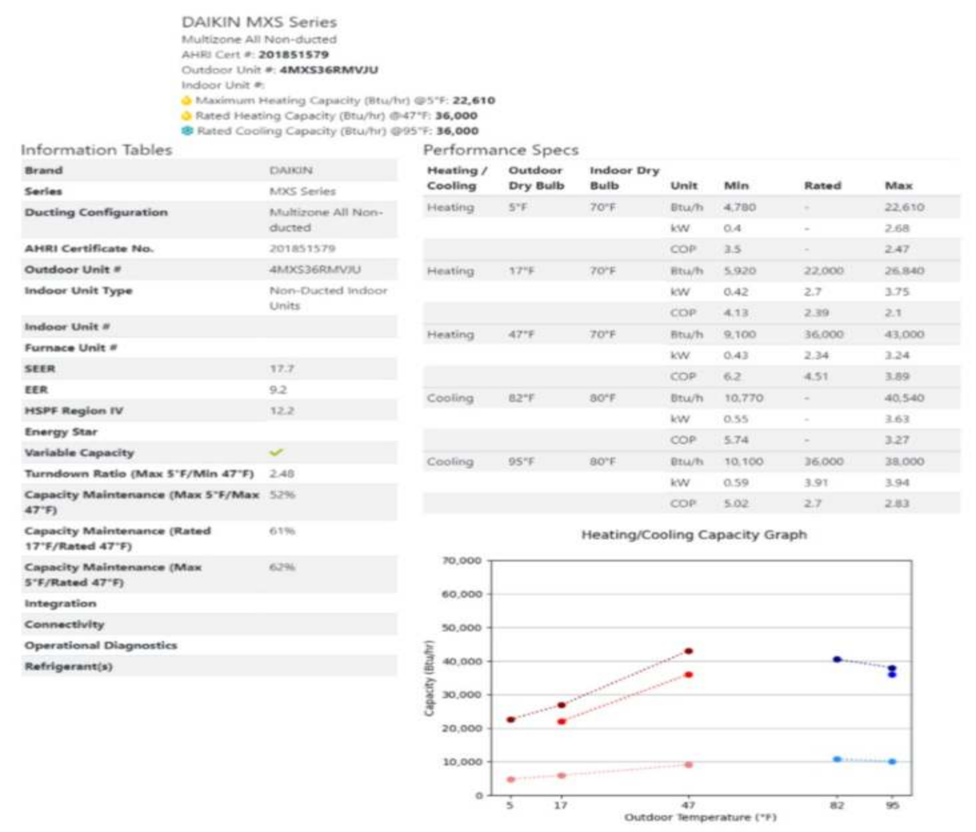
- Not enough to just be on a list
- Too small?
- Too big?
- The right ASHP can check all boxes

NEEP's Cold-Climate ASHP Product List

ashp.neep.org

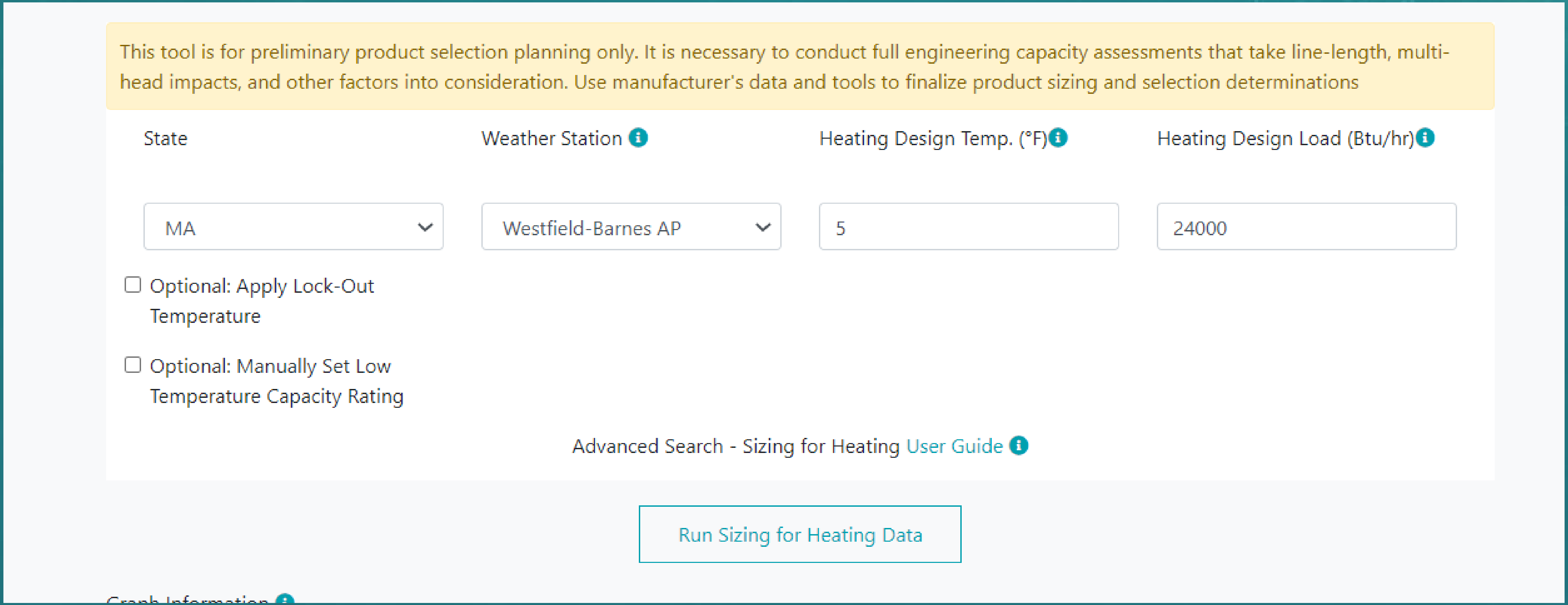
One-stop-shop for cold-climate qualified air source heat pumps





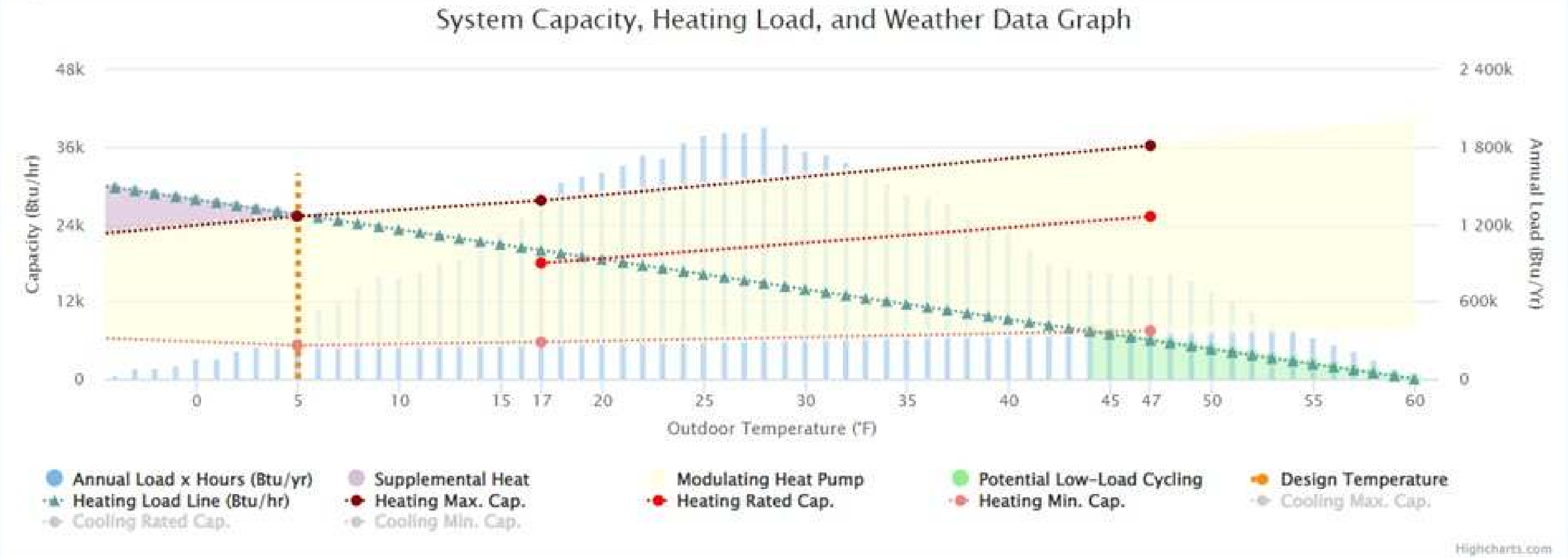
Now 40,000+ systems from over 100 major brands

Characteristics of the project- Location and load



Product view – Advanced Data

Graph Information



Product Sizing For Heating

Field Information

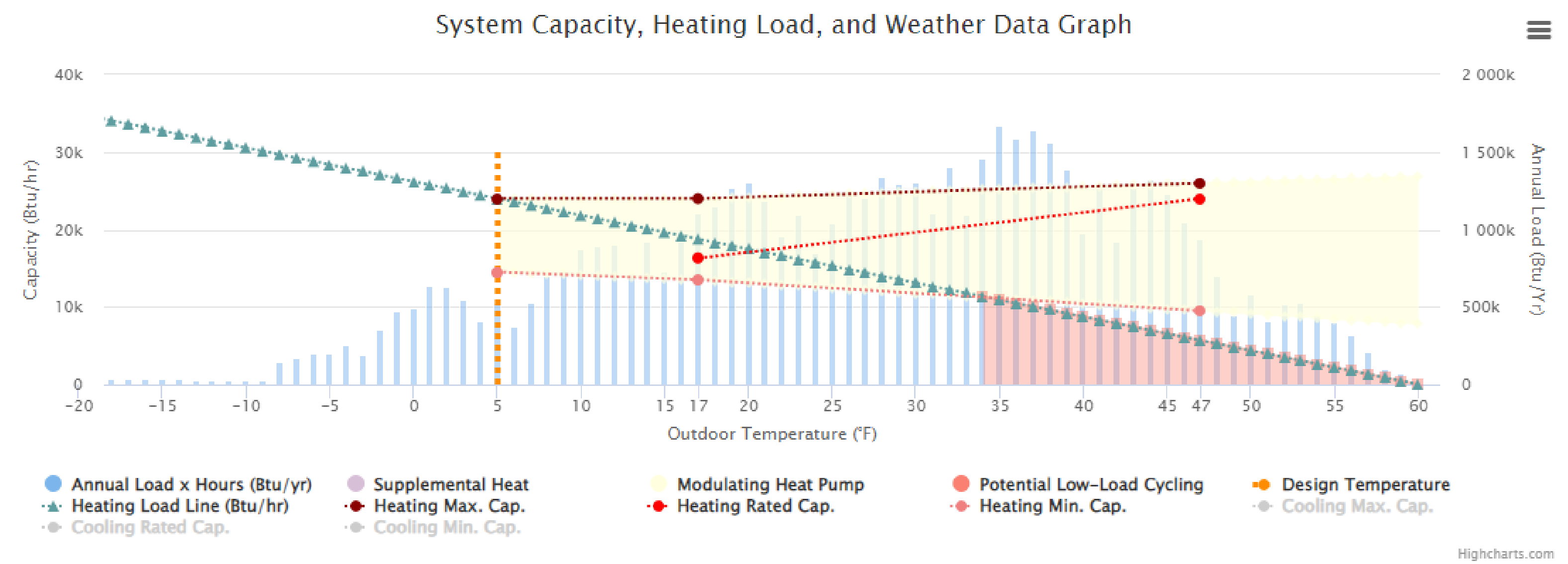
Balance Point (°F)	5
Minimum Capacity Threshold (°F)	44
Maximum Capacity at Design Temp (Btu/hr)	25,220
Percent Design Load Served	98.9%
Annual Heating Load (MMBtu)	61.7
Percent Annual Heating Load Served	97.9%

Field Information

Annual Btu's Covered by Supplemental Heat (MMBtu)	1.3
Hours Requiring Supplemental Heat	54
Percent Hours Requiring Supplemental Heat	0.9%
Percent Annual Load Modulating	83.9%
Percent Annual Load with Low-Load Cycling	12.6%

Potential Low load cycling

Graph Information



Product Sizing For Heating

Field Information

Capacity Balance Point (°F)	5
Minimum Capacity Threshold (°F)	34
Maximum Capacity at Design Temp (Btu/hr)	24,000
Percent Design Load Served	100.0%
Annual Heating Load (MMBtu)	56.9
Percent Annual Heating Load Served	91.1%

Field Information

Annual Btu's Covered by Supplemental Heat (MMBtu)	5.1
Hours Requiring Supplemental Heat	190
Percent Hours Requiring Supplemental Heat	3.2%
Percent Annual Load Modulating	50.6%
Percent Annual Load with Low-Load Cycling	37.9%

Links

- Cold Climate Air-source Heat pump Product List (including sizing tools); https://ashp.neep.org/
- User Guide: Cold Climate Heat Pump Sizing Support Tools; https://ashp-production.s3.amazonaws.com/NEEP_ccASHP+Heating+Visualization+User+Guide_v2.2_TRC_04.01.22.pdf
- Cold Climate Air-source Heat pump Specification; https://neep.org/heating-electrification/ccashp-specification-product-list
- Installer Guides/Videos; https://neep.org/high-performance-air-source-heat-pumps/air-source-heat-pump-installer-and-consumer-resources
- Heat Pump Initiative; https://neep.org/smart-efficient-low-carbon-building-energy-solutions/air-source-heat-pumps

THANK YOU!

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Natural Resources Canada | Ressources naturelles Canada

Status Update: cc-ASHP Activities at the CanmetENERGY-Ottawa Alternative Energy Lab

AHPC Fall Webinar, November 30, 2022

Jeremy Sager, HVAC & Renewables Research Engineer, CanmetENERGY-Ottawa

Canada

View from Above

Mission Statement:

CanmetENERGY Ottawa leads the development of energy S&T solutions for the environmental and economic benefit of Canadians.

Excellence Canada Awards:

Gold-level accreditations in:

- Excellence, Innovation & Wellness
- Mental Health at Work

Hybrid Systems Performance Evaluation

Hybrid System - Characteristics

Heat Pump Indoor HX Coil

Existing Gas Furnace

Heat Pump Outdoor Unit

- **Goal: Reduce GHGs from gas heating**
- **Early market entry: replace central A/C with a heat pump**

Operating approach:

- Use gas when it's coldest outside
- Use the heat pump when it's more moderate outside
- Allows homeowners to switch between fuels depending on when one system is more cost-effective to operate

Hybrid System Field Trial – What was Done

- Replaced A/C condenser with heat pump outdoor unit of equivalent capacity

Hybrid System Field Trial – What was Done

New coil (SEER 16)

Old coil (SEER 13)

- Replaced A/C evaporator coil with heat pump indoor coil (matched to outdoor unit performance)

Hybrid System Field Trial – What was Done

2 ton, two stage outdoor unit with snow cover

- Install snow cover!

Hybrid System Field Trial – What was Done

Existing Tstat

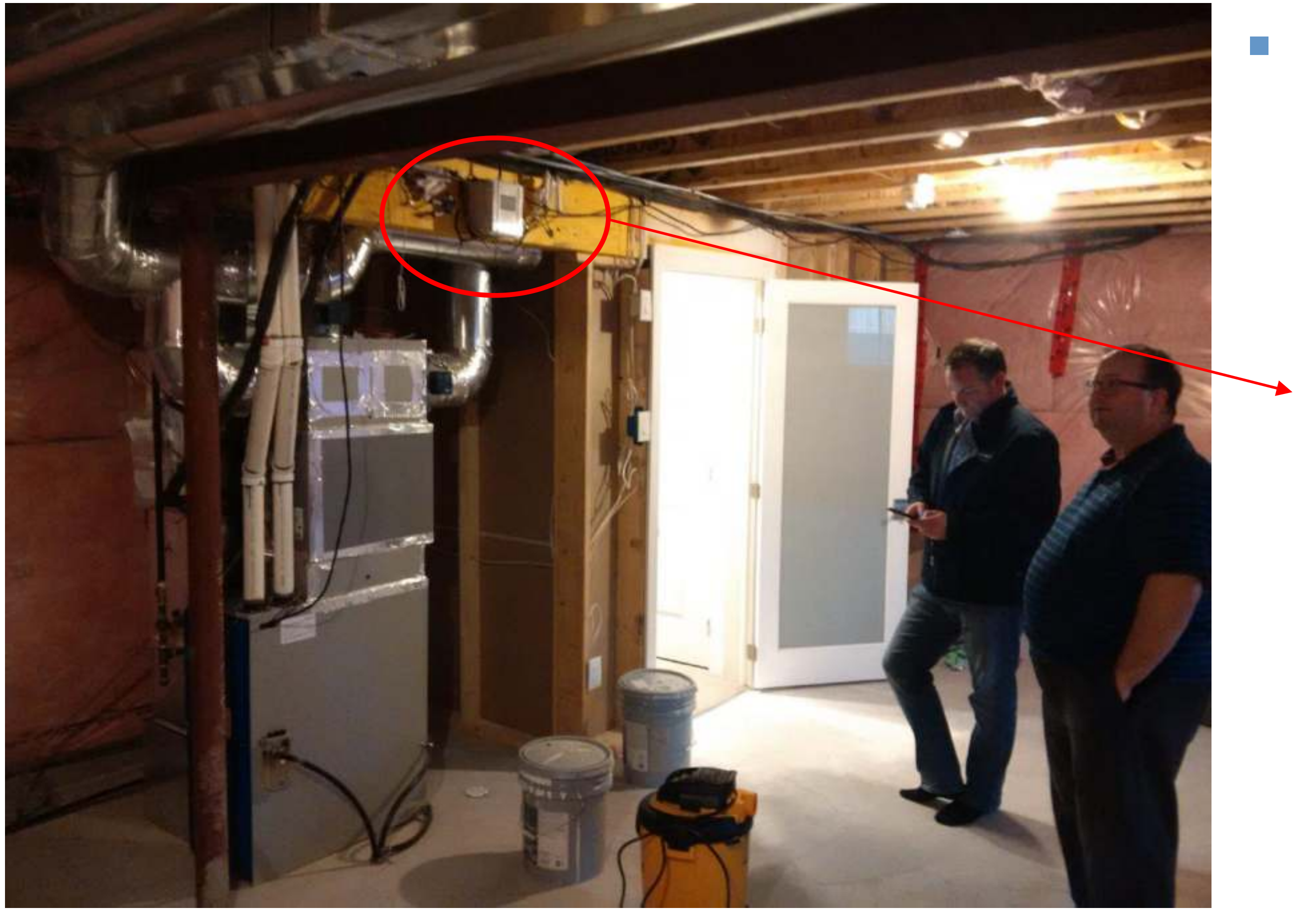
- **Single switchover temp**

Replacement Tstat

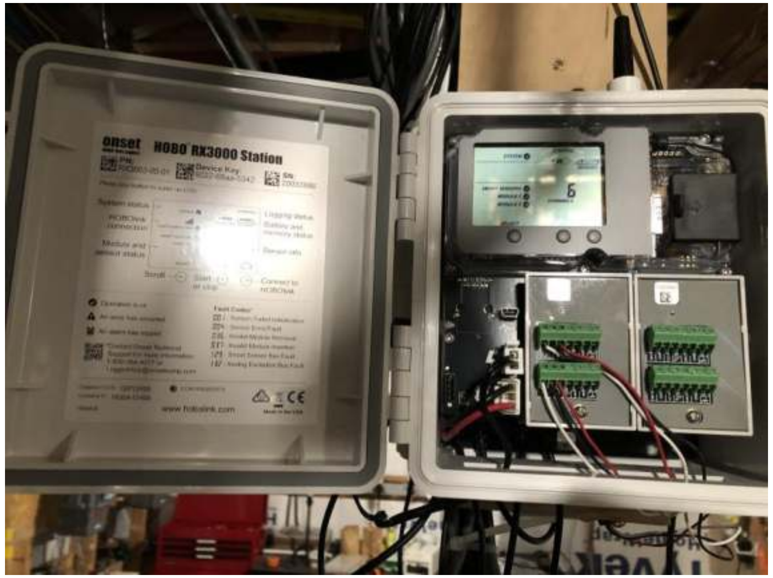
- **Hourly switchover temps**

- Replaced existing t-stat with new t-stat (that has smart switching control capability)

Hybrid System Field Trial – What was Done



- Instrument the system
  - Airflow, temperature, RH, electricity & gas consumption, etc.



Hybrid System Field Trial – Results Summary

Performance Measure	Hybrid with Smart Controls vs Baseline
Seasonal Energy Savings	19%
Seasonal Cost Savings	-6.5%
GHG Emissions Reductions (hourly emissions factor*)	32%
GHG Emissions Reductions (marginal emissions factor**)	26%

- **Energy Savings:** 19% seasonal energy savings
- **Cost:** 6.5% higher than the baseline, but with improved defrost control, more representative performance data and improved switching controls, could cost the same or less
- **GHG Reductions:** 32% based on hourly avg emissions factor, 26% based on hourly marginal emissions factor

* Based on hourly electrical grid emissions factor (ranging from 14 to 127 gCO2e/kWh)
** Seasonal hourly marginal emissions factor (ranging from 54 to 226 gCO2e/kWh)
Note: Furnace natural gas combustion emissions factor 193 gCO2e/kWh)

ASHP Project Status Updates

ASHP Sizing and Selection Toolkit


Français

Government of Canada Gouvernement du Canada

Search the website

MENU

Canada.ca › Natural Resources Canada › Maps, Tools and Publications › Tools › Data analysis software and modelling tools

Toolkit for air source heat pump sizing and selection

Natural Resources Canada has developed a package of materials related to air source heat pump (ASHP) sizing and selection, intended for use by mechanical system designers and renovation contractors. The materials were designed to assist these individuals with sizing and selecting ASHPs for Canadian climates, in both new and existing (retrofit) residential applications.

Components of the toolkit

1. **ASHP Sizing and Selection Guide** (referred to as "the Guide") and **ASHP Key Specifications Summary Worksheet** (included in the Guide as Appendix B)
2. **ASHP Sizing and Selection Tool:** an electronic representation of the ASHP Sizing and Selection Guide. The tool interactively guides users in applying the step-by-step process described in the Guide, while providing additional charting and performance analysis features **(version V1.1 is now available. Existing users are encouraged to replace V1.0 with V1.1)**
3. **Addendum of worked examples:** provides case studies of the Guide being used to select either centrally ducted or ductless mini-split ASHPs for various installation scenarios

Download the toolkit

ASHP Sizing and Selection Guide and Key Specifications Summary Worksheet (PDF, 4.5 MB)

ASHP Sizing and Selection Tool, version V2 (xls, 2.4 MB)

Addendum of worked examples (PDF, 3.1 MB)

Learn how to use the toolkit

Watch this video to learn how to use the ASHP Sizing and Selection Toolkit. The video includes an introduction and overview of the Guide, as well as an overview of the tool and a walk-through using several example scenarios.

Report a problem on this page

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Date modified: 2022-03-14

Status

- Published and used by trades associations, colleges, contractors, distributors and manufacturers across Canada
- Components:
  - Guide with 1-page Summary Worksheet
  - Spreadsheet Tool
  - Addendum of Worked Examples
  - "How to" Videos

Next Steps

- Modifications to enable more accurate estimation of energy, GHG and cost savings
- App development underway to make Tool more accessible and easier to use
- Separate portal for contractors and homeowners

Search: NRCan ASHP Sizing and Selection

Evaluating Representativeness of SPE-07

East House Indoor & Outdoor Units

West House Indoor & Outdoor Units

Status

- Controlled field trial (side-by-side instrumented test facility with simulated occupancy)
- Heating and cooling season testing of 2 CCHPs completed in 2021/2022
- Data analysis nearly complete

Next Steps

- Units will be shipped to UL for testing to:
  - SPE-07 (with and without thermostat emulator)
  - Appendix M1
- **Output:** Report on performance of fixed speed tests, load-based tests and field tests

Ratings Procedures for air to water heat pumps

Outdoor Unit

DX to water HXer, pump, controls

Buffer Tank

AH & t-stat

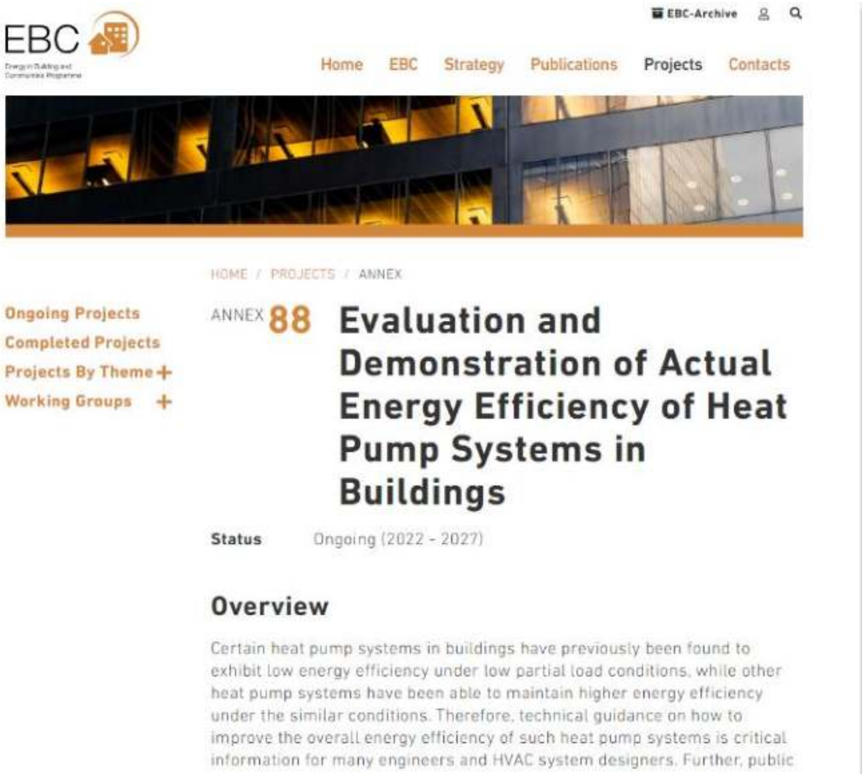
Status

- Review of air to water heat pump ratings procedures for space and water heating
  - AHRI Standard 550-590
  - ANSI/ASHRAE 206
  - CSA SPE-10
- Lab testing of an air to water combination heat pump system (forced air distribution)

Next Steps

- Test systems to fixed speed procedure to inform market performance
- Identify opportunities for performance improvement of combination system
- Explore load-based test procedure for combined air to water HPs (e.g., SPE-07 + SPE-10)

New IEA EBC Annex 88



Status

- July 2022-July 2027
- Objective:
  - more accurate estimation of energy efficiency of heat pump systems for heating and cooling of buildings and,
  - more reliable and transparent design strategies for building applications of heat pump systems
- Initial meetings to define sub-tasks completed
  - A: State-of-the-art review
  - B1: Test methods
  - B2: Monitoring methods and database
  - C: Energy use calculation methods
  - D: Design guidelines for practitioners

Next Steps

- CE-O will co-lead sub-task on Test methods, research plan development now underway

Questions

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NEXT GENERATION ELECTRICALLY DRIVEN HEAT PUMPS

R&D and Deployment Activities
November 2022

May 21, 2020

INTRODUCTION

Mr. Martin Kegel, MASc, P. Eng

Natural Resources Canada, CanmetENERGY
Located in Varennes, Quebec
Project Manager in the Buildings Group
Email: Martin.Kegel@nrcan-rncan.gc.ca

CanmetENERGY is a Science and Technology Leader in the Federal Government, conducting innovative science and research activities to develop and implement solution pathways for a sustainable energy future for Canada.

Buildings Group has two research themes – Renewable Heating & Cooling Systems and Intelligent Buildings.

TWO MAIN RESEARCH ACTIVITIES

Simulation to Support Research

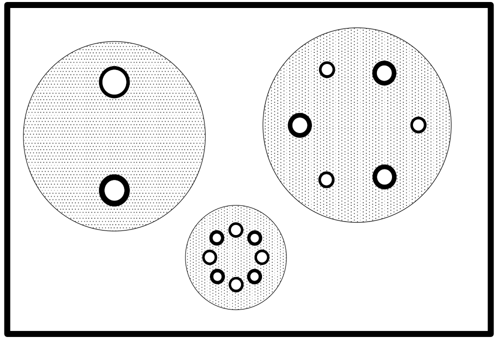
Ground Source Based Heating Systems

- Field test and investigate opportunities to reduce first costs of borefields
- Simulate and test to acquire knowledge and improve the performance of CO2 based heat pump systems

Air Source Based Heating System Solutions

- Investigate strategies to better predict and improve the efficiency of air source heat pump systems and opportunities for building flexibility
- Simulate and test low-GWP (HFO) refrigerant mixtures to improve the performance of heat pumps in cold climates

GROUND SOURCE BASED HEATING SYSTEMS



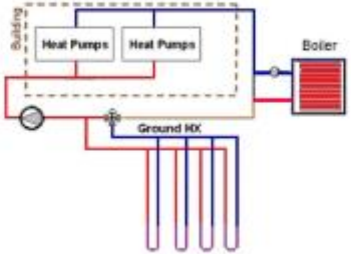
A. Multiple U-pipe DX-GHE

C. Field testing-CO2 GSHP System at CanmetENERGY

D. Saturated sand boreholes

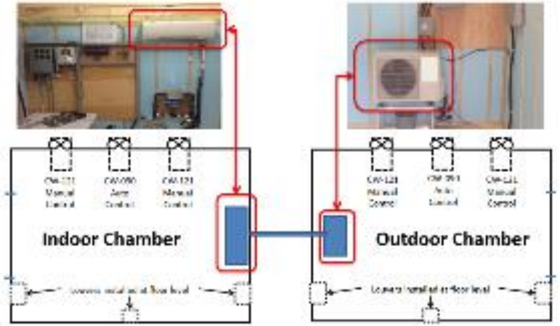
B. Standing column well (SCW)

E. Reference borehole

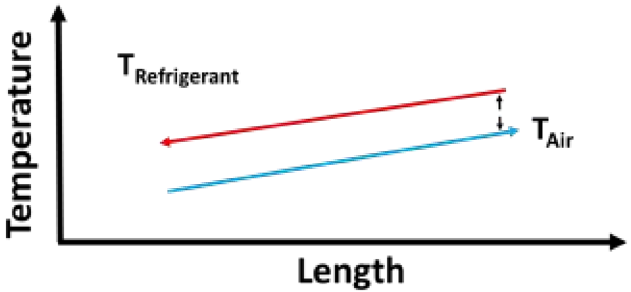


F. Optimal Borefield Sizing with dual fuel systems

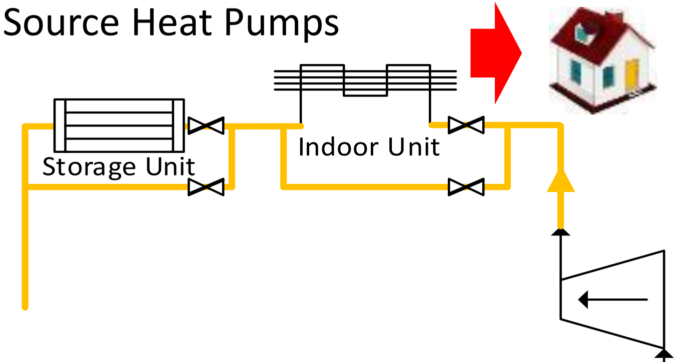
AIR SOURCE BASED HEATING SYSTEMS



A. Performance Testing of Variable Capacity Air Source Heat Pumps



B. Refrigerants Mixtures: Improve cold climate HP heating performance



C. Simulation of HP + Integrated Storage to mitigate peak demand and enable building flexibility

NEXT STEPS AND COLLABORATION

Next Steps:

Five year Research and Development Plan is currently being developed. Proposals are being submitted early January 2023 for review and approval.

Collaboration:

We work closely with industry, universities, NGOs and all levels of government, sharing knowledge and lending our expertise through R&D collaborations.

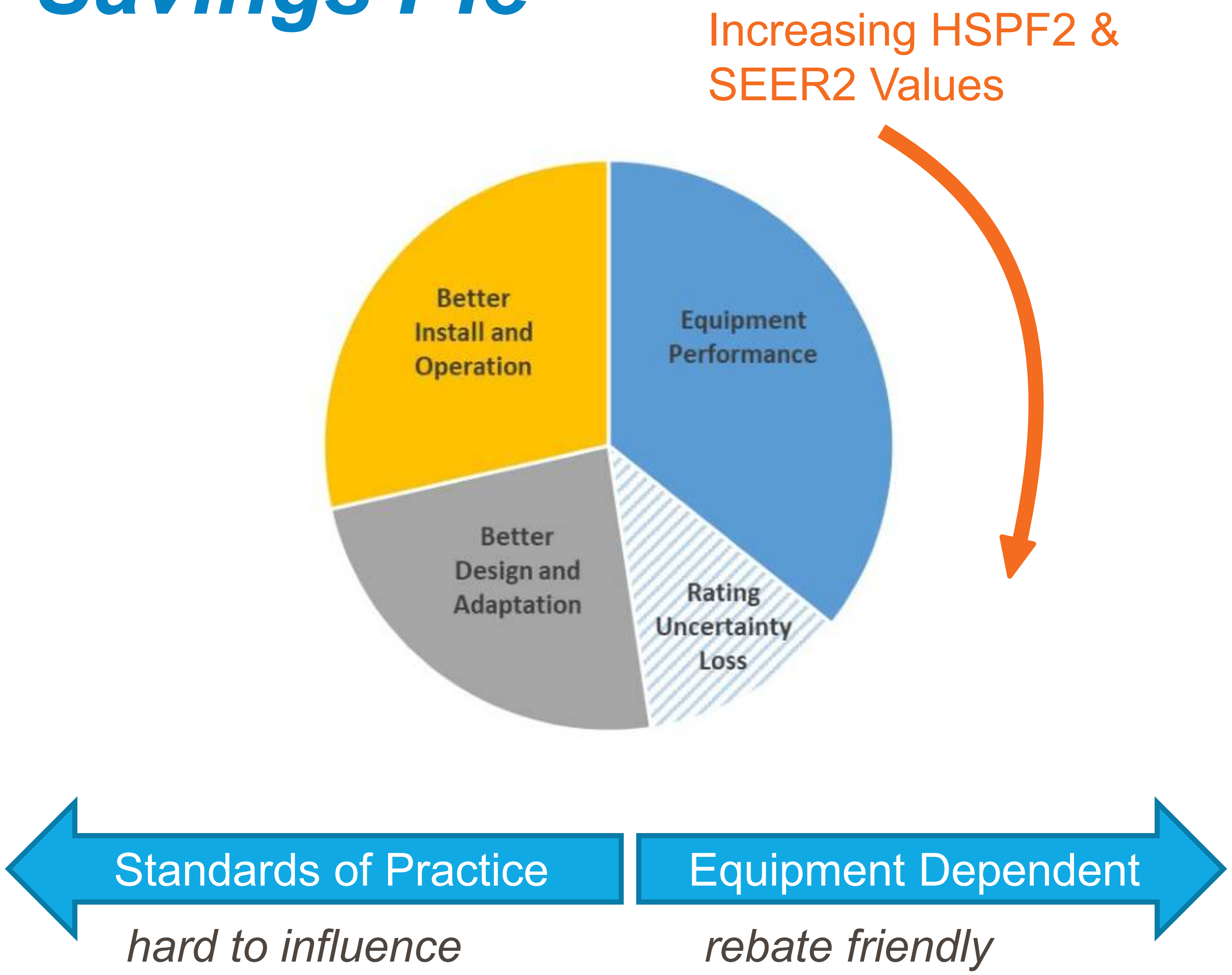
As part of the dissemination process we look for project partners to provide feedback on the need for activities and help advance the technology readiness level.

Advanced Features and Capabilities of Variable Speed Heat Pumps

AHPC – Fall 2022 Webinar

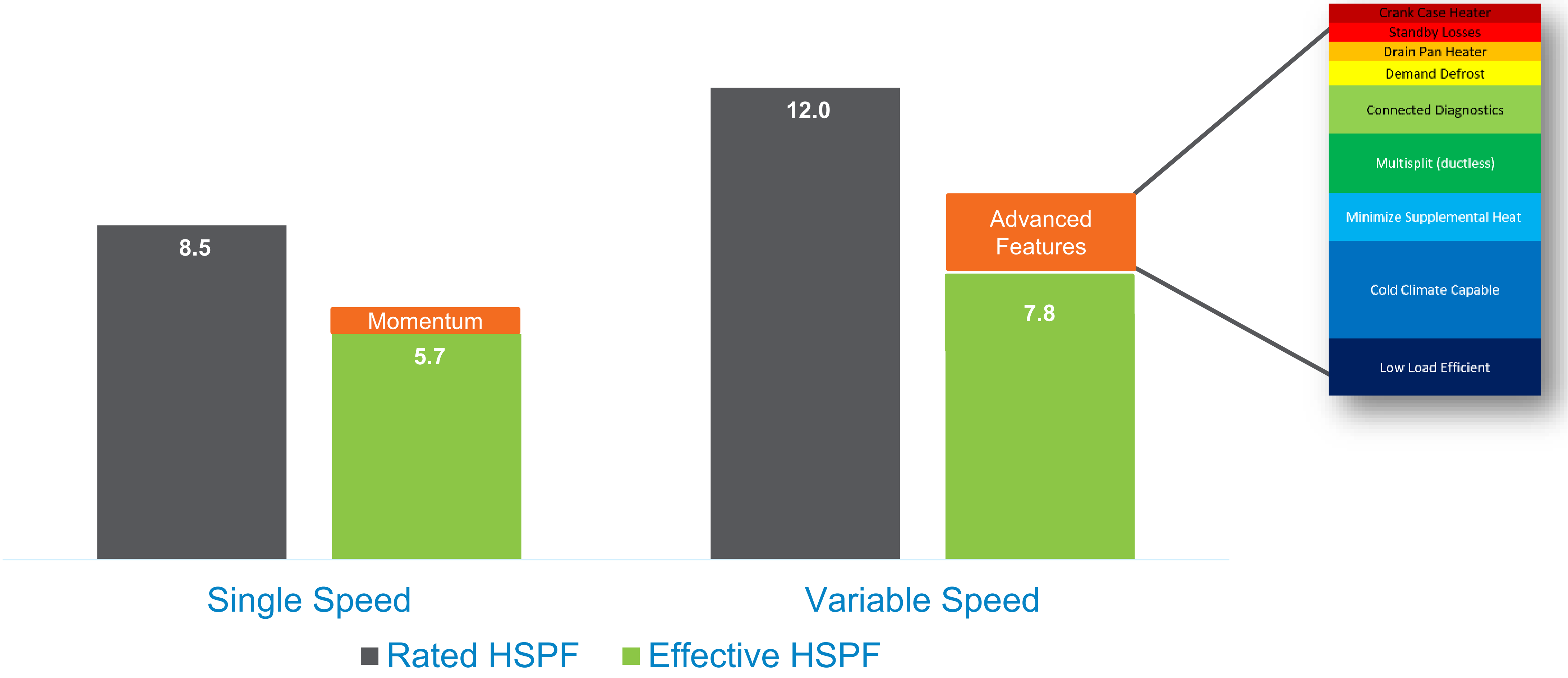
Presented by
Christopher Dymond *Sr. Product Manager, NEEA*

Savings Pie



*Savings compared to current practice

Advanced Features and Capabilities



 |

Advanced Features and Capabilities

Features and Capabilities	Est. Energy Savings	Peak Savings
Low Load Efficient	6%	small
Cold Climate Capable	10%	5+ kW
Minimize Supplemental Heat	5%	medium
Connected Diagnostics	5%	
No Duct Losses	6%	small
Auto Demand Response	0%	medium
Adaptive Defrost	2.5%	
Drain Pan Heater	2%	
Standby Losses	2%	
Crankcase Heater	2%	

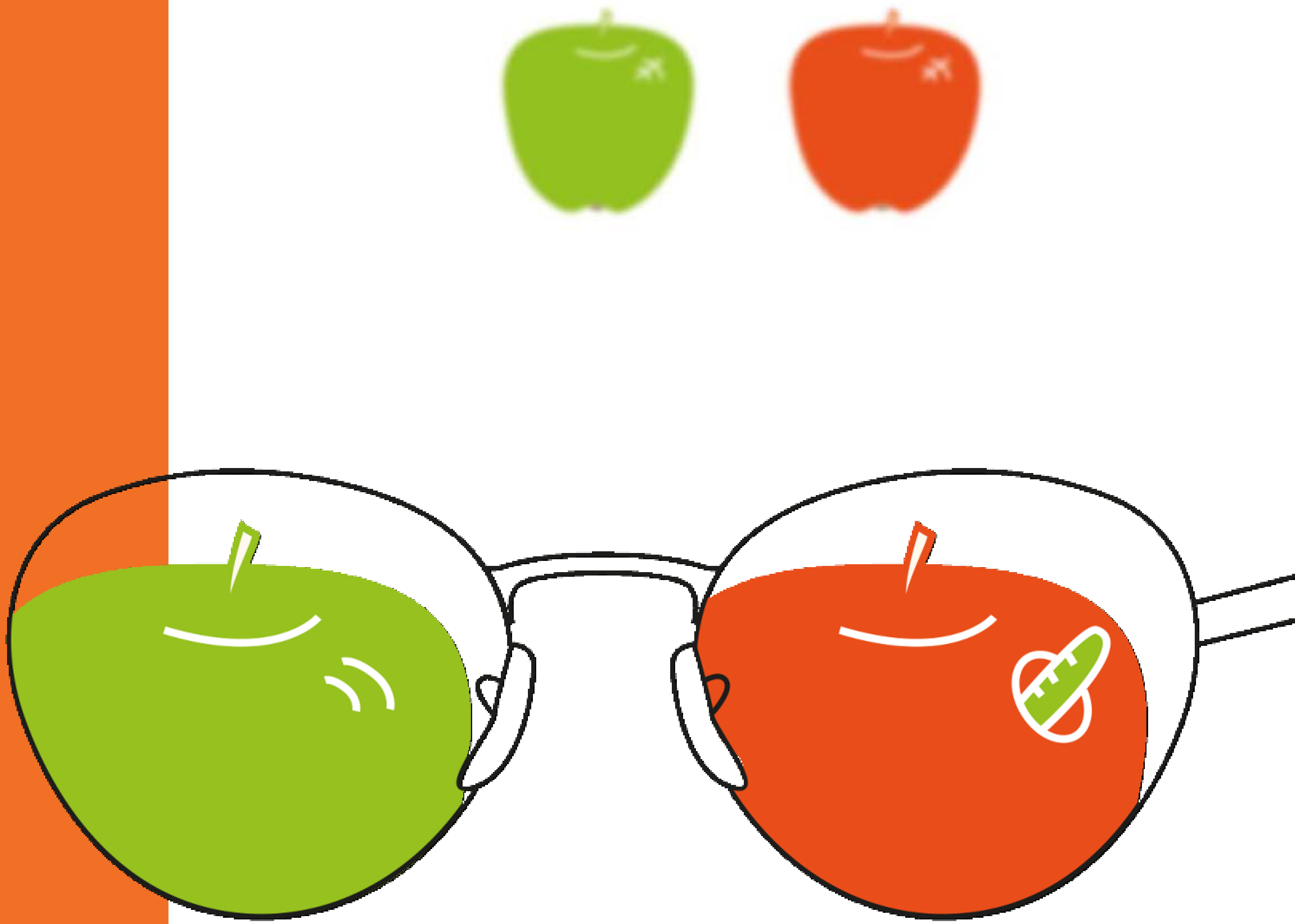
- We want to increase ***system*** efficiency
- Advance those product features and capabilities that improve ***system*** efficiency (or make it more likely)
- Some are strong candidates, Some are less likely candidates
- Some apply all system types, Some only apply to specific system types or conditions

We Need Three Things

Definition	Savings	Identification
What is the description of the feature? What is the technical specification that defines it?	Energy Savings • % improvement Peak Savings • kW reduction in peak load Carbon Savings • lbs of CO_2/yr avoided	How do we know it when we see it? Where can I find a list of qualifying products? Do we trust manufacturer reported data or does this require additional testing or 3rd party certification?

Ratings & Identifiers …

… let us see key details we otherwise might have missed.



Timeline

- F&C Work Sessions — November – January
- Manufacturer Meetings — December – March
- 2023 “Hot Air Forum” — March 7, 2023 – San Diego
- IEA Heat Pump Conference — May 15-18 – Chicago
- F&C Research Projects — 2023-2024

Inform Specifications
Program, CEE and ENERGY STAR

2023 Hot Water Forum & Hot Air Forum

SAN DIEGO, CA

MARCH 7-9, 2023

- **Hot Air Forum, Mar 7-8**
- Hot Water Forum, Mar 8-9

DoubleTree by Hilton San Diego | San Diego, CA

American Council for an Energy-Efficient Economy

The inaugural **Hot Air Forum (HAF)** is an addition to the ACEEE Hot Water Forum. It will focus on both technical and program implementation details of decarbonizing space conditioning.

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MASSACHUSETTS CLEAN ENERGY CENTER

U.S. DEPARTMENT OF ENERGY

Winter is Coming: Is the Northeast Ready for Whole-Home Electrification?

Advanced Heat Pump Coalition Fall 2022 Webinar

Scope of Work

Residential (1-4 family) building electrification

Assess **ccASHP** performance in Massachusetts and New York

Whole-home and **primary** w/ backup ccASHP systems

Quantitative Research

- Program database review
- Online surveys with customers (n=628)
- Site visits + metered data collection (n=43)
- Customer billing analysis (n=84)

Qualitative Research

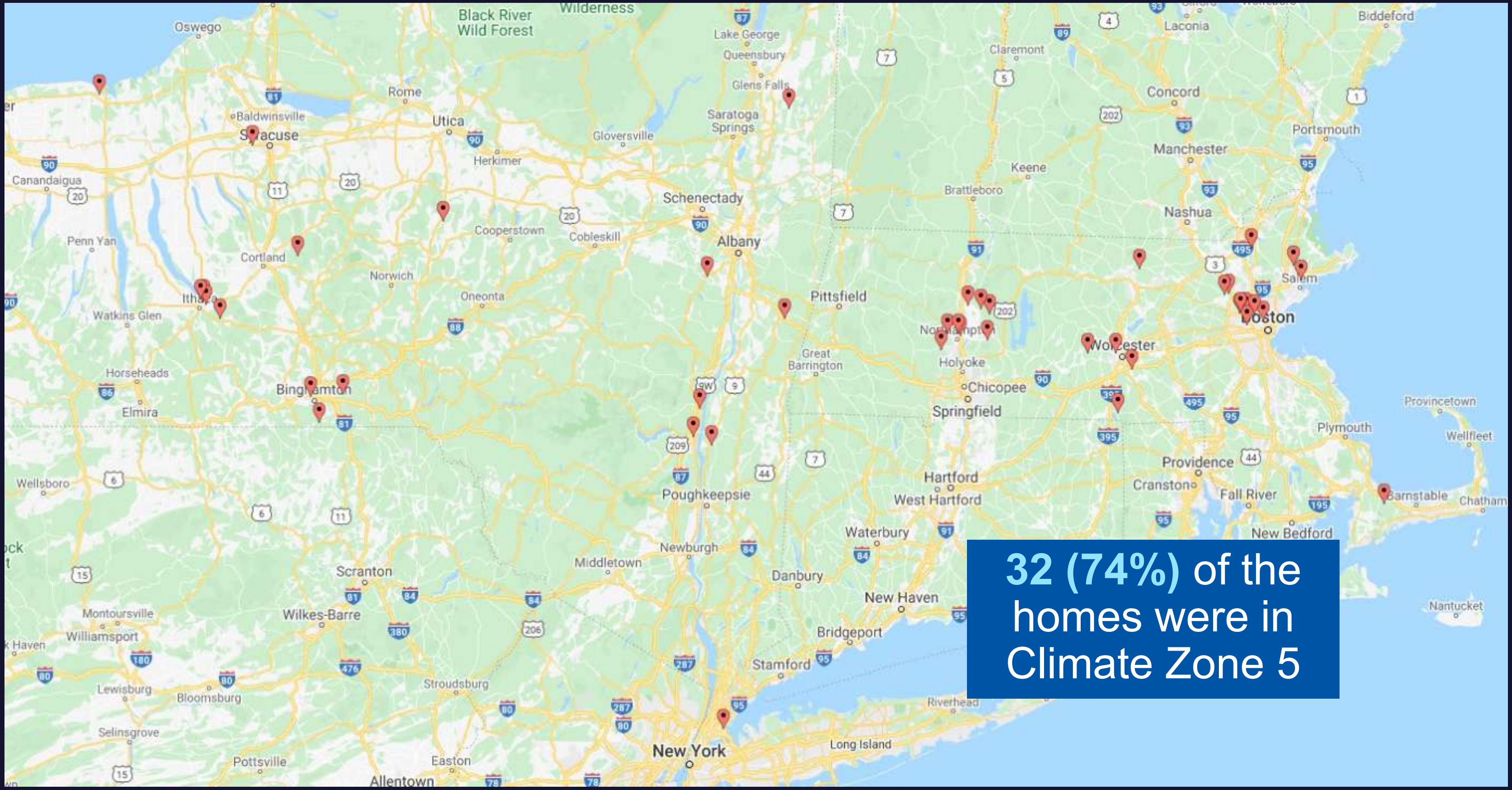
- Literature review
- Stakeholder interviews (n=4)
- Heat pump contractor interviews (n=19)

Full Study: https://e4thefuture.org/deep-dive-research-heat-pump-building-electrification/

Site Distribution and Overview

State	IECC Climate Zone			Total Homes
	4	5	6	
MA	0	24	0	**24**
NY	1	8	10	**19**

Application	Ducted	Ductless	Mixed
Whole-home	6	13	4
Primary	5	14	1



32 (74%) of the homes were in Climate Zone 5

Key Questions

1. Are ccASHP systems meeting home comfort expectations?

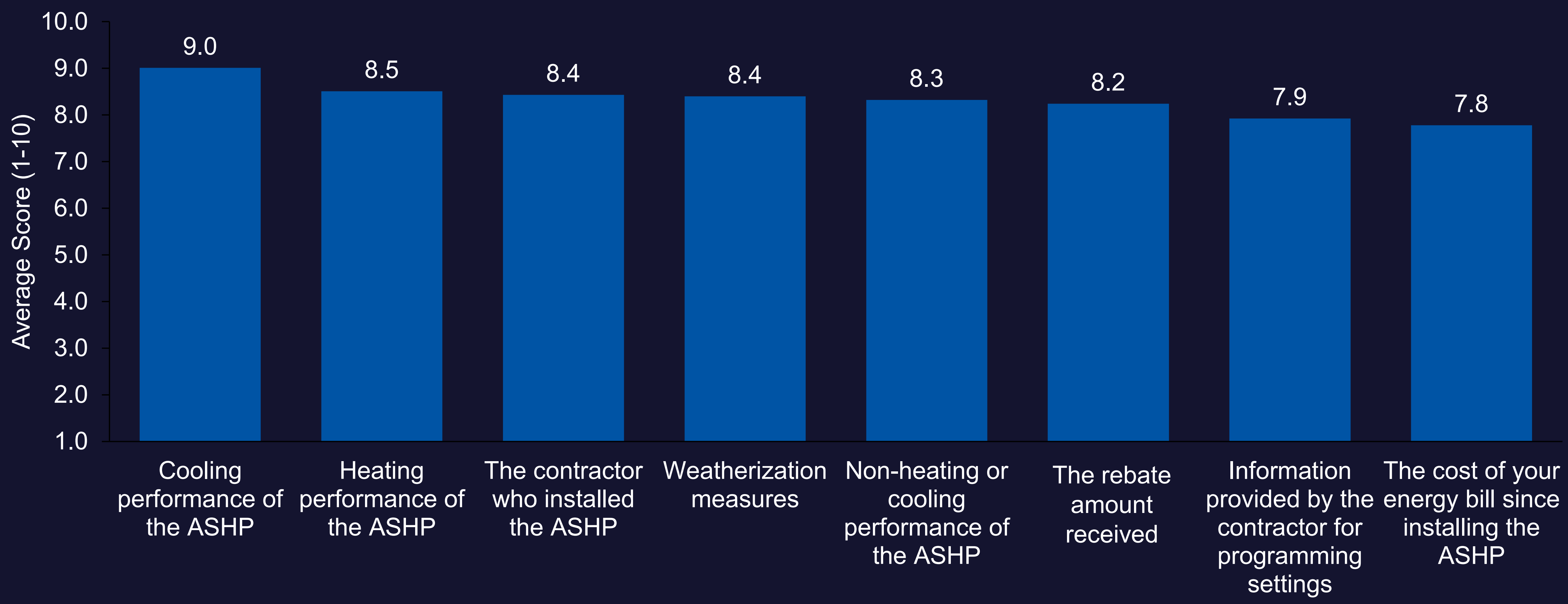
2. Are ccASHPs efficiently delivering heating and cooling?

3. How does ccASHP system heating performance differ between system types and applications?

4. What are the potential electric grid impacts of wide-scale residential heating electrification?

IMPORTANT CAVEAT: This study analyzed a small sample of systems, and it is not designed to represent the full population of installations in these states or be statistically significant. Our findings only show the potential of this technology.

1. Are ccASHP systems meeting home comfort expectations?



In general customers reported an **extremely high likelihood to recommend an ASHP** to others, with slightly lower likelihood for customers with whole-home systems (whole-home = 8.9/10 would recommend; primary w/ backup = 9.3/10).

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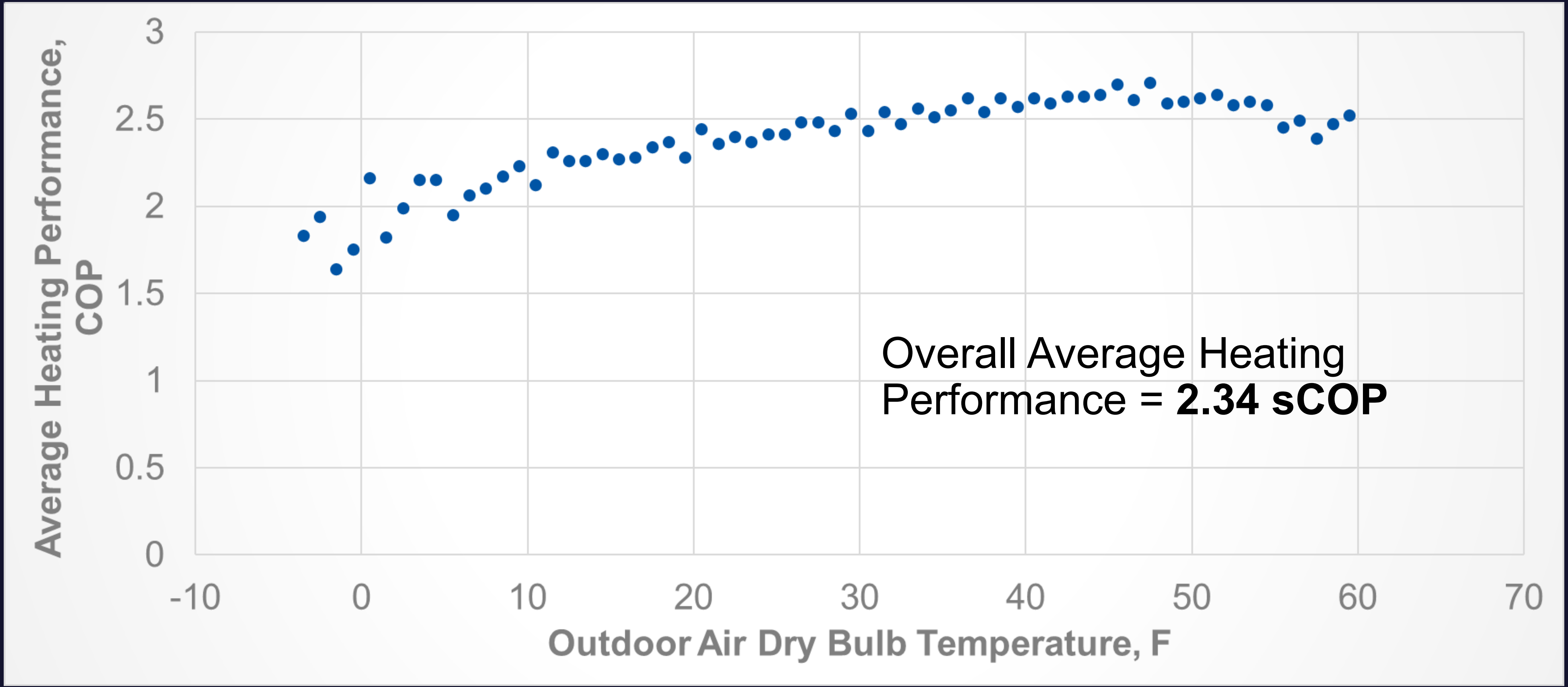
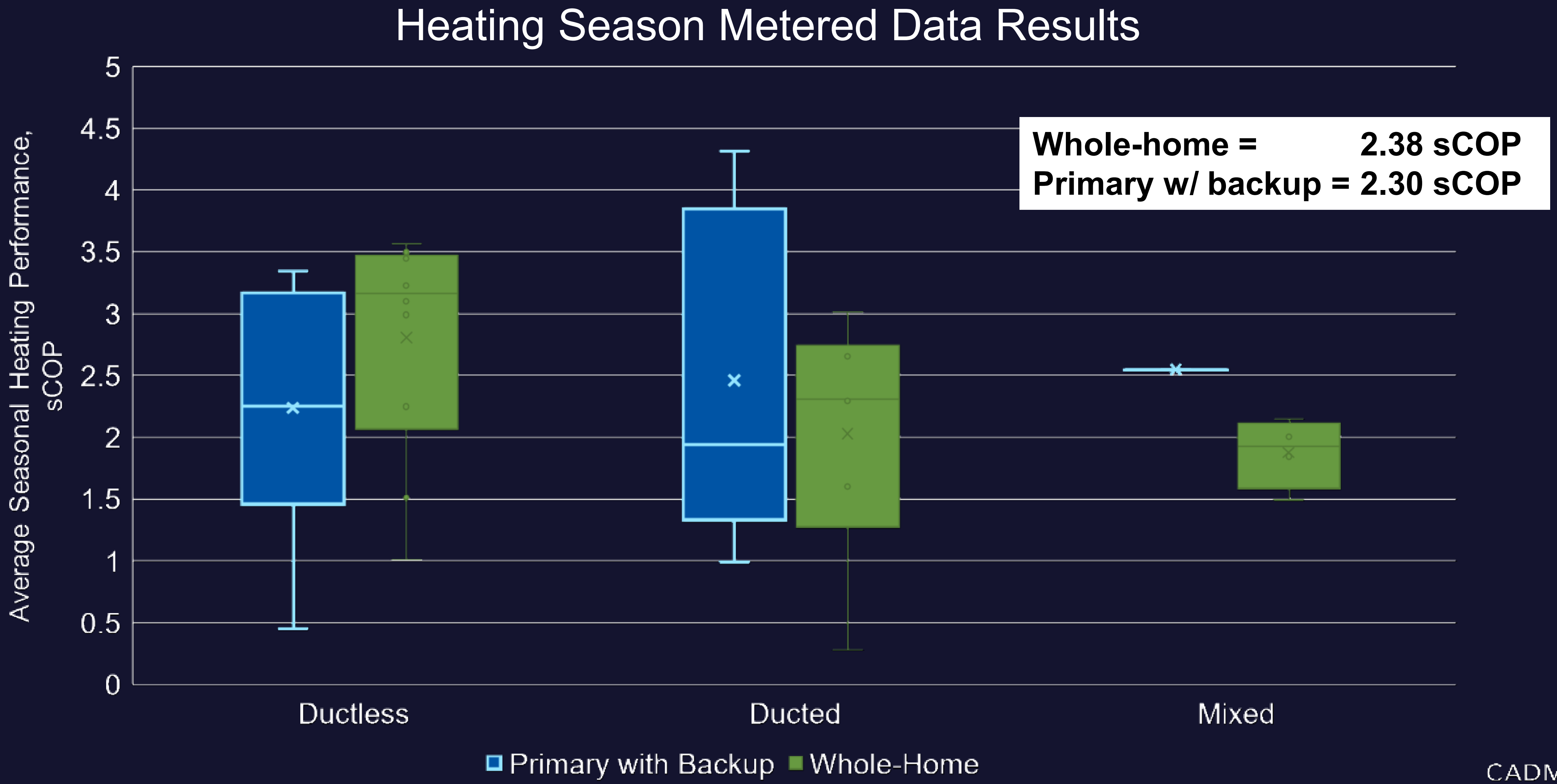
2. Are ccASHP systems efficiently delivering heating and cooling?

Average Heating Performance by Outdoor Air Temperature Bin



3. How does ccASHP system heating performance differ between system types and applications?



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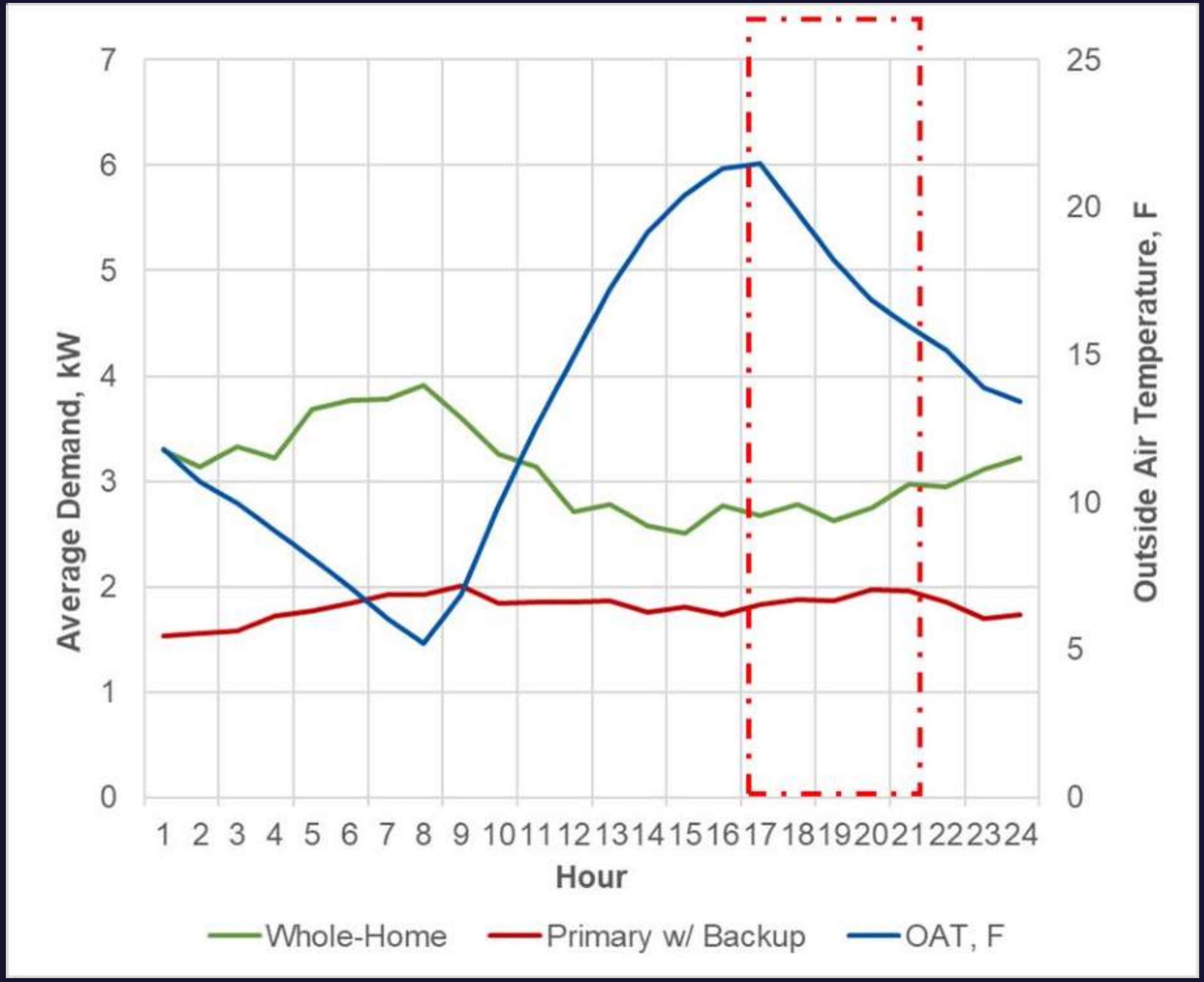
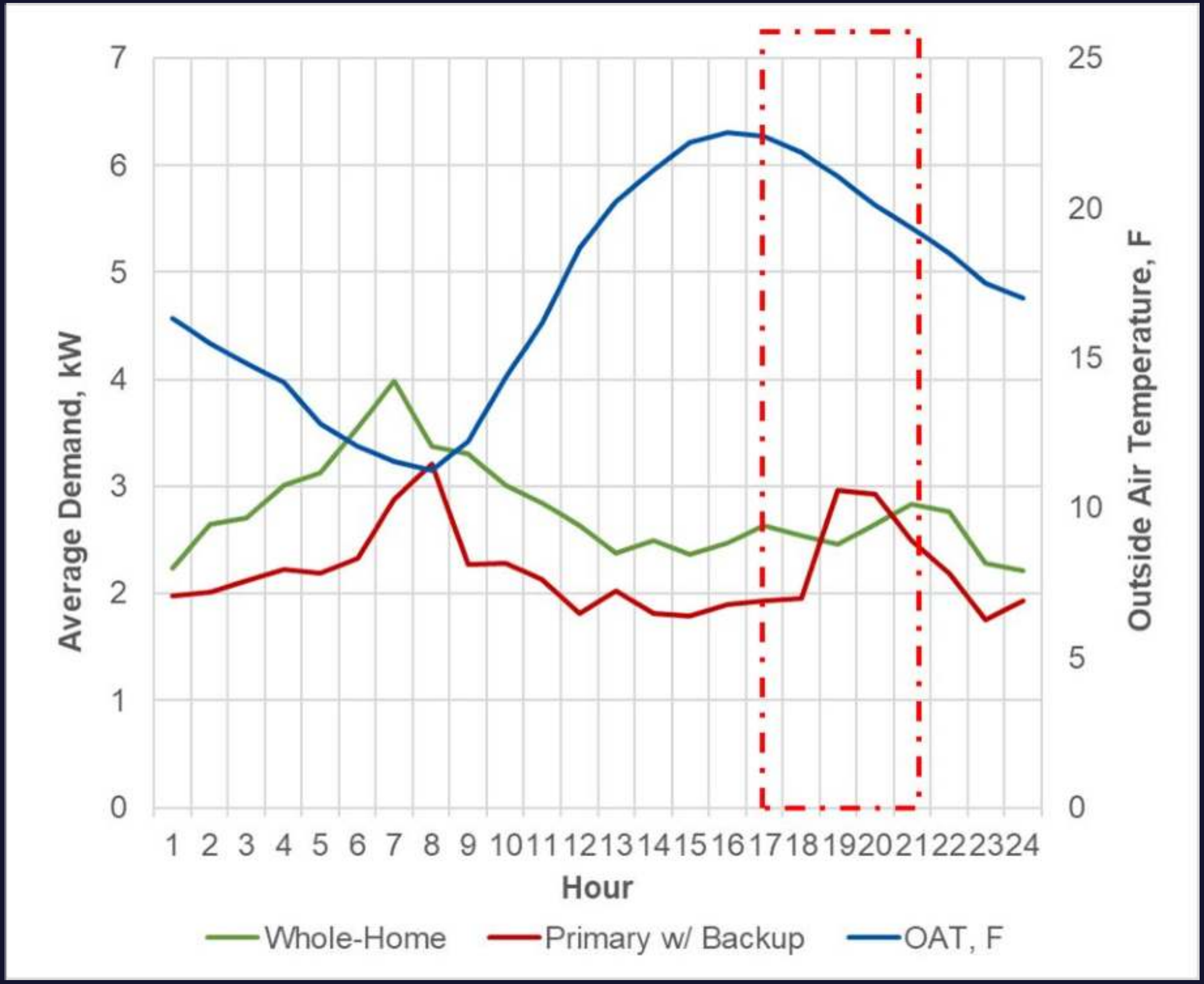
4. What are the potential electric grid impacts of wide-scale residential heating electrification?

Massachusetts Sites (n=24)



New York Sites (n=19)



Key Takeaways and Questions for Further Study

- When were setpoints not met and how did room-by-room temperature change during coldest periods?
- What are the issues contributing to low multi-zone performance, overall variation between sites, and weak performance at mild temperatures?
- What will be the key utility grid management tactics and their impacts on performance and comfort?
- Expand sample size and meter homes over longer period, with tighter data intervals (30-60 second) to investigate defrost demand and energy

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Thank You / Questions

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https://e4thefuture.org/deep-dive-research-heat-pump-building-electrification