Regional Emerging Technology Advisory Committee (RETAC)

Northwest Energy Efficiency Alliance

Q2 2026 Meeting

June 17, 2026

8:30 a.m. – 12:00 p.m.

Name, Title, Organization and…

If you could fast-track one product or technology, what would it be?

Agenda

8:30 am	Welcome and Announcements
9:00 am	Electric Power Research Institute (EPRI)
10:00 a.m.	*Break*
10:15 a.m.	Round Robin
11:00 a.m.	Consortium for Energy Efficiency (CEE)
12:00 p.m.	Wrap-Up

 |

Announcements

- Conferences
- Product Councils
- Q3 RETAC Date Change

 |

End-Use Thermal Systems

Ongoing Research

Ron Domitrovic – Program manager, Grid-Edge Customer Technologies

June 17, 2026

Some History & Fundamentals

Current Efforts

Looking to the Future

Heat Pumps—Devices and Applications

Residential

Residential

Residential

Hydronic heating—boiler

Or gas furnace

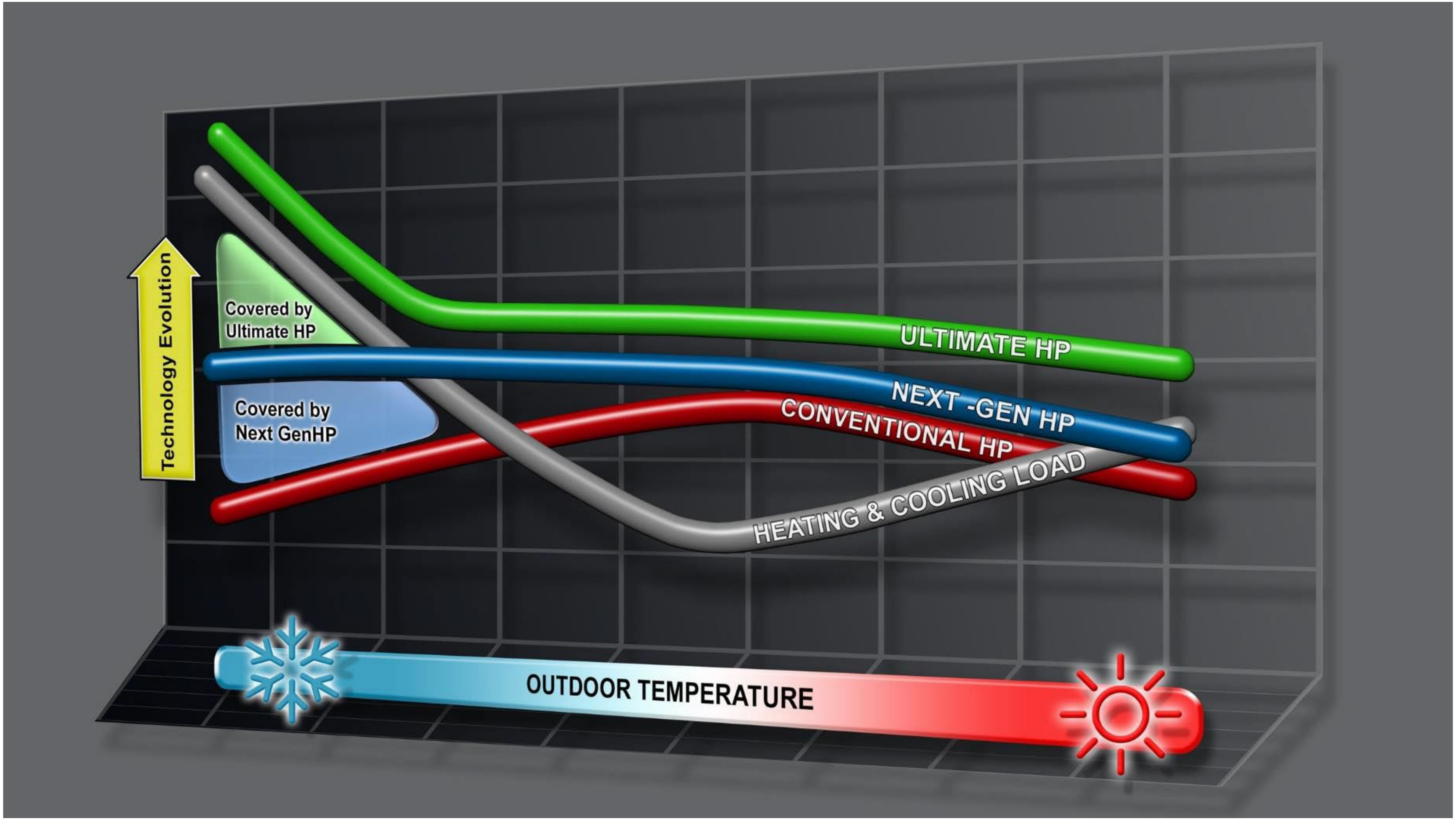
Ground-source heat pump

Air-source split-system

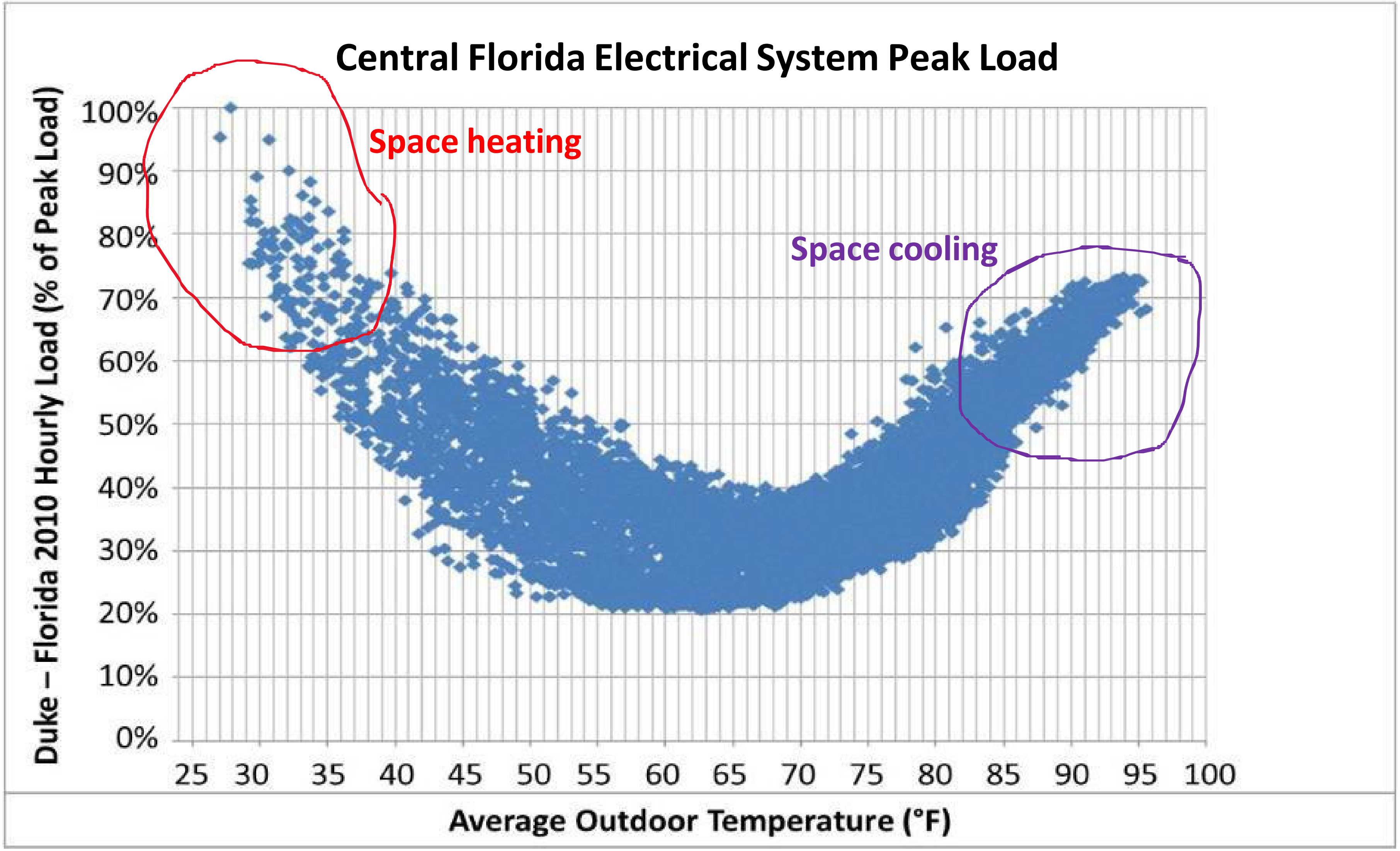
The Foundation

- Inverter driven, variable-speed compressor

- Capacity modulation
- Full-spectrum efficiency gains
- Flexible power draw profile
- Higher heating capacity
- Better comfort
- Quieter operation

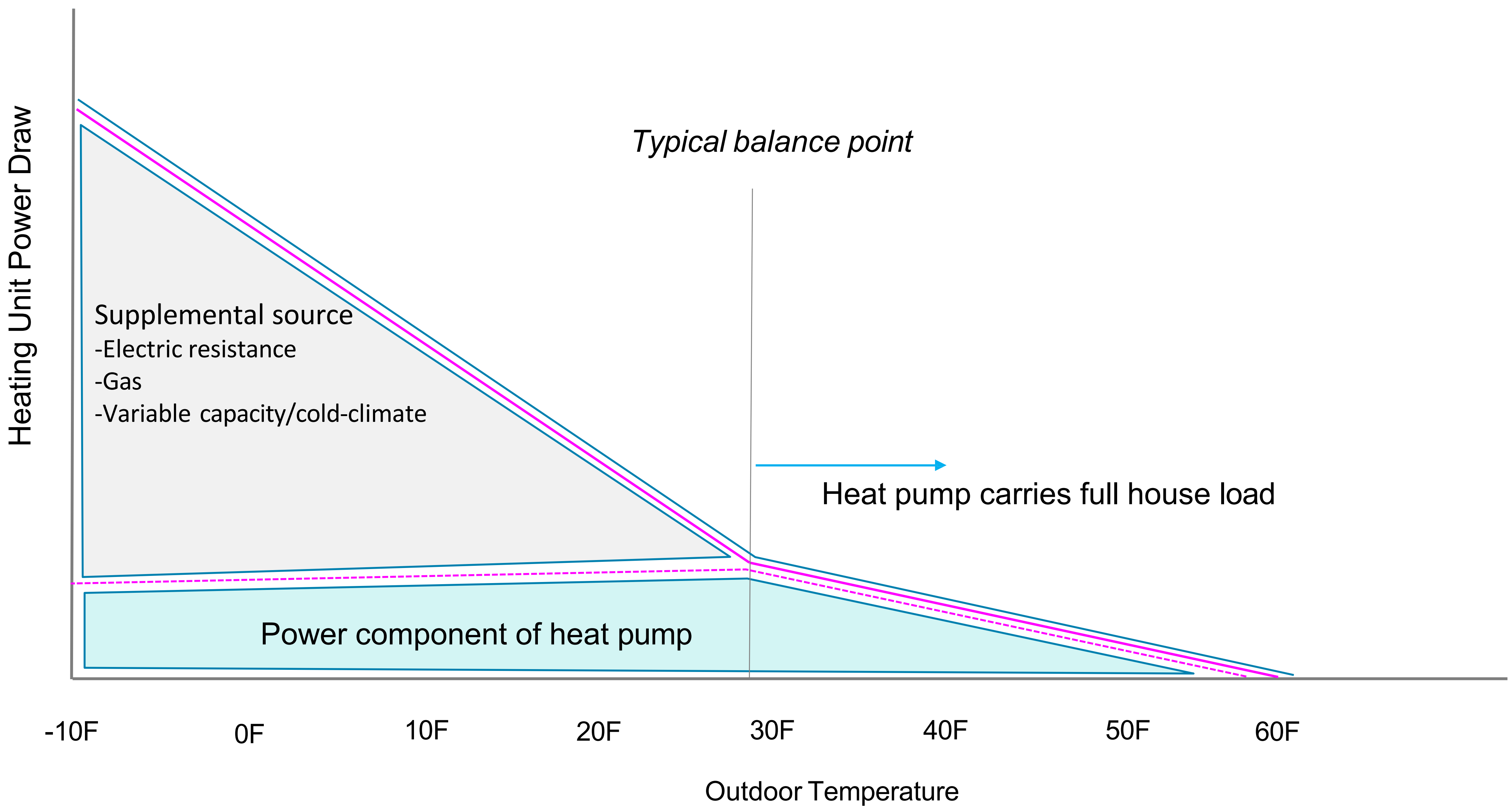

Technology Evolution
Covered by
Ultimate HP
Covered by
Next GenHP
ULTIMATE HP
NEXT -GEN HP
CONVENTIONAL HP
HEATING & COOLING LOAD
OUTDOOR TEMPERATURE

The Challenge

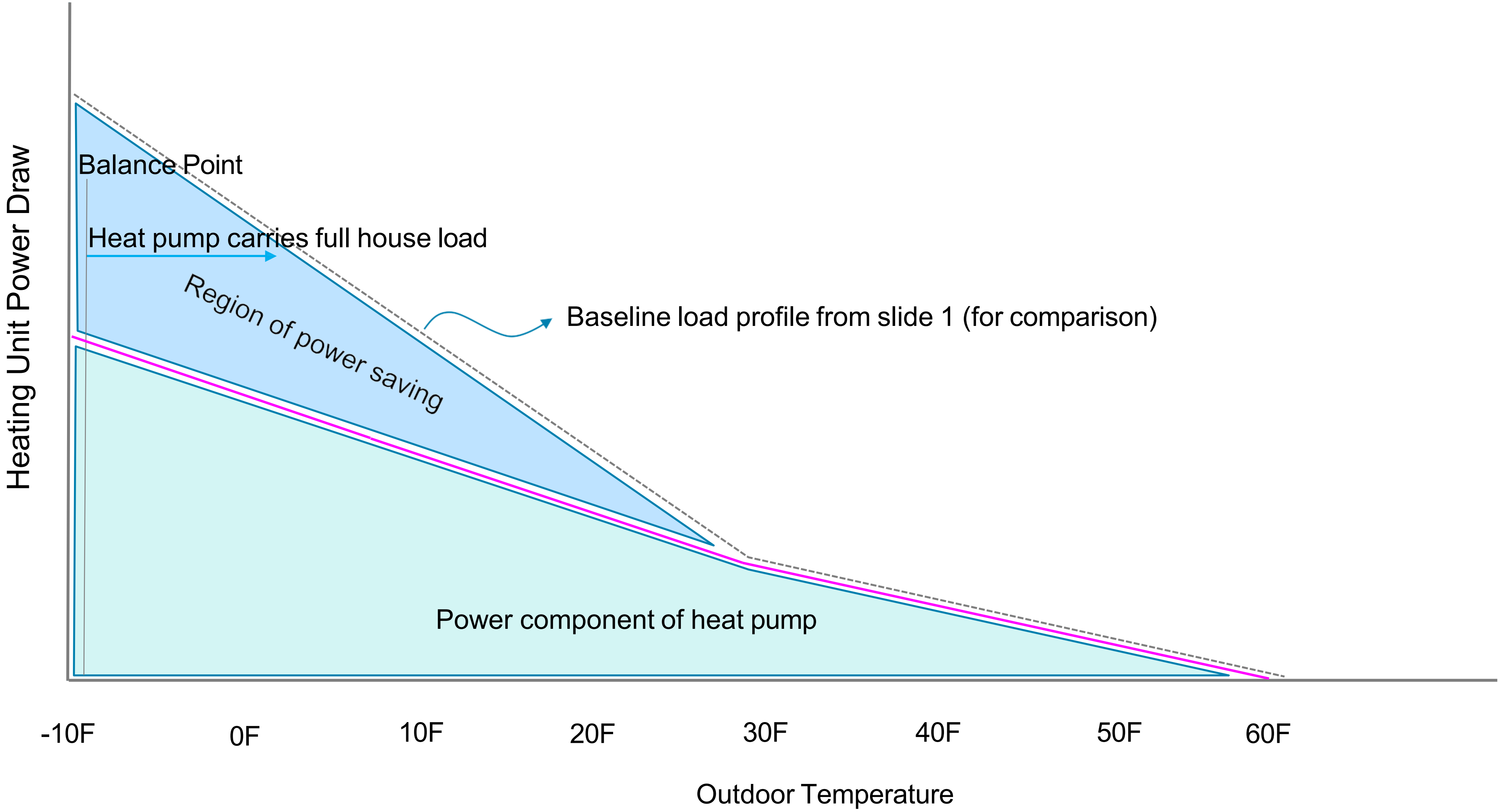


300GW U.S. peak demand from residential A/C

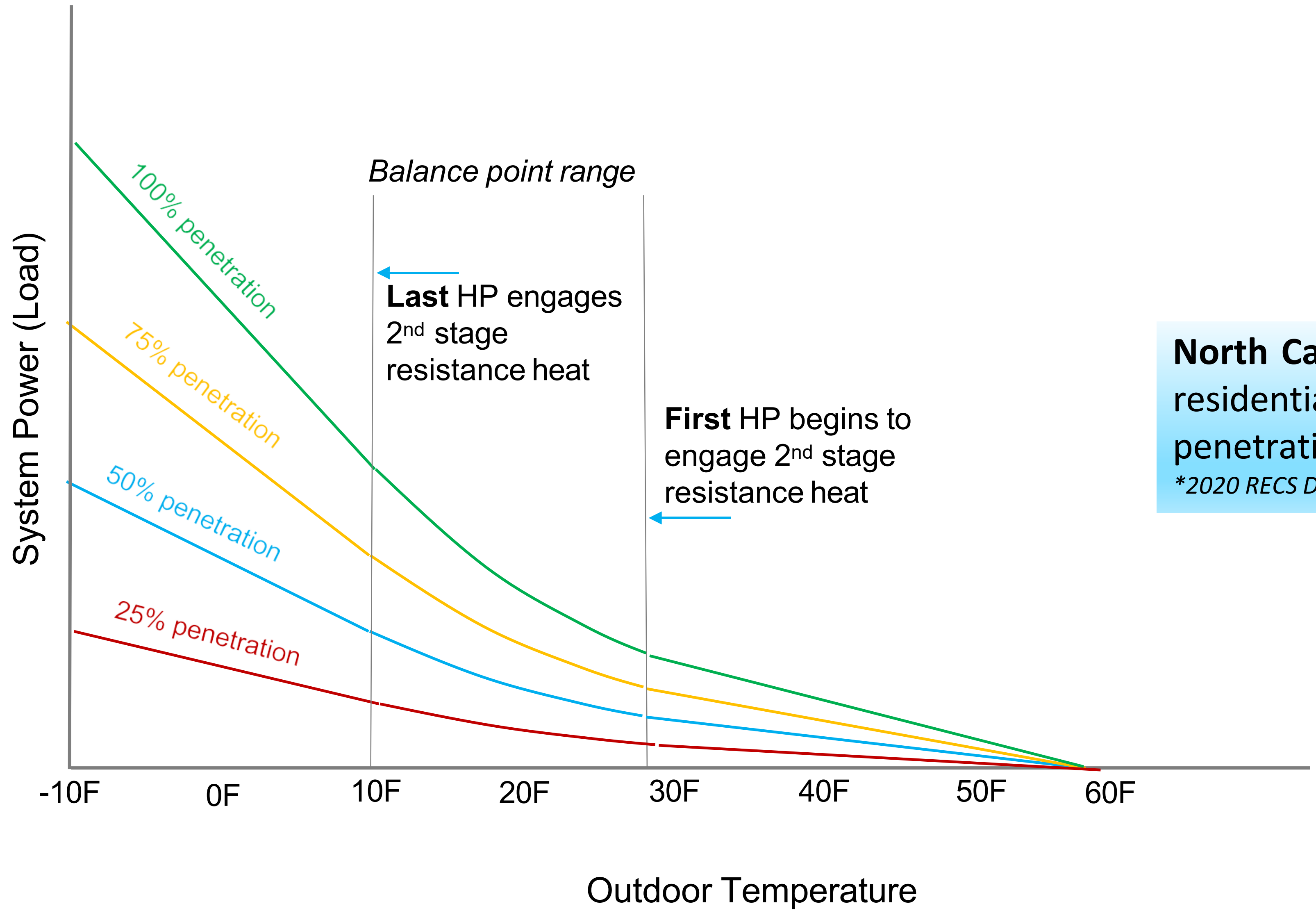
Representative Power Profile of a HP + 2nd-Stage Resistance Heat



Balancing Load and Capacity
-Variable-speed heat pump



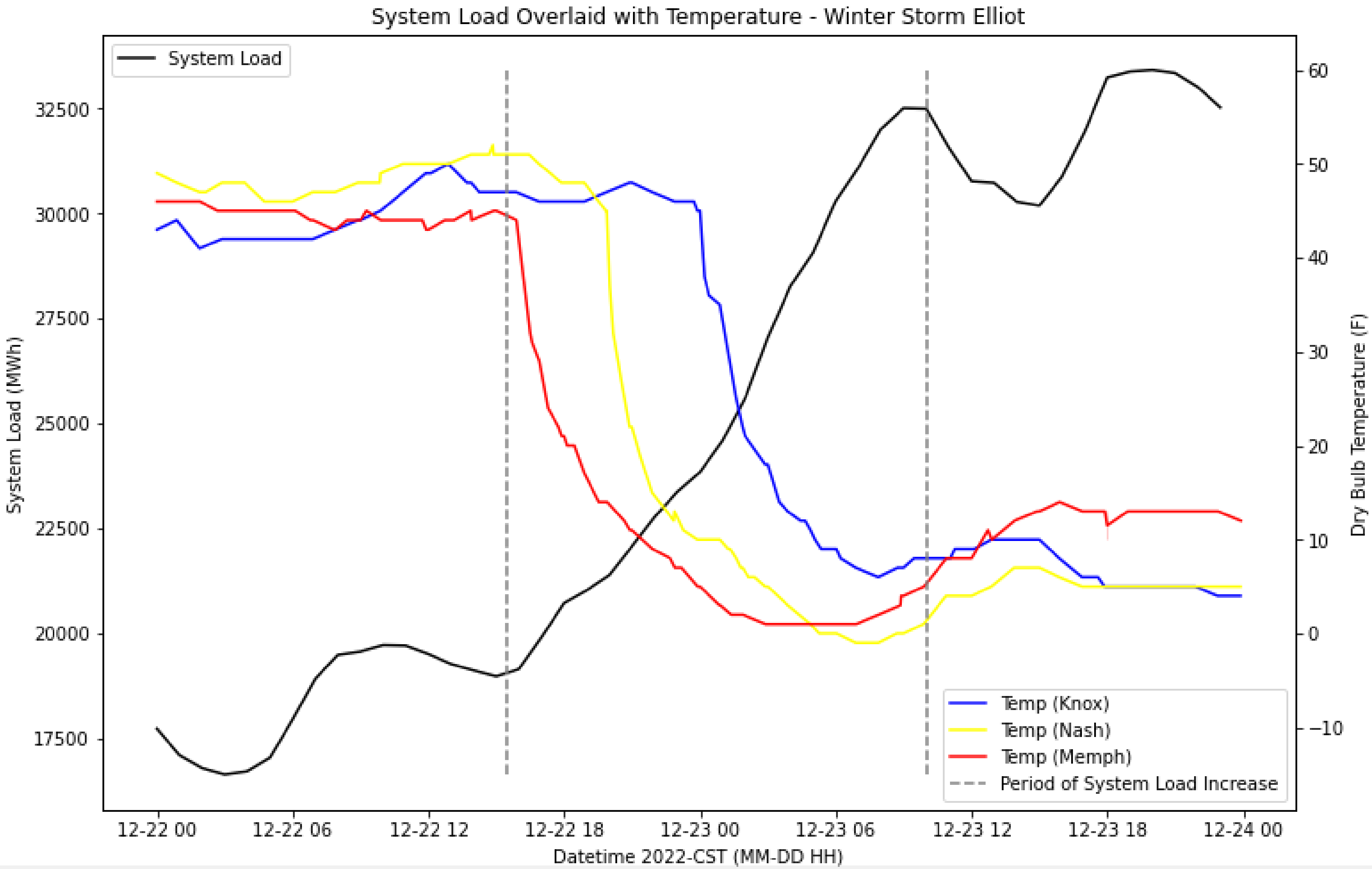
Illustrative Effect of 2nd-stage Electric Heat on Aggregate Load

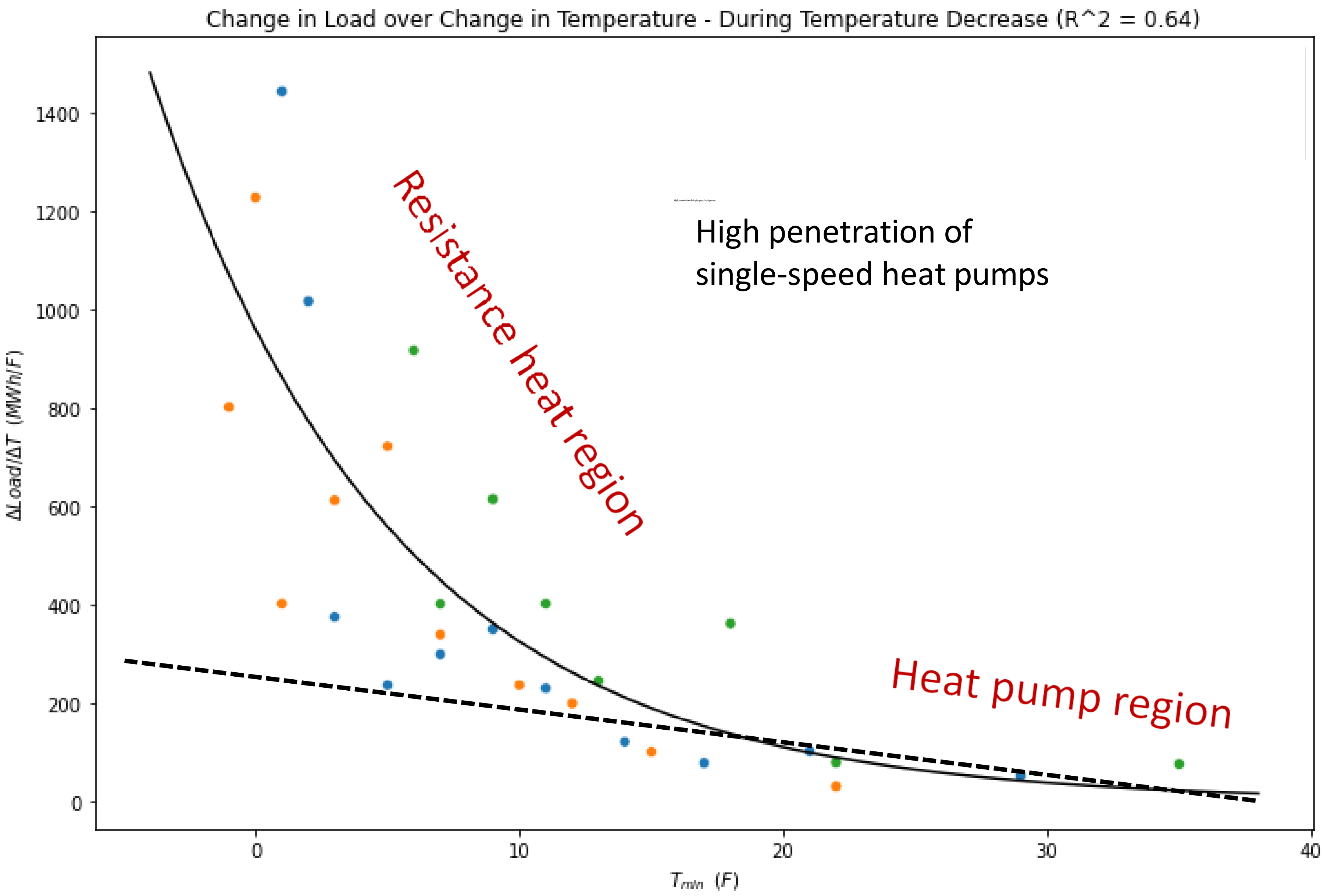


North Carolina: ~40% residential heat pump penetration

**2020 RECS Database*

TVA Territory During Winter Storm Elliott




Change in Load over Change in Temperature - During Temperature Decrease (R^2 = 0.64)
ΔLoad/ΔT (MWh/F)
1400
1200
1000
800
600
400
200
0
0
10
20
30
40
T_{min} (F)
Resistance heat region
High penetration of
single-speed heat pumps
Heat pump region

Next Generation Heat Pump Deployment

TRI-STATE Generation and Transmission Association, Inc.
A Touchstone Energy® Cooperative

Nebraska Public Power District
Always there when you need us

Seattle City Light

SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

NEW YORK STATE OF OPPORTUNITY. | NY Power Authority

cps ENERGY

FirstEnergy

7 utilities, 35 heat pumps

EPRI

TVA's Home Uplift Program

Deployment of Variable Capacity Heat Pumps (VCHP)

Home Uplift

- Income qualified
- No cost to homeowner
- Whole home approach
- Installed 24 new VCHPs
- Monitor homes for 12-15 months
- Assess energy efficiency and peak demand benefits
- ~2kW peak savings per home

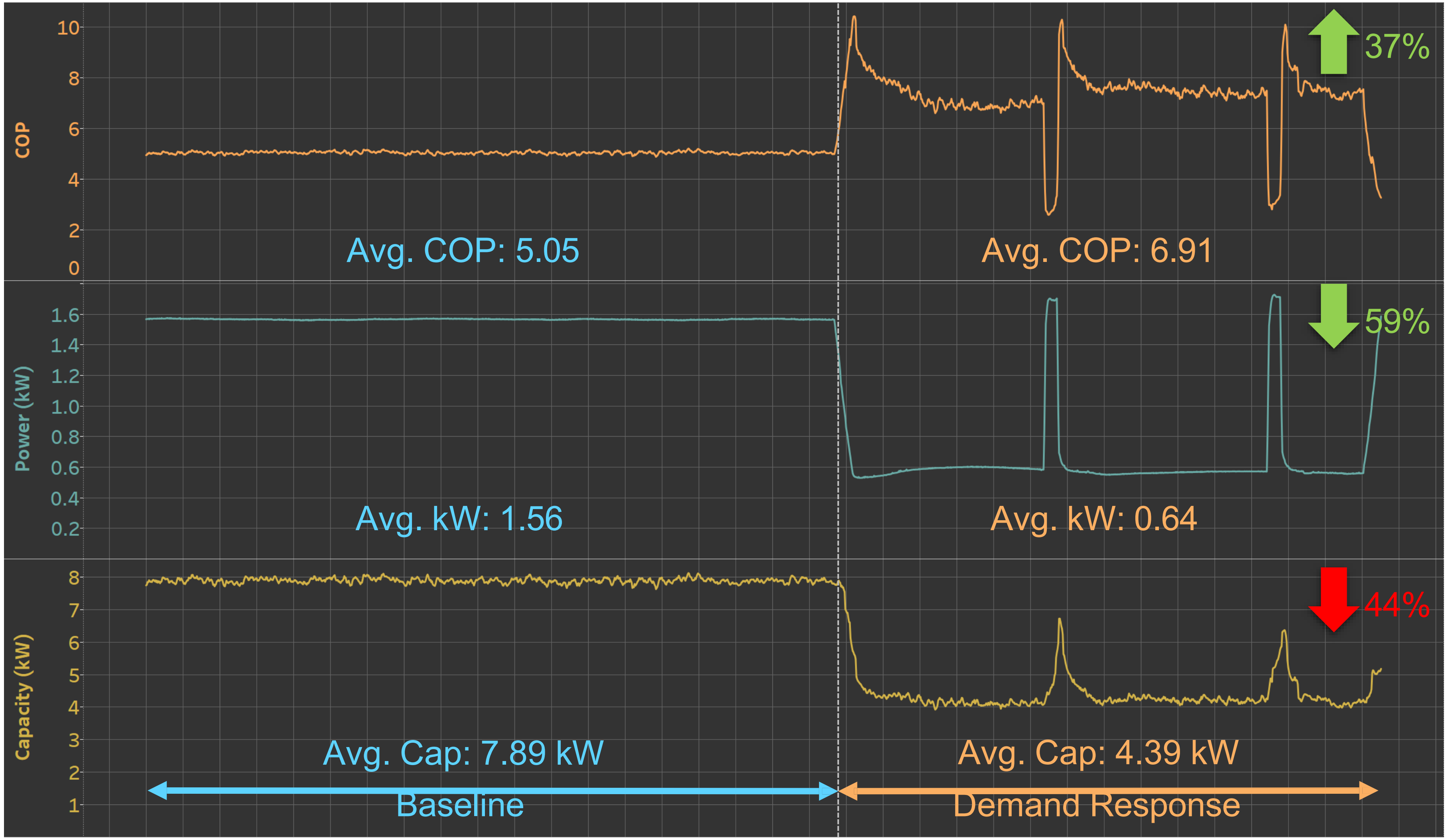
Cooling Remains a Challenge

June 2021—Pacific Northwest Temperatures

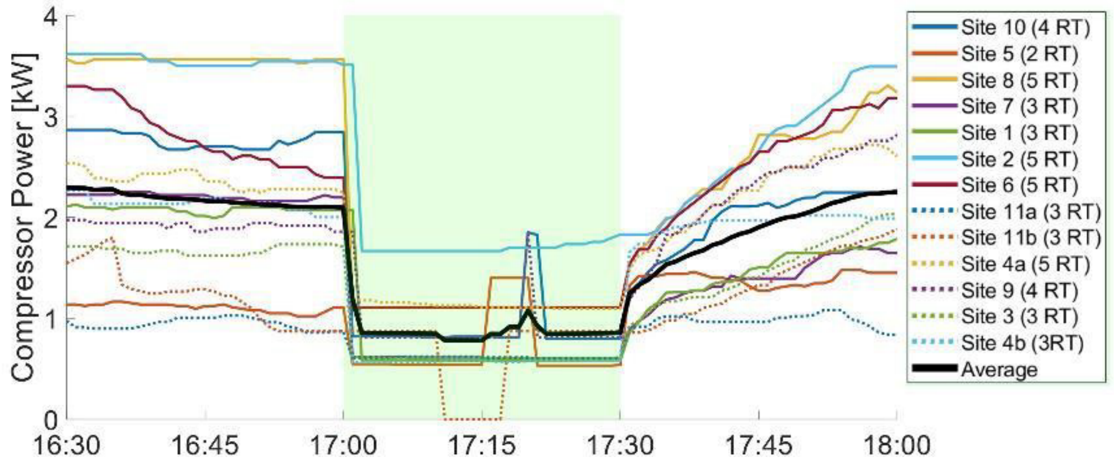
City	0.4% Cooling Design	1.0% Cooling Design	50-year Extreme (n50)	20-year Extreme (n20)	June 2021 Cooling Extreme		Delta June 2021 Extreme vs. 0.4%	Delta June 2021 Extreme vs. n50
	°F	°F	°F	°F	°F	Date	°F	°F
Portland, OR	91.2	87.1	107.5	105.1	115	6/28/21	+23.8	+7.5
Seattle, WA	78.7	75.4	97.1	94.2	107	6/27/21	+28.2	+9.9

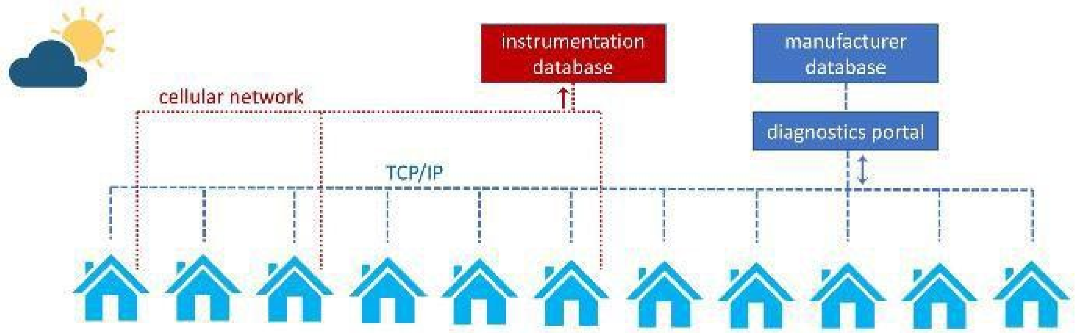
Advanced HVAC DR

The basic concept: more gain, less pain



Scaling Up through Residential Pilots

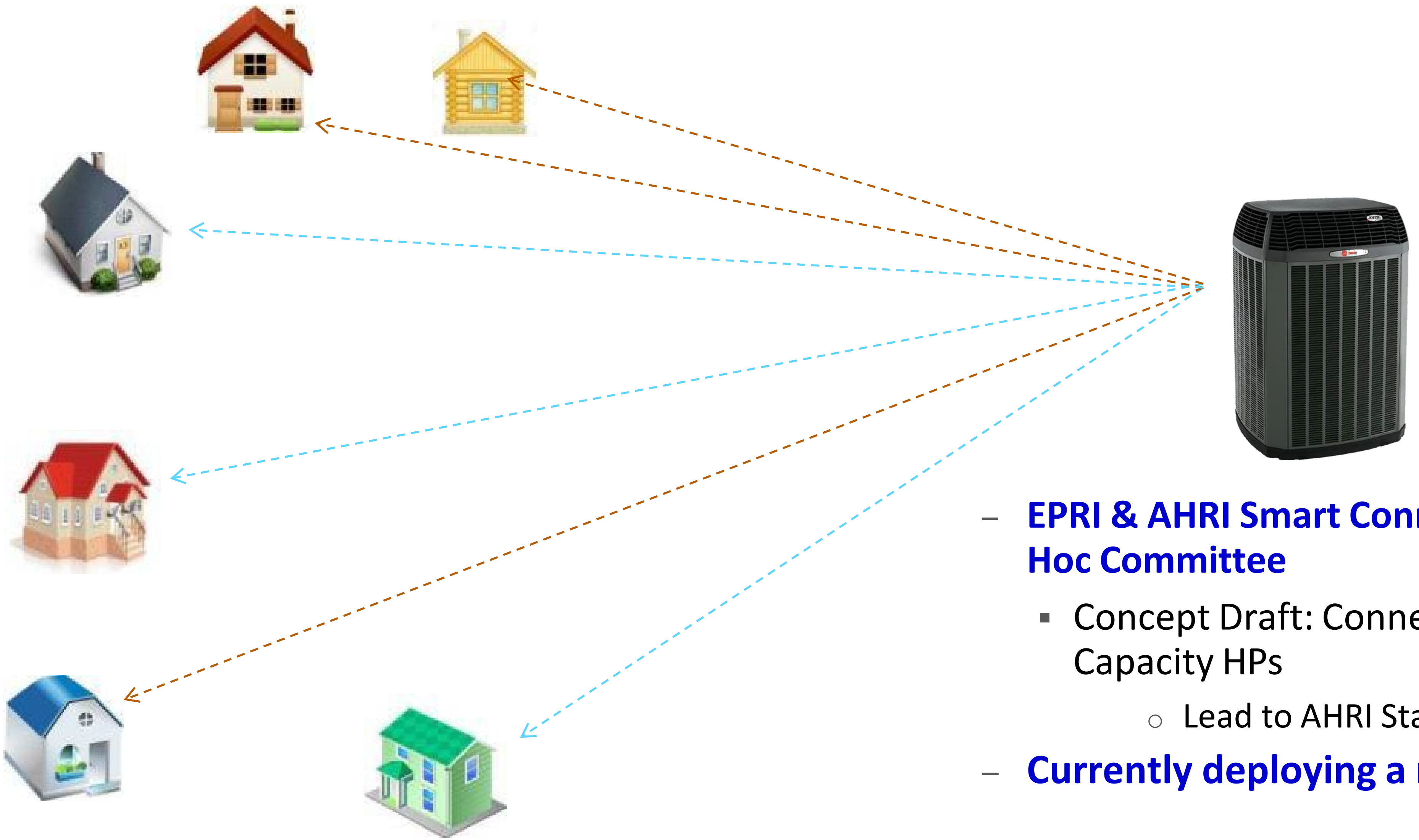




- 20 customers in central Florida
- Variable heat pumps (2-5 tons) from major US manufacturer
- Events initiated manually via manufacturer’s cloud dashboard
- Results showed matched comfort conditions and no complaints

Key manufacturer engagement and proof-of-concept demonstrated

Advanced HVAC Demand Response



- **EPRI & AHRI Smart Connected Equipment Ad Hoc Committee**
  - Concept Draft: Connected Variable Capacity HPs
    - Lead to AHRI Standard 1380
- **Currently deploying a national demo**

Advanced HVAC DR National Demonstration

SRP
Delivering water and power®

TVA

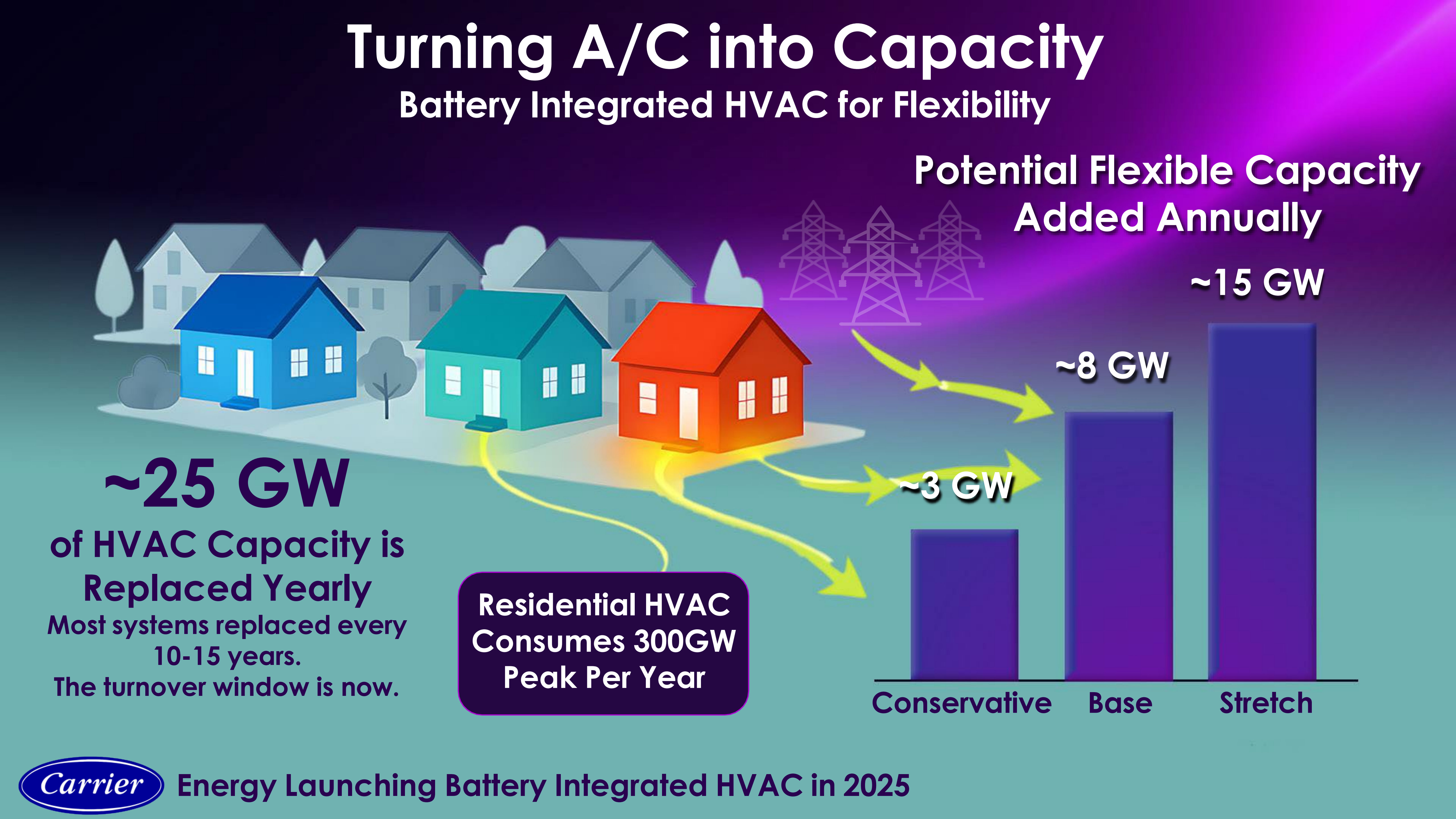
DUKE ENERGY®

SOUTHERN CALIFORNIA EDISON®
An EDISON INTERNATIONAL® Company

NEW YORK STATE | NY Power Authority

SDGE™

Southern Company



Turning A/C into Capacity
Battery Integrated HVAC for Flexibility
Potential Flexible Capacity Added Annually
~15 GW
~8 GW
~3 GW
Conservative
Base
Stretch
~25 GW
of HVAC Capacity is Replaced Yearly
Most systems replaced every 10-15 years.
The turnover window is now.
Residential HVAC Consumes 300GW Peak Per Year
Carrier
Energy Launching Battery Integrated HVAC in 2025

Advanced Window Units

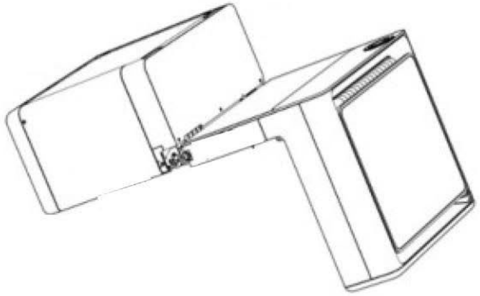
Advanced Window Units

Advanced Window Heat Pumps

Advanced Window Heat Pumps

Partners, Goals, & Future Steps

- Project Goals:
  - Determine efficiency & peak demand characteristics at full & partial load operation
  - Gather customer feedback about performance & ease of use



- Future Steps:
  - Lifecycle cost-benefit analysis
  - More demos *(climate & customer diversity)*
  - Explore Demand Flexibility services

comed℠ AN EXELON COMPANY

TVA TENNESSEE VALLEY AUTHORITY

Southern Company

Georgia Power

Additional partners welcome!

Commercial Building HVAC

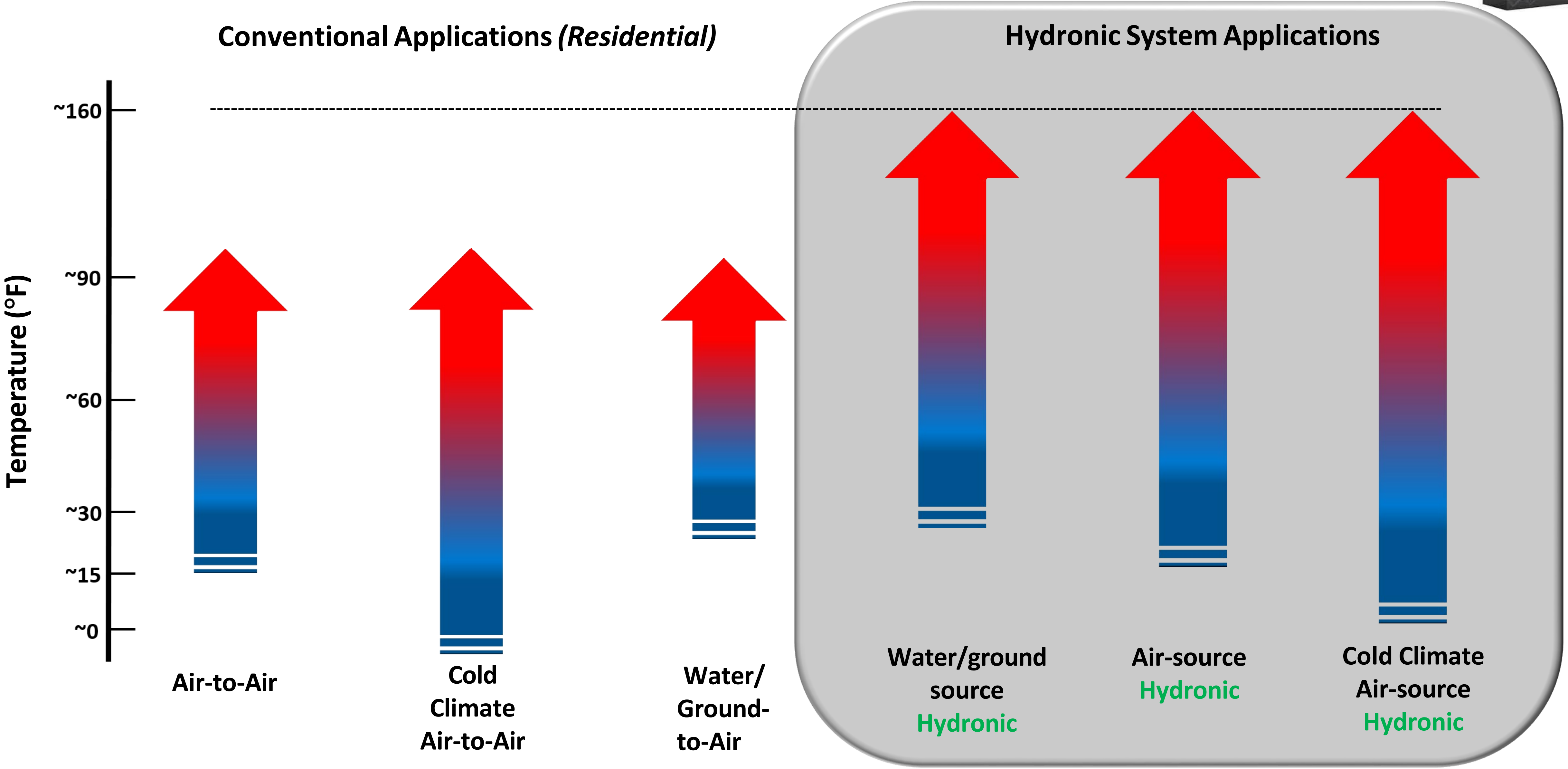
Commercial Building HVAC

High Lift Hydronic Heating

High Lift Hydronic Heating

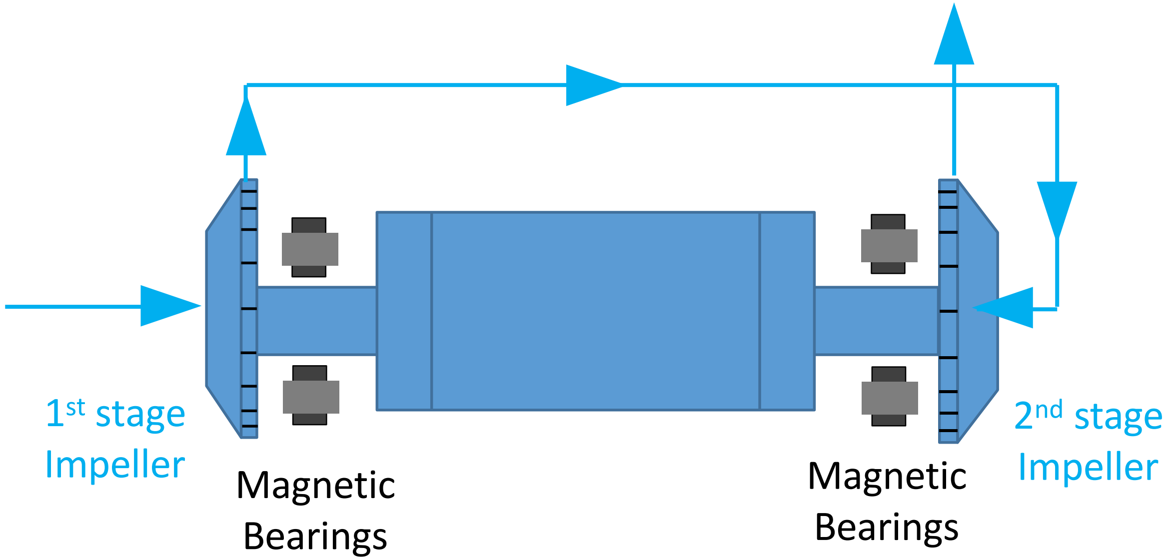
Commercial Heating Research

Required Temperature Lift to Heat - Hydronic



Emerging Technologies for Commercial Heating

High-Lift Oil-Less Compressor



For Use in Large System Applications (~40 tons or greater)

New Cold-Climate Psychrometric Chambers @ EPRI’s Knoxville Lab

20 Ton Capacity from -30°F to 180 °F

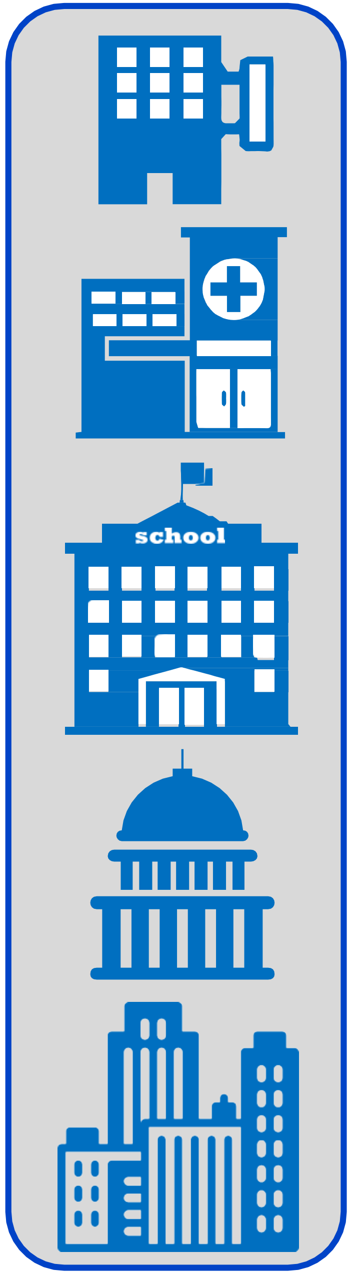
Large enough to test a car!

2X the capacity of the existing “Super Chamber”, and capable of testing at temperatures ~30°F colder and ~50°F hotter.

Enables performance characterization of wide range of advanced HVAC and other residential, commercial, and industrial technologies

Provides the opportunity to test technologies like cold-climate heat pumps!

Evaluation of Emerging Systems

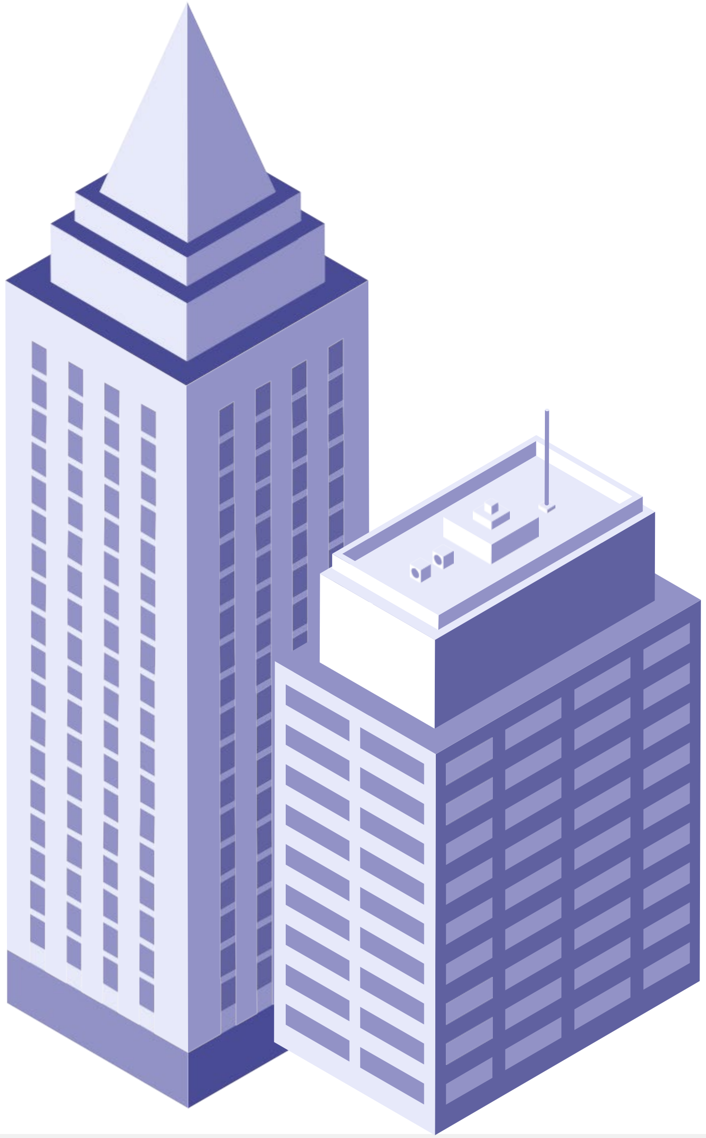


REMAINING CHALLENGES

(In Addition to Residential Challenges)

- **Footprint**
- **Retrofit vs. New**
- **Custom Design Needs**

Commercial Buildings in the United States

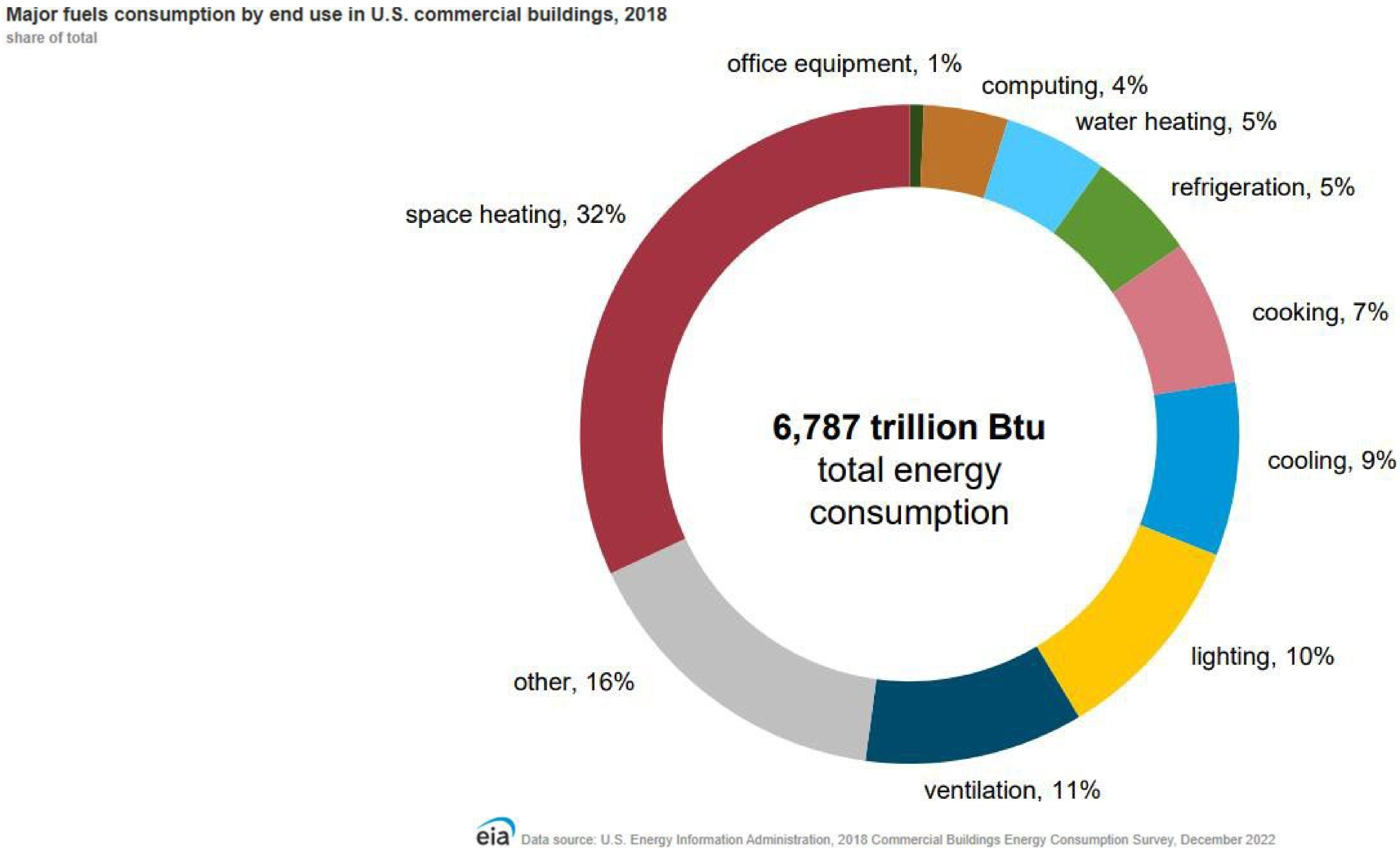


17% — Commercial Buildings use 17% of total energy usage in US.[1]

35% — Commercial Buildings use 35% of total electricity usage in US.[2]

1. U.S. EIA (2025) Monthly Energy Review June 2025
2. U.S. EIA (2022) CBECS 2018

Commercial Building Energy Usage



Ventilation in Commercial Buildings – The Opportunity

Commercial Building Ventilation provides a largely untapped opportunity for energy efficiency and demand response potential

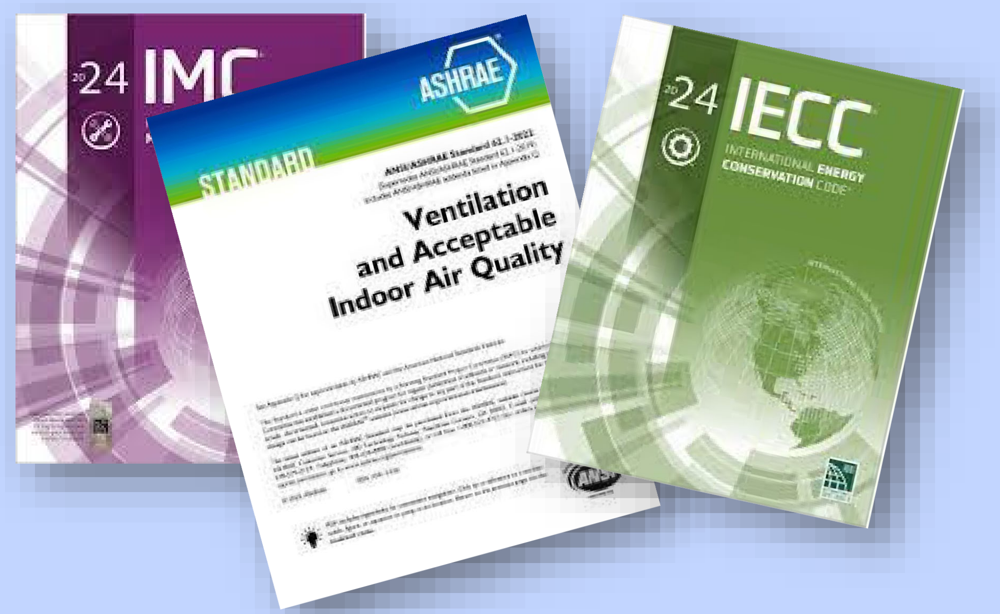
Significant energy is being thrown out the window (well, the roof, or sidewall…)

Ventilation- Many Codes & Many Technologies

+

Exhaust Fans & Make-Up Air Units

ERV's &
Emerging DOAS



+ Local Codes and Building Performance Standards

Ventilation Systems Require Coordination

Roof-Top Equipment is the “Tip of the Iceberg”

Potential Technologies to be Evaluated

Carrier

Munters

VENTACITY SYSTEMS
Making Buildings Healthy – Efficient – Smarter

GREENHECK

Swegon

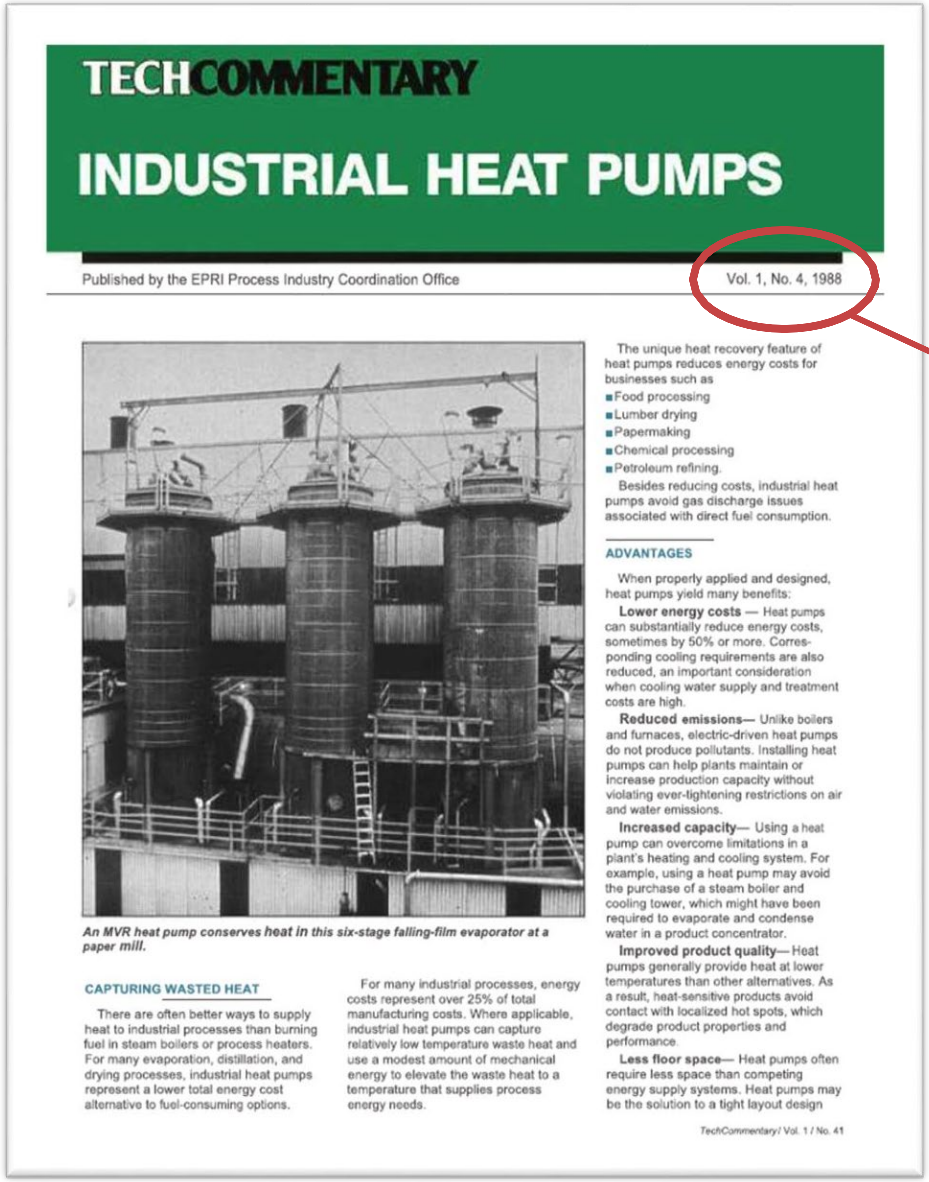
BLUE FRONTIER™

transaera

Industrial Heat Pumps

Industrial Heat Pumps

Industrial Heat Pumps & EPRI– 40+ years in the making



TECHCOMMENTARY

INDUSTRIAL HEAT PUMPS

Published by the EPRI Process Industry Coordination Office Vol. 1, No. 4, 1988

An MVR heat pump conserves heat in this six-stage falling-film evaporator at a paper mill.

CAPTURING WASTED HEAT

There are often better ways to supply heat to industrial processes than burning fuel in steam boilers or process heaters. For many evaporation, distillation, and drying processes, industrial heat pumps represent a lower total energy cost alternative to fuel-consuming options.

For many industrial processes, energy costs represent over 25% of total manufacturing costs. Where applicable, industrial heat pumps can capture relatively low temperature waste heat and use a modest amount of mechanical energy to elevate the waste heat to a temperature that supplies process energy needs.

The unique heat recovery feature of heat pumps reduces energy costs for businesses such as

- Food processing
- Lumber drying
- Papermaking
- Chemical processing
- Petroleum refining.

Besides reducing costs, industrial heat pumps avoid gas discharge issues associated with direct fuel consumption.

ADVANTAGES

When properly applied and designed, heat pumps yield many benefits:

Lower energy costs — Heat pumps can substantially reduce energy costs, sometimes by 50% or more. Corresponding cooling requirements are also reduced, an important consideration when cooling water supply and treatment costs are high.

Reduced emissions— Unlike boilers and furnaces, electric-driven heat pumps do not produce pollutants. Installing heat pumps can help plants maintain or increase production capacity without violating ever-tightening restrictions on air and water emissions.

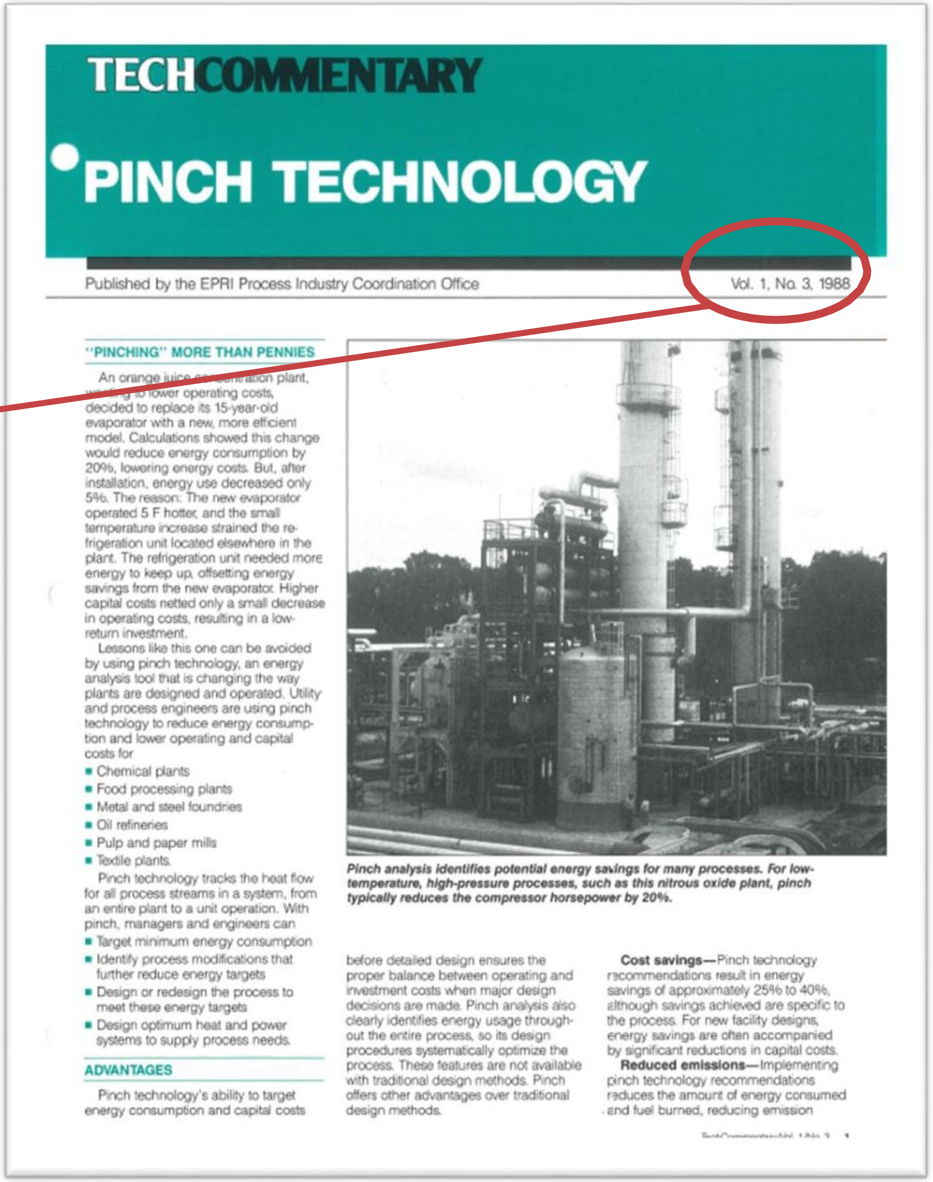
Increased capacity— Using a heat pump can overcome limitations in a plant's heating and cooling system. For example, using a heat pump may avoid the purchase of a steam boiler and cooling tower, which might have been required to evaporate and condense water in a product concentrator.

Improved product quality—Heat pumps generally provide heat at lower temperatures than other alternatives. As a result, heat-sensitive products avoid contact with localized hot spots, which degrade product properties and performance.

Less floor space— Heat pumps often require less space than competing energy supply systems. Heat pumps may be the solution to a tight layout design

TechCommentary / Vol. 1 / No. 41

1988



TECHCOMMENTARY

PINCH TECHNOLOGY

Published by the EPRI Process Industry Coordination Office Vol. 1, No. 3, 1988

"PINCHING" MORE THAN PENNIES

An orange juice concentration plant, wanting to lower operating costs, decided to replace its 15-year-old evaporator with a new, more efficient model. Calculations showed this change would reduce energy consumption by 20%, lowering energy costs. But, after installation, energy use decreased only 5%. The reason: The new evaporator operated 5 F hotter, and the small temperature increase strained the refrigeration unit located elsewhere in the plant. The refrigeration unit needed more energy to keep up, offsetting energy savings from the new evaporator. Higher capital costs netted only a small decrease in operating costs, resulting in a low-return investment.

Lessons like this one can be avoided by using pinch technology, an energy analysis tool that is changing the way plants are designed and operated. Utility and process engineers are using pinch technology to reduce energy consumption and lower operating and capital costs for

- Chemical plants
- Food processing plants
- Metal and steel foundries
- Oil refineries
- Pulp and paper mills
- Textile plants.

Pinch technology tracks the heat flow for all process streams in a system, from an entire plant to a unit operation. With pinch, managers and engineers can

- Target minimum energy consumption
- Identify process modifications that further reduce energy targets
- Design or redesign the process to meet these energy targets
- Design optimum heat and power systems to supply process needs.

ADVANTAGES

Pinch technology's ability to target energy consumption and capital costs before detailed design ensures the proper balance between operating and investment costs when major design decisions are made. Pinch analysis also clearly identifies energy usage throughout the entire process, so its design procedures systematically optimize the process. These features are not available with traditional design methods. Pinch offers other advantages over traditional design methods.

Cost savings—Pinch technology recommendations result in energy savings of approximately 25% to 40%, although savings achieved are specific to the process. For new facility designs, energy savings are often accompanied by significant reductions in capital costs.

Reduced emissions—Implementing pinch technology recommendations reduces the amount of energy consumed and fuel burned, reducing emission

Pinch analysis identifies potential energy savings for many processes. For low-temperature, high-pressure processes, such as this nitrous oxide plant, pinch typically reduces the compressor horsepower by 20%.

Today – Industrial Heat Pumps Gaining Momentum

*Includes industrial heat pumps (IHPS) and thermal batteries

Industrial Heat Pump Maturity & Adoption

Image: Everllence

Industrial Heat Pump Demand is Rising

Variety of economic drivers

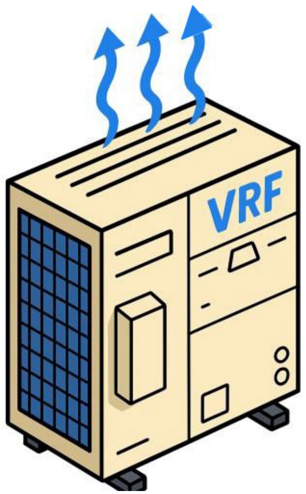
Laboratory Testing Informs Technology Adoption

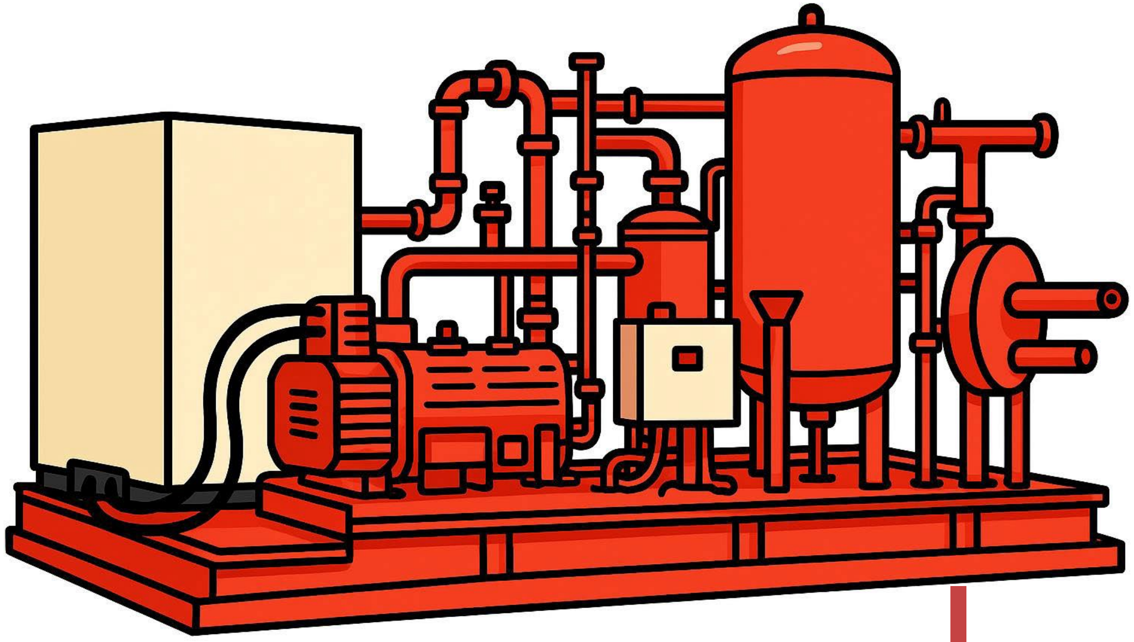
System performance and non-energy considerations

Utilities Drive Adoption Success

Resource to key industrial customers

Sizing comparison of IHPS vs other HPs





Capacity

Residential HP
~1-5 Tons
(12,000-60,000 BTU/hr)

VRF HP
~6-20 Tons
(72,000-240,000 BTU/hr)

Industrial Heat Pump
~100kW – 10MW+ (thermal)
(340,000-34,121,420 BTU/hr)

Graphics created with assistance from AI

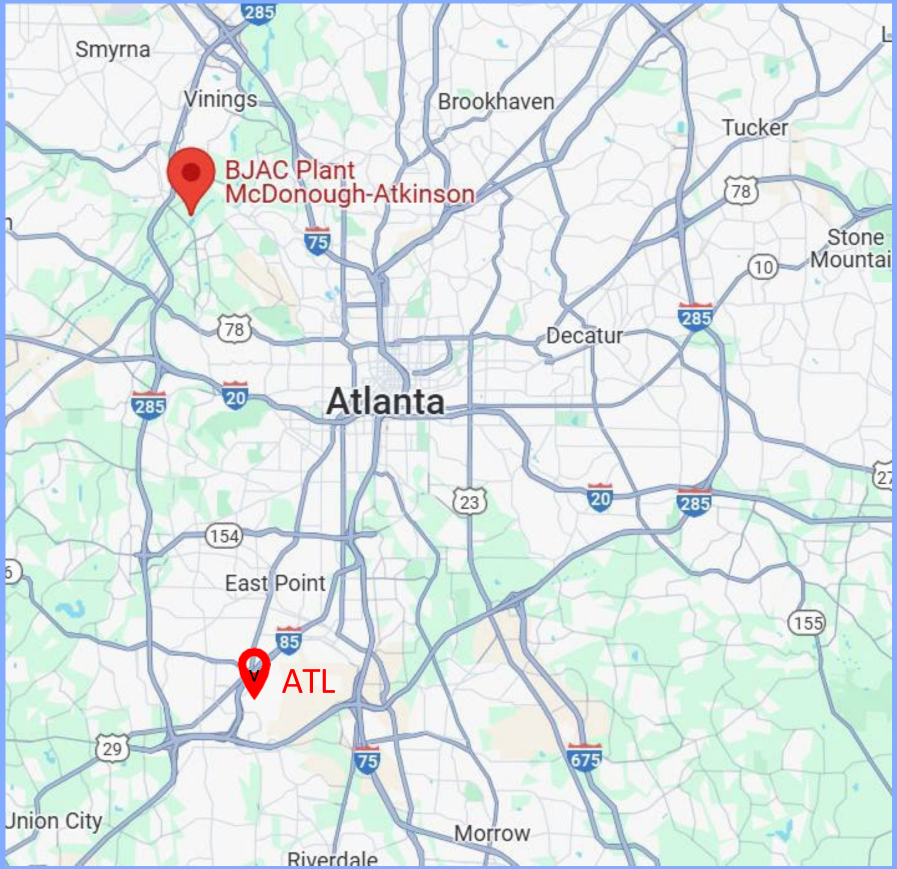
Industrial Heat Pump Test & Demonstration Facility

Value

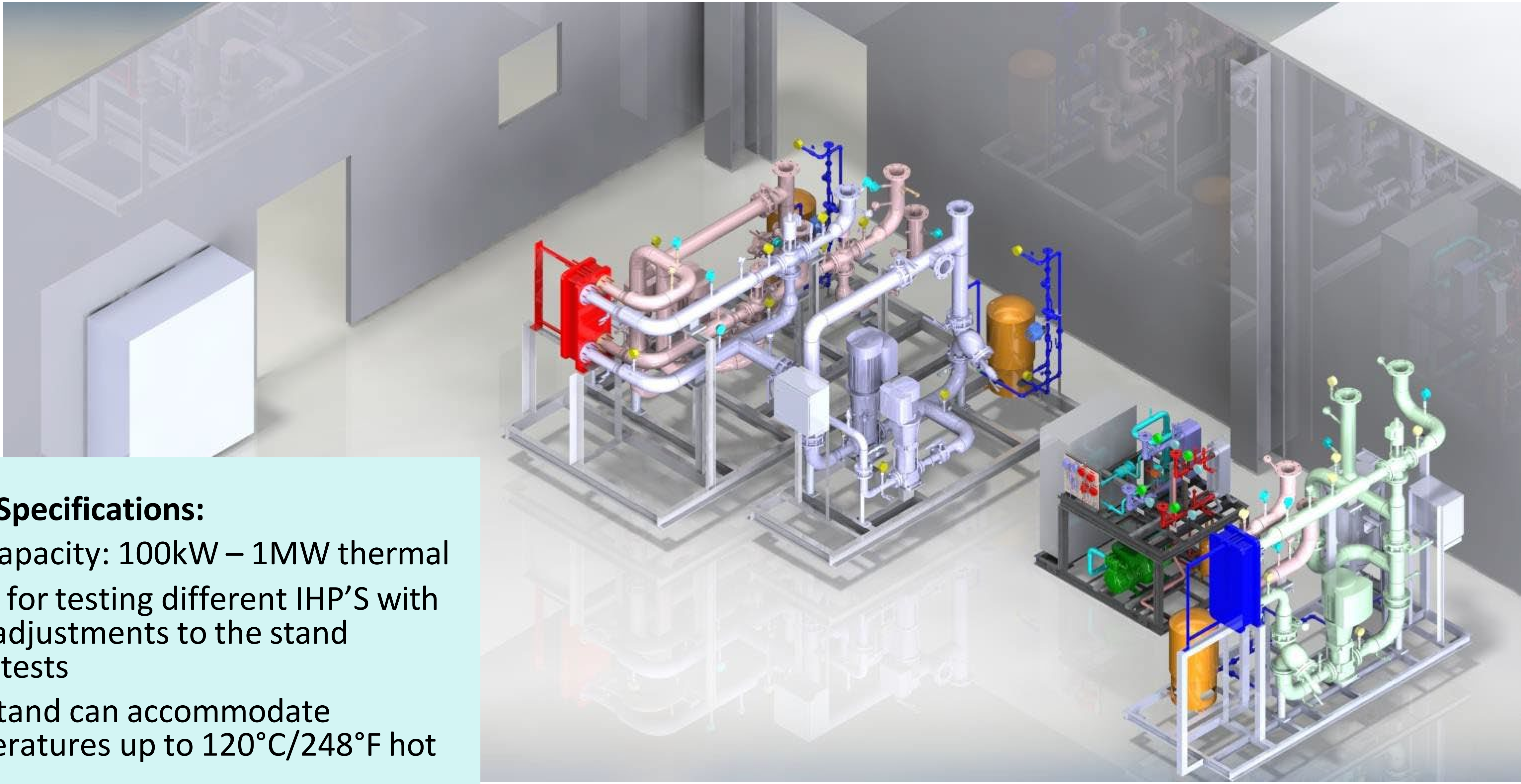
- Independent third-party testing capability at scale.
- Also serves as an operational product showcase location
  - Information sharing between manufacturers, utilities, potential customers
  - Potential new product demonstrations

EPRI & Southern Company team members during visit to the WRCC

Industrial Heat Pump Test Facility Location



Test Stand Overview



Test Stand Specifications:

- Testing Capacity: 100kW – 1MW thermal
- Designed for testing different IHP’S with minimal adjustments to the stand between tests
  - Test stand can accommodate temperatures up to 120°C/248°F hot water

Project Partners

Project Partners

Facility Commissioning in July

Questions?

TOGETHER…SHAPING THE FUTURE OF ENERGY®

www.epri.com

Return at 10:15

Round Robin

 |

EMERGING TECHNOLOGY COLLABORATIVE

OVERVIEW FOR RETAC MEMBERS

Spencer Sator
Principal, Emerging Technology
June 17, 2026

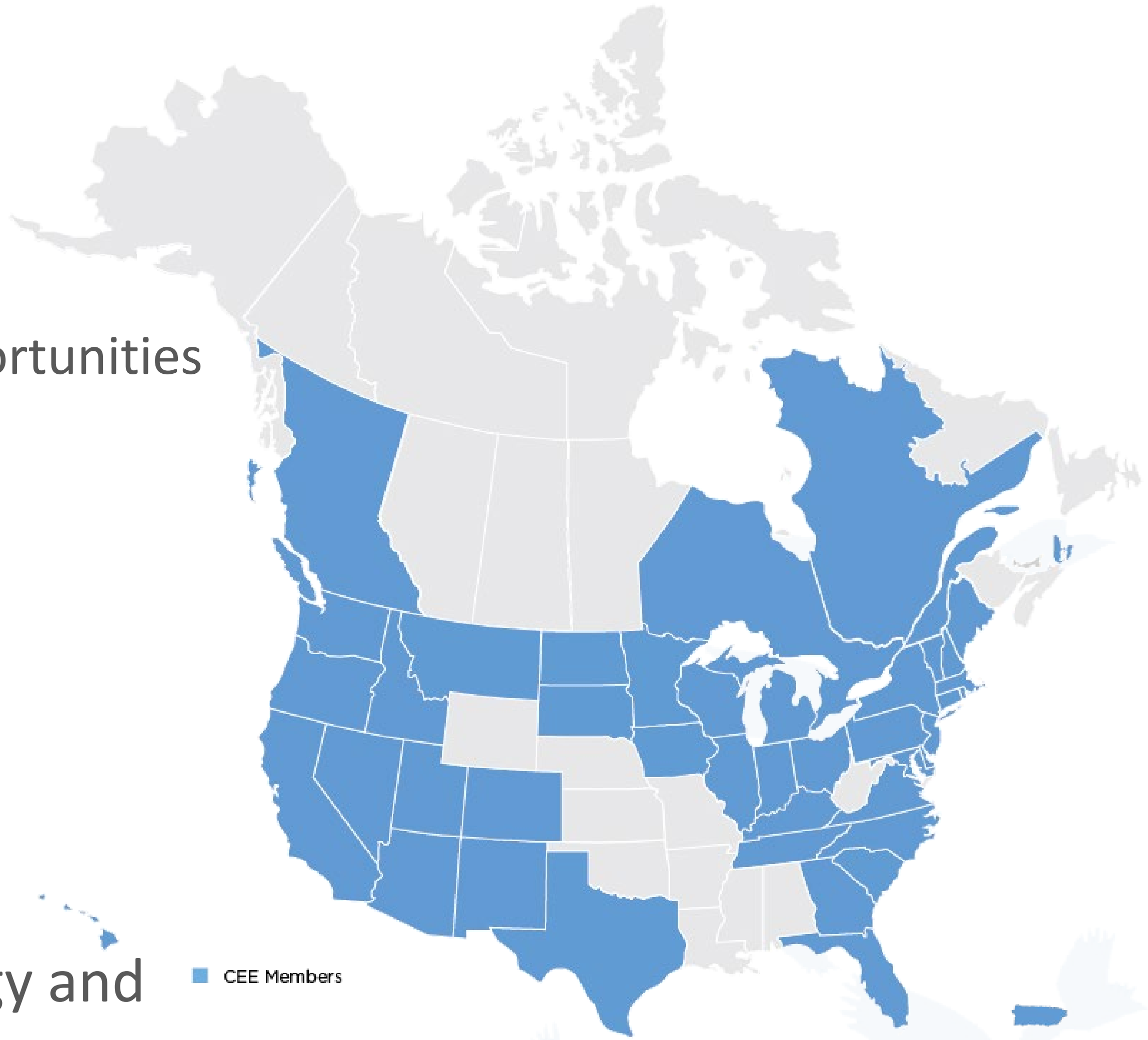
AGENDA

- Who is this guy?
- Who is CEE
  - Mission, Goals, Governance
  - Spheres of Influence
  - Examples of Success
- About CEE's Emerging Technology Collaborative
- CEE Program Deliverables
  - Platforms for market transformation

WHO IS THIS GUY?

- CEE’s Principal of Emerging Technology
- 20 years in ET
  - 12+ years at E Source as researcher, consultant, and Director of ET
  - Consultant working for BPA, NEEA, and NW utilities
    - Have participated in RETAC - speaking at events, providing SME guidance on technologies including refrigerants and lighting
  - Founded multiple ET consultancies
  - Worked as an in-house consultant for ComEd’s ET Program
- Started at CEE in Nov 2025 after a year sabbatical

- Founded in 1991
- Focused on shared member goals
  - Tackling nationally-significant barriers and opportunities
  - Facilitate utility leadership
- Representing the largest PAs
  - 70% of $9 billion industry
  - 100M electric and 50M gas customers
- Not to be confused with MN Center for Energy and Environment (who also go by CEE)



CEE MEMBERS WORKING TOGETHER

Program Administrators

Ameren Illinois
Austin Energy
Avangrid
- Berkshire Gas
- Connecticut Natural Gas
- New York State Electric & Gas
- Rochester Gas & Electric
- Southern Connecticut Gas
- United Illuminating

Baltimore Gas & Electric Company
BC Hydro
Cape Light Compact
CenterPoint Minnesota
Commonwealth Edison Company
Consolidated Edison Company
Consumers Energy
Dominion Energy South Carolina
Dominion Energy Utah
DTE Energy
Duke Energy
Efficiency Maine
Efficiency Vermont
Elizabethtown Gas
Enbridge Gas
Énergir
Energy Trust of Oregon
Eversource
FortisBC
Hawai'i Energy
Hydro-Québec
IESO
Los Angeles Department of Water and Power
LUMA Energy
Minnesota's Efficient Technology Accelerator
Missouri River Energy Services
National Grid
New Jersey Natural Gas
New Mexico Gas Company
New York Power Authority
Nicor Gas
Northern California Power Agency
NYSERDA
Oncor
Pacific Gas and Electric Company
PNM
PSEG Long Island
Public Service Electric & Gas
Puget Sound Energy
Rhode Island Energy
Sacramento Municipal Utility District
Seattle City Light
Snohomish County PUD
SoCalGas
South Jersey Gas
Southern California Edison
Southern Minnesota Municipal Power Agency
Southwest Gas
Tacoma Power
Tampa Electric Company
TECO Peoples Gas
VGS
Xcel Energy

Efficiency Organizations & National Laboratories

American Council for an Energy-Efficient Economy
California Energy Commission
Efficiency Canada
Fraunhofer USA Center for Manufacturing Innovation
GTI Energy
Lawrence Berkeley National Laboratory
Midwest Energy Efficiency Alliance
National Laboratory of the Rockies
Northwest Energy Efficiency Alliance
Oak Ridge National Laboratory
Pacific Northwest National Laboratory
Southwest Energy Efficiency Project

Federal Advisors

Natural Resources Canada
US DOE
US EPA

CEE'S SPHERES OF INFLUENCE

AO Smith
Carrier
LENNOX

Manufacturers

ARISTON
Rheem
DAIKIN

NARUC
National Association of Regulatory Utility Commissioners

Regulators & Evaluators

RESNET
RESIDENTIAL ENERGY SERVICES NETWORK

Standard Setting Bodies

ASHRAE
AHRI

U.S. DEPARTMENT OF ENERGY

Federal Government

ENERGY STAR

ACCA
Air Conditioning Contractors of America

Retailers & Installers

THE HOME DEPOT

CEE STRATEGIC GOALS

- Advance Energy Efficiency
- Decarbonize Buildings
- Shape Electrification
- Scale Capabilities for Automated Demand Response and Demand Flexibility
- Position "Equity" as a Measurable Program Impact
- Represent Consensus Interests to Federal Agencies and Educate Regulatory Leaders

CEE PORTFOLIO AND ENGAGEMENT

CURRENT CEE PORTFOLIO

Residential

Integrated Home

New Construction

Existing Homes

Space Heating and Cooling

Water Heating

Room Heat Pumps

Appliances

Commercial

Dynamic Energy Management

Income-Qualified Multifamily

Air-Conditioning
and Heat Pumps

Water Heating

Gas Boiler Systems

Kitchens

Lighting

Industrial

Strategic Energy Management

Compressed Air Systems

Pump Systems

Motor Systems

Industrial Heat Pumps

Sponsored Projects

Integrated Home Competition

Heat Pump Installation Education and Guidance

Emerging Technologies Collaborative

Center for Equity and Energy Behavior

Cross Cutting

Evaluation

Research

Decarbonization Strategy

Behavior

Equity

Natural Gas Strategy

Federal Agency Engagement

CURRENT CEE PORTFOLIO

Residential

Integrated Home

New Construction

Existing Homes

Space Heating and Cooling

Water Heating

Room Heat Pumps

Appliances

Commercial

Dynamic Energy Management

Income-Qualified Multifamily

Air-Conditioning and Heat Pumps

Water Heating

Gas Boiler Systems

Kitchens

Lighting

Industrial

Strategic Energy Management

Compressed Air Systems

Pump Systems

Motor Systems

Industrial Heat Pumps

Sponsored Projects

Integrated Home Competition

Heat Pump Installation Education and Guidance

Emerging Technologies Collaborative

Center for Equity and Energy Behavior

Cross Cutting

Evaluation

Research

Decarbonization Strategy

Behavior

Equity

Natural Gas Strategy

Federal Agency Engagement

Program Initiatives

Template to help inform local program design

Specifications

Utility-defined performance requirements

Qualifying Product Lists

List of products meeting CEE Specification levels

Program Summaries

Detailed characterizations of leading programs in the U.S. and Canada

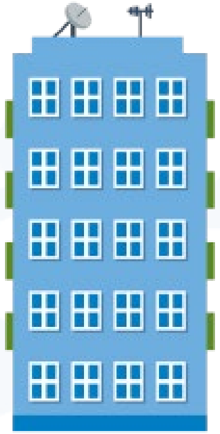
Miscellaneous Program Resources

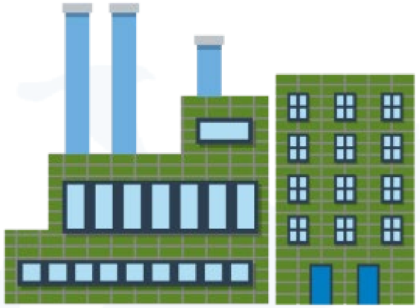
Heat pump installation guide, NEIs attribution report, emerging technologies catalog

https://cee1.org/program-resources/

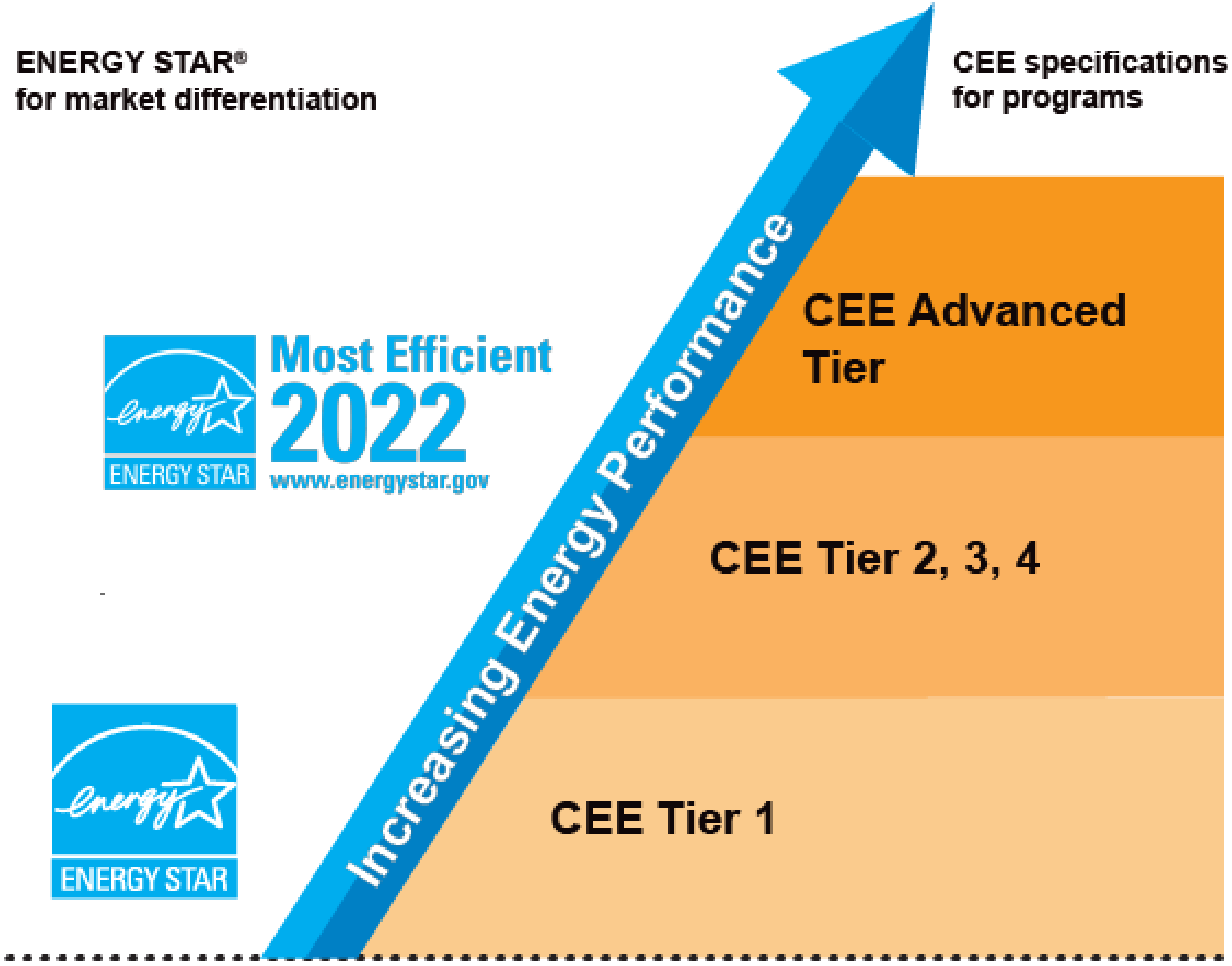
CEE PERFORMANCE SPECS

- Committees develop, shape, and approve product specs
  - Updated as needed to define the best product performance
- Rigorous vetting process that prioritizes member needs
  - Specs are vetted with manufacturers
  - When specs are passed, industry listens
- CEE specs go above and beyond minimum efficiency
  - Near-term cost-effective savings and aspirational targets
  - Shape the future of the market by supporting OEM design teams
  - Allow members to stipulate their shared needs/goals





CEE TIERS



Top 25% of energy performers in a mass market product category

- Reserved for stretch target
- Exceptional, aspirational performance
- Attracts early adopters
- Ideally, two or more manufacturers
- Cost-effective in the future

- Tiers above ESTAR merit differentiation
- Typically 3+ OEMs in a category
- Cost-effective for customer w/incentive
- Cost-effective for most programs

- Cost-effective when aligns with ESTAR®
- Cost-effective for customer
- Multiple OEMs make product available
- Top 25% of models

CONSENSUS THROUGH COMMITTEE

- Managed and facilitated by CEE staff
- Participation restricted to CEE members
- Committees base work plans on collective member interests and goals
- Produce deliverables available only to members
- Committees advance work through:
  - Team calls every month/quarter
  - In-person meetings (3 per year)
  - Offline document review and input

- Three in-person meetings a year
  - Portland in September 2026
- Attendance restricted to members – ***<u>NEEA represents entirety of RETAC</u>***
- Deliberative meetings, advancing solutions to the member goals
- Networking and collaboration
  - Safe space free of commercial interests
- Opportunity to influence and liaise with manufacturers

EMERGING TECHNOLOGY COLLABORATIVE (ETC)

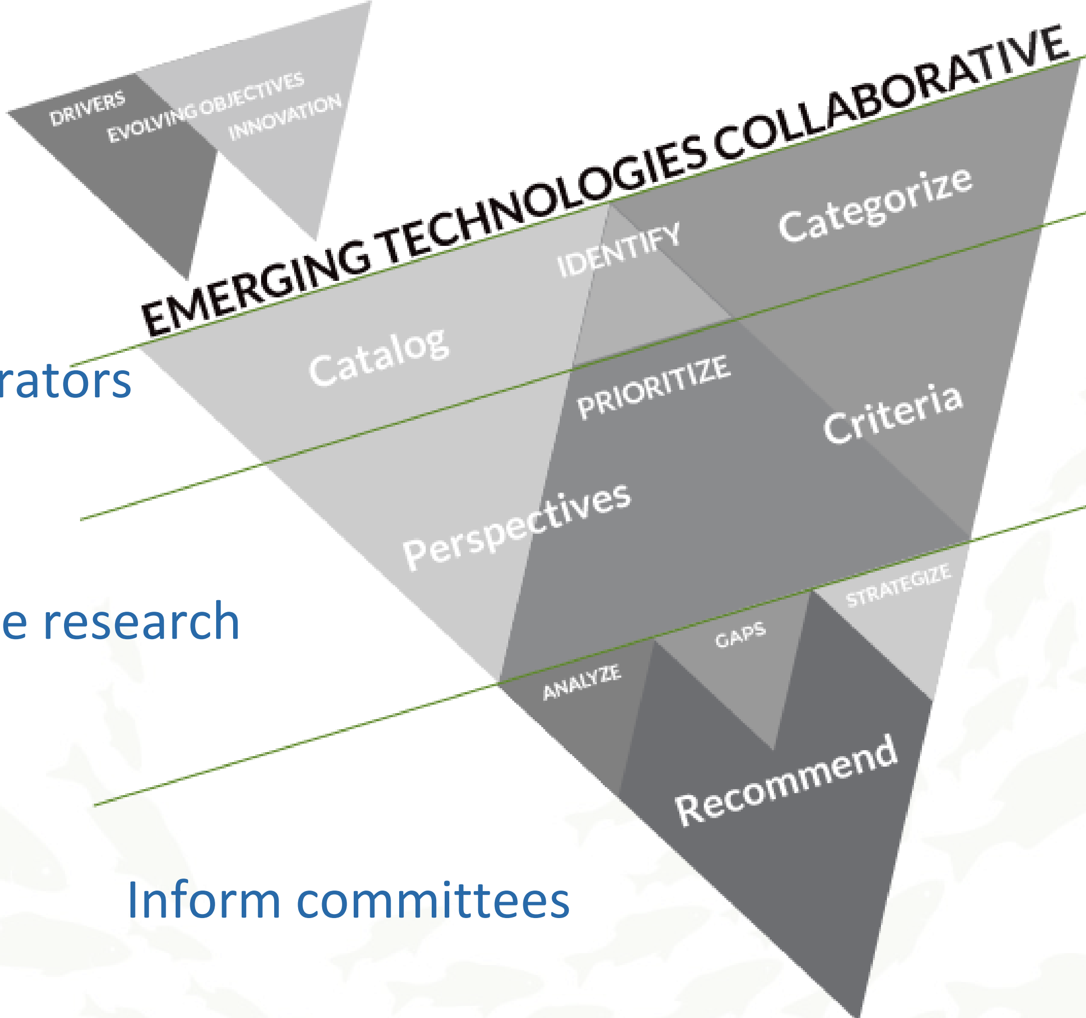
CEE

ETC OVERVIEW

- ETC goals
- 2026 ETC membership
- Products and resources
- ETC processes
- Current activities
- Wrap up/questions

- Goals: Emerging Technology **COLLABORATIVE**
  - Align
  - Inform
  - Leverage
  - Partner
- Deliverables
  - ET Pilot Catalog
  - Webinars
  - Reports
  - ET Prioritization meetings
  - Conference sessions

Prioritizing Emerging Opportunities (EOs) for the Energy Program Industry



Find collaborators

Leverage research

Inform committees

Increase impact

Manage risk

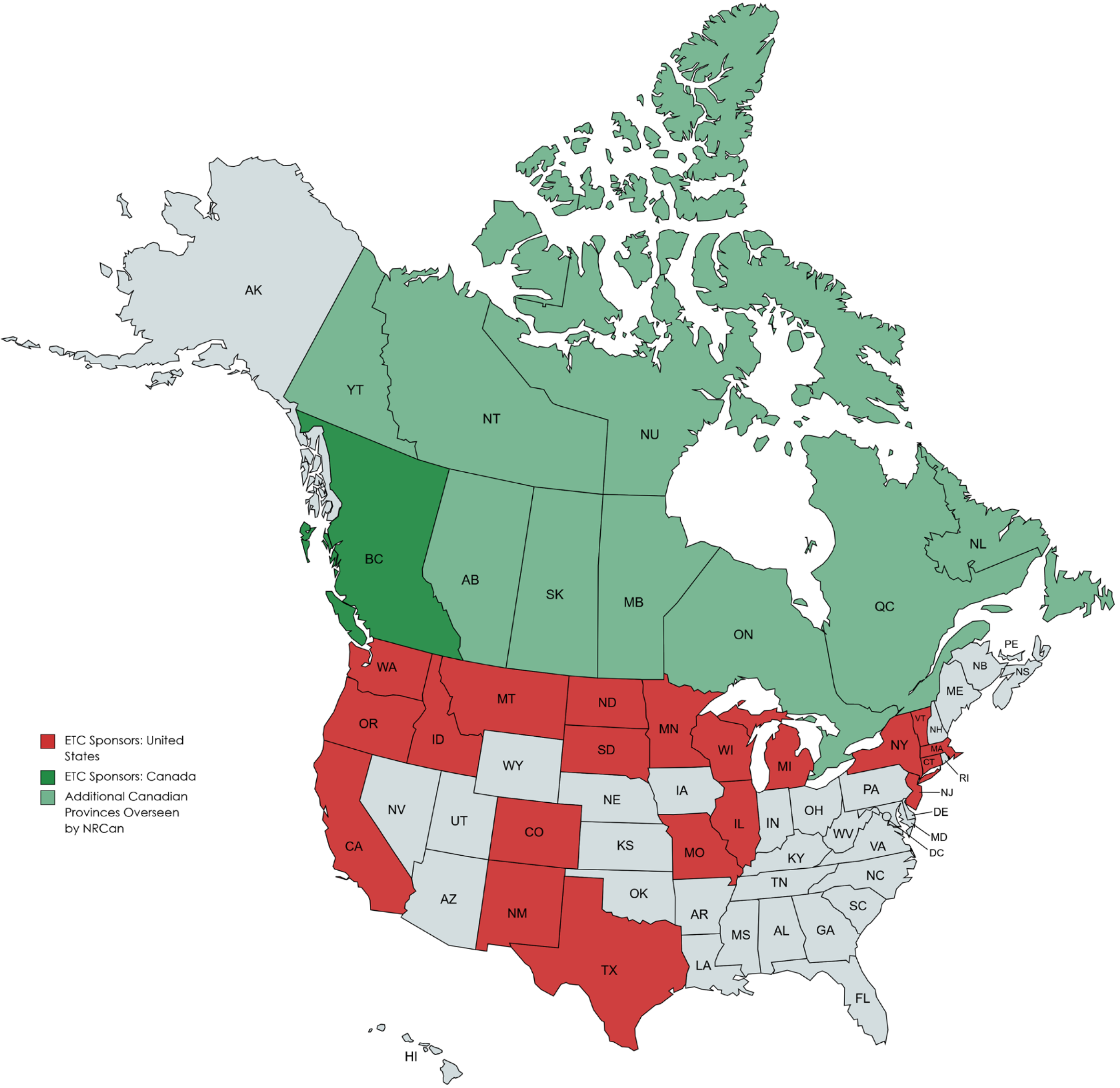
Critical mass

Trust

Spencer Sator
Program Principal

Lindsey Snyder
Program Assistant

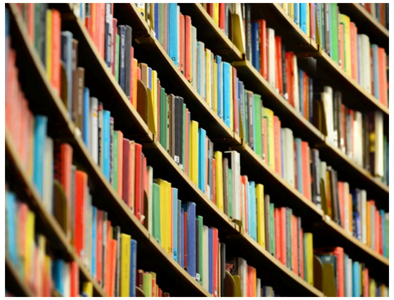
ETC SPONSORSHIP



Created with mapchart.net

2026 ETC Members	
Avangrid/United Illuminating/ New York State Electric & Gas/Rochester Gas & Electric	Natural Resources Canada
BC Hydro	Northwest Energy Efficiency Alliance
Commonwealth Edison	Oncor
Consumers Energy	Public Service Electric and Gas
DTE Energy	Public Service Enterprise Group-Long Island
Efficiency Vermont	Southern California Gas
FortisBC	Southern California Edison
National Grid	Xcel Energy

More effective use of emerging opportunities resources:

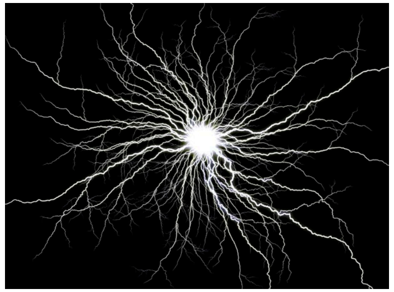


- Assess technologies faster and more effectively
- Leverage EO resources of other members
- Find opportunities to partner on EO assessments

Knowledge sharing and collaboration:

- Participate in working groups with fellow ETC sponsors to research EOs
- Understand assessment and program efforts undertaken by other ETC sponsors
- Gain information from industry and program implementers

Greater emerging opportunity program impact:



- Move markets faster through voluntary adoption of EOs into programs across the US and Canada
- Set the binational program agenda

NEEA Represents ALL RETAC Members Through:

Expected Annual Commitments:

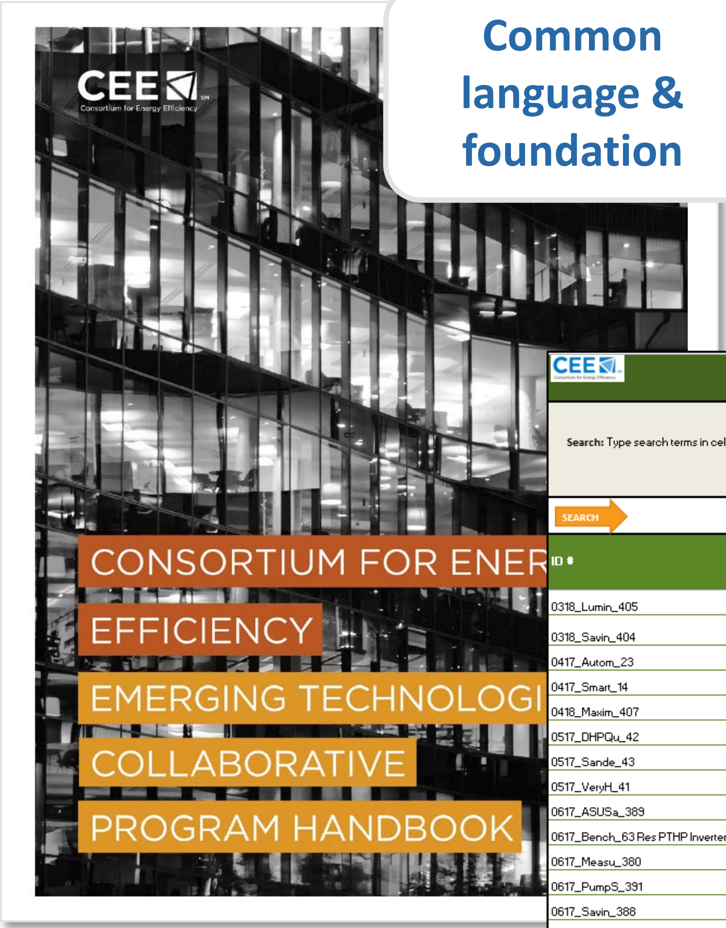
- Attend Quarterly ETC Advisory Committee meetings.
- Act as liaison to identify the right people at your organization to participate, as appropriate.
- Update EO Catalog with assessment data:
  - Provide new assessment information related to your organization's programs, projects, and pilots.
  - Update any assessment data that your organization had previously submitted to the EO Catalog.

NEEA Represents ALL RETAC Members Through (ctd):

Annual Activities:

- Nominate opportunities for additional ETC EO consideration.
- Contribute to Roundtable Discussion calls of EOs considered for research for that year.
- Participate on Working Group calls for extended research.
- Contribute to Spotlight Roundtable discussions.
- Other meetings (e.g., related to the prioritization process, catalog framework revisions, or orientation).

Established, Maintained Infrastructure



Common language & foundation

ETC Catalog: Platform to leverage research and to connect on opportunities

Emerging Opportunity Prioritization

2024 Catalog of Emerging Opportunities Assessments

Emerging Opportunities Assessments

Search: Type search terms in cell B4 and hit enter. Records with matching text will be highlighted. Sort by highlighting to move them to the top (select the dropdown arrow next to Assessment Name > Filter by Color > select highlight).

SEARCH

ID #	Assessment Name	Contact Name	Email Address	Phone Number	Date Added to Catalog	Date Updated in Catalog	Contributor's Assessment ID#	Fo Ar Di Im
0318_Lumin_405	Luminaire Level Lighting and HVAC Proof of Concept Study	Chris Wolgamott	cwolgamott@neea.org	503-688-5484	5/18/2018	5/31/2023		Di
0318_Savin_404	Savings Estimate Switch Reluctance Motor	Mark Rehley	mrehley@neea.org	+1 (503) 68854	5/18/2018	5/31/2023		Di
0417_Autom_23	Automated Measurement and Verification	Nick Leritz	nleritz@neea.org	541-688-5455	5/18/2018	4/3/2018		
0417_Smart_14	Smart Residential Thermostats Indoor Temperature Baseline Study	Janice Peterson	jcpeterson@bpa.gov	(503) 230-3543	1/1/2017	5/3/2023		Di
0418_Maxim_407	Maximizing Mini-Split Heat Pump Performance	Christopher Dymo	cdymond@neea.org	503-688-5454	5/18/2018	5/31/2023		Di
0517_DHPQu_42	Ductless Heat Pump (DHP) Quick Connect pilot	Christopher Dymo	cdymond@neea.org	503-688-5454	5/18/2018	5/1/2019		Di
0517_Sande_43	Combo Water and Space Heat - CO2: Sanden Eco Runo demonstration project	Christopher Dymo	cdymond@neea.org	503-688-5454	1/1/2017	5/3/2023		Di
0517_VeryH_41	Very High Efficiency Dedicated Outdoor Air System (VHEDOAS) pilot projects	Jeff Rigotti	jrigotti@neea.org	503-688-5494	5/18/2018	5/3/2023		Di
0617_ASUSa_389	Air Saver Unit (ASU) Savings Validation	Geoff Wickes	gwickes@neea.org	503.688.5456	1/1/2017	5/31/2023		Di
0617_Bench_63 Res PTHP Inverter Driven Bench Test 2017	Bench Test for Inverter Driven Package Terminal Heat Pump	Robert Weber	rmweber@bpa.gov	206.220.6783	1/1/2018	3/8/2017		Di
0617_Measu_380	Measure Development Study for Extended Motor Products Labeling Initiative (EMPLI) for Pumps in	Erin Hope	ethope@bpa.gov	509-822-4587	5/18/2018	4/5/2018		Di
0617_PumpS_391	Pump System Assessment Professional Assessment	Shouka Darvishi	sdarvishi@neea.org		1/1/2017	5/3/2023		
0617_Savin_388	Extended Motor Products: Savings validation for "planned" unit energy savings (UES) numbers by	Geoff Wickes	gwickes@neea.org	503.688.5456	1/1/2017	5/31/2023		Di
0617_Super_390	Super Efficient Dryers Field and Lab Testing	Christopher Dymo	cdymond@neea.org	503-688-5454	1/1/2017	5/1/2019		Di
0717_HopeW_392	Hope Works Station	Rob Marks	rlmarks@snopud.com	(425) 783-8169	5/18/2018	4/3/2018		Di
0717_Water_393	Waterfront Place Apartments	Rob Marks	rlmarks@snopud.com	(425) 783-8169	5/18/2018	4/3/2018		Di
0917_UHDTV_394	Ultra High Definition (UHD) TV Test Procedure/Clip and ENERGY STAR Specification	Rajeev Kotha			5/18/2018	5/3/2023		Di
1	EERD: Trumbly Residential Geothermal Ground Loop, Heat Pump & Desuperheater (ET13SMUD10	Owen Howlett	owen.howlett@smud.org	(916) 732 7156	11/1/2011	2/16/2018		Di

TOC | Background | Terms of Use | Benefits and Use | Tech Tips | Limitations | Categorization Criteria | Search Terms Index | Public Databases | Assessment Data | UniqueEOs

Guide to ETC Projects and Processes

2021

CEE
Consortium for Energy Efficiency

For information, contact:
Adam Cornelius, Senior Program Manager
Emerging Technologies Collaborative
acornelius@cee1.org
510-388-4748

Consortium for Energy Efficiency
35 Village Road
Middleton, MA 01949

Annual Reports

Preliminary Research Reports

PRELIMINARY RESEARCH REPORT: NEXT GENERATION HEAT PUMPS

STAFF RATED SCORECARD (SUMMER 2020)

Definition • This opportunity encompasses air source heat pumps (ASHPs) that are able to achieve very high efficiency levels. Most of these technologies are coming out of Europe and Asia and are not yet available in North America at scale. These systems typically have high heating capacity at lower outdoor temperatures, variable capacity operation, and built in diagnostics.	**Potential Program Value: Medium** • Energy Efficiency Potential: Medium • Utility System Benefits: Medium • Nonenergy Benefits: Positive **Timeline: Mid Term** • Technology: Demo • Market: Enabled • Program: Emerging **ETC Sponsor Interest: Medium**
Related CEE Committee Work: • CEE is currently working to revise the Residential Heating and Cooling Systems Initiative, which will include some emerging aspects of ASHPs (variable capacity, low-ambient performance, gas heat pumps, and customized equipment selection).	

STAFF RECOMMENDATION

Based on the research conducted over the last month, CEE staff believes that next generation heat pumps may be a good candidate for the ETC to dedicate additional resources to advance at this time. Anecdotal information indicates that "next generation" heat pumps are able to achieve extremely high efficiency levels, but there is currently inadequate in-field data to support this claim, and many next generation technologies are unsupported in the US and Canada. There is, however, broad interest in new heat pump technologies, and various CEE members are in the process of installing "next generation" systems in their service territories to better understand performance. CEE is well positioned to assess preliminary findings from these installations when data becomes available. Advanced ASHPs are primarily coming out of Europe and Japan, and efforts are under way to better understand what drives high performance in these markets. Until more information is made available and greater commitment is made to support products installed in North America, it is not clear what market leverage points energy programs can influence together to accelerate commercialization and adoption of emerging ASHP technologies. Significant questions related to affordability, technical performance, and program design also remain.

POTENTIAL PROGRAM VALUE: MEDIUM

Extended Research Reports

Residential Integrated HVAC Controls

Opportunity Overview, Technology Status, Market Barriers, and Development Needs

CEE Consortium for Energy Efficiency

For information, contact:
Chloe Mayhew
Program Assistant
cmayhew@cee1.org
978-972-5511
Consortium for Energy Efficiency
Ferncroft Corporate Center, 35 Village Road
Middleton, Massachusetts 01949
December 2020

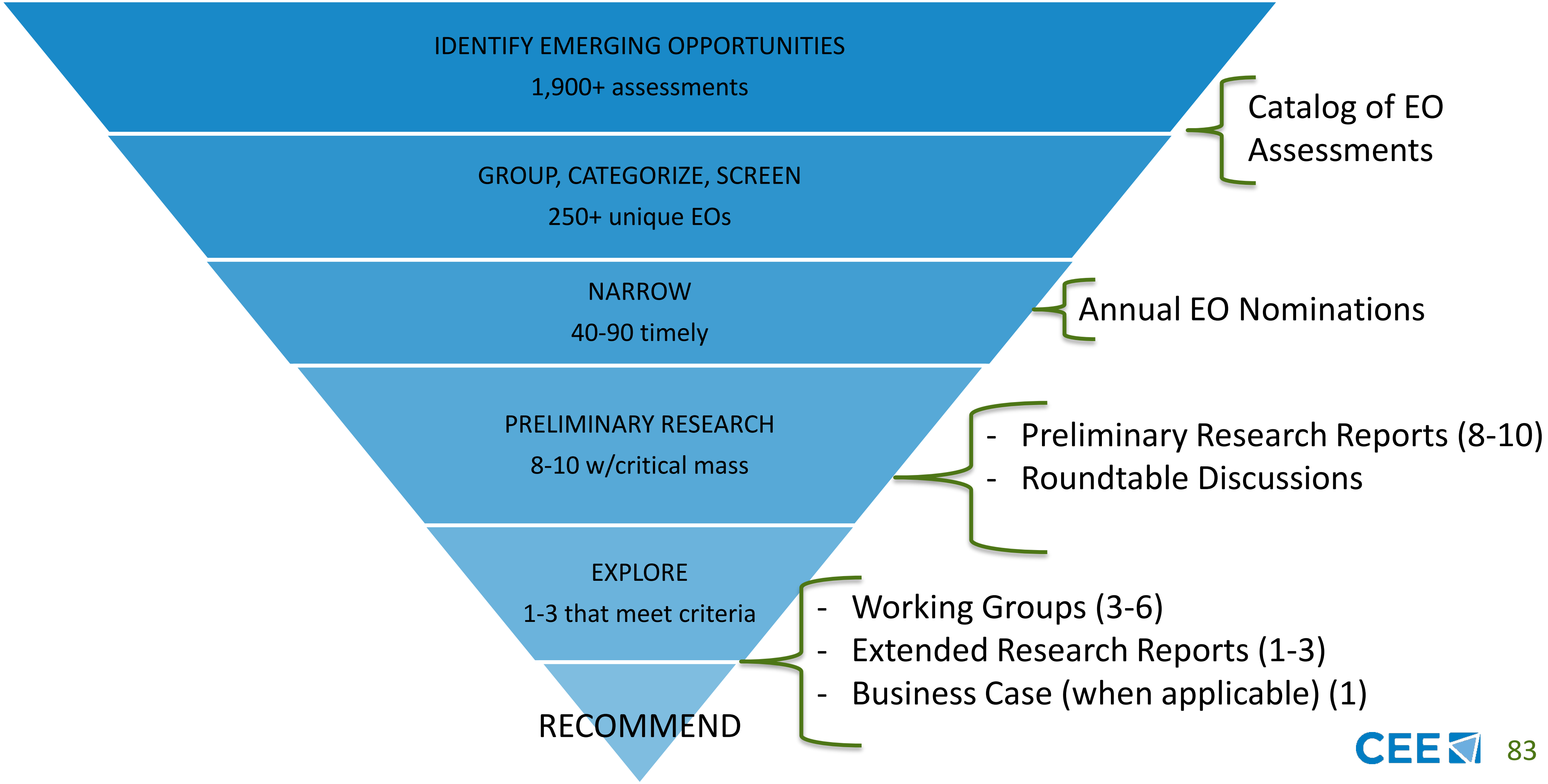
UPCOMING ETC REPORTS

- Split-system heat pump water heaters for multifamily buildings
- Load flexibility via smart panel solutions
- Dual fuel RTU controls with load flexibility
- Grid benefits for DR with variable speed heat pumps
- Thermal energy storage integrated water heaters
- Dual fuel water heating
- AI and building controls/building management
- Quality heat pump installation
- **Integrated residential HVAC controls (multi heating system)**
- Residential combination heat pumps (space conditioning + DHW)
- **Alternative form factor heat pumps**
- Luminaire-Level Lighting Controls (LLLCs) and integrated batteries for load management
- Stirling cycle engine heat pumps
- **Building envelope technologies: Prefabricated wall assemblies, high-performance windows**
- Commercial heat pump dryers

RECENTLY PUBLISHED ETC REPORTS

- Residential heat pump water heaters for multifamily buildings
- Data centers
- Phase change materials (thermal energy storage applications)
- Residential building envelope technologies
- Combi heat pumps (HVAC and water heating)
- High-temperature air-to-water heat pumps
- Induction cooktops
- Navigating the Low-GWP refrigerant landscape
- Secondary and high-performance windows
- Smart panels
- Variable speed heat pumps
- Thermal energy storage for industrial electrification
- AI-enabled building energy management software
- Industrial high-temperature heat pumps
- Residential deep energy retrofits

Stage-Gates: Multiple Levels of Investigation



UPCOMING REPORT: ROOM HEAT PUMPS

Different from mini-splits, central/ducted systems, and PTHPs

- Plug into a 120V outlet
- Can (theoretically) be installed without a certified HVAC technician or electrician
- Are capable of both heating and cooling
- Generally for less than 1,000 square feet


Best Use Cases

- LMI households
- Apartments / multifamily
- Older homes with inadequate panels or wiring, historic preservation concerns, asbestos/lead
- High-risk populations – immediate relief during heat waves

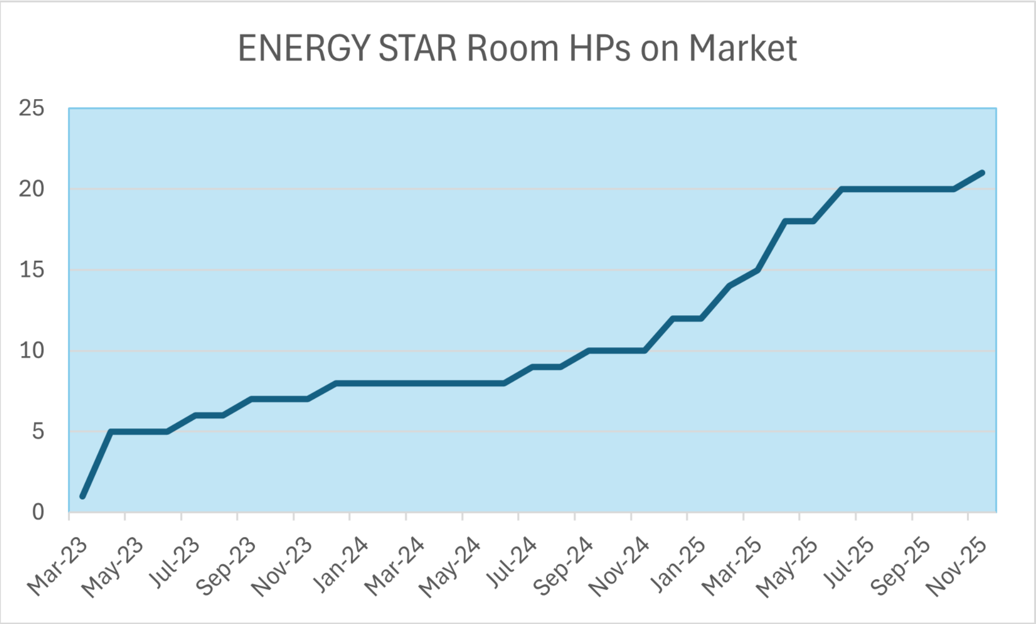
ROOM HEAT PUMPS: READY FOR EE PORTFOLIOS NOW

Good fit for:

- Fit for NW climate specifically
- Technology has rapidly matured in last few years →
- Can slot easily into existing programs
- Possible DR and electrification applications (not ideal)

But many considerations:

- Not all form factors are equal
    - *Portable = cheap and plentiful in market*
    - *Saddlebag = expansive and still tough to find*
- Self-installation is… mixed
- Not much cooling savings v/s traditional room Acs
- Biggest savings: moderate weather heating (esp v/s baseboards, fuel oil, propane, and other expensive / inefficient technologies)



Unusually rapid market growth for a new technology

IT IS A COMPLEX TECHNOLOGY MARKETPLACE

Room HPs: Portable HP, Window HP, Saddlebag HP

Competing technologies: Packaged Terminal HP, Vertical Stack HP, Portable AC, Room AC, Cold-Climate Mini-Split HP

Comparison of RHPs vs. PTHPs vs. Mini-Splits

Product Category	Avg. Cooling Efficiency	Capacity Range (Cooling / Heating at 47° F)	Cutoff Temperature	ENERGY STAR® Specification	Average Installed Cost	Market Maturity
Portable HP	CEER 8.2	12,000 / 11,000 BTU	35 to 40 °F (1 to 4 °C)	No	\$500-\$700	Mostly Mature
Window HP	CEER 14.1	12,000 / 10,000 BTU	30 to 40 °F (-1 to 4 °C)	Draft V6/7	\$500-\$800	Early Market
Saddlebag HP	CEER 17.4	10,000 / 9,500 BTU	-5 F to 5 °F (-20 to –15 ° C)	Draft V6/7	\$2,500-\$3,500	Emerging / Early Market
Packaged Terminal HP	CEER 10.8	9,000-15,000 / 10,000-16,500 BTU	20 to 30 °F (-6 to -1 °C)	Yes	\$4,500	Mature
Vertical Stack HP	EER 11.2	12,000-27,000 / 12,500-32,000 BTU	10 to 20 °F (-12 to -6 °C)	N/A	\$9,000	Mature
Portable AC	CEER 7.6	10,000 BTU / N/A	N/A	Yes	\$200	Mature
Room AC	CEER 11.2	11,000 BTU / N/A	N/A	Yes	\$200	Mature
Cold-Climate Mini-Split HP	SEER2 17-25	6,000-32,000 BTU	-15 to -5 °F (-26 to -20 °C)	Yes	\$12,000-\$14,000	Mature

CEE IS WORKING TO DEVELOP PROGRAM TOOLS

CEE Room Heat Pump Specification						
Tier	CEER	HEER	COP at 17°F	COP at 5°F	Defrost	Capacity Ratio
CEE Tier 1	≥ 13.2	≥ 5.8	N/A	N/A	Passive	N/A
CEE Tier 2	≥ 14.4	≥ 7.0	≥ 1.75	N/A	Active	≥ 70% at 17°F v/s 47°F
CEE Advanced Tier	≥ 15.1	≥ 8.5	N/A	≥ 1.75	Active	≥ 70% at 5°F v/s 47°F

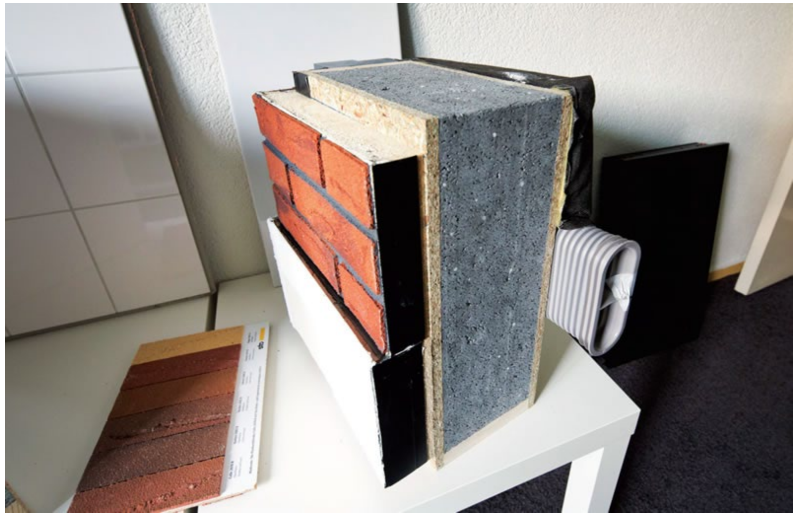
For context there are CEE specification levels for competing technologies: room air conditioners and mini-split heat pumps

CEE Room Air Conditioner and Mini-Split Specifications						
Tech/Tier	CEER	SEER2	EER2	HSPF2	COP at 5°F	Capacity Ratio
CEE RAC Tier 1	≥ 12.1	≥ 5.8	N/A	N/A	N/A	N/A
CEE RAC Tier 2	≥ 14.85	≥ 7.0	≥ 1.75	N/A	N/A	≥ 70% at 17°F/47°F
CEE Mini-Split HP Tier 1 (Path A)	N/A	≥ 16.0	≥ 9.8	≥ 8.5	≥ 1.75	≥ 65% at 5°F /47°F
CEE Mini-Split HP Tier 1 (Path B)	N/A	≥ 16.0	≥ 11.0	≥ 8.0	≥ 1.75	≥50% at 5°F /47°F

EMERGING TECHNOLOGY HIGHLIGHTS FROM OUR SUMMER MEETING

CEE

Rethinking Deep Energy Retrofits: Exterior Insulated Cladding



Sources: Byggmeister (2009), Neuhauser (2011), PNNL (2022), Wotzak (2009)

Digitizing Exterior Wall Insulation Retrofits

Client: DOE Advanced Building Construction Initiative (DOE-ABC), MassCEC

Partners: Boston Housing Authority, Green Building Alliance, Progressive Foam, Rising Tide Partners, VEIC

Opportunity: Exterior wall insulation retrofits reduce space heating by 21-36%

Challenge:

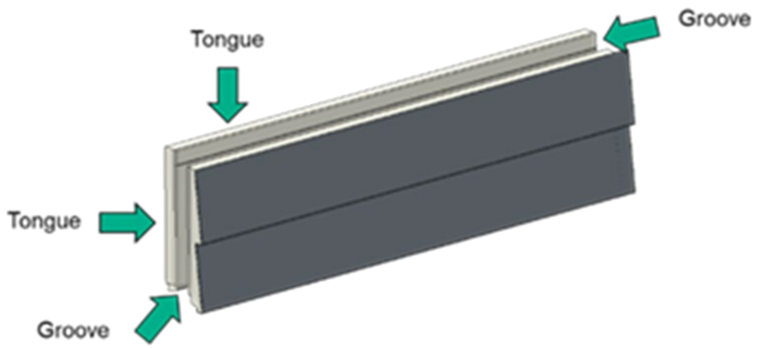
- Walls = most challenging aspect of deep energy retrofits
- Current approaches are time- and labor-intensive, hence costly and disruptive
- Workers custom-cut insulation to fit wall penetrations, build extension boxes for windows, cut and apply air and vapor barriers and sealants, tape insulation joints, etc.
- State-of-the-art *incremental* cost ~$20+/ft^2 of wall area circa 2020 = Negligible uptake

Solution:

- Re-engineering the entire process to achieve $10/ft^2 and installation in ≤5 days
- Apply digital processes to greatly reduce site work, worker skill required, and installation time and cost.

Sources: Byggmeister (2009), Neuhauser (2011), PNNL (2022), Wotzak (2009)

Our Solution: The insulated panel block (PB)



- ~4” exterior polyiso insulation
- Integral factory-applied cladding
- Currently vinyl siding
- Potentially: Stucco, thermally modified wood, ma
- Installs over existing siding
- Tongue-and-groove feature to manage water anc
- Weighs <5 pounds

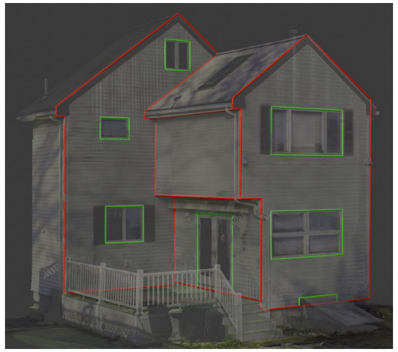
Image Sources: Fraunhofer USA.

Development Focus: Scalable Wall Retrofit Process

1.

Use Standard (~4'x1') Lightweight Insulated Panel Blocks (PB) with integral cladding = +R-24

2.



Laser Scanning and Processing yields

Façade BIM, identifies features + edges within ±3-6 mm

3.

Panelization

Algorithm Determines Optimal Wall PB Set for a Home

Outcomes:

- Reduce wall-driven HVAC loads by 70-85%
- Installed cost ~$10-12/ft^2 at volume
- Installation time ≤5 days
- Reclads with superinsulated vinyl siding at similar cost as uninsulated vinyl siding

4.

Façade CAD File Feeds CNC PB Fabrication and Kitting Process

5.

Augmented Reality (AR) Assist for On-site Install over existing cladding

Image Sources: Fraunhofer UISA, QYPC, UMN.

Augmented reality is a major innovation in this space

Image Sources: Fraunhofer USA.

DUAL FUEL HEAT PUMP WATER HEATERS

GTI ENERGY

solutions that transform

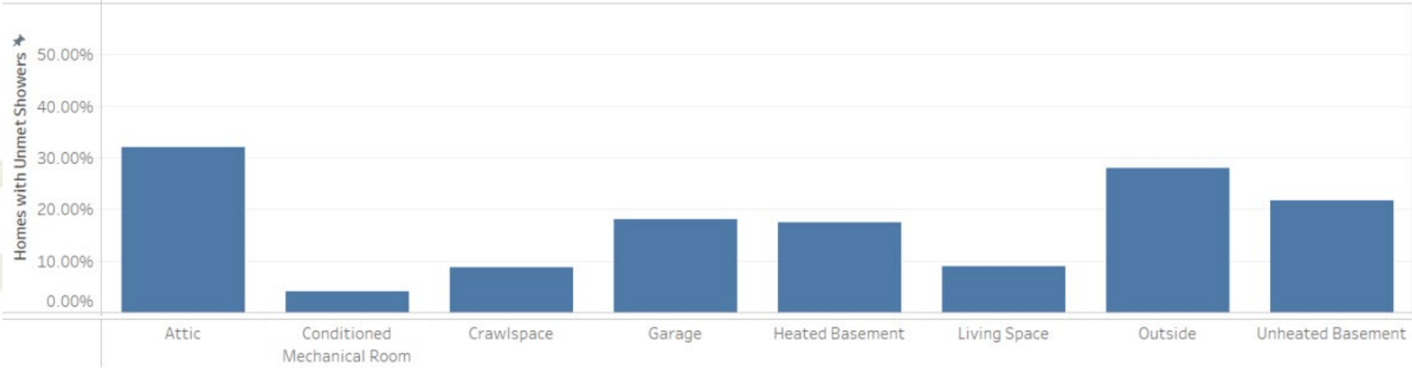
DUAL FUEL HEAT PUMP WATER HEATER-
WHY DUAL-FUEL 120V WATER HEATERS?

- Dual-Fuel water heating potential benefits:
  - Energy efficiency
  - Operating cost
  - Emissions reduction
  - Grid flexibility
  - *Seamless comfort ?*
  - *Installation cost and barriers ?*
  - *Easy market transformation ?*

Lab tests (Energy efficiency, Operating cost, Emissions reduction, Grid flexibility)

Field pilots (Seamless comfort, Installation cost and barriers, Easy market transformation)

Homes with Unmet Showers by Installation Location – 120V HPWH



Maguire, Liu, and Fry. "National Simulation Analysis of 120V Heat Pump Water Heaters" 2025 ACEEE Hot Water Forum. Portland, OR

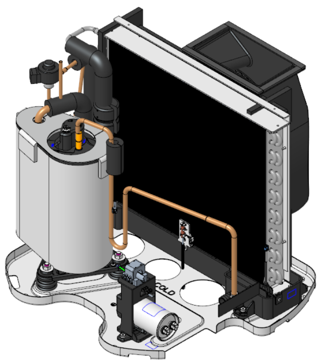
Emerging Product Category

Navien dual-fuel hybrid WH
Q3 2026

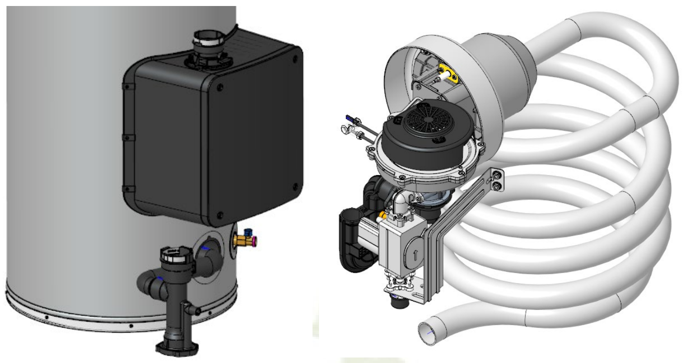
Rheem dual-fuel hybrid WH
~2027

NAVIEN DUAL FUEL HEAT PUMP CONTROLS

Electric Heat Pump



Natural Gas Heating



Operating Modes	120V Plug-in heat pump with condensing gas backup
E-Saver (default)	**Hybrid mode** with heat pump primary heat source; gas back-up for fast recovery.
Hi-Dem	Prioritizes faster hot water recovery for larger volume users.
Gas only	Can be set to gas-only. Fast recovery time with minimal electric usage
Heat Pump only	Maximum energy savings using only the heat pump. Results in longer recovery times.
Future Controls (in Development)	
Demand Response	**Will switch to gas mode during demand response events, turning off heat pump while maintaining hot water (in-development)**
Time of Use (TOU cost-saver)	Switches between heat pump and gas operation based on time of use or real-time energy costs.
Intelligent Tank Heating	Use of an intelligent algorithm to learn user's hot water usage patterns and reduce energy consumption

Laboratory Research Sponsors:

ICF

APGA RESEARCH FOUNDATION

SoCalGas

SEMCO

neea

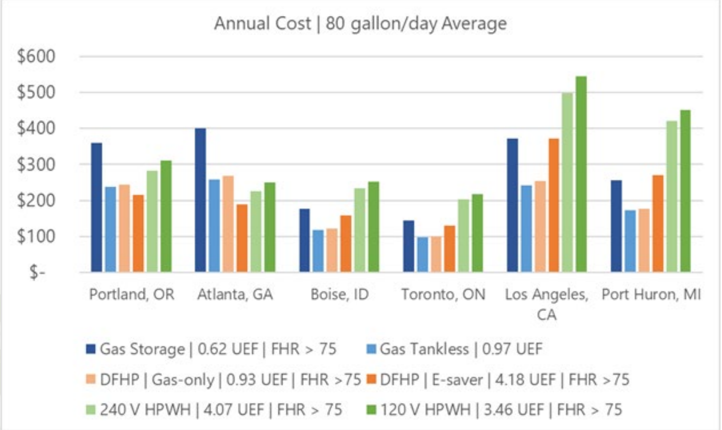
ENBRIDGE

DUAL FUEL HEAT PUMP–TESTING AND ANALYSIS

- Test results compared to those from certification testing.
- GTI testing used for comparison, validation and basis for extended performance and load-based testing.
- **FHR and UEF testing in close agreement with CSA results**
- *GTI developed a detailed operating map of unit performance under operating modes, including ... to ... eff*

Performance Testing, 60 kBtu/h unit	CSA Testing	GTI Energy Testing
Gas-Only Mode		
FHR (gal)	99.7	98.2
UEF	0.929	0.928
Recovery Efficiency	1.02	1.0
E-saver (Default Mode)		
FHR	99.7	98.2
UEF	3.82	3.79
Recovery Efficiency	4.15	4.18

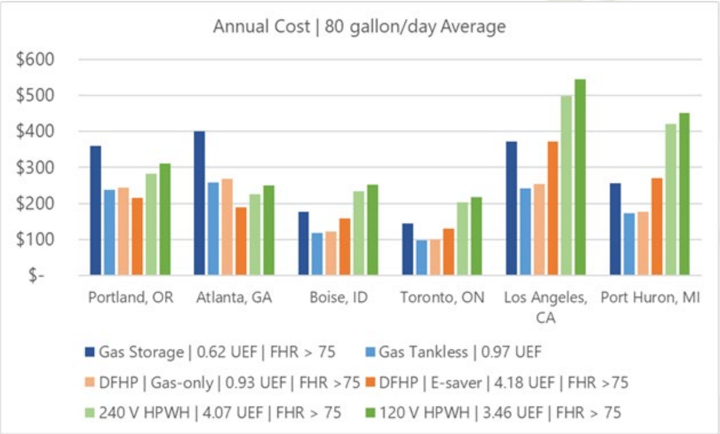
This item was tested for performance by CSA Group's Testing Services. Report# 80273494, 2025 **CSA Certification** expected by July 1, 2026

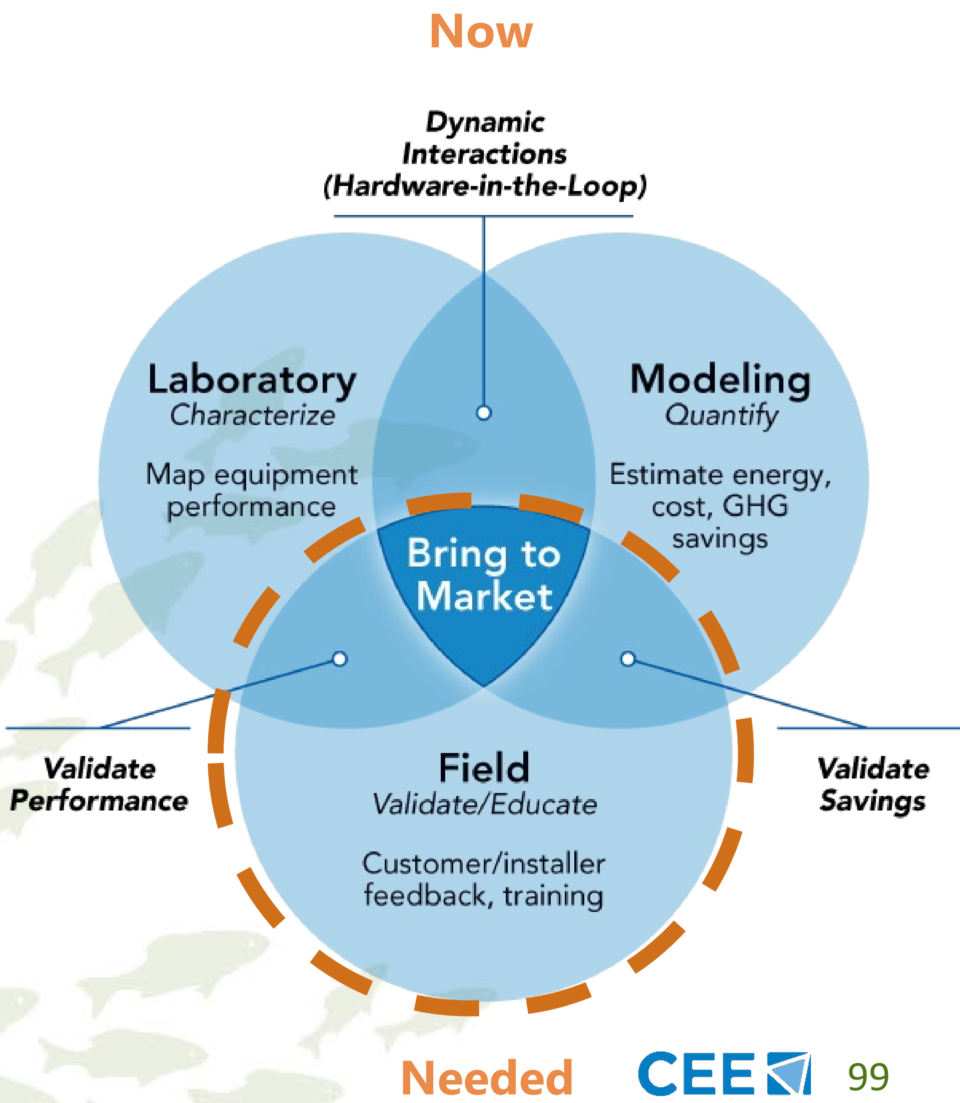


DUAL FUEL HEAT PUMP WATER HEATER- NEXT STEPS

Pilot Research Questions:

- Installation experience?
- How do location and control modes respond to various hot water usage draw patterns?
- Operating costs, DR potential?





QUESTIONS + DISCUSSION?

CEE

CONTACT

Spencer Sator
Principal, Emerging Technology
ssator@cee1.org
720.415.5470

UPCOMING CEE MEETINGS

Industry Partners Meeting
Portland, OR
September 16-17, 2026
CEE Members and Invited Industry Guests

Winter Program Meeting
Los Angles, CA
January 13-14, 2027
CEE Members Only

CEE

Open Discussion/ Q&A

Thank You!