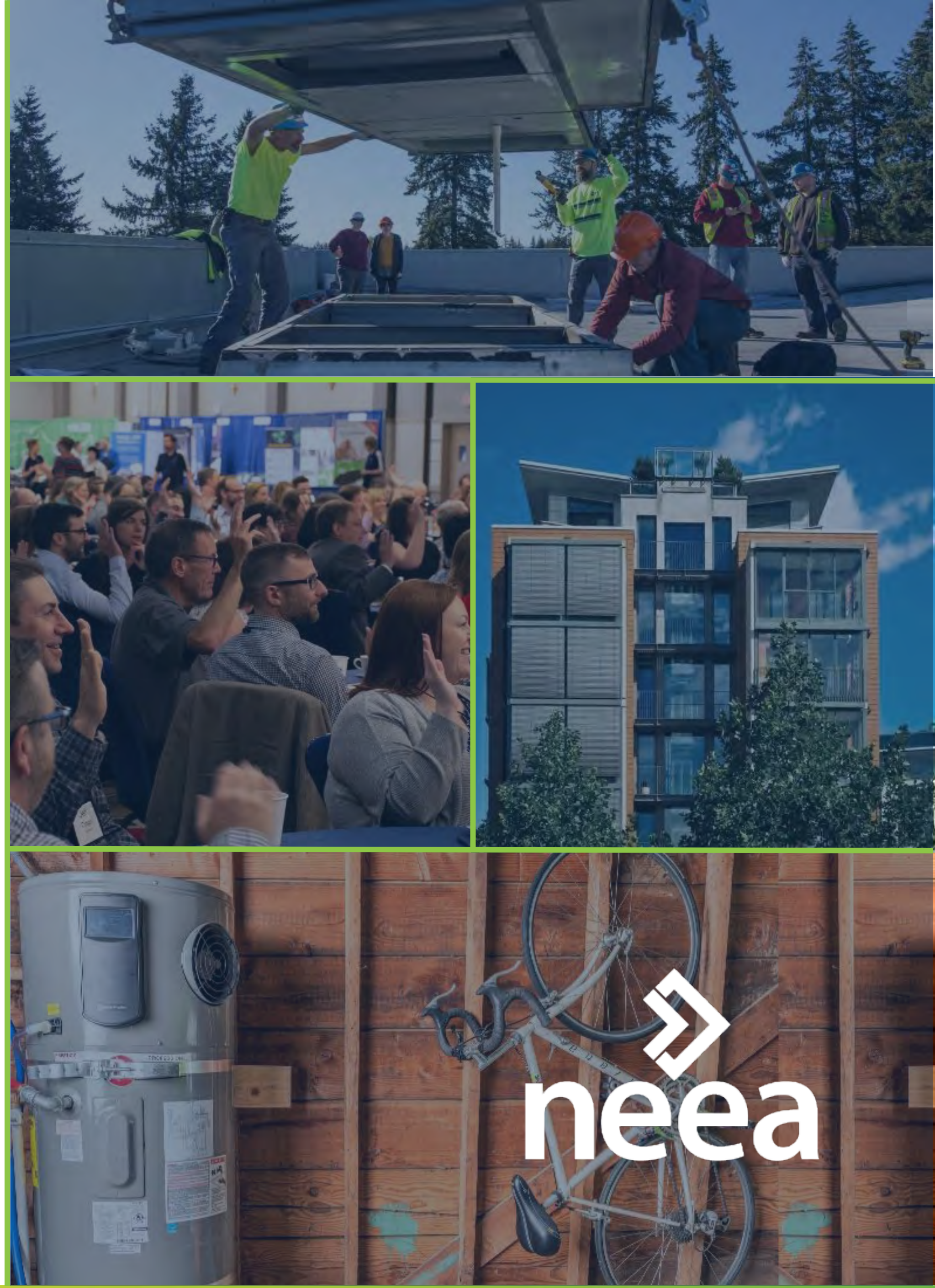
Regional Emerging Technology Advisory Committee (RETAC)

Northwest Energy Efficiency Alliance

Q3 2023 Meeting

September 21, 2023

9:00am – 12:30pm

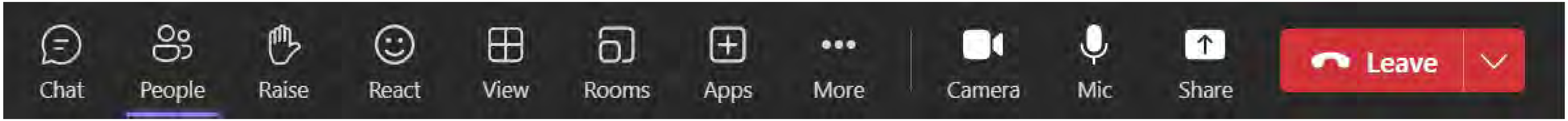


CLASSIFICATION LEVEL: PUBLIC

Navigating MS Teams Layout

Raise Hand

Camera &
Microphone



Chat

Exit Call

Note: These options may vary, depending on which version you're using.

Name,

Title,

Organization

and …

What commercial jingle or bit of advertising has stuck with you all these years?

Agenda

9:00 am	Welcome
9:30 am	*New!* EPRI Emerging Technology Update
11:30 am	*Break*
11:40 am	Announcements
11:55 am	*New!* Heat Pump Update
12:25 pm	Wrap-Up

EPRI Emerging Technology Update

EPRI OVERVIEW

Presentation to RETAC Members

Ammi Amarnath
Principal Technical Executive

Q3 2023 RETAC Meeting
September 21, 2023

What is EPRI?


"All the News That's Fit to Print"

The New York Times.

LATE CITY EDITION

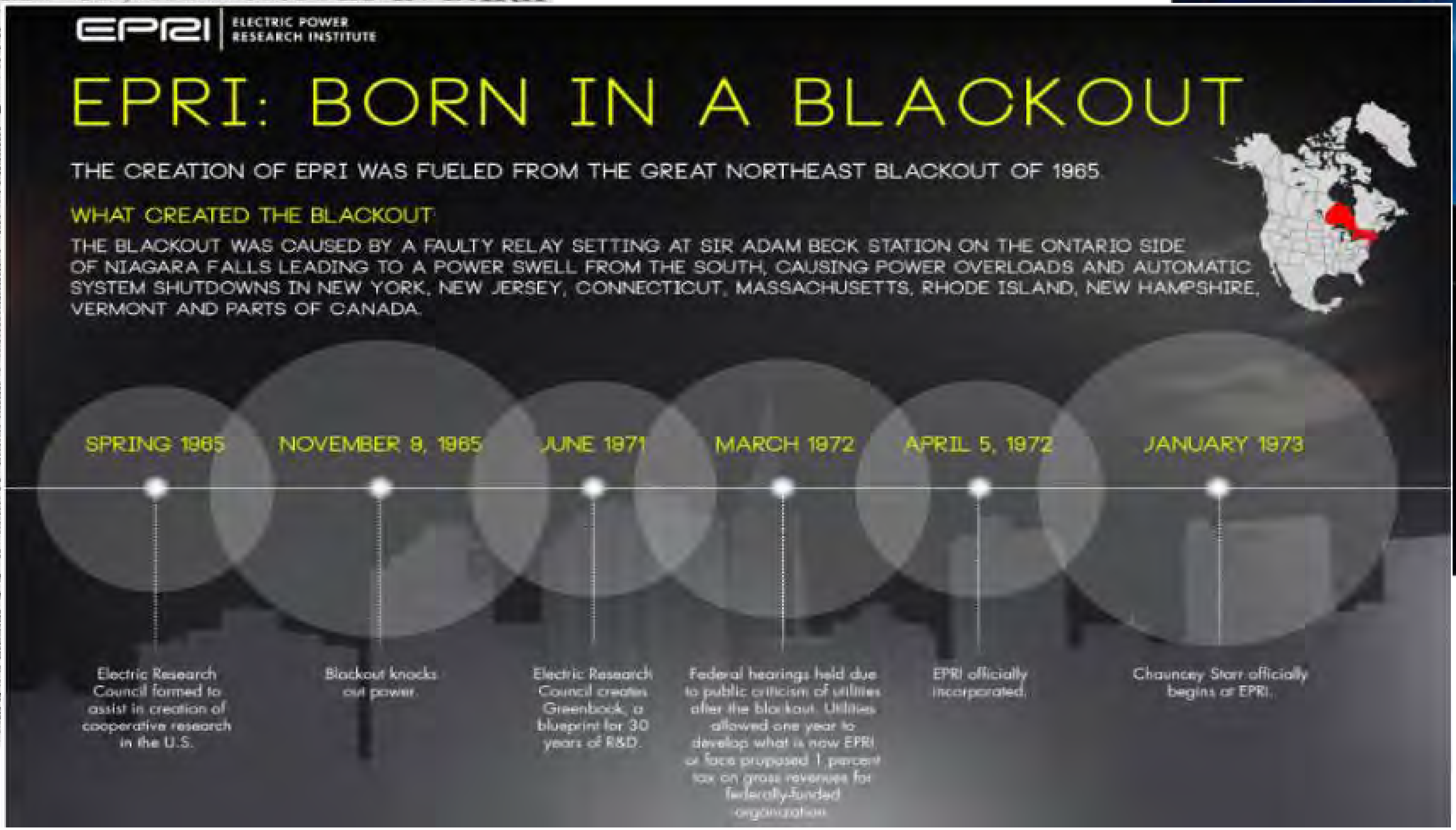
POWER FAILURE SNARLS NORTHEAST;
800,000 ARE CAUGHT IN SUBWAYS HERE;
AUTOS TIED UP, CITY GROPES IN DARK

To Our Readers

Johnson Restates
Goals in Vietna

G.I.'s Score
Big Victory

Man, 22, Immolate
In Antiwar P



Three Key Aspects of EPRI

Collaborative

Bring together scientists, engineers, academic researchers, and industry experts

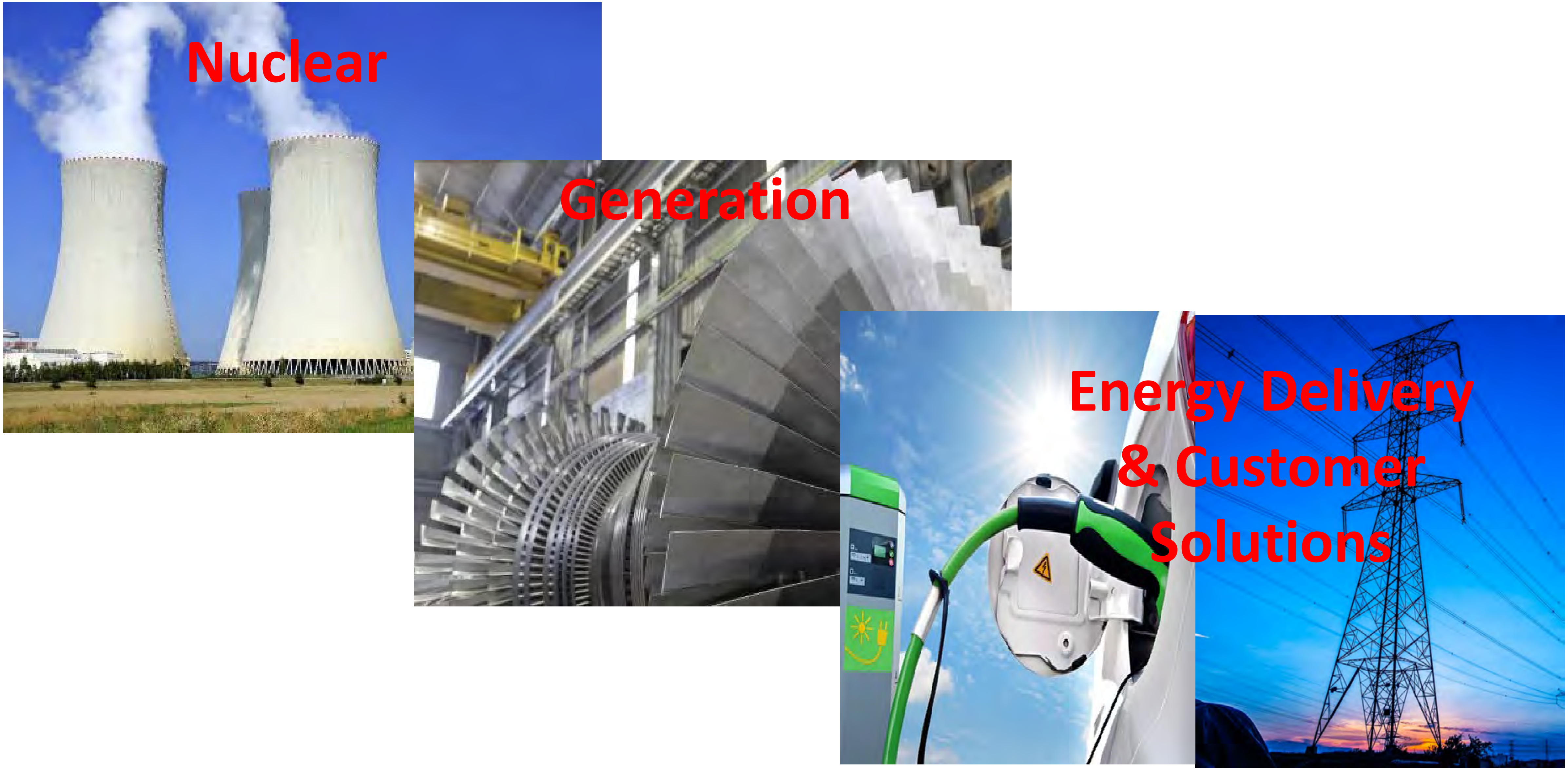
Independent

Objective, scientifically based results address reliability, efficiency, affordability, health, safety, and the environment

Nonprofit

Chartered to serve the public benefit

EPRI R&D Spans the Entire Electric Industry



Some Cross-Cutting Strategic Research Areas

EPRI Research & Development

TECHNOLOGY INNOVATION

Driving thought leadership, advanced R&D, and technology scouting and incubation to sustain a full pipeline of solutions

Nuclear Power

Energy Supply and Low-Carbon Resources

Electrification and Sustainable Energy Strategy

Transmission and Distribution Infrastructure

Integrated Grid and Energy Services

STRATEGIC RESEARCH

- Low-Carbon Resources
- End-Use/ Economy-Wide Carbon Reduction
- Electric System Reliability/Resilience
- Electric System Flexibility
- Market Transformation/ Policy/Regulatory Education

EPRI Accelerates Technology Advancement

LABORATORIES AND UNIVERSITIES

Basic research and development

SUPPLIERS AND VENDORS

Technology commercialization

EPRI

Collaborative technology development, integration, and application

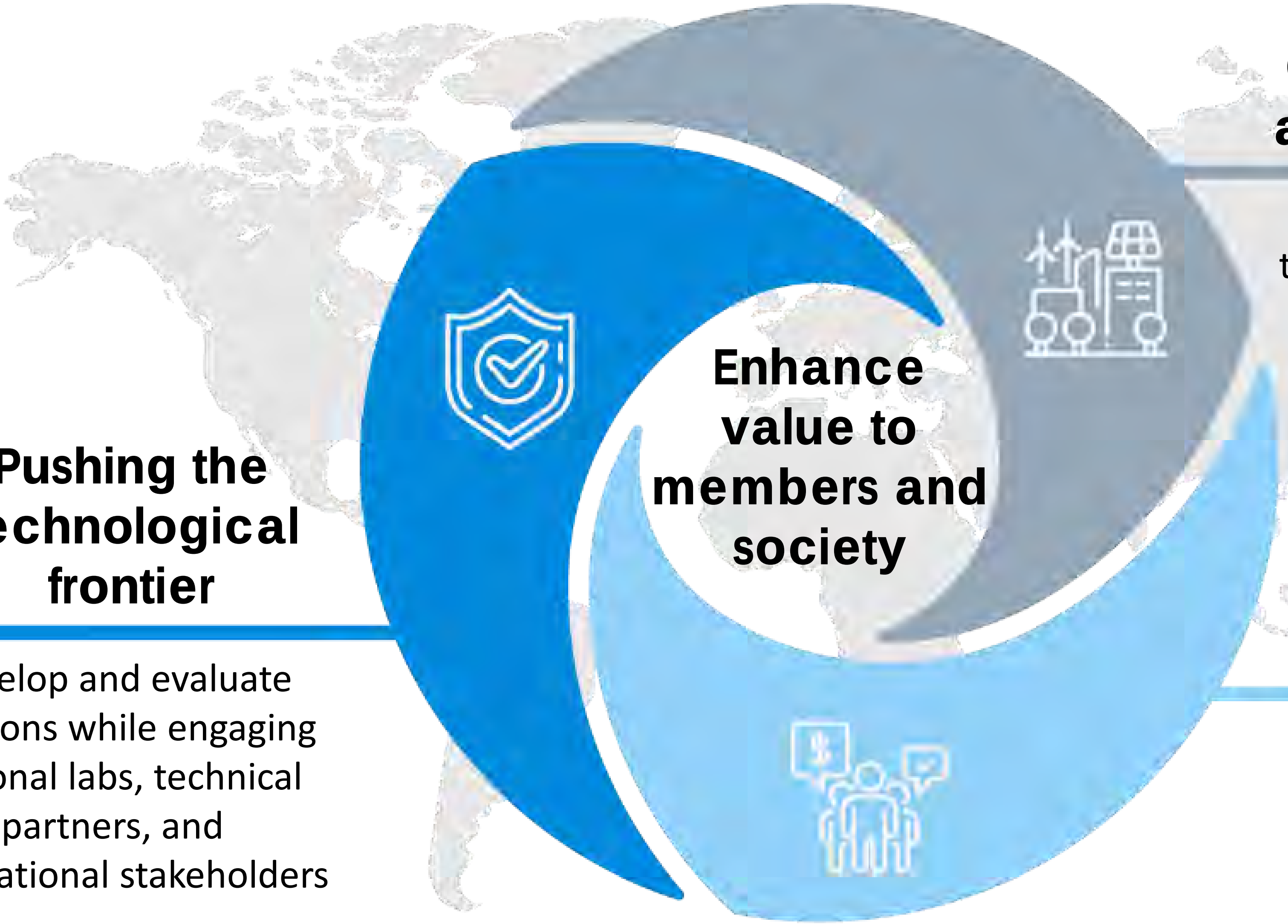
Thought leadership illuminates emerging developments, opportunities, and trends.

Technology Innovation Scouting searches globally for emerging technologies and concepts to provide insights on industry challenges and solutions.

Sector R&D conducts research and demonstrations to address challenges, deploy results, and provide supporting services for existing and emerging technologies.

EPRI stimulates innovation and plays a key role in validating technology across multiple utilities, fostering widespread acceptance, and helping accelerate technology to commercial development and industry adoption

EPRI's Role



Guiding climate and grid strategy

Economy-wide modeling to optimize sustainability, reliability, and resiliency solutions

Pushing the technological frontier

Develop and evaluate solutions while engaging national labs, technical partners, and international stakeholders

A trusted source of information

Industry, lawmakers, policymakers, thought leaders, regulators, financial community

Energy Delivery & Customer Solutions

From Generator Bus Bar to End Use

Transmission, Substations and Grid Operations

Distribution

Electrification & Customer Solutions

Distributed Energy Resources

Information, Communication, and Cyber Security

R&D Collaboration (DOE, EU, Universities, Labs, etc.) → **Application of Results- Demonstrations, Training, etc.** → **Commercialization, Transformation, Industry Guides, Standards**

Coordinated Research | **Tech Transfer** | **Change the Practice**

Global Thought Leadership for R&D in Energy Delivery and Customer Solutions

Strong Collaborative with Hundreds of Members

Resources (Laboratories, Technical Staff) as Extensions of our Member's Staff

2023 Energy Delivery & Customer Solutions Portfolio (Programs)

Transmission & Substations

- 34 Transmission Asset Analytics
- 35 Overhead Transmission
- 36 Underground Transmission
- 37 Substations

Transmission Operations & Planning

- 39 Grid Operations
- 40 Grid Planning
- 173 Bulk Electric System Renewable Integration

Information, Communication & Cyber Security

- 161 Information & Communication Technology
- 183 Cyber Security of Power Delivery & Utilization

Electrification & Customer Solutions

- 1 Power Quality
- 18 Electric Transportation
- 170 Customer Technologies
- 182 Customer Insights
- 199 Electrification
- 204 Advanced Buildings

Distribution

- 94 Energy Storage & Distributed Generation
- 174 Integration of Distributed Energy Resources
- 180 Distribution Systems
- 197 Environmental Aspects of Fueled Distributed Generation & Energy Storage
- 200 Distribution Operations & Planning

T&D Environmental Impacts

- 51 Transmission & Distribution: Environmental Issues
- 60 Electric and Magnetic Fields and Radio-Frequency Health Assessment and Safety

**Energy Systems & Climate Analysis*

- 178 Resource Planning for Electric Power Systems
- 201 Energy, Environmental, and Climate Policy Analysis

**Sustainability & Ecosystem Stewardship*

- 55 Ecosystem Risk & Resiliency
- 195 Endangered & Protected Species
- 198 Strategic Sustainability Science

**Worker & Community Health and Safety*

- 62 Occupational Health & Safety

**Programs migrated from the Energy & Environment Sector*

Unique and Valuable – Cutting Edge Capabilities

CHARLOTTE

- Non-Destructive Evaluation
- Welding Technologies
- High Temperature Splice Testing
- Corrosion and Materials
- T&D Component Aging
- T&D Sensor Development

LENOX

- High Voltage Testing
- Full Scale Component Aging
- Stray Voltage Detection and Mitigation
- Manhole Events

KNOXVILLE

- Energy Efficiency
- System Compatibility
- Electro Magnetic Compatibility
- Distributed Resources Integration

2023 Energy Delivery & Customer Solutions Programs

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34 Transmission Asset Analytics
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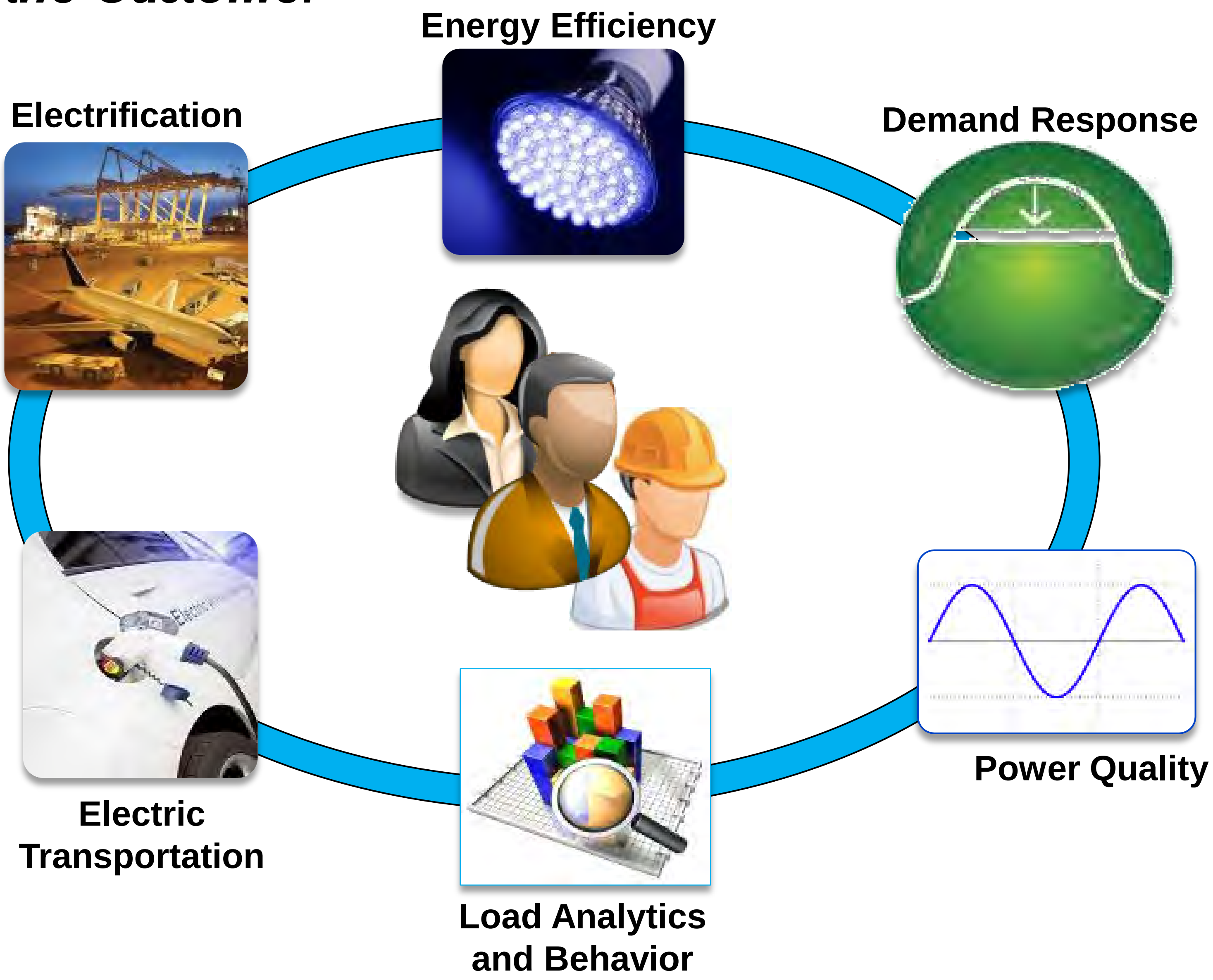
Electrification & Customer Solutions Research Area

Revolving Around the Customer



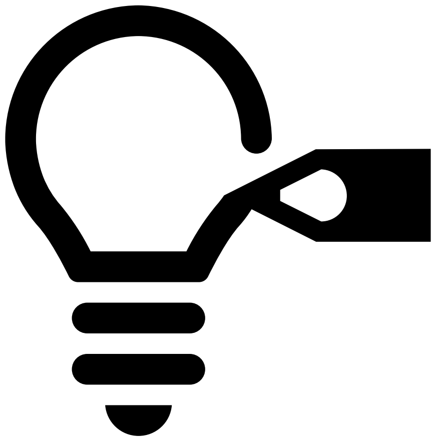
EPRI Laboratory in Knoxville

Smart Grid – Efficiency – Renewables – Storage – Cyber Security

Program 170: All Aspects of End Use Customer Technologies

How can advances in end use customer technologies be applied most effectively for:

- Demand response
- Efficiency
- Load flexibility
- Resiliency
- Electrification
- Carbon reduction
- Generation integration
- Business opportunities
- Customer productivity



Characterize and quantify the impact

Collaborate with other programs (Storage, Electrification…)

Program 170 – Grid-Edge Customer Technologies Structure

Project Sets for 2023

- **A** – Load Analytics and Grid Insights
- **D** – Technology Transfer and Education
- **E** – Efficiency and Decarbonization Evaluation
- **X** – Next-Gen Technologies and Demand Flexibility

Program 170 Lab Capabilities

EPRI Knoxville

Appliances & Plug Loads

- **Thermal System Lab** - controlled condition testing for HVAC, water heating, and refrigeration technologies
- **End Use Technology Lab** - evaluation of end use technologies within real world conditions, including communication and controls
- **Lighting Lab** - evaluation of full capabilities including spectral output, efficacy, lifetime, and control
- **Compatibility Lab** - evaluation of end use devices power quality performance, radiated and conducted emissions, and EMC / EMI characteristics
- All labs complement field evaluation sites

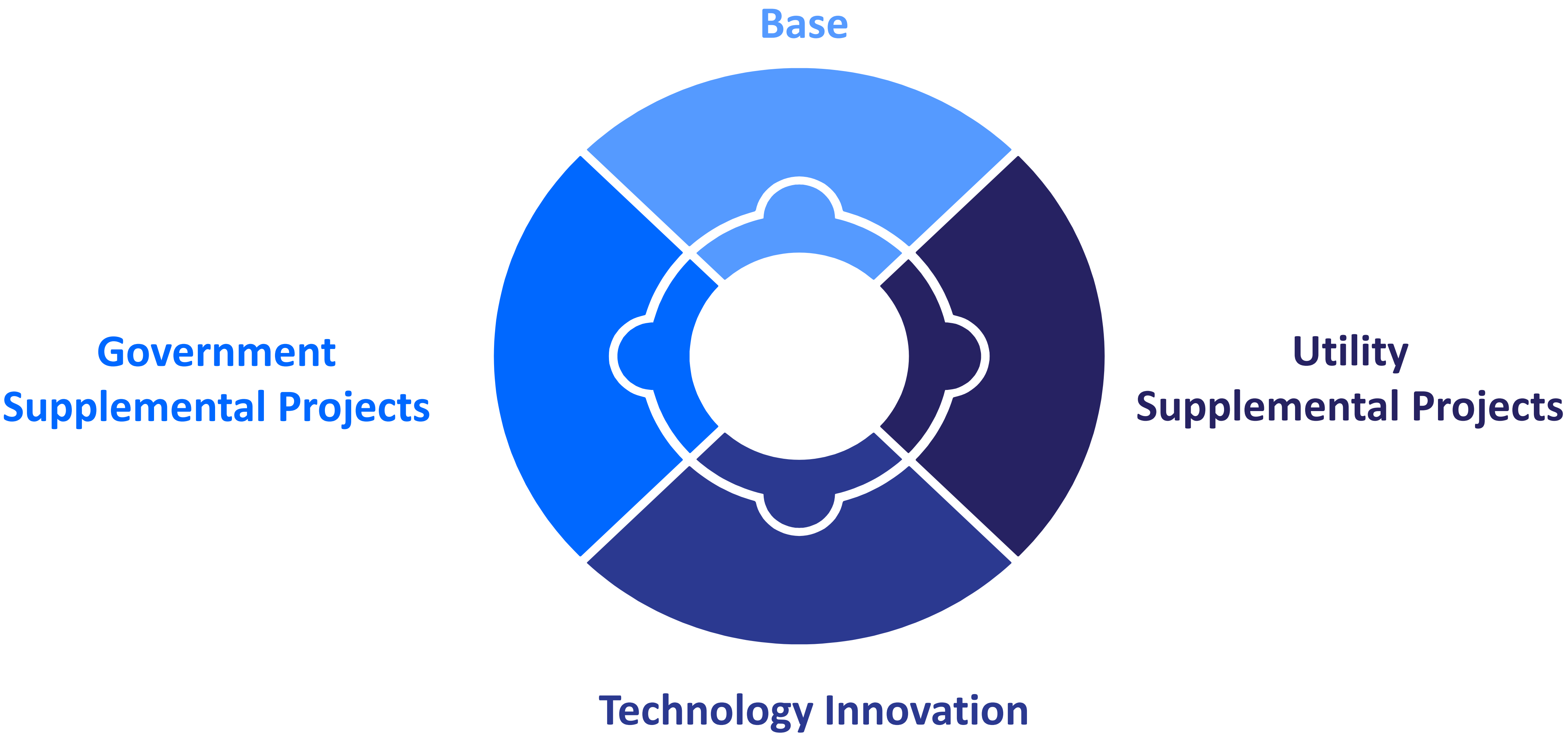
Lighting

Data Center

Load Disaggregation & Low Cost Sensors

Thermal

Program 170 Research



Program 170: Summary of Deliverables

2009-2020 Editions

Public Documents – Can be Downloaded from epri.com

Project Set Overview

Evaluation of technologies and systems to provide utilities with data and information to enlighten and enhance utility programs

P-Set 170E: Efficiency and Decarbonization Evaluation

Example Deliverables

- Affordable technologies for equitable decarbonization
- Advancement of cold-climate heat pumps
- Heat pumps for large commercial applications
- Understanding and informing new technical codes and standards
- Evaluation of innovations in agricultural lighting
- Water + energy savings strategies
- International survey of heat pump water heaters (HPWHs)
- Performance evaluation of 120V HPWHs

Project Set Overview

Conceptualization, Research and Development of new tools and technologies that respond to emerging opportunities and needs in energy

P-Set 170X: Next-Gen Technologies and Demand Flexibility

Example Deliverables & Topic Areas

- Applibility and usage of emerging Alternative Refrigerants
- Research into using light for data transmission
- Water distribution energy intensity tool
- Advanced Demand Response
- Application model for heat pump water heating
- Core research on advanced dehumidification processes
- Electrochemical desalination technologies & applications
- Research into new functions & applications for existing technologies

Program 170: Key Collaborative Supplemental Projects

Evaluating Demand Response Capabilities of Connected Variable Capacity Heat Pumps
SPN 3002023989

Evaluation of Large Heat Pumps for Electrifying Building Hydronic Heating (“High Lift HPs”)

SPN 3002017667

Flexible DR Collaborative (Phase 2)
SPN 3002024828

Field Evaluation of Heat Pump Water Heaters in Small Commercial Applications
SPN 3002016744

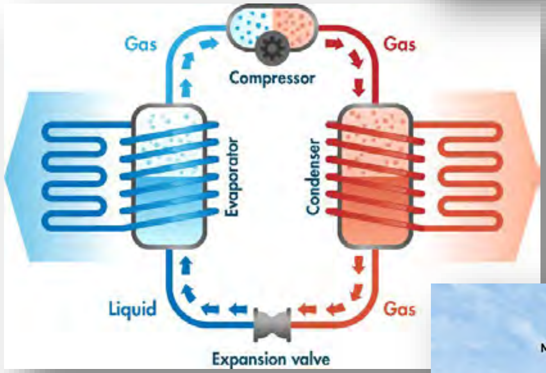
Heat Pump Working Council
SPN 3002019816

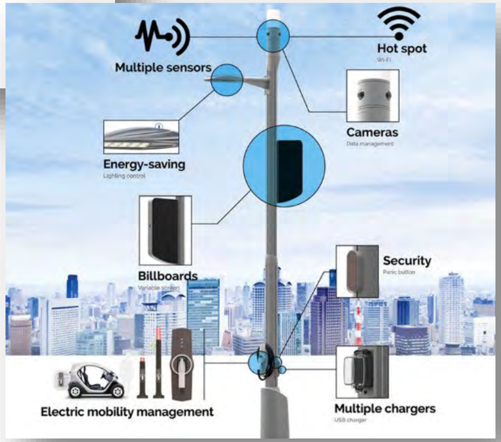
Next-Gen Heat Pumps: Meeting Customer Needs for Space Conditioning
SPN 3002009414

Smart City Pole Demonstration
SPN 3002015499

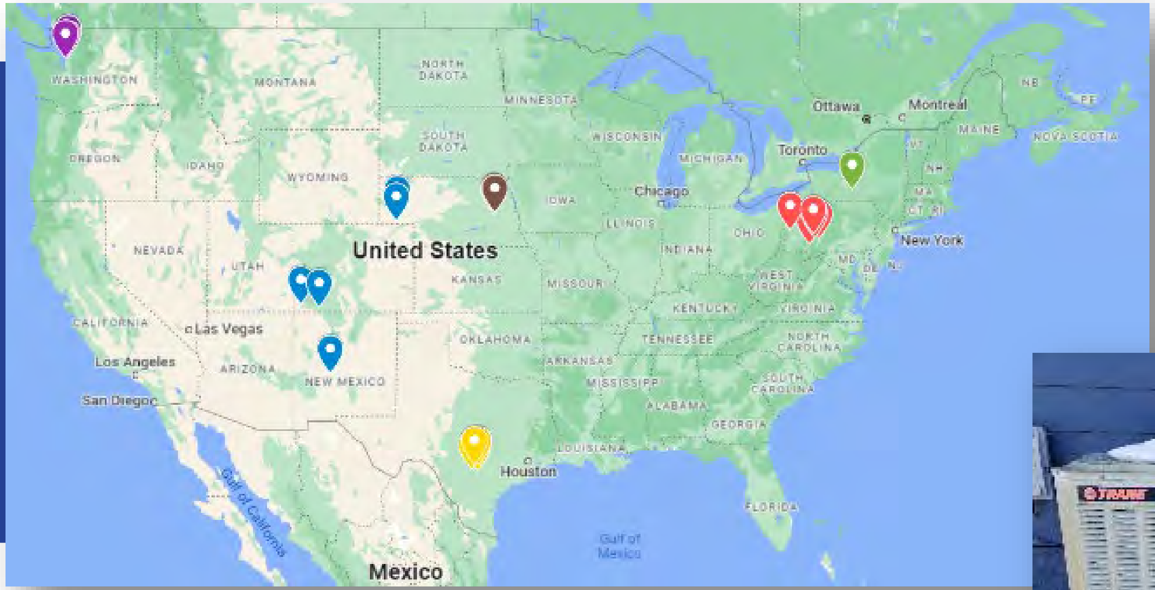
Advanced Window Heat Pump Deployment
In Development!

Industrial Heat Pump Evaluation
In Development!





Next-Generation Heat Pump Deployment



SNOHOMISH COUNTY PUD PUBLIC UTILITY DISTRICT NO. 1

Nebraska Public Power District
Always there when you need us

New York Power Authority

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

FirstEnergy

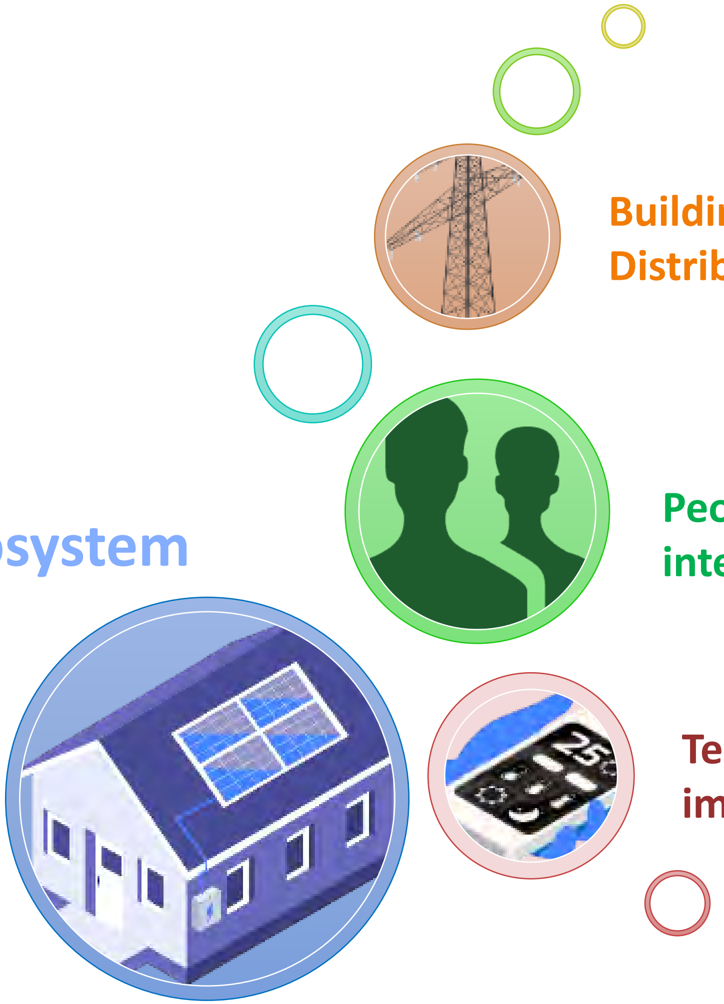
cps ENERGY

EPRI

Program 204 – Advanced Buildings & Communities

Advanced Buildings & Communities research is about…

Building Ecosystem



Building-Grid interaction with Distributed Energy Resources

People-Built environment intersection

Technologies integration and implementation at scale

P204 Vision is to provide *fundamental approaches and scalable tools* for Grid-Interactive Efficient Buildings & Connected Communities to achieve a *decarbonized future for all*

Current Government-Funded Projects

- CEC 15-094: *Demonstration of Affordable and Comfortable Grid-Integrated Zero Net Energy Communities*
- CEC 16-068: *Enabling Clean Energy in Disadvantaged Communities with Integrated PV and Storage*
- CEC 17-005 *Integrated Building-Scale Solar + Storage Advancing Technologies Maximizing Value to Customer and the Distribution Grid*
- CEC 19-012: *Decarbonizing Healthcare with Zero-Carbon Reheat Systems*
- CEC 19-030: *CO_2 Heat Pump Water heaters for Multifamily Buildings*
- CEC 19-035: *Title 24 Manufactured Homes*
- CEC 19-054: *Demonstrating Code-compliant Energy Storage Systems and their Capabilities for Grid Harmonization*
- CEC 21-028: *Net Positive Resilient All-Electric Affordable Housing at Pacific Station North Transit Center*
- DOE: Connected Communities *Deep Efficiency and Smart Grid Integrated Retrofits in Disadvantaged Communities (DESIRED)*

Leveraging Base Funding with Government Funding

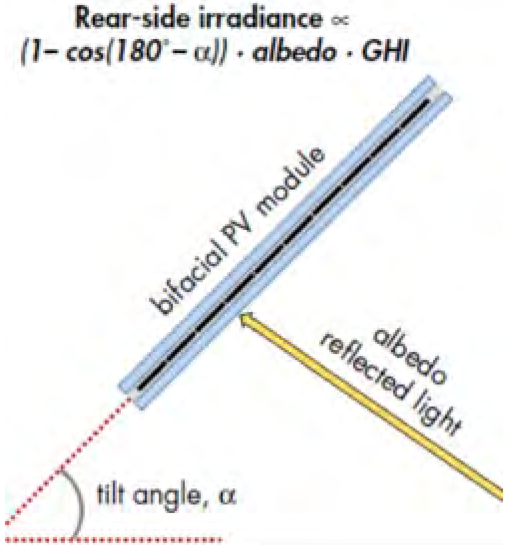
EPC 16-068 Solar+: Enabling Clean Energy in Disadvantaged Communities w/ Integrated PV + Storage (Willowbrook, CA)

Project Scope:

Demonstration of community-level resource integration and controls at an affordable housing property in a low-income, disadvantaged neighborhood

Innovations

- High-Efficiency Bifacial Solar PV
- Battery Energy Storage
- DC-coupled Bi-directional Smart Inverter
- Energy Efficient Direct Current Loads
- Multi-Level Controls Integration through Cloud-Based Platform
- Innovative Community-Sharing Business Model (VNEM)



EPRI

Decarbonization Retrofit for Multifamily Apartments (Fresno, CA)

3-year journey for comprehensive retrofit

CEC EPC-15-053

- Insulated, replaced lighting & appliances, installed heat pumps, added community solar
- Implemented measures: 150 kW PV, insulation, some appliances, some lighting
- Circuit metering in each unit

- 60 units in 10 buildings plus common area (multifamily)
- Built in 1969, Fresno CA
- 1 – 4 bedroom apartment units, 4-10 units per building
- Master metered on gas, electric and water
- 200 A panel for each building and 125 A panel in each apartment

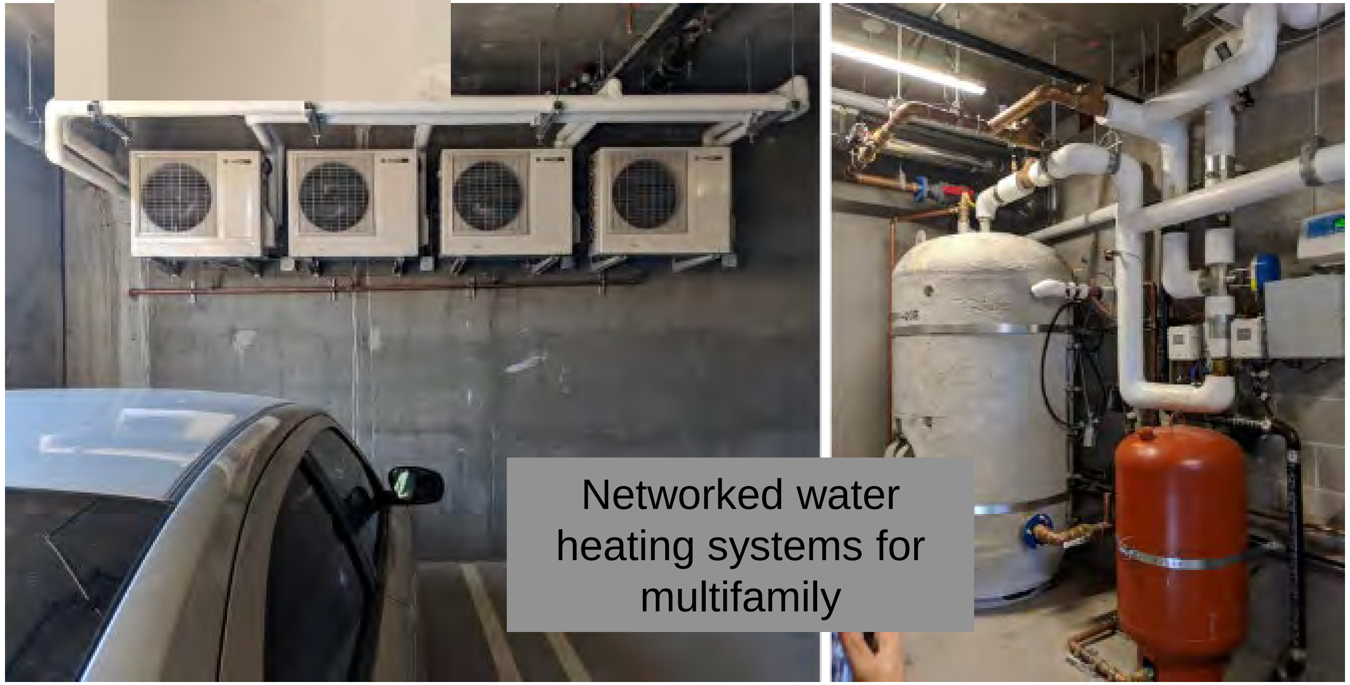
Key New Electrification Technologies Implemented

110 V Heat Pumps with asbestos mitigation

Low cost/ low draw cooktops

Wall mount HPWH with potential for 110 V retrofit

Smart Panels for retrofits



Networked water heating systems for multifamily

Alabama Power

SMART NEIGHBORHOOD™

Objective:

Design and build a first-of-a-kind high-performance community and residential microgrid to learn how to better serve changing customer needs.

Tomorrow's Homes. Today - Built to ICC code for 2030/2040

Program 199 – Electrification

Project Set: A **Analytical Tools and Knowledge Base**	• P199.001: Analytics and Modeling Framework • P199.003: Knowledge Base of Technologies and Markets
Project Set: B **Technology Assessments and Case Studies**	• P199.004: Technology Assessment and Application • P199.007: Case Studies and Technology Cut Sheets
Project Set: C **Technology Transfer and Stakeholder Networks**	• P199.005: Working Councils and Interest Groups • P199.006: Development of Training and Marketing Materials
Project Set: D **Technology Scouting**	• P199.008: Emerging Technology Overview

ELECTRIFICATION 2024

INTERNATIONAL CONFERENCE & EXPOSITION

Accelerating Together for an Electrified Future

March 12-14, 2024 | Savannah, GA

www.electrification2024.com

Event Details

Dates: March 12-14, 2024

Location: Savannah Convention Center

1 International Drive

Savannah, GA 31421

Schedule of Events

Monday, March 11, 2024
- Registration Opens
- Pre-Conference Workshops

Tuesday, March 12, 2024
- Pre-Conference Workshops
- Exhibitor Set Up
- Open Reception in Expo Hall

Wednesday, March 13, 2024
- Opening Plenary Session
- Educational Track Sessions
- Expo Open
- Signature Evening Event

Thursday, March 14, 2024
- Educational Track Sessions
- Expo Open
- Closing Plenary Session
- Closing Reception

www.electrification2024.com

Questions?

Ammi Amarnath

aamarnath@epri.com

(650) 855-1007

Together…Shaping the Future of Energy®

INDUSTRIAL HEAT PUMPS

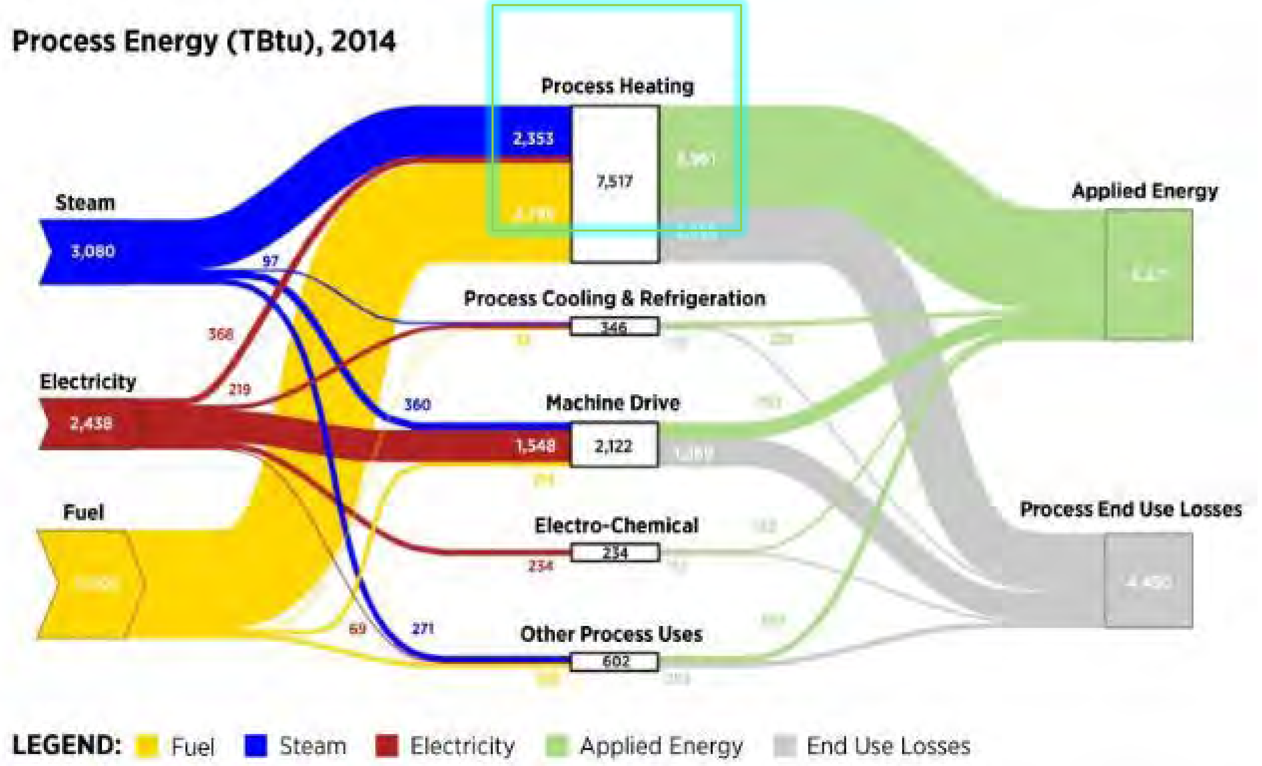
Overview of EPRI Activities

Ammi Amarnath
Principal Technical Executive

Q3 2023 RETAC Meeting
September 21, 2023

Industrial Decarbonization: Process Heating Uses Most Fossil Energy

- Total process heat (PH) energy use for U.S. manufacturing sector is 7,517 TBtu
  - Accounts for ~70% of the total process energy consumed in the manufacturing sector.
- Direct fossil fuel use for process heating is 4,796 TBtu/yr
- Direct and indirect (e.g., fuel used to generate steam) energy use for PH is 7,149 TBtu/yr
  - ~95% of all the process heating energy demand.
- About 35% of fossil energy is lost as waste heat



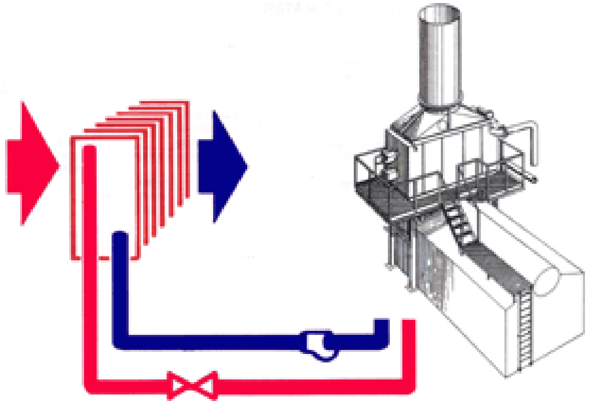
Source: https://www.energy.gov/eere/amo/static-sankey-diagram-process-energy-us-manufacturing-sector-2014-mecs

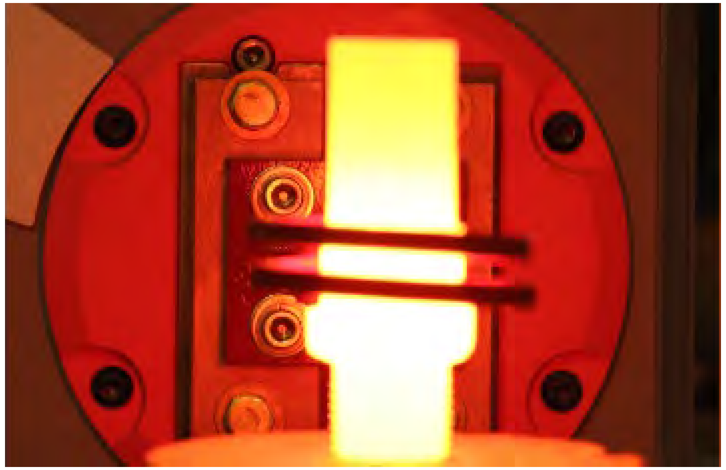
Only about 5% of energy used by Industrial Process Heating is Electric Energy

Opportunities for Decarbonization in Industry

Efficiency, Electrification, Low Carbon Fuels, Carbon Capture

- Process Integration
  - Pinch Technology
- Waste Heat Recovery and Reuse
  - Industrial Heat Pumps
- Electric-Driven Process Heating
  - MW, RF, IR, Acoustic, Ohmic etc.
- Low Carbon Fuels
  - Hydrogen, Ammonia etc.
- Carbon Capture & Utilization

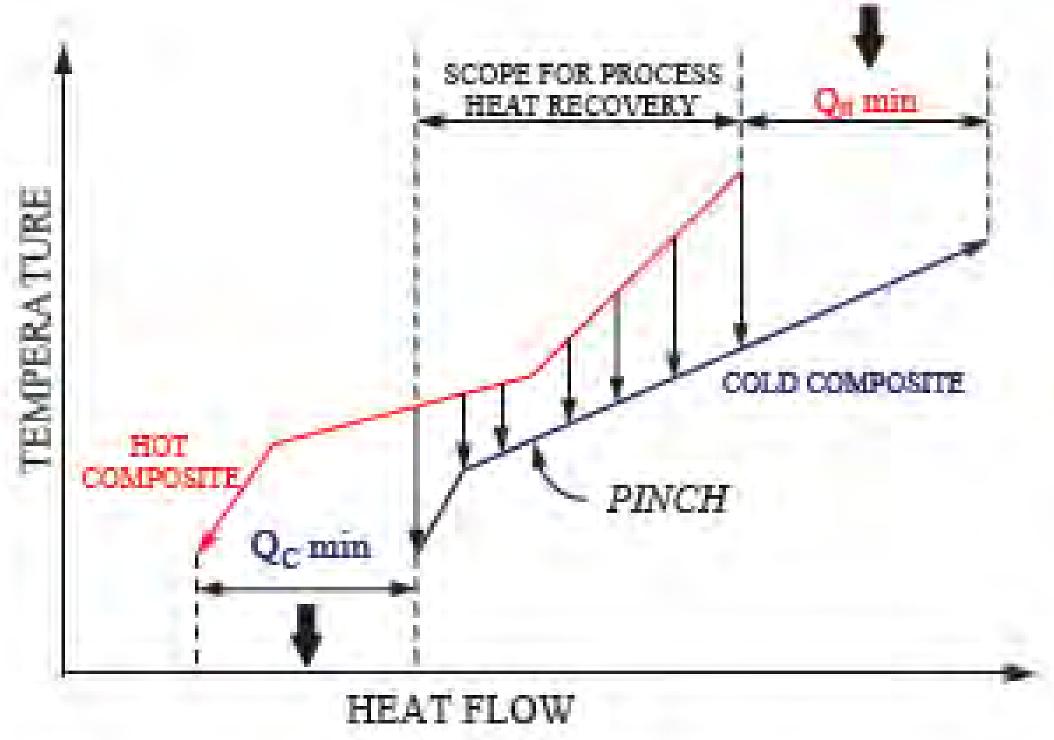




Heat Recovery HP/Chiller

Pinch Analysis – Efficiency is the Lowest Hanging Fruit!

- Minimize heat loss by thermal energy optimization technique
- Matching hot streams with cold streams via optimum heat recovery
- Minimize reliance on external energy inputs
- Pinch temperature (where heating and cooling curves come close together) defines an industrial site's unique heat distribution
- **Pinch Analysis also provides amount of waste heat that can be recovered by Industrial Heat Pumps**



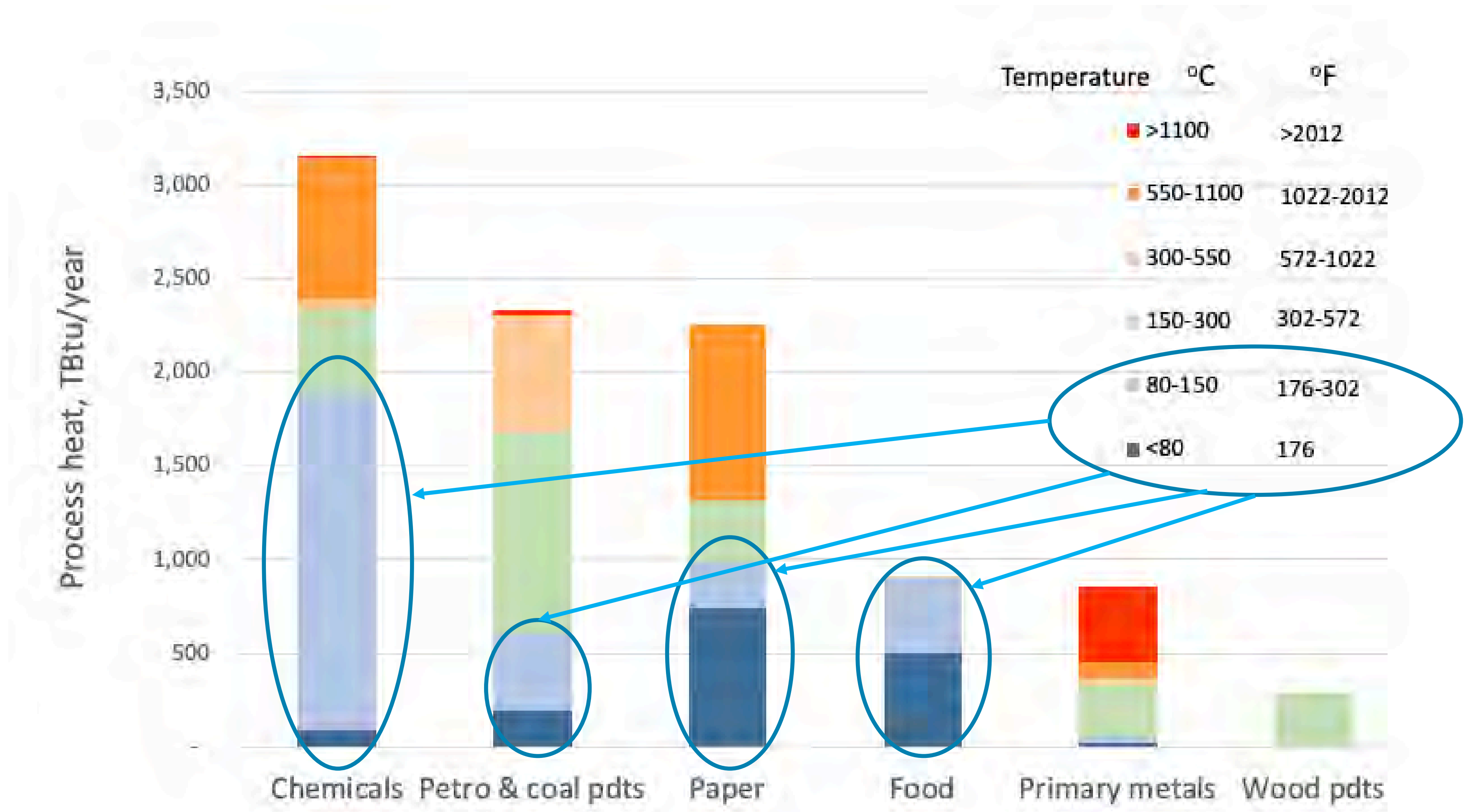
Source: EPRI Report CU-6775

EPRI and US DOE Championed "Pinch Technology" in 1990s

How to Use Low Temperature Industrial Waste Heat?

- Low-temperature waste heat streams available abundantly in industries
- Typical waste heat are at temperatures in the 70-80 ^{o}C range
- Sources of waste heat: chillers, cooling processes, return steam condensate
- Many industries needs low-pressure steam in 120-125 ^{o}C range
- Industry applications: food manufacturing (e.g., bakeries, dairy etc.), paper, chemical, and textiles

Significant Industrial Process Heat is Below 150 ^{0}C



Data Source: McMillan 2019

EPRI's History in Industrial Heat Pump Space

ELECTRIC POWER RESEARCH INSTITUTE

Topics:
End use
Electrotechnology
Heat pumps
Technology utilization
Electrification
Industry

EPRI EM-6057
Project 2783-11
Final Report
October 1988

Industrial Heat Pump Manual

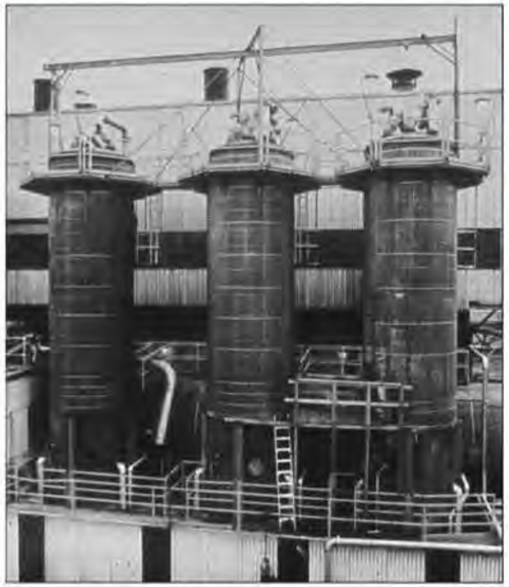
Technical and Applications Resource Guide for Electric Utilities

Prepared by
Linnhoff March, Inc.
Leesburg, Virginia

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.

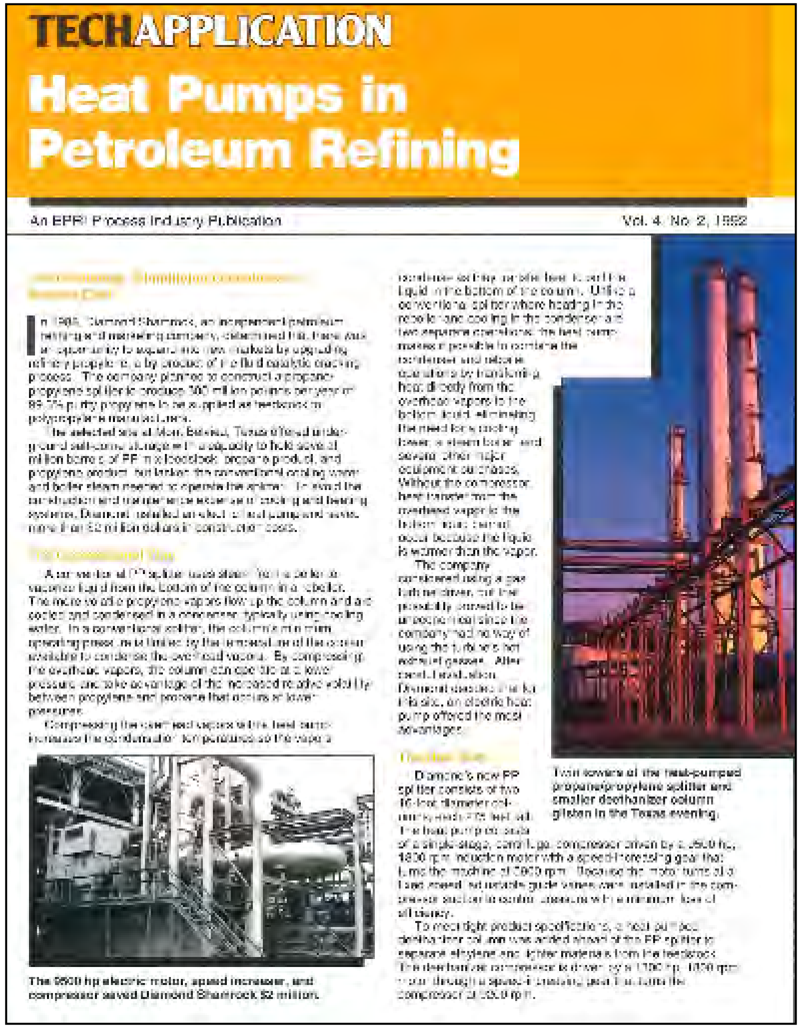
Increased capacity— Using a heat pump can overcome limitations in a plant's heating and cooling system. For example, using a heat pump may avoid the purchase of a steam boiler and cooling tower, which might have been required to evaporate and condense water in a product concentrator.

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

EPRI's History in Industrial Heat Pumps (Continued)



TECHAPPLICATION

Heat Pumps in Petroleum Refining

An EPRI Process Industry Publication Vol. 4, No. 2, 1992

Twin towers of the heat-pumped propane/propylene splitter and smaller deethanizer column glisten in the Texas evening.

The 2500 hp electric motor, speed increaser, and compressor saved Diamond Shamrock $2 million.

TECHAPPLICATION

Heat Pumps in Food Processing

An EPRI Process Industry Publication Vol. 3, No. 4, 1991

The Challenge: Evaporating Energy
Costs and Milk

Galloway-West Co., Inc. of Fond du Lac, Wisconsin required an energy efficient and flexible method to condense whole milk, skim milk, and whey products for use in sweetened condensed milk, dry milk powders, and milk solids sold to other segments of the food industry. The company's two steam-powered evaporators were expensive to operate due to high fuel costs for the gas-fired boilers supplying the steam. The limited range of evaporating temperatures of the older units also strained Galloway-West's ability to produce dairy products requiring low or high processing temperatures.

Galloway-West overcame its production limitations by installing an energy-efficient mechanical vapor recompression (MVR) heat pump that increased production capacity and enabled the company to produce a wider range of products.

Galloway-West's MVR system with a turbofan reduced energy costs by 70%.

The Old Way

Galloway-West used a thermal vapor recompressor (TVR) system and a straight steam-driven evaporator with a combined throughput of 40,000 lbs/hr. The company considered upgrading its existing evaporators, but the older technology would not be as successful in the production of specialty milk products and a gas-based system would still be expensive to operate and vulnerable to fluctuating fuel prices. However, the operating cost of an electric-based system promised to be more predictable and less expensive.

The New Way

In mid-December 1990, Galloway-West started up its new MVR falling-film evaporator and began saving energy right away.

The new evaporator is a two-effect, multi-pass, semi-open heat pump driven by a 600 hp motor with a variable speed drive coupled to a turbofan. Since most of the energy used by the unit is electrical, the company reduces production costs by running the unit "off-peak" much of the

The MVR heat pump compresses the low-pressure water vapor removed from the evaporating milk products to a higher pressure, increasing the vapor's temperature. The hot compressed steam is then used to further evaporate the milk. The product makes multiple passes through the unit, becoming more and more concentrated. A new TVR finisher is used to boost concentrate levels on some products. As part of the MVR's heat-exchange design, cold incoming milk is pre-warmed as it cools the condensed product and condenses the steam.

The MVR heat pump in conjunction with a heat treatment system ahead of the MVR provides a greater range of heat treatments, so Galloway-West can more easily produce the products its customers want.

The new system lets operators adjust the turbofan's speed and use a variety of heat treatments.

The Results: Much More For Much Less

By switching to the MVR evaporator, Galloway-West saves energy and labor while increasing revenues.

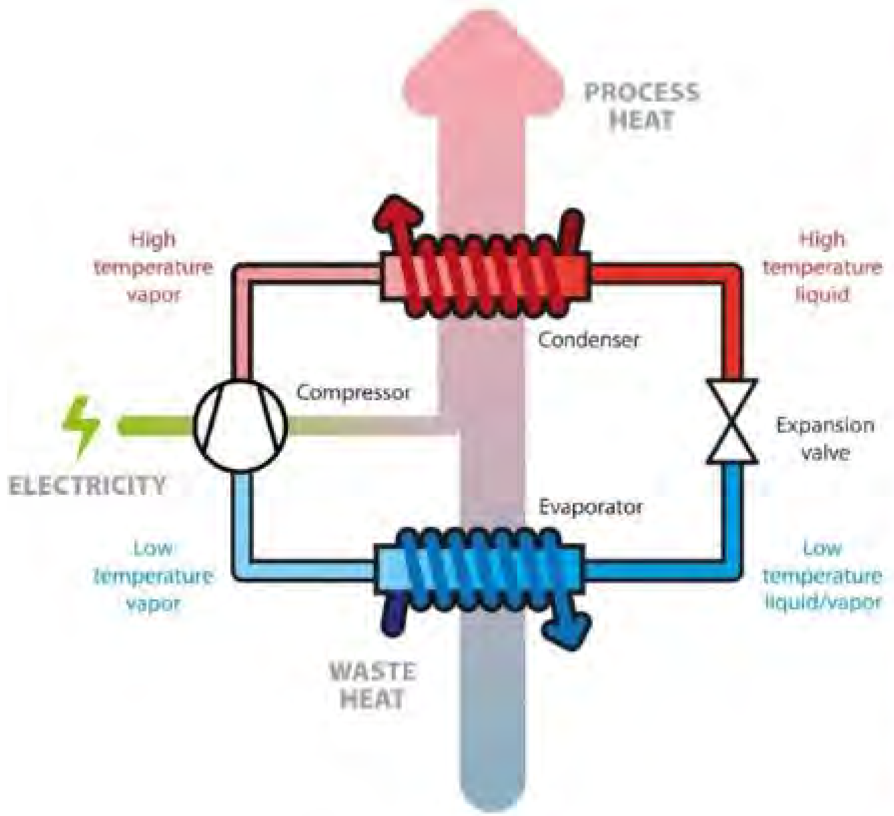
Energy Savings: Using the MVR, Galloway-West saves 70% of its previous energy expense. The unit operates at a rate of $0.46 for every 1000 lbs of water removed, compared to the old system's rate of $1.56. An annual energy savings of $263,000 is projected from having replaced gas with electric power and utilizing its economical off-peak rates.

The evaporation process itself accounts for 92% of the savings, while 4% is due to the system's design for preheating and cooling product and for condensing steam. The rest of the savings results from the MVR's 50% turndown that allows the product to run directly to the dryers, avoiding cooling costs during storage and subsequent reheating.

Documented in early 1990s

Closed Cycle Industrial Heat Pumps – Current SOA

IEA Estimates 500 MW IHPs Needed per Month for Next 30 Years!



- HTHPs for supply > 100 °C require compressor developments

Compressors from process industries
Advanced technologies | Application specific design
Cost intensive | Applications > 15-20 MW

Upgraded refrigeration compressors
Currently limited to < 90 °C | Standard compressors
Proven technology | Applications < 15-20 MW

Novel and (strongly) adapted technologies
Technologies based on equipment from automobiles, pumps, ...| Capacities of kW to MW

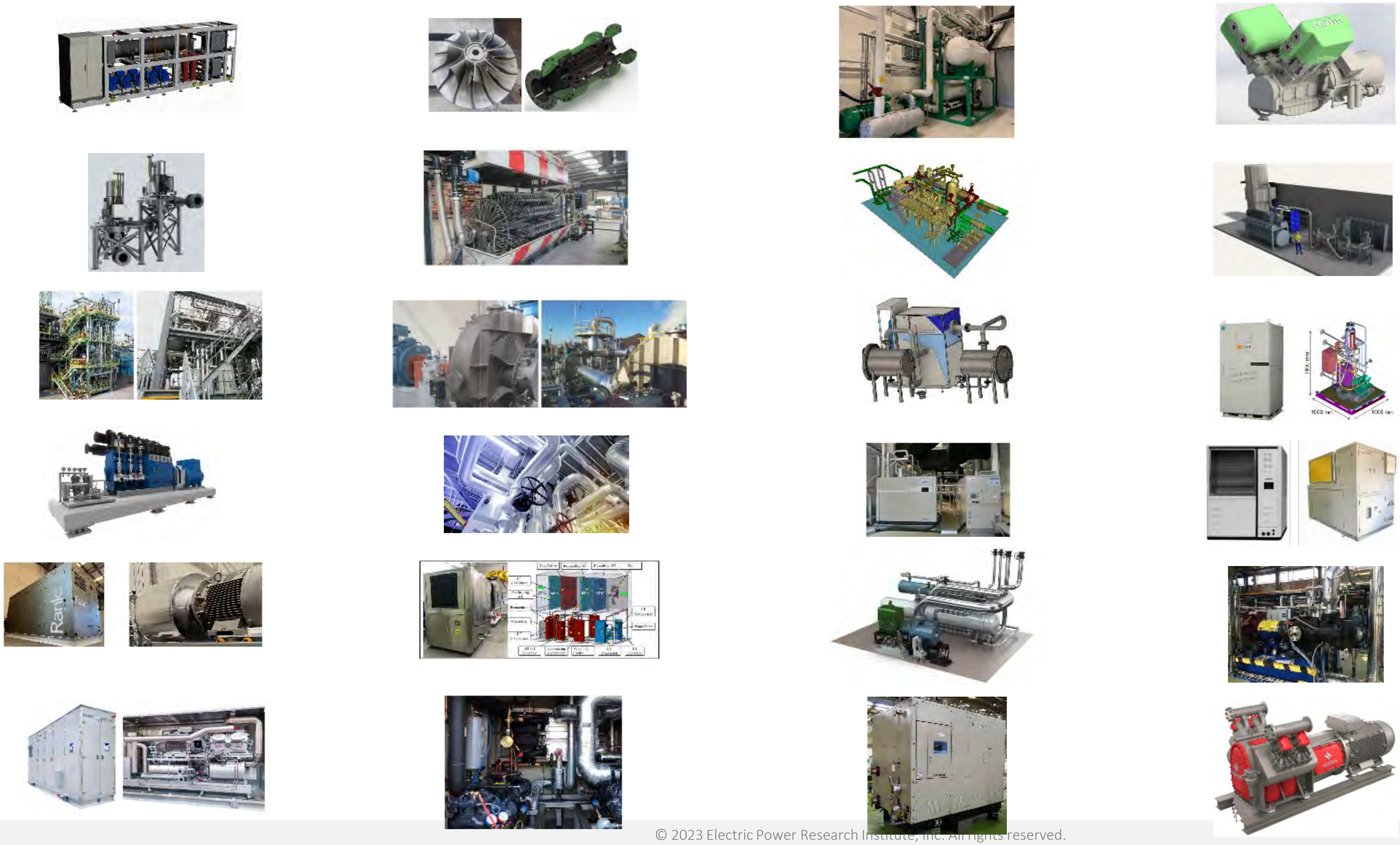
Source: Danish Technological Institute

Players in the Industrial Heat Pumps Space (1 of 3)

- GEA Engineering for a better world.
- enertime
- HybridEnergy
- enerin ENERGY ENGINEERING
- Combitherm APPARATE- UND ANLAGENBAU
- EPCON Evaporation Technology AS
- ecop
- MAN Energy Solutions
- ANEO
- OLVONDO TECHNOLOGY
- QPINCH
- PILLER Blowers & Compressors
- Weel & Sandvig ENERGY AND PROCESS INNOVATION
- Fuji Electric
- SPH Sustainable Process Heat
- SPILLING Technologies
- TURBODEN clean energy ahead
- KOBELCO
- MAYEKAWA MYCOM
- FENAGY FUTURE ENERGY SOLUTIONS
- Rank®
- EMERSON
- SIEMENS energy
- SRM
- toCircle INDUSTRIES
- SABROE Johnson Controls
- :skala fabrikk
- MITSUBISHI HEAVY INDUSTRIES THERMAL SYSTEMS
- HEATEN

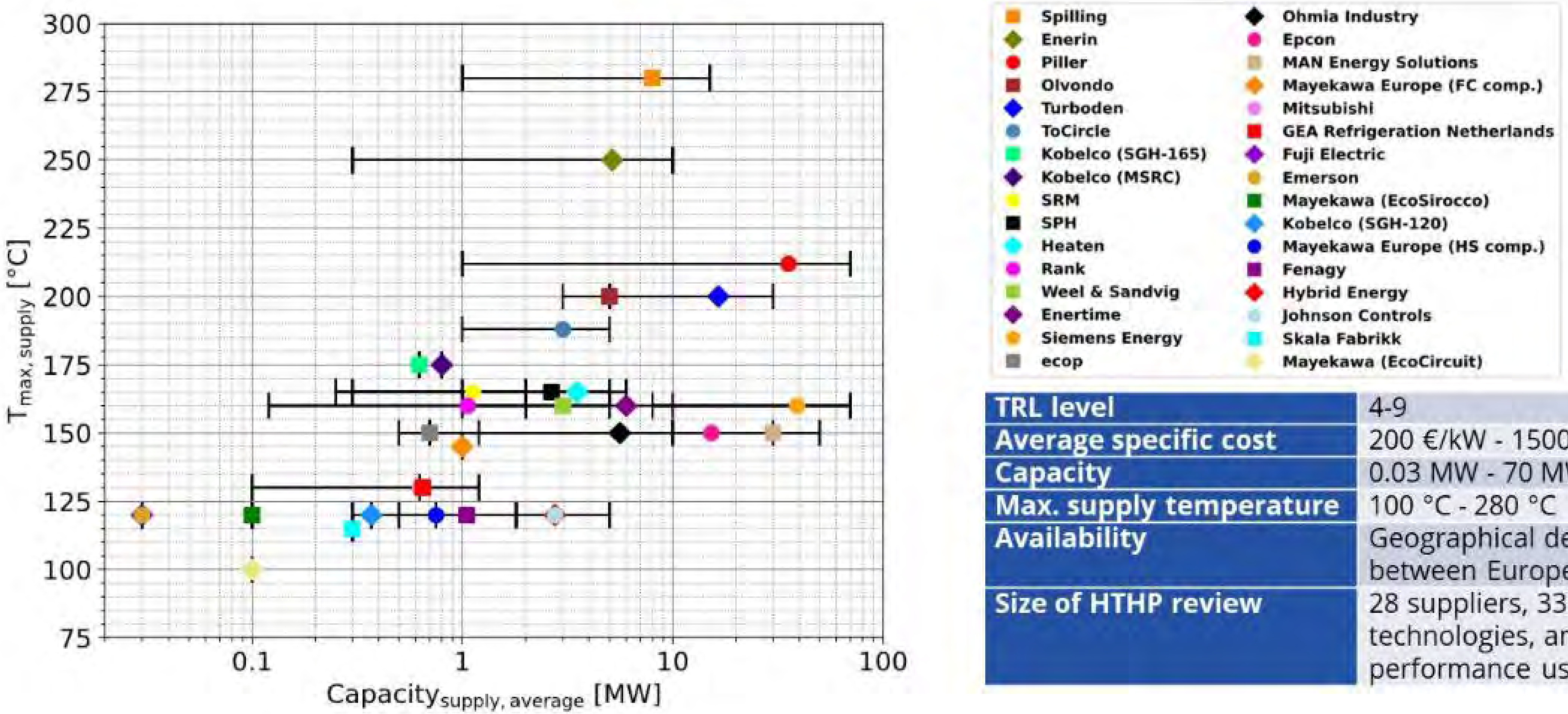
Source: Danish Technological Institute

Players in the Industrial Heat Pumps Space (2 of 3)



Source: Danish Technological Institute

Players in the Industrial Heat Pumps Space (3 of 3)



TRL level	4-9
Average specific cost	200 €/kW - 1500 €/kW
Capacity	0.03 MW - 70 MW
Max. supply temperature	100 °C - 280 °C
Availability	Geographical dependent, e.g. between Europe and Japan
Size of HTHP review	28 suppliers, 33 different technologies, and 83 performance use cases

Source: Danish Technological Institute

Some Industrial HP Successes in the U.S. (<100 ^{0}C)

High End Cabernet Estate Winery Facility located in Alexander Valley California

First New Commercial Winery in the World to Achieve LEED Platinum Certification!

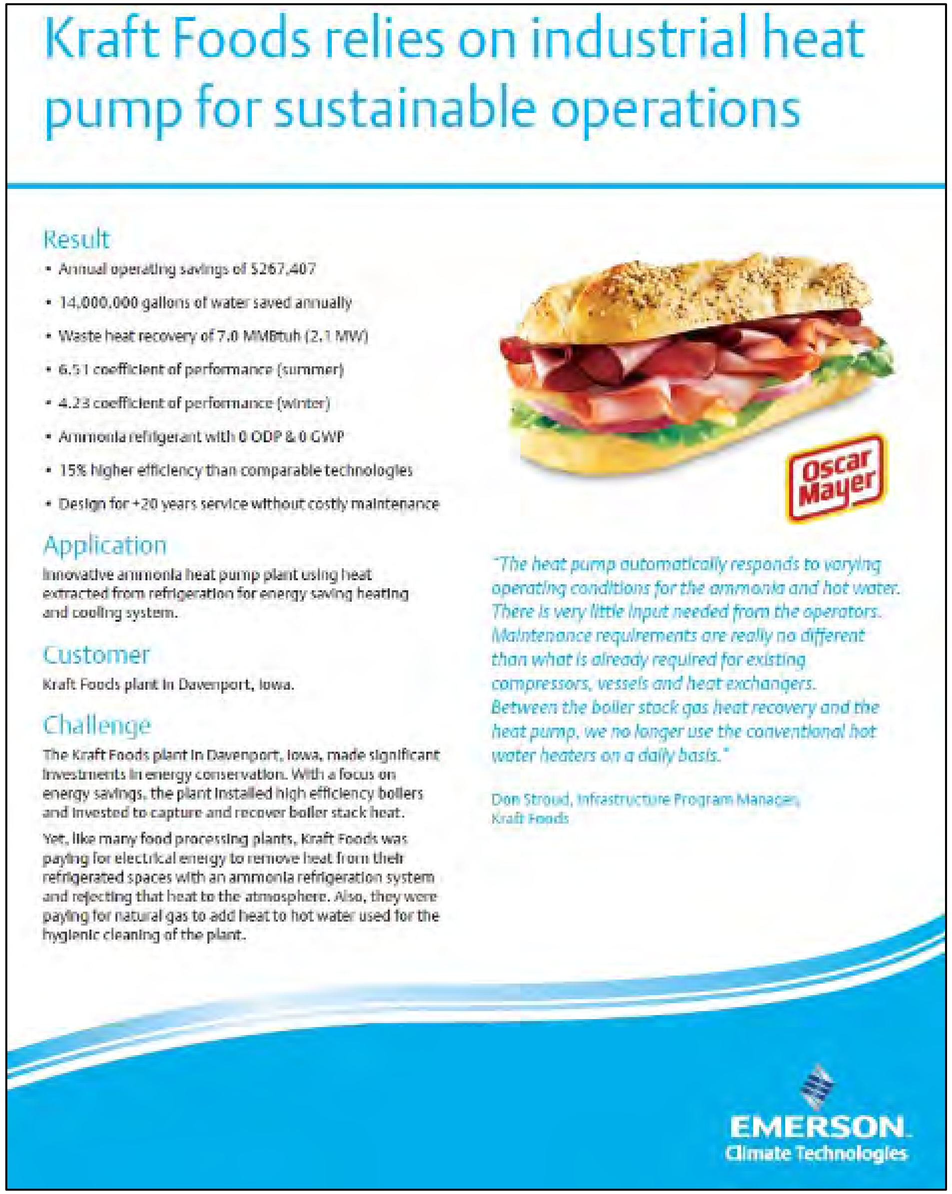
Water Source CO_2 Heat Pumps provide Hot Water for Winery DHW/Tank/Barrel Cleaning and Chilled Glycol for Barrel Room and Tank Cooling

(2) UNIMO ww units installed in Mechanical Room

Unit piping

Courtesy of Mayekawa MYCOM

Other Installations in the U.S. (<100 ^{0}C)



Kraft Foods relies on industrial heat pump for sustainable operations

Result
- Annual operating savings of $267,407
- 14,000,000 gallons of water saved annually
- Waste heat recovery of 7.0 MMBtuh (2.1 MW)
- 6.51 coefficient of performance (summer)
- 4.23 coefficient of performance (winter)
- Ammonia refrigerant with 0 ODP & 0 GWP
- 15% higher efficiency than comparable technologies
- Design for +20 years service without costly maintenance

Application
Innovative ammonia heat pump plant using heat extracted from refrigeration for energy saving heating and cooling system.

Customer
Kraft Foods plant in Davenport, Iowa.

Challenge
The Kraft Foods plant in Davenport, Iowa, made significant investments in energy conservation. With a focus on energy savings, the plant installed high efficiency boilers and invested to capture and recover boiler stack heat.

Yet, like many food processing plants, Kraft Foods was paying for electrical energy to remove heat from their refrigerated spaces with an ammonia refrigeration system and rejecting that heat to the atmosphere. Also, they were paying for natural gas to add heat to hot water used for the hygienic cleaning of the plant.

Oscar Mayer

"The heat pump automatically responds to varying operating conditions for the ammonia and hot water. There is very little input needed from the operators. Maintenance requirements are really no different than what is already required for existing compressors, vessels and heat exchangers. Between the boiler stack gas heat recovery and the heat pump, we no longer use the conventional hot water heaters on a daily basis."

Don Stroud, Infrastructure Program Manager, Kraft Foods

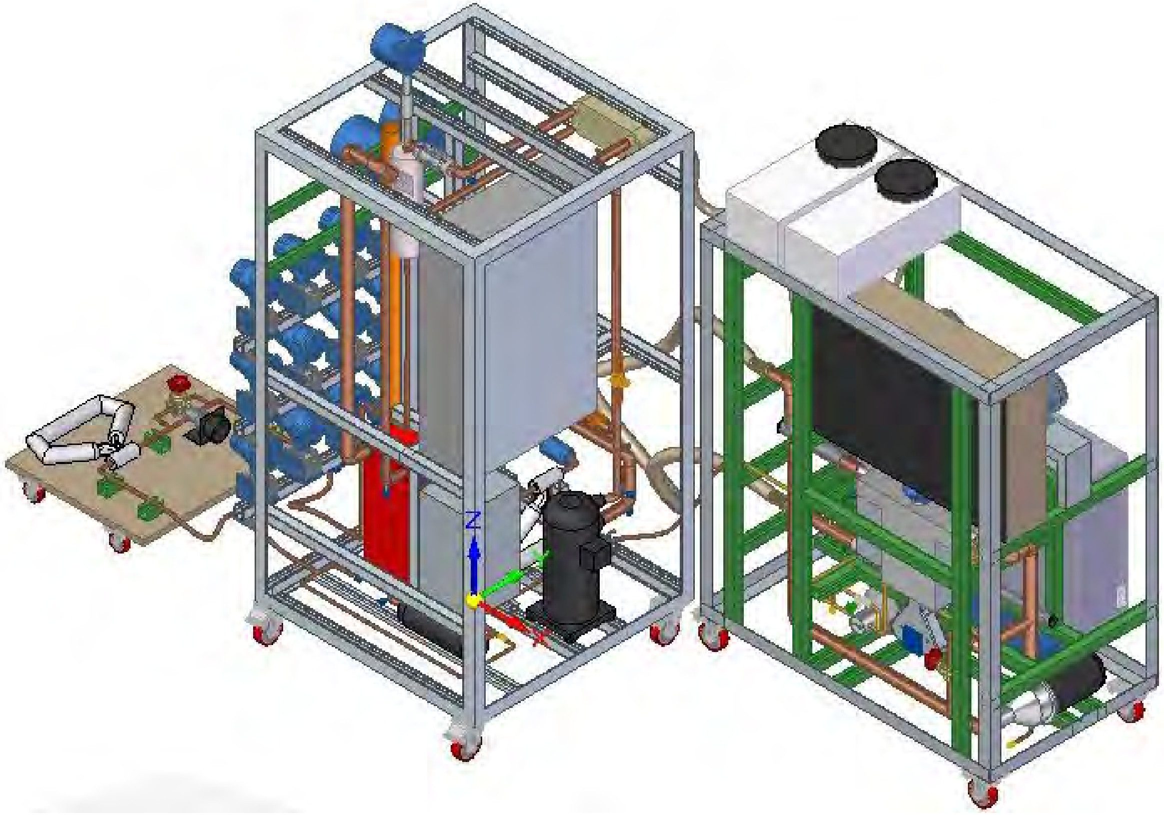
EMERSON. Climate Technologies

Ref – AMI Foundation Conference 2012

Ref – Emerson Website

EPRI Project: Low-Cost Steam Generating High Temp Heat Pump

- Key characteristics of the heat pump:
  - 30 kW prototype system
  - Low ODP, GWP refrigerant
  - Develop prototype system produce steam at 120 °C from waste heat (80 °C) @ COP of 3.4
  - Test in a lab in California; make it ready for field deployment
  - Offer low-cost solutions for industry al decarbonization in California and around the country



Project funded by California Energy Commission – Ongoing

EPRI

Photos of the 30 kW Prototype System

HP Prototype System

Prototype Showing Monitoring Instrumentation

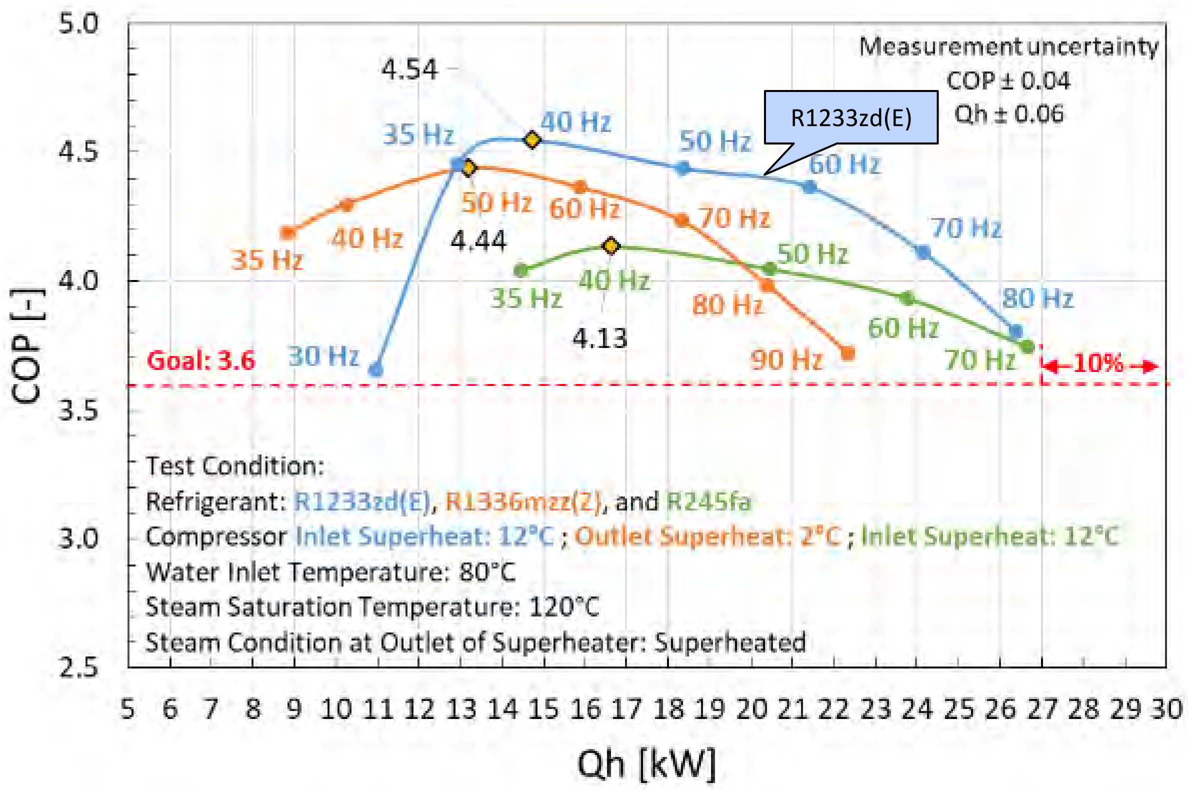
Prototype Showing Controllers and ASDs

Photos of Breadboard and Prototype System

Prototype System Test Results

Key findings from the tests:

- Coefficient of Performance (COP) has an inverse relation with system speed, a direct indicator of system load
- Higher load (capacity) or compressor speed results in lower COP values
- Two refrigerants performed the best
  - R1233zd[E]: Higher COP, but has ODP
  - R1336mzz[Z]: Lower COP, no ODP
  - System should be optimized to obtain the target COP of 3.4 or greater



Next Steps – EPRI Lab Tests + Field Tests

Europe's Bamboo Project – 2023 Demo at Arcelor Mittal

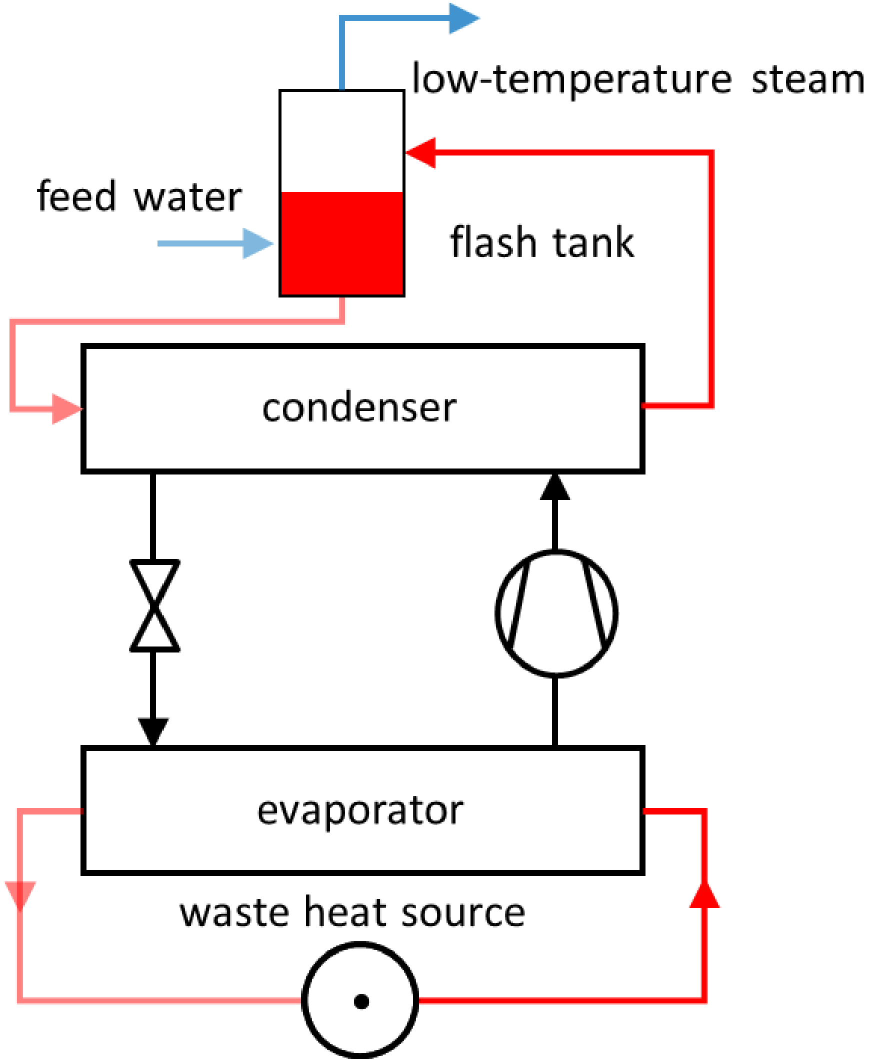


Photo – EDF, AIT

Summary

- Initial test results are promising
- Technology has potential to recover abundantly available waste heat
- Steam can be used readily in many processes
- Can easily integrate with existing boilers and reduce fossil-fuel use
- A variety of industrial applications (Food, Chemical, Pulp and Paper etc.)

Heat Pumps and the Grid – A Consideration

Top barriers to Heat Pumps at scale that must be addressed:

- **Power availability**
- **Power reliability**
- **Grid interconnections**
- **Grid readiness**

Some Enabling Actions

Ensure utilities (and regulators) are in lock-step with technology developers, OEMs, and consumers

Optimize systems and processes that support the pace of activity/investment required

Develop needed tools and technologies that enable HP scale and (perhaps) capture the grid benefits of HPs

Customers and Utilities Need to Work Together!

Industrial Heat Pumps – Needs

- Document Status of Current Applications
- Focus on Technology Development
- Apply Technology to Several Applications
- Conduct Case Studies and Technology Transfer

Collaboration Between Customers, Developers and Utilities

Questions?

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Together…Shaping the Future of Energy®

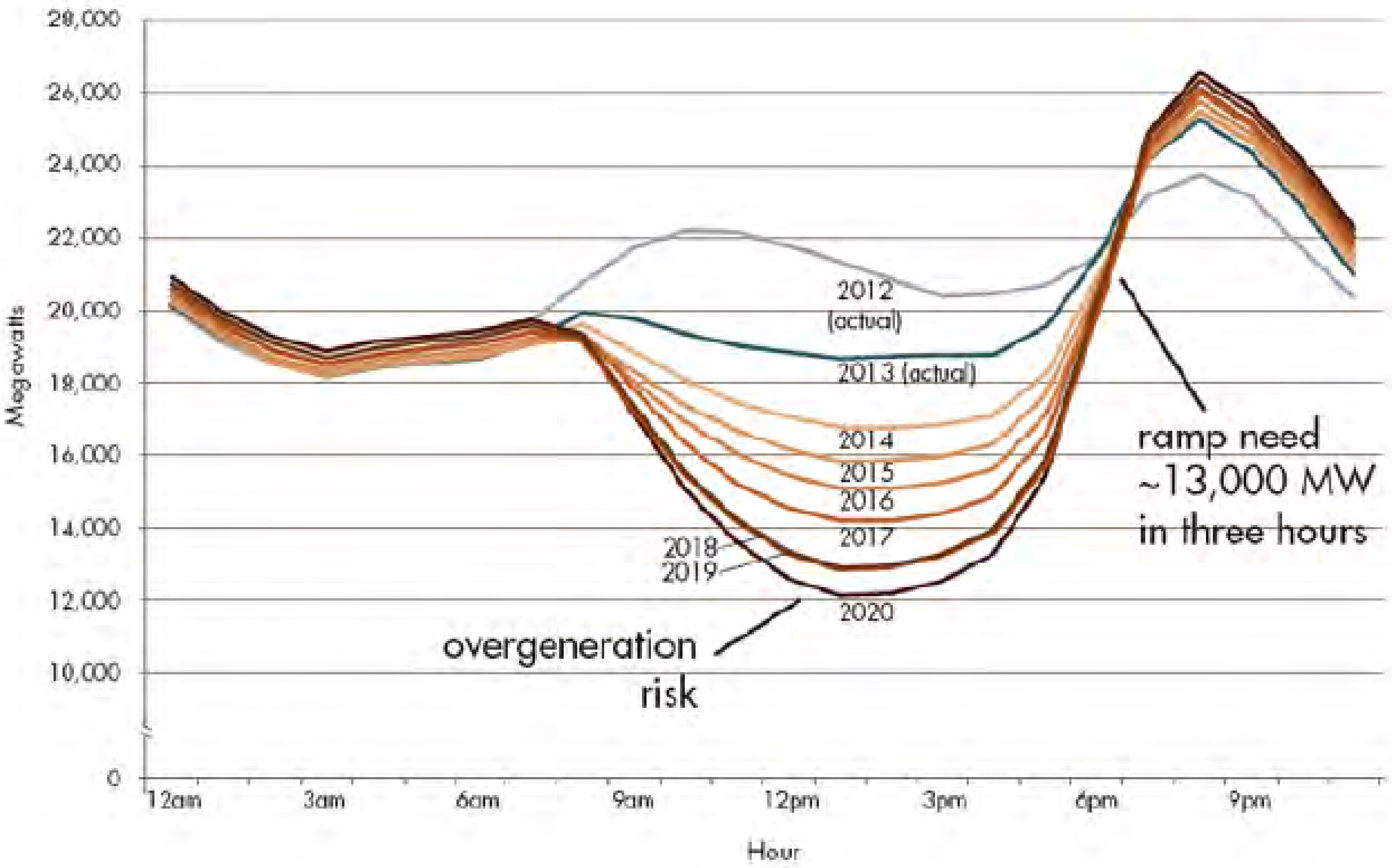
Demand (or Load) Flexibility

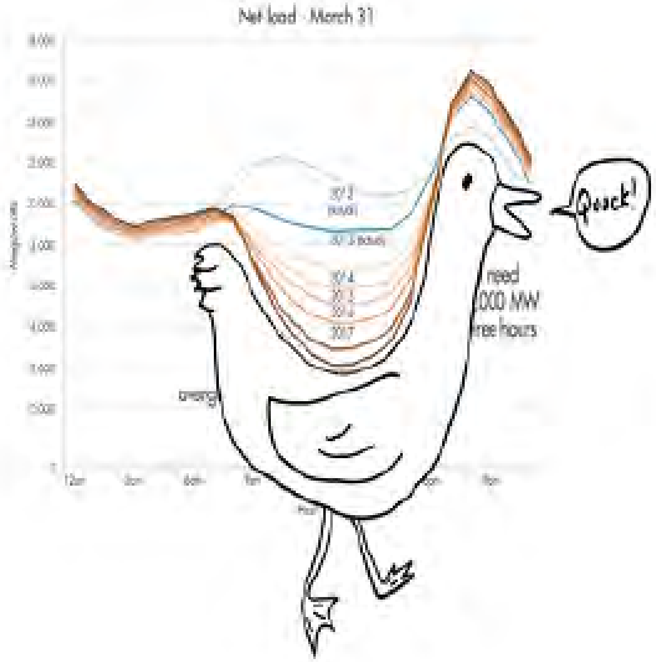
An Opportunity for Decarbonization

Ammi Amarnath
Principal Technical Executive

Q3 2023 RETAC Meeting
September 21, 2023

The Duck Curve in California



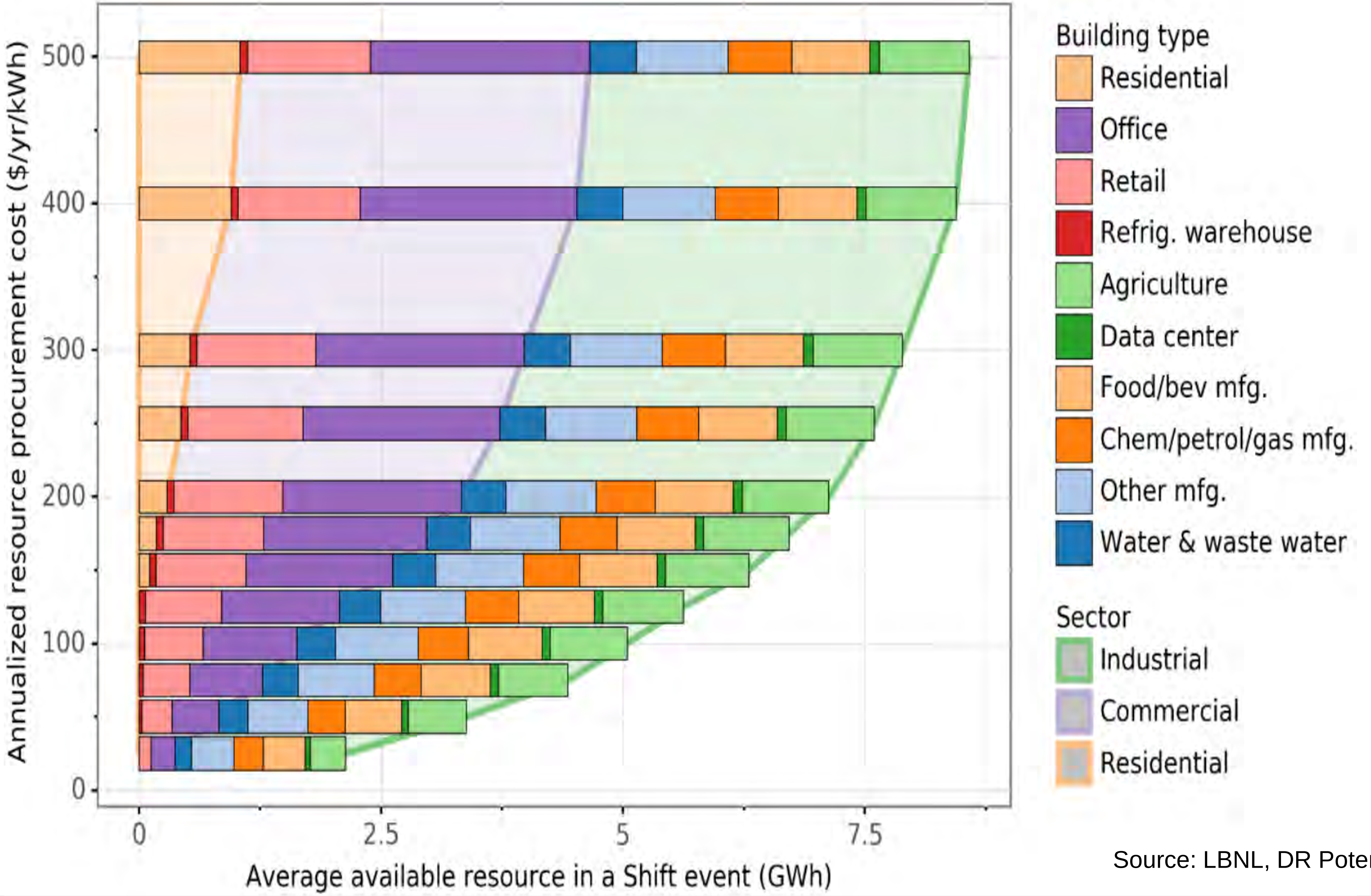


Source: California ISO

End-Use Load Flexibility is Necessary to Support the Grid

Available Demand Response Resources in Shift Events

The California Demand Response Potential Study, Phase 3, LBNL, 2020



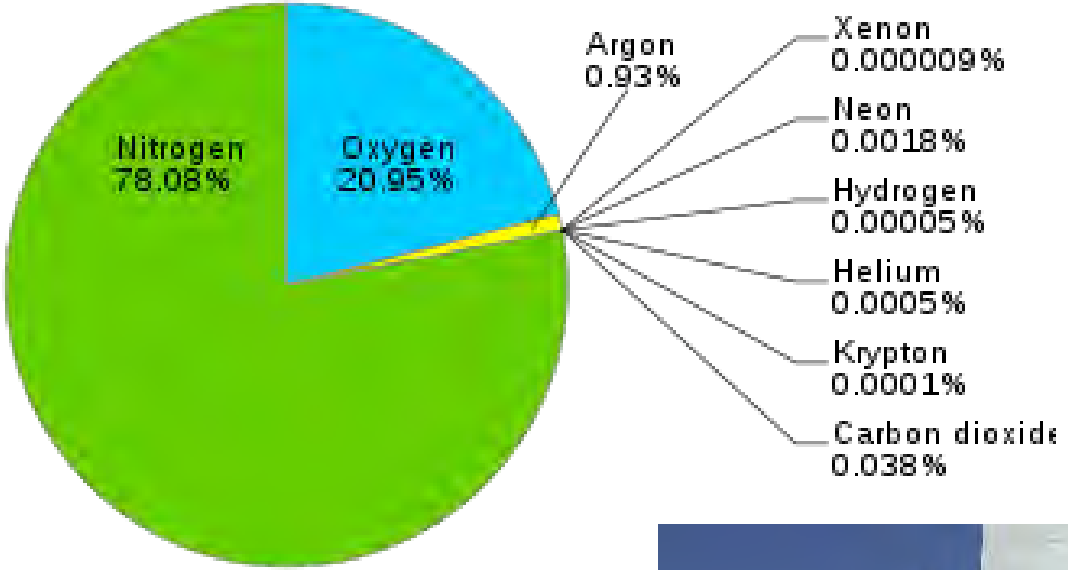
Source: LBNL, DR Potential Study – Phase 3

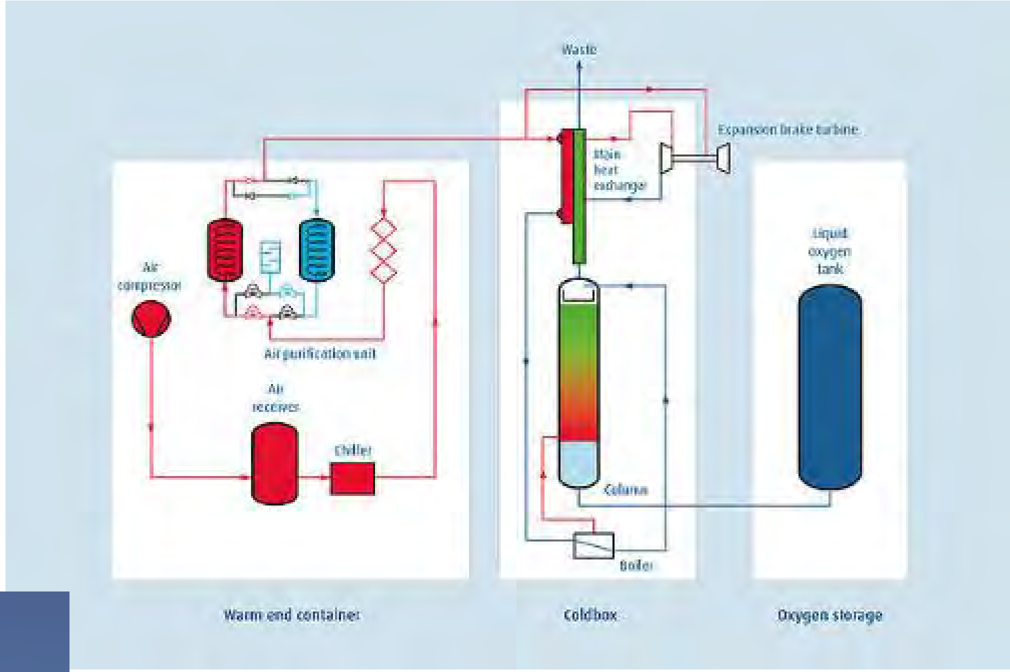
Opportunities for Demand Flexibility in the C & I Sectors

- Chemicals Industry
- Data Centers
- Agriculture – Water Pumping
- Domestic Water Supply and Wastewater Treatment
- Food Processing and Storage
- Future – Dynamic Pricing?

Photo: F. Wayne Hill

Chemicals Industry – Cryogenic Air Separation Plants

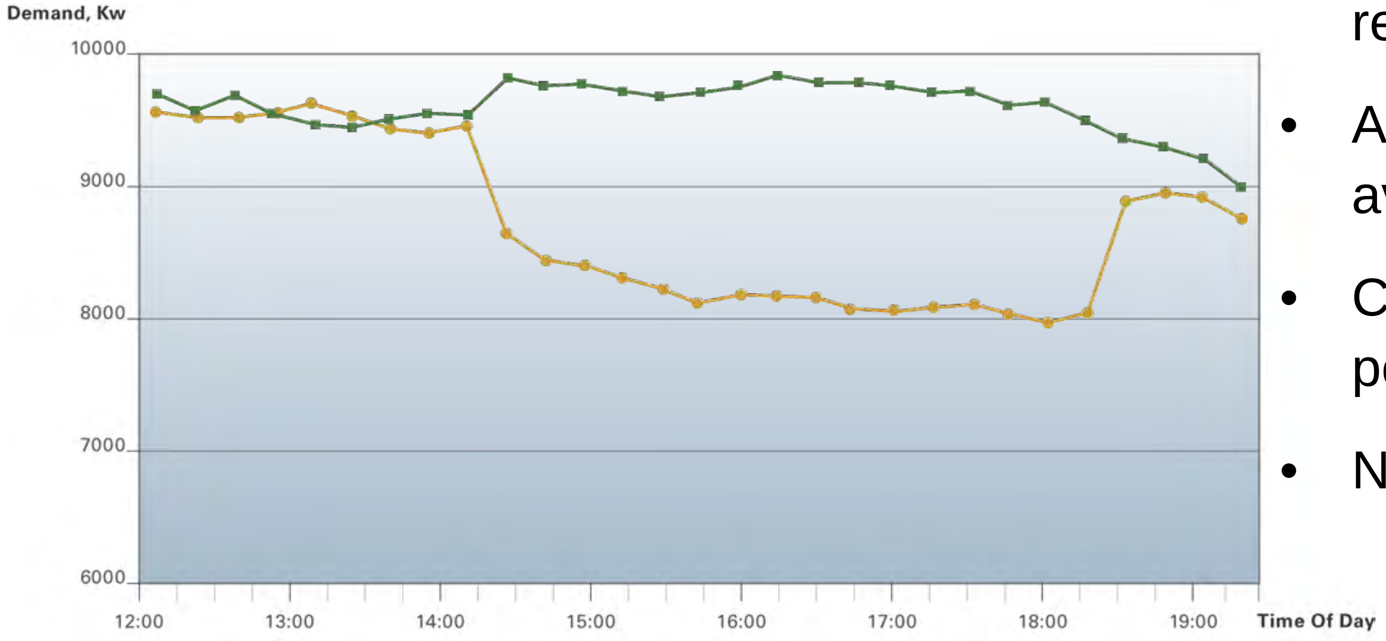




Source - Wikipedia

DR in Data Centers – Power Capping

Demonstrate potential of automatic IT loads reduction without disruption and minimal user impact



2001 PILOT TEST DATA

Reference – Tests at Oracle

- Prepare for the future grid with greater renewables
- Adjust data center power needs to electricity availability
- Coordinate operations with utilities to avoid power interruptions
- Newer power capping technology available

intel XEON inside

AMD OPTERON

EPRI

Agricultural Pumping

- Agriculture – Large Electricity User
  - ~1.6 GW Summer Peak Load in California
- DR Programs Offered by Utilities
  - Pumping Interruptible Program
  - Other Auto DR Pilot Programs

Source – SCE and ETCC

Demand Flexibility Opportunities in Agriculture Pumping

- 1.1 GW DR Potential [1]
- Relatively flat daily profiles
- Large, binary (on/off) loads
- Dual-use storage potential (reservoirs, canals)

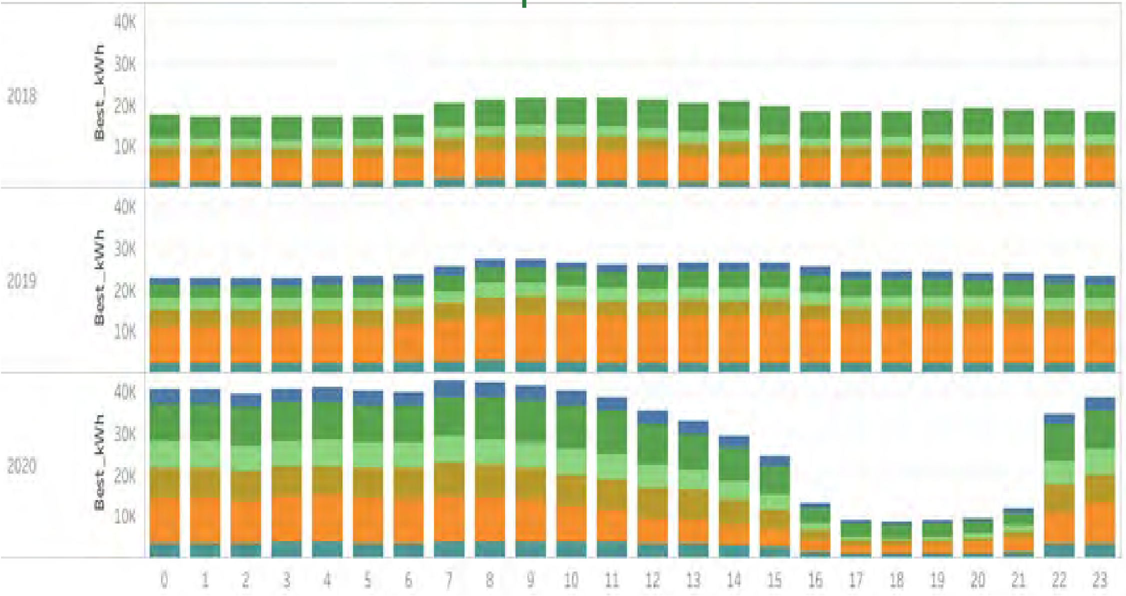
[1]LBL Energy Technologies Area: Opportunities for Automated Demand Response in California Agricultural Irrigation, 2015

Source: POLARIS ENERGY SERVICES

Proof of Concept for Transactive Energy Based Load Shifting
CEC EPC-16-045 Project (Polaris Energy)

- 67% of load shifted from ramp hours of 94% that can potentially be shifted
- Energy users responded to signals for an average $0.14/kWh in incentives
- Reported improved crop and 30% labor savings
- ROI on automation investments for farmers range from 7-41% based on energy savings alone

Hourly Total Usage by Pump Before and During Transactive Energy Pilot: Apr - Jun



Source: POLARIS ENERGY SERVICES

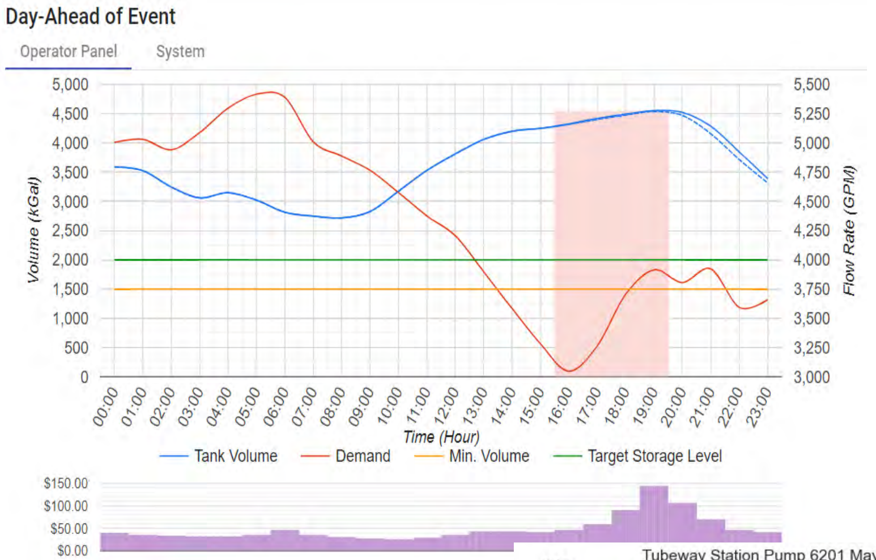
Flexible Water Pumping
CEC EPC-16-026 Project (EPRI)

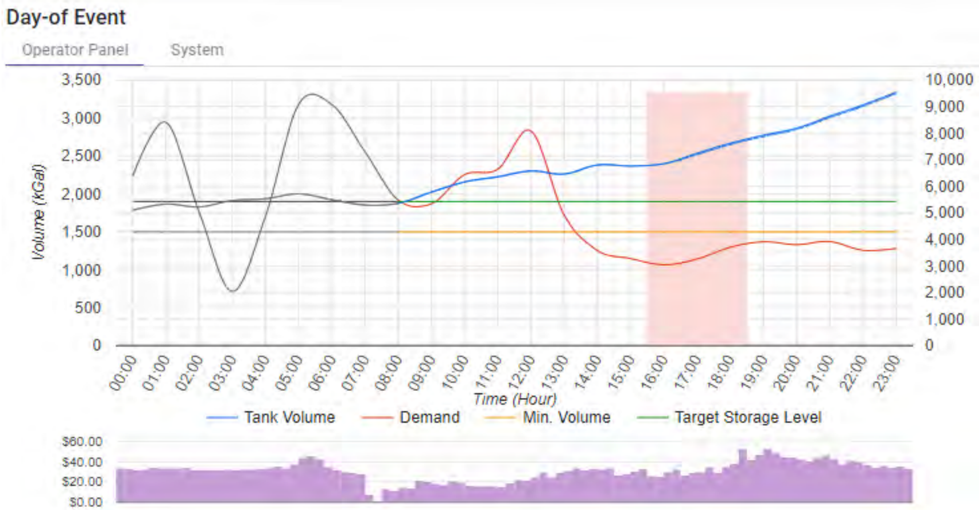
Big Picture
- Large electricity user – ~6 GWh/year
- Demonstrate what it takes to make pumping flexible
- Prepare for future DR Programs

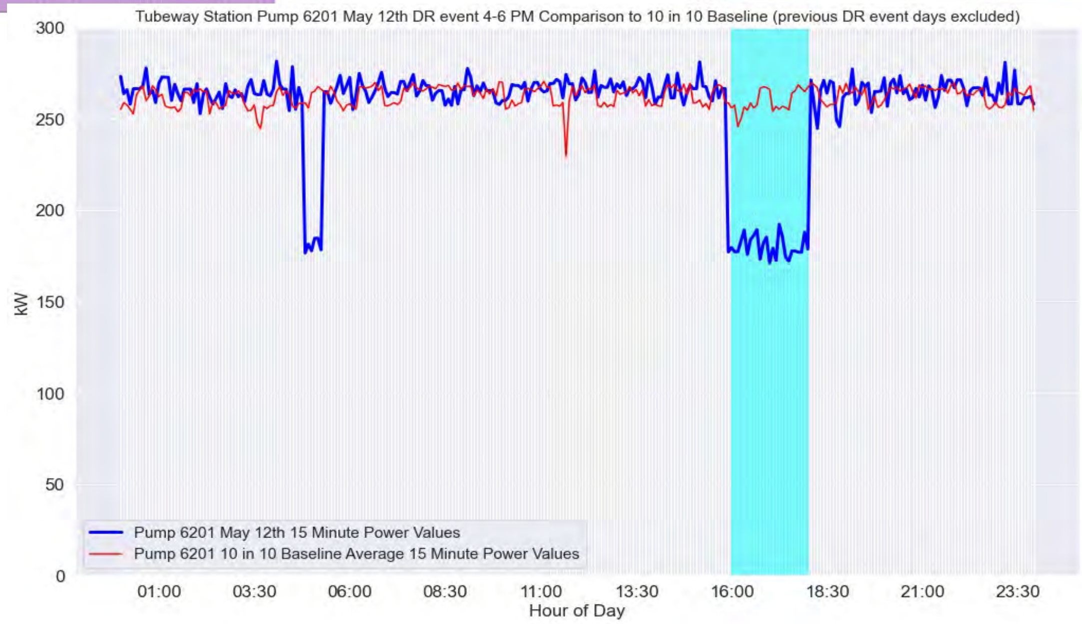
Objective
- 20% demand adjustment
- Support California policy goals for Demand Response and Renewable Integration

Activities
- Conduct industry interviews, data collection
- Identify DR Strategies, operational constraints
- Pilot test developed strategies
- Technology demonstration and final reporting

Decision Support Tools Developed for Operators to Take Actions

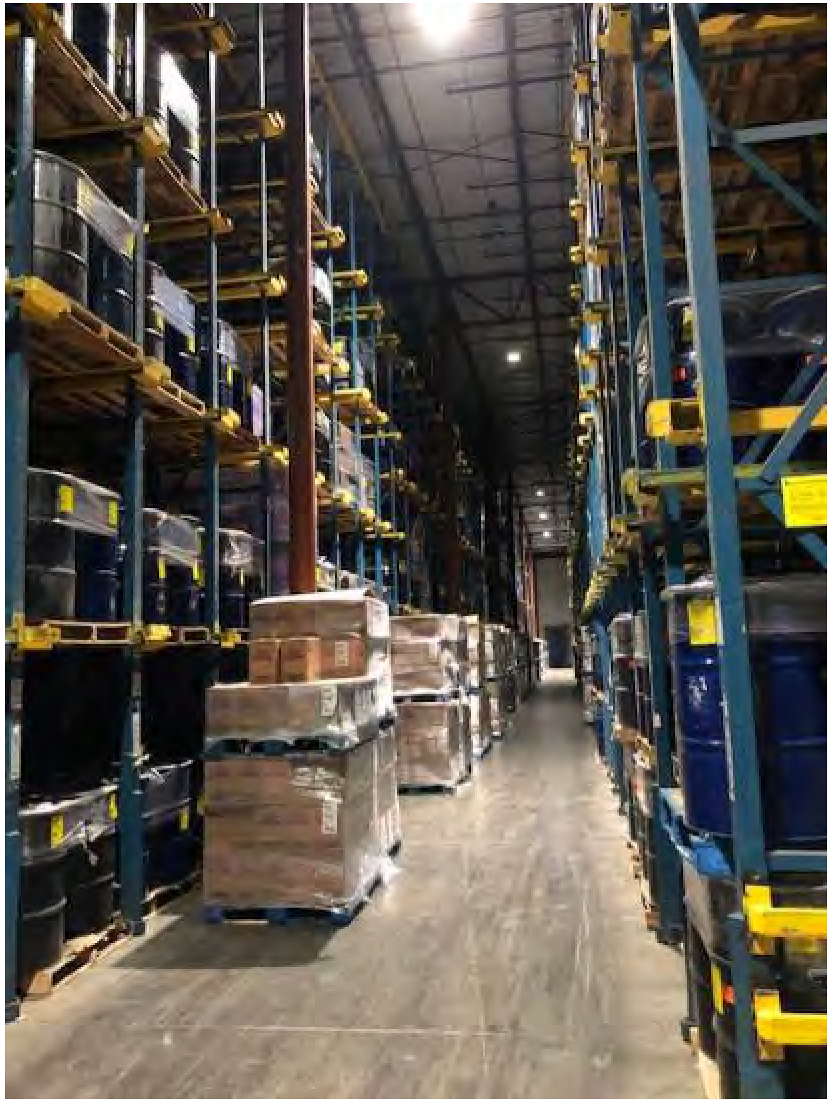






Flexible DR Opportunities in Refrigerated Warehouses

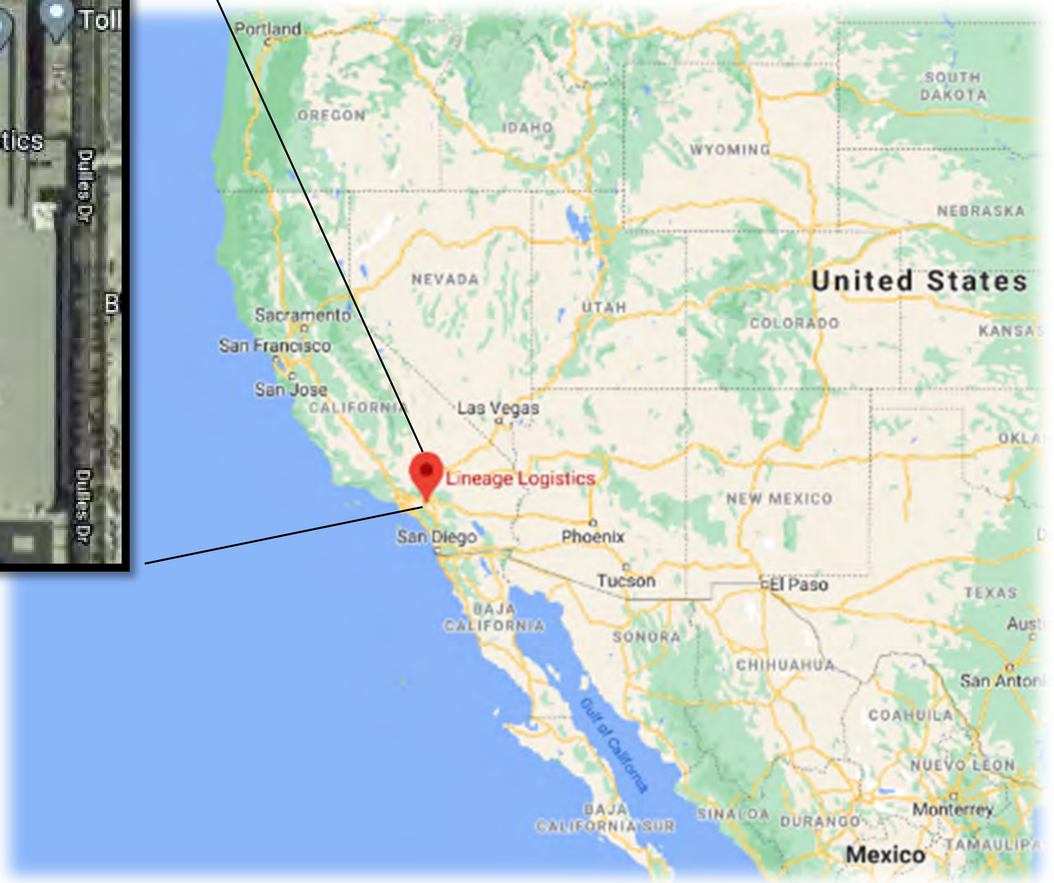
- Over 400 Refrigeration Plants in California
- Power Demand per Site – 250 kW to 4 MW
- Estimated DR Potential – 200 MW to 300 MW available
- Equipment Available for DR
  - Blast freezers: high capacity for fast cooling, reduces damage to food
  - Freezer rooms: for long-term storage of packaged foods: must ensure that temperature remains below a specific setpoint, typically 0°F
  - Additional equipment available for DR… (will be discussed)



Example of Refrigerated Warehouse – Lineage (Mira Loma, CA)

- Regional Distribution Site: Mira Loma, CA
  - 700,000 sq.ft. 24/7 facility
  - **$1M+** annual energy cost
  - **Cold Storage,** High Pressure Processing, Co-pack, Repack & Packaging, other distribution services.
  - **~4MW** maximum demand; normal demand is **~2MW**

Lineage



EPRI

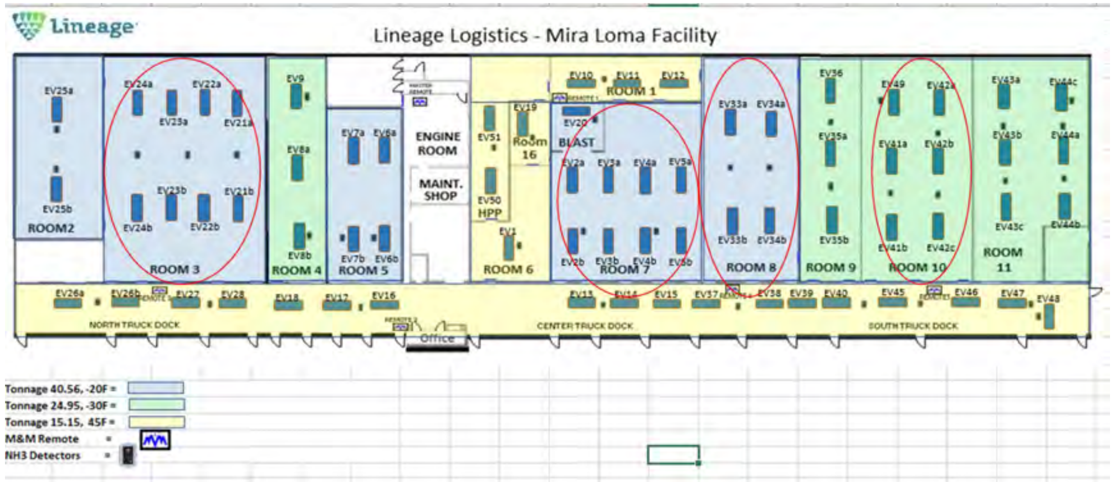
Flexible DR in Industrial Refrigeration at Lineage CEC's EPC-16-026 Project with EPRI

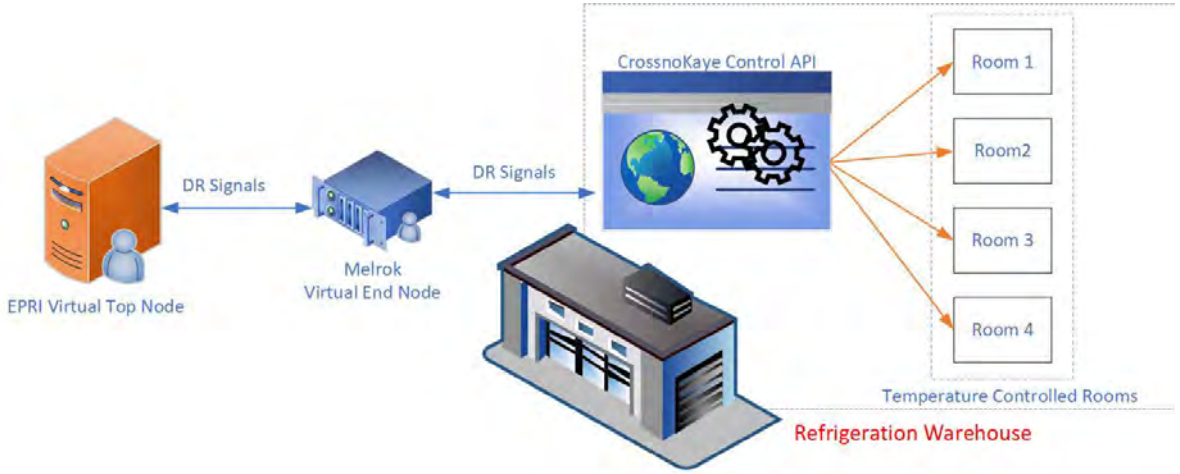
Primary Goal

- Achieve 20% demand adjustment in either direction

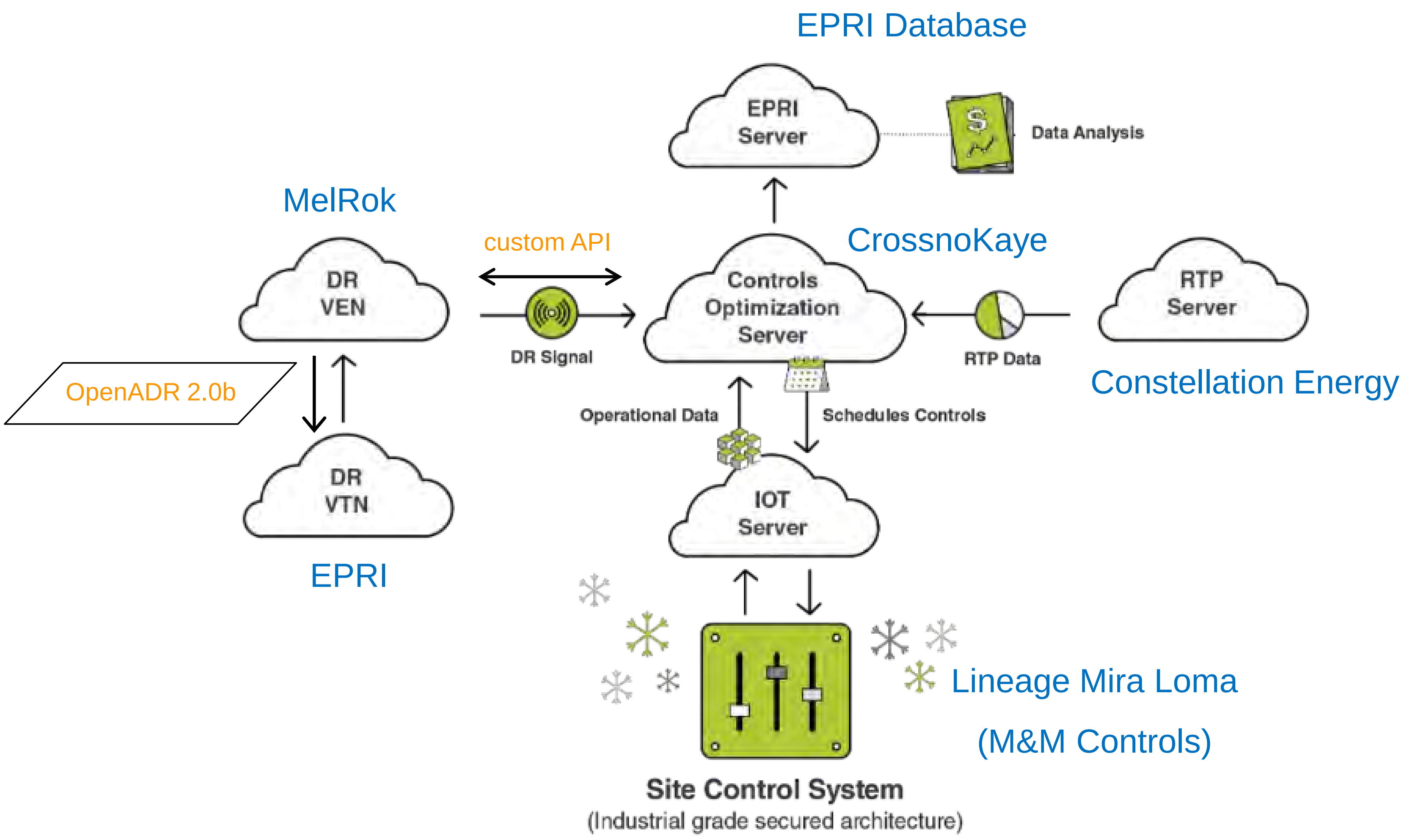
Our approach

- Use frozen rooms as thermal batteries
- Control compressors that serve the frozen rooms
- Use OpenADR 2.0b to send DR signals and receive feedback
- Power up events – reduce temperature setpoint & adjust number of rooms to control magnitude of response
- Power down events – pre-cool frozen rooms prior to event, return temperature setpoint to original value at event



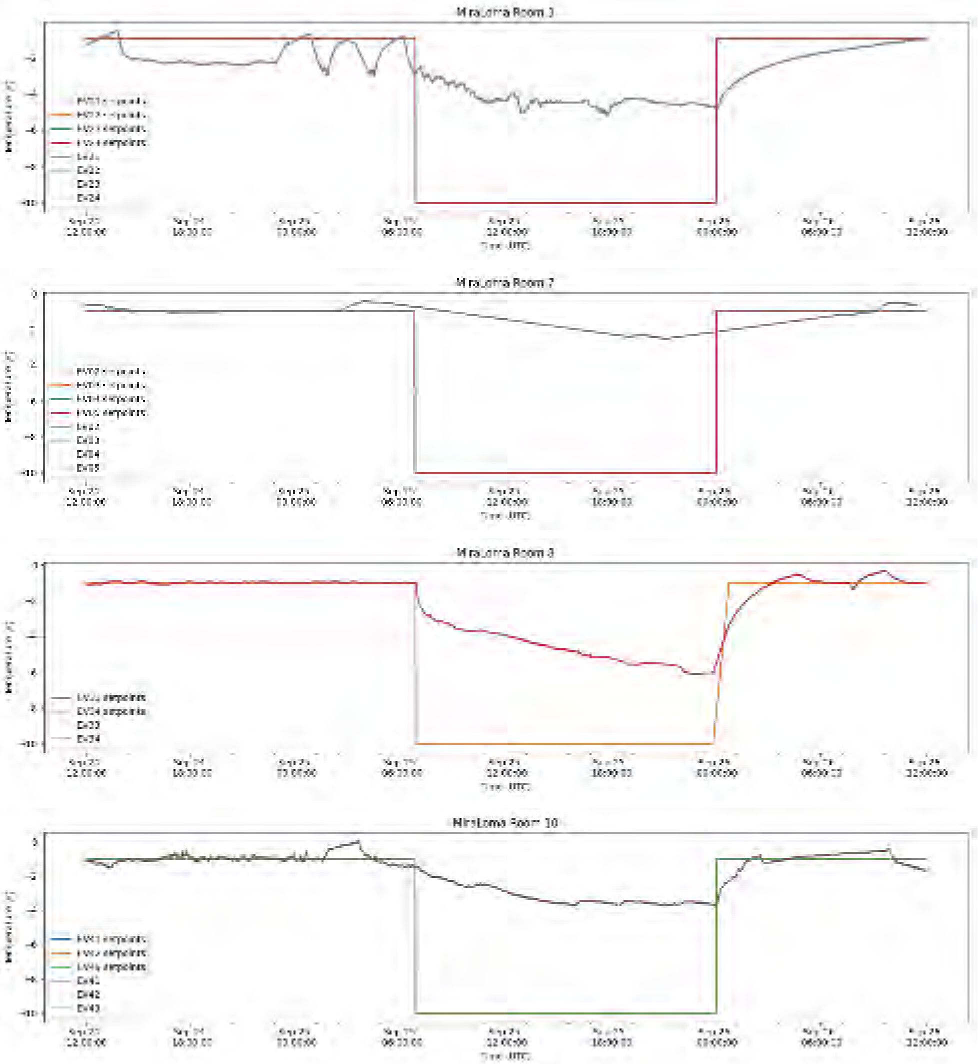


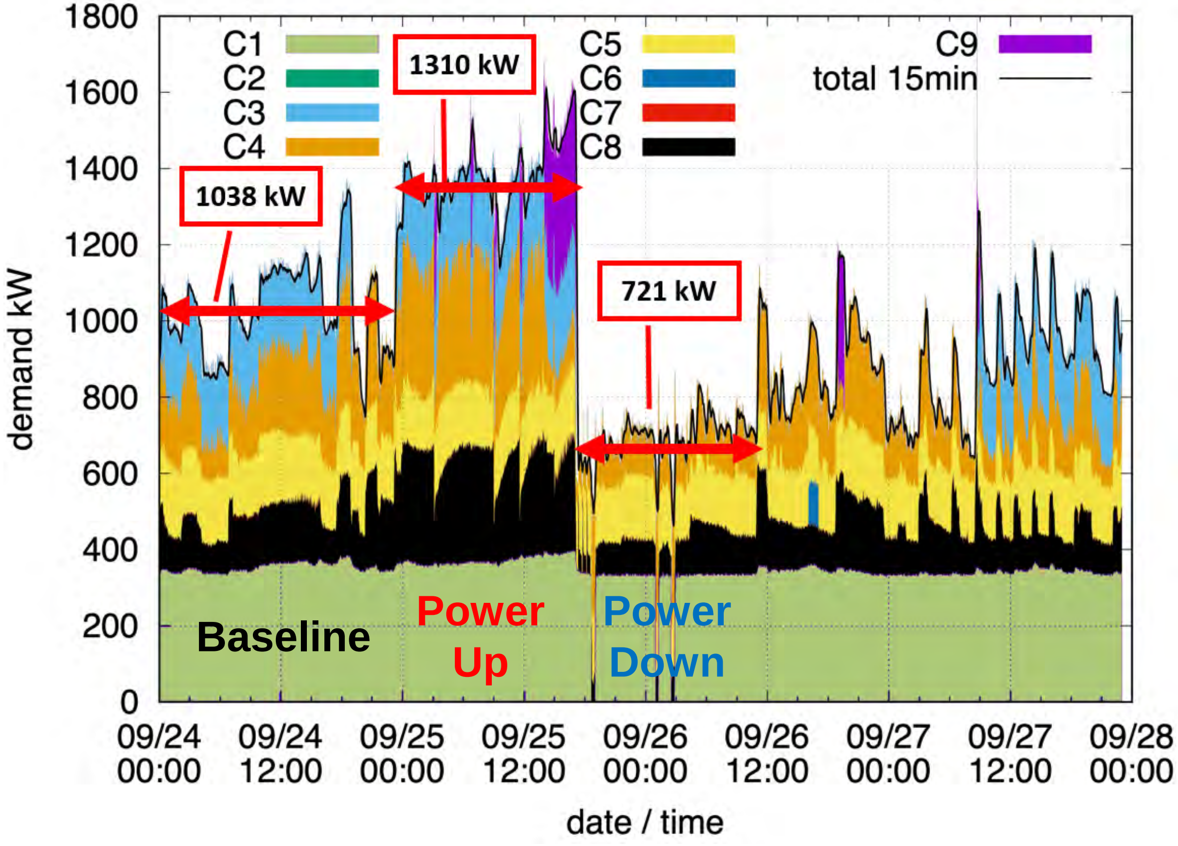
Demand Response Control Architecture



- Our solution required a custom integration with legacy scheduling and controls system
- It is representative of the vast majority of refrigerated warehouses in California and nationwide

The Results of our Improved Control Scheme



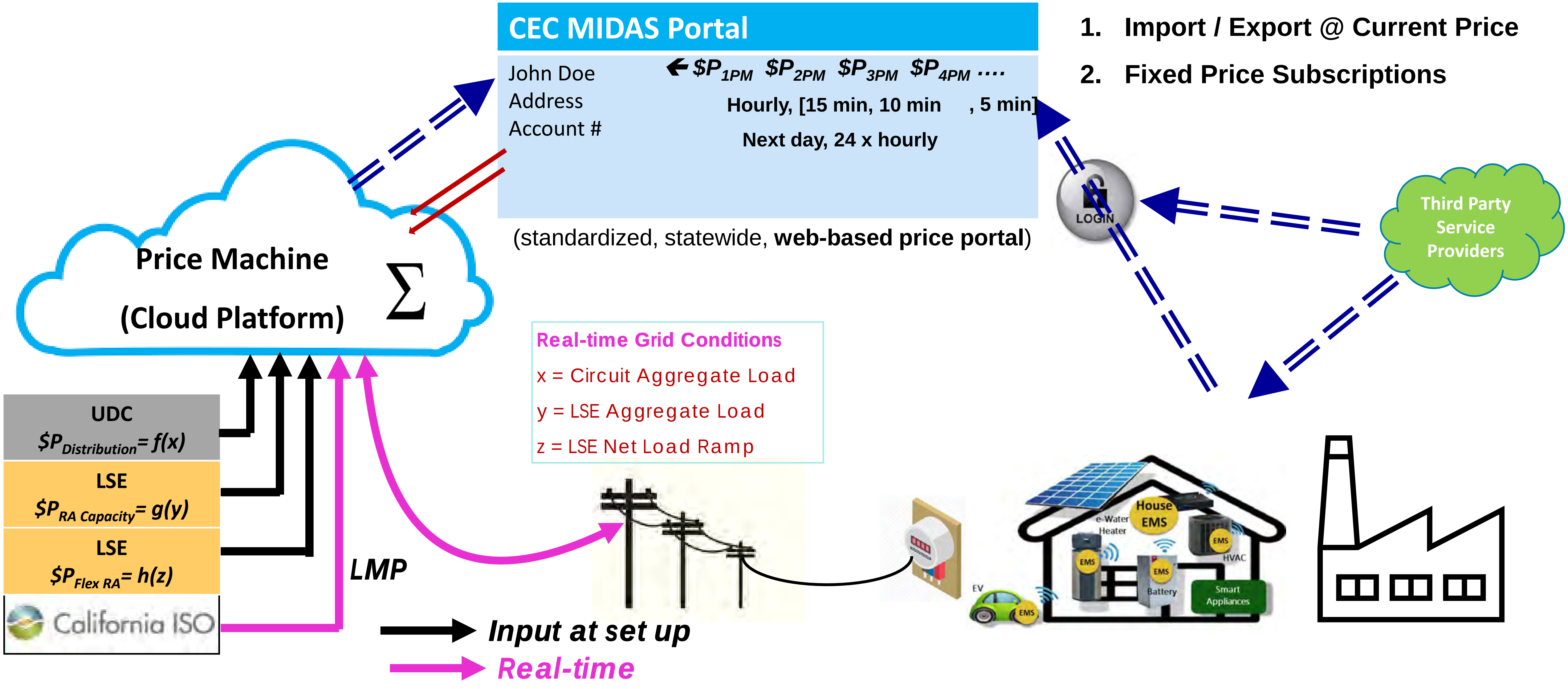


Baseline: 1038 kW

Up: +272 kW (+26.2%)

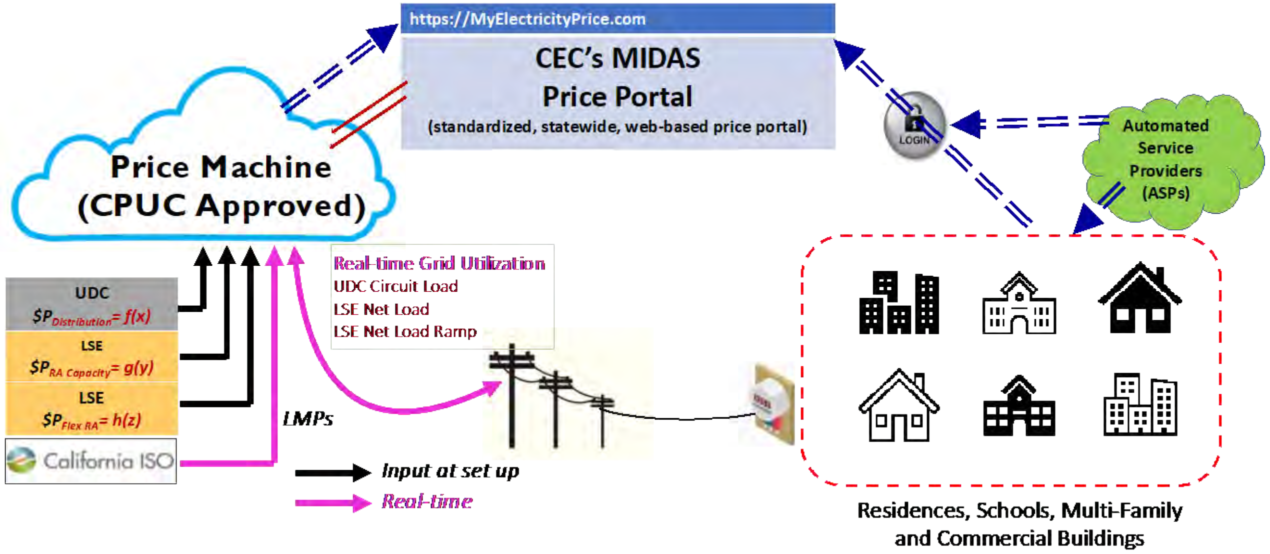
Dn: -317 kW (-30.5%)

NEW PROJECT: Dynamic Rate (aka CalFUSE) Pilot in California



EPRI's Proposal to DOE under GRIP – DynaFLEX

- Implement dissemination of dynamic prices, building from the CalFUSE pilot program, using commercially operational and CPUC-approved price machine(s).
- Utilize the CEC's MIDAS price portal at scale.
- Deploy flexible loads and smart distributed energy resource (DERs) technologies in buildings.
- Deploy local hardware devices capable of accepting signals from the price portal using MIDAS-based web interfaces and standards.
- Demonstrate value to the end-user and the grid through actual results and use cases.
- ***Focus on disadvantaged and underserved communities*** by deploying >40% of hardware and software solutions that can engage in Smart Grid functions in such communities.



Cost-share Partners

EPRI
SILICON VALLEY CLEAN ENERGY
Universal Devices
DAIKIN
ELEXITY
edf Innovation Lab

Questions?

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Together…Shaping the Future of Energy®

Break

Announcements

Q3 2023 Emerging Tech Newsletter

2023 Q3 Emerging Technology Quarterly Newsletter

WHAT'S NEW:

The third quarter of 2023 demonstrated the interest in heat pump technology throughout the region.

The micro heat pump field study concluded and was presented at a Product Council. Participants were pleased with the units' performance, and the technology looks promising for efficient air conditioning and heating. Work is also proceeding on residential dual fuel efforts, testing laundry centers and all-in-one washer-dryers with heat pump dryers, and central gas heat pump water heater (HPWH) research and product testing are also in progress. Scoping work for industrial heat pumps has also begun.

NEEA also completed a Modulating Gas Valve for Commercial Dryer Study investigating the energy savings potential of retrofitting existing commercial gas clothes dryers with modulating gas valves. The region has more than 50,000 commercial dryers and the report revealed potential savings of more than 200 therms per dryer.

Be sure to check out our new projects around monitors, commercial displays, exterior luminaire level lighting controls and our other updates.

Recent Product Councils:

- Heat Pump Rating Representativeness Preliminary Results
- Harvest Thermal Space and Water Heating
- Variable Speed Heat Pump Advanced Features and Capabilities Update
- Micro Heat Pump Field Study Results
- Displacing Central AC with ASHPs for Dual Fuel Energy & Cost Savings

Upcoming Product Councils are always available at https://neea.org/get-involved/product-council.

Please reach out to Eric Olson or one of NEEA's product managers with questions or suggestions on NEEA's emerging technology work. NEEA staff would love to hear from you.

~ **Eric Olson**, Manager, Emerging Technology & Product Management ~

TABLE OF CONTENTS

Questions about this report may be addressed to:
Eric Olson
Manager, Emerging Technology & Product Management
eolson@neea.org

PUBLISH DATE: SEPTEMBER 15, 2023

https://neea.org/resources-reports

- Selected Q3 Highlights
  - Several Product Councils
    - Preliminary results of Heat Pump Rating Representative Project
    - Micro Heat Pump Field Study
    - Modeling results for replacing central AC units with ASHPs with gas-backed furnaces
  - Study for retrofitting commercial has dryers with modulating gas valves
  - All TVs sold in the U.S. must now be tested to the NEEA-developed ANSI/CTA-2037D as TV Test procedure

2023 RETAC Meeting Dates

Q1	Thursday, March 30
Q2	Tuesday, June 27
Q3	Thursday, September 21
Q4	Thursday, December 14

2024 RETAC Meeting Dates (Proposed)

Q1	Thursday, March 28
Q2	Thursday, June 27
Q3	Wednesday, September 25
Q4	Thursday, December 12

Conferences
Product Councils

Conferences

Past Conferences

- ACEEE 2023 Industrial Summer Study – July 2023
- Illuminating Engineering Society Conference – August 2023
- Smart Building Exchange – August 2023
- CEE Industry Partners Meeting – September 2023
- AMCA North America Insites Technical Conference – September 2023
- ENERGY STAR Products Partners Meeting – September 2023
- Design Lights Consortium Controls Summit – September 2023
- Building Owners and Manager Association NW – September 2023

Upcoming Conferences

- WA Association of Maintenance of Operations Administrators Fall Conference – October 2023
- Hydraulic Institute 2023 Annual Conference – October 2023
- NW SEM Collaborative Fall Workshop – October 2023
- NEEP Heating Electrification Workshop – October 2023
- IES Street and Area Lighting Conference – October 2023
- Joint Engineers Conference – November 2023
- GTI Emerging Technology Program Fall Summit – November 2023
- ACEEE Behavior, Energy and Climate Change – November 2023
- HARDI International Annual Conference – December 2023

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Q3 2023 Product Council Presentations

Presenter	Topic	Date Scheduled	Webinar Recording
Christopher Dymond & C+C	Micro Heat Pump Field Study	July 18, 2023	Northwest Energy Efficiency Alliance (NEEA) | Micro Heat Pump Field…
Christopher Dymond & Cadeo Group	VSHP Advanced Features and Capabilities Update	August 1, 2023	Northwest Energy Efficiency Alliance (NEEA) | VSHP Advanced Features…
Pierre Delforge, Harvest Thermal	Thermal Battery System for Heating and Hot Water	August 8, 2023	Northwest Energy Efficiency Alliance (NEEA) | Harvest Thermal -…
UNL, NEEP, BC Hydro, NEEA, DNV	Heat Pump Rating Representativeness Project Update	August 15, 2023	Northwest Energy Efficiency Alliance (NEEA) | Heat Pump Rating…

Integrated Design Lab Product Council Presentations

Presenter	Topic	Date Scheduled	Webinar Recording
Siobhan Rockcastle, U of O	Integrated Design Lab Series: University of Oregon	January 31, 2023	Northwest Energy Efficiency Alliance (NEEA) | Integrated Design Lab…
Damon Woods, University of ID	Integrated Design Lab Series: University of Idaho	February 7, 2023	Northwest Energy Efficiency Alliance (NEEA) | Integrated Design Lab…
Shelby Ruiz, WSU	Integrated Design Lab Series: Washington State University	February 14, 2023	Northwest Energy Efficiency Alliance (NEEA) | Integrated Design Lab…
Chris Meek, Heather Burpee, UW	Integrated Design Lab Series: University of Washington	March 7, 2023	Northwest Energy Efficiency Alliance (NEEA) | Integrated Design Lab…

Upcoming Product Council Presentations

Presenter	Topic	Date Scheduled	Registration Link
NEEA, SkyCentrics, eRadio, Shifted Energy	How Will All These Smart Appliances Talk to the Smart Grid**	October 3, 2023	Registration Link
Geoff Wickes, NEEA Nick Young, AEA	Central Heat Pump Water Heaters: Stories from the Field	October 24, 2023	Registration Link
Christopher Dymond, NEEA Brady Peeks, NW Energy Works	Heat Pump Ready Manufactured Homes and Federal Tax Credits	December 5, 2023	Registration Available Soon
Kevin Amende, Montana State University	Integrated Design Lab – Session 1	December 12, 2023	Registration Available Soon
Jaya Mukhopadhyay, Montana State University	Integrated Design Lab – Session 2	December 19, 2023	Registration Available Soon

**Note: Two-hour session – 10:00 a.m. – 12:00 p.m. PDT

Agenda

9:00 am	Welcome
9:30 am	*New!* EPRI Emerging Technology Update
11:30 am	Break
11:40 am	Announcements
11:55 am	*New!* Heat Pump Update
12:25 pm	Wrap-Up

Residential HVAC

https://commercialhvactoronto.ca/rooftop-units/

Recent and Active Heat Pump Research

- Micro Heat Pumps (aka Window Heat Pumps)
- Best Practices Gap Analysis → CEE Quality Installation Project
- Heat Pump Test Procedure and Ratings
  - Rating Representativeness Project
  - Load Based Testing & Why Metrics Matter
  - AHRI Test Procedure Revision
- Advanced Features and Capabilities
  - Low Load Efficient
  - Cold Climate Capable
  - Minimize Supplemental Heat
  - Connected Commissioning

Advanced Heat Pump Program

- Manufactured Home "Heat Pump Ready"
- Technology Differentiation Investigations
  - Low load efficient hardware differences (started 8/1)
  - Connected commissioning specification workgroup (started 9/14)
  - Multi-zone heat pump performance (pending)
- BPA High-Performance High-Capacity Field Testing
  - ~40 field test units with detailed monitoring
- Expanded EULR field monitoring
  - adding performance monitoring to 20-50 units to capture baseline performance

 |

Window Heat Pumps

Different Shapes and Forms

Window AC

Portable

Saddlebag

 |

Limited Products Available Today (2023)

(Window Heat Pumps - also called window AC w/ reverse cycle)

- Twice as efficient in heating than electric resistance
- Heat Pump only works when outdoor temperature is above 40°F
- Typically cost $700

Portable
(dual hose)

Dual hose is very important to performance

Window AC
w/reverse cycle

Future "Cold Climate Capable" Versions (2024)

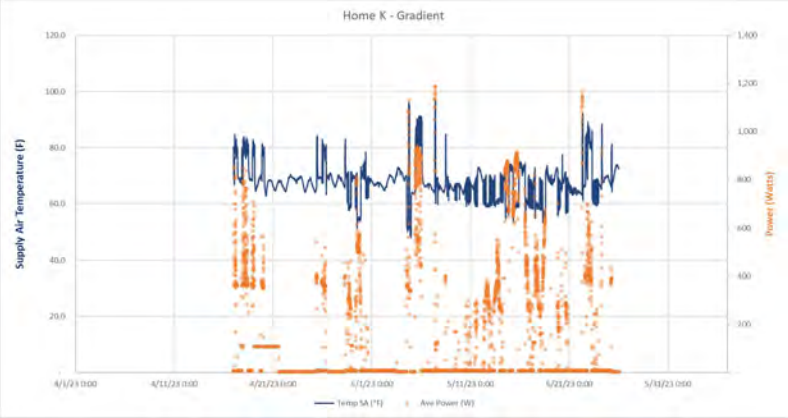
- Much larger size
- Operates when outdoor temperature down to 5F or lower
- Estimated at $3000
- Available in 2025

2023 NEEA Micro HP Research

1. Understand the **customer experience** installing, operating and their expectations of what a window heat pump is and does.
2. **Understand, installation, noise,** and any mechanical limitations that may impact performance or customer experience.
3. Understand how **users changed behavior** such that the window HP displaced heating and cooling from preexisting sources.

Aug 1 - Product Council Presentation Recording

[Northwest Energy Efficiency Alliance (NEEA) | Product Council]



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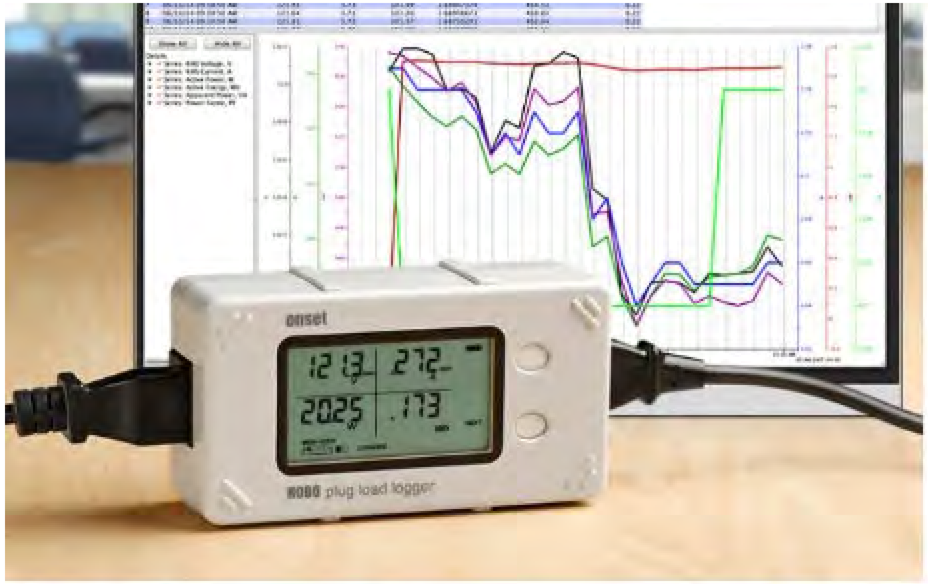
NEEA Field Study

- Phase 1 – Online Interviews
- Phase 2 – Home use test
  - 13 Homeowner installations
  - 6 activities over ~10 weeks
  - Data logging of usage



- 5 “saddlebag” heat pumps
- 4 window heat pumps
- 4 portable heat pumps

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Phase 1 Findings

- Energy and Comfort top priorities
  (Note - efficiency was not top priority once installed)
- Customers already use multiple products to heat and cool their homes – most are familiar with portable products
- 72% completely agree the concept of a dual heat/cool window unit is appealing
- Portability and 120V outlet compatibility drive interest
- Intended use will likely be to improve comfort in rooms or areas not currently well served by existing heating system

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Phase 2 Observations

- Most participants were at least somewhat satisfied across all attributes . Participants were most satisfied with the ease of use , followed by overall heating performance , then noise level
- Units worked as expected
- Although installation was considered easy overall, there were some issues (site specific challenges)
- Once instructed, participants used product for primary heat in space, but w/o guidance they didn’t.
- Potential deal breakers : 40F limit, aesthetics, physical barriers, noise level

Market Challenges

- Condensate water
- Defrost
- Heat from existing sources
- Weight and Size
- Need sash style windows
- Not advertised as heat pumps

Sash Window

Source: Pexels.com

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Pros and Cons

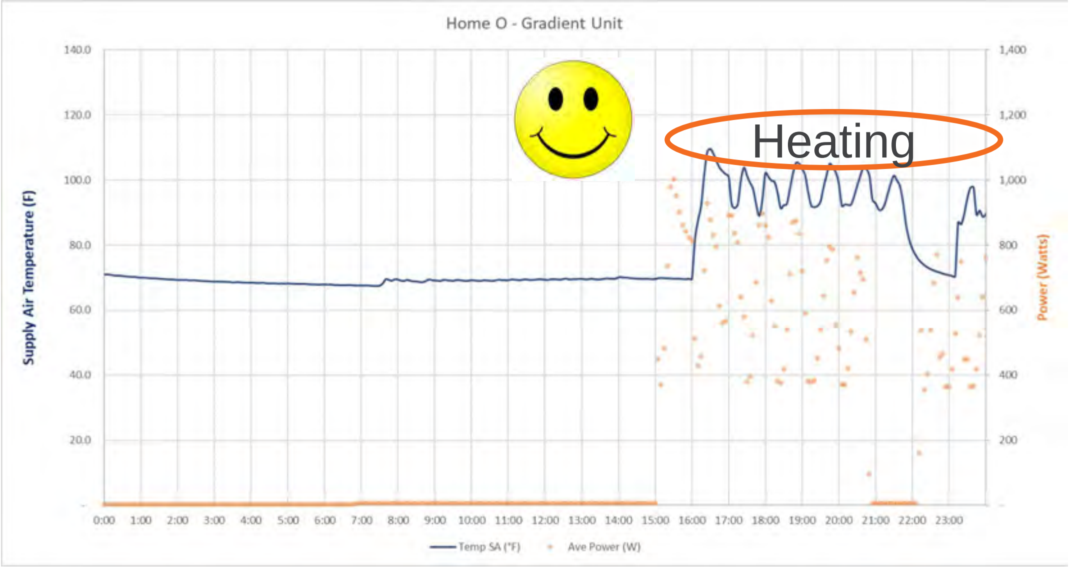
	Window HP	Portable HP	Cold Climate	Ductless
	You can take it with you when you move			
PROs	Retail Purchase – Do it yourself installation			Professional Installation
	smallest	Any Window	Unobstructed view	Comes in larger sizes
	$600-$800	$600-$900	$3,000-$4,000	$4000-$7,000
CONs	Doesn’t heat if outdoor temp is below 41F		Cold climate capable	Full range of operation
	Limited size options			Lots of options
	lowest efficiency		Decent efficiency	Highest efficiency

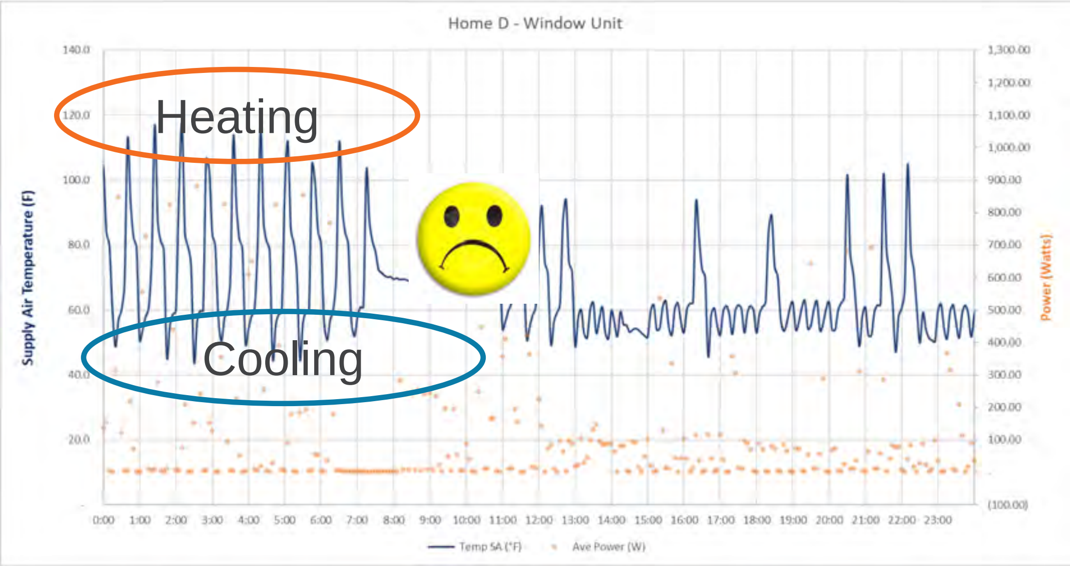
Appropriate Application

- Electric heated home (baseboard or electric furnace)
- Single room with comfort issues
- Rental / Multifamily
- Low and Moderate Income
- Homes without AC
- Sash Windows with
  - Interior and exterior clearance
  - Nearby plug
  - Not on circuit with other large loads

Tricks to get the most value

- Turn down thermostat in room with window heat pump
- Do not use "auto" mode – set it to heat or cool
- Limit setback to 3-4 degrees
- Turn off only when you're gone for more than 24 hours





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Do They Qualify for a Tax Credit?

- Inflation Reduction Act – 30% Tax Credit for heat pumps identified by the Consortium for Energy Efficiency (CEE)
- CEE needs a heating performance rating and database of available products
- No such seasonal heating rating exists

not yet, but likely

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Heat Pump Test Procedures and Ratings

Product Type	DOE Cooling Test Procedure	DOE Cooling Metric(s)	DOE Heating Test Procedure	DOE Heating Metric(s)	DOE Upcoming Changes	Cold Climate Products?
 **Central AC/HP (Split/ Packaged)**	10 CFR 430 Appendix M1 (modification of AHRI 210/240)	SEER2, EER2, Capacity@95F	10 CFR 430 Appendix M1 (modification of AHRI 210/240)	HSPF2, Capacity@47F		Numerous
 **Packaged Terminal AC/HP**	10 CFR 431.96(g) (references AHRI 310/380)	EER, Capacity@95F	10 CFR 431.96(g) (references AHRI 310/380)	COP@47F	NOPR for SCP and SHP published 5/11/23	Ice-Air
 **Single Package Vertical AC/HP**	10 CFR 431 Appendix G (references AHRI 390)	EER, Capacity@95F	10 CFR 431 Appendix G (references AHRI 390)	COP@47F (Option to test at H2 and H3 conditions)	Voluntary Appendix G1 for IEER starting 12/3/23	Ephoca, Ice-Air
 **Portable AC/HP**	10 CFR 430 Appendix CC (modification of AHAM PAC-1)	CEER*, SACC	none	none	Required Appendix CC1 for AEER starting TBD	none
 **Room AC/HP**	10 CFR 430 Appendix F (modification of AHAM RAC-1)	CEER*, Capacity@95F	none	none		Gradient, Midea, others coming soon

*PACs and RACs have different definitions of CEER

Estimated Timeline for Cold Climate Window Heat Pumps

- 2023
  - Industry is finalizing designs of cold climate systems
  - Manufacturers and DOE are developing an interim test and rating for EPA
- 2024
  - Pilots and field testing (Various organizations)
  - Interim ratings and tax credit criteria determined
- 2025
  - ENERGY STAR Rating and database
  - CEE will evaluate available ratings and establish minimum criteria

Heat Pump Test Procedure Changes

May 2023 - DOE asked AHRI for help

- Address known Issues in test procedure to improve representativeness of the ratings
- Non-AHRI members participated (PG&E, NEEA, ASAP, Energy Solutions)
- Get it done by August 31st
- 13 full day meetings
  (11 of which in person)
  plus subgroup meetings

	Topic	Subtopic	June 12/13 – PG&E	July 12/13 – DC	July 26/27 - DC	Aug 9/10 – DC	Aug 29/30 - DC
NEAR	CVP		Deep dive #1 – Stem	First draft	Second draft	Final	
	CCHP		Deep dive #2 – GH	First draft	Second draft	Final	
	"Minor"	Low static		First draft	Second draft	Final	
	"Minor"	Cut-in / cut-out		First draft	Second draft	Final	
	"Minor"	A2L fan power	Dive #14 - JB	First draft	Second draft	Final	
	"Minor"	"Other"		First draft	Second draft	Final	
LONG	HP	Strip heat dfst	Deep dive #3 – Berry		First draft	Second draft	Final
		Strip heat supp	Deep dive #4 – Chad		First draft	Second draft	Final
		Dem dfst credit	Dive #10 – DW/EB		First draft	Second draft	Final
	Full season	Standby/off	Dive #11 – GH/KM/JB		First draft	Second draft	Final
		Shoulder fan pwr	Dive #12 – GH/KM/JB		First draft	Second draft	Final
		Bin weights	Deep dive #5 – GH/KM/JB		First draft	Second draft	Final
		Load lines	Deep dive #6 – GH		First draft	Second draft	Final
	CCHP	CCHEI	Deep dive #9A - GH		First draft	Second draft	Final
		Size for heating	Dive #13 – HY		First draft	Second draft	Final
	Coil only	Default watts	Deep dive #7 – BB/DW		First draft	Second draft	Final
		Floor	Deep dive #8 – BB/DW		First draft	Second draft	Final
	Hybrid		Deep dive #9B - CK		First draft	Second draft	Final
	IDDB/IDWB						
	Dehumidify		Dive #15 - JB		First draft	Second draft	Final
	"Minor"	"Other"			First draft	Second draft	Final

Template for survey - GH

NEEA Hosted 2-days

Members present, constituting a quorum were:

2050 Partners	John Bade
Aaon	Kevin Teakell
Appliance Standards Awareness Project	Rachel Margolis
	Joanna Mauer
Allied Air	Dave Winningham
Allstyle	Justin Martin
Bosch	Armen Davtyan
	Jonathan Lau
	Sudarshan Sekar
Bruce Harley Energy Consulting LLC	Bruce Harley
Carrier	Chad Kirkwood
	Pat Riley
	Jason Thomas
Copeland	Gary Clark
Daikin	Bob Berry
	Kevin McFadden
	Rusty Tharp (Chairman)
	Hiroshi Yoh
Energy Solutions	Laura Degitz
	Aniruddh Roy
Fujitsu	Ned Bent
	Arturo Thur de Koos
GD Midea Air-Conditioning	Yinshan Feng
	Greg Thomas
GD Midea Heating & Ventilating	Lily Huang
	Marc Neufcourt
Guidehouse	Benjamin Andrews
	Ali Kazmi
	Saad Saleem
	Detlef Westphalen
Hadley Energy Engineering LLC	Adam Hadley
Intertek	Anthony Cacciotti
	Byron Horak
Johnson Controls, Inc.	Jeff Nichols
Lennox	Eric Berg
Mitsubishi Electric	Jeremy Tidd
Mortex	Gary Patterson
National Comfort Products	Jeff Bauman
	Zehdan Qidwai
NEEA	Nicky Dunbar
	Christopher Dymond
	Kevin Rose
Nortek	Majid Emadi
	Andrew Larson
PG&E	Mark Alatorre
	Mary Anderson
Purdue	Parveen Dhillon
Rheem	Scott Creamer
	Harshad Inamdar
	Swapnil Khaire
Samsung	Chandra Gollapudi
	Matt Wall
Shec	Aiguo Li
Stem Integration	Mike Stem
Trane	Darryl Denton
	Judd Jackson
	Aaron McCloud
	Dominique Schaefer Pipps
	Jeff Stewart

NEEA Priorities

- NEAR TERM
  - Load Based Controls Verification Procedure
  - More Equipment Data
    - AHRI certification includes 4-corners test data
    - Cd Value used in rating (Default or reported)
  - Cold Climate HP definition
  - Dual Fuel Metric
- LONGTERM
  - Full Season Metric
    - Standby
    - Bin-hours – national climate
  - Test adds Defrost ER energy
    - during defrost and duration of ER

2025 Impact

Cold Climate Heat Pump Definition

- Both low-temperature compressor cut-out and cut-in temperatures are specified to be less than 5 °F
- The capacity for the H4full test (at 5 ºF) is certified to be at least 70% of the capacity for the nominal full capacity test conducted at 47 ºF (H1Full or H1Nom).

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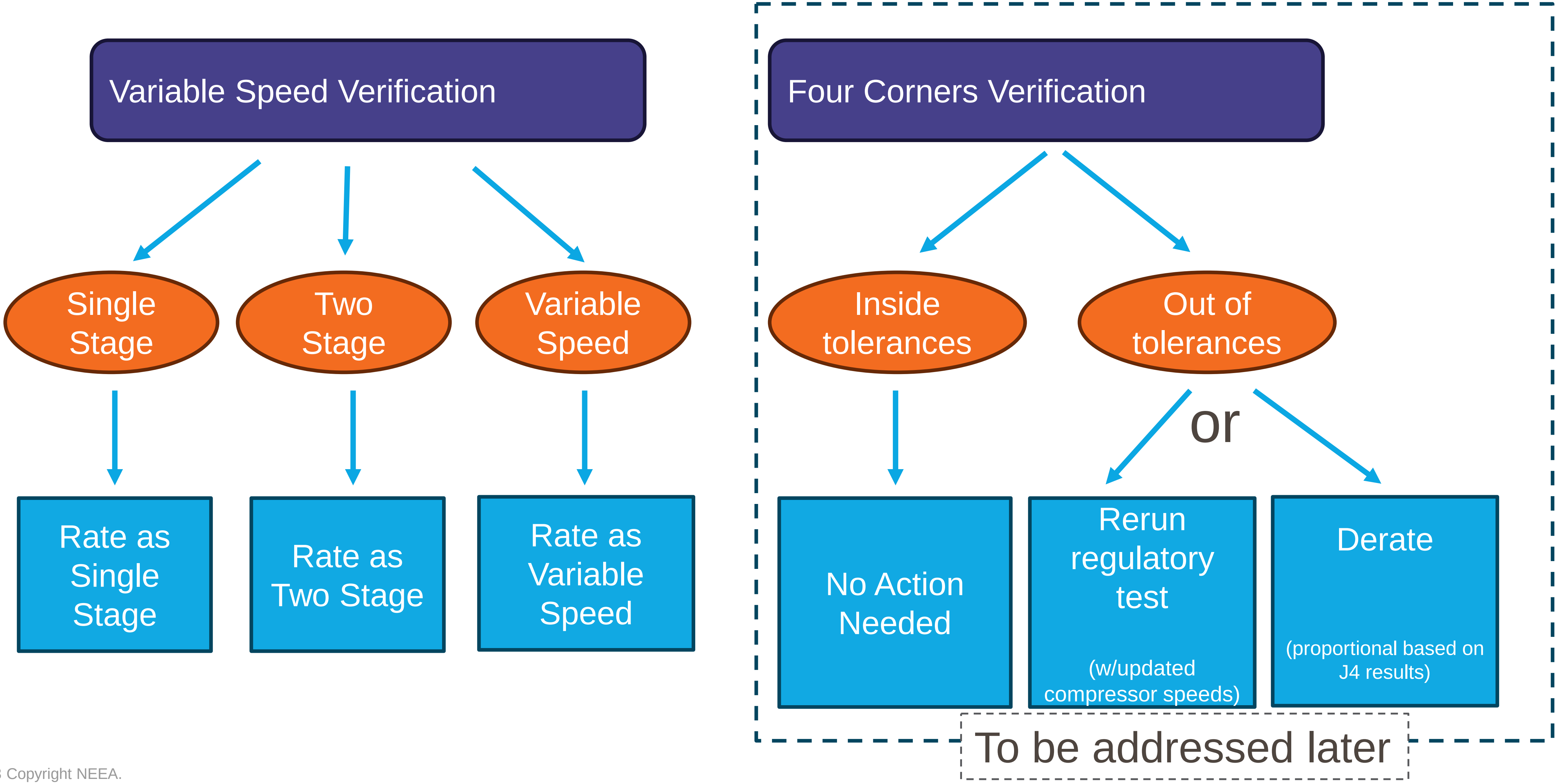
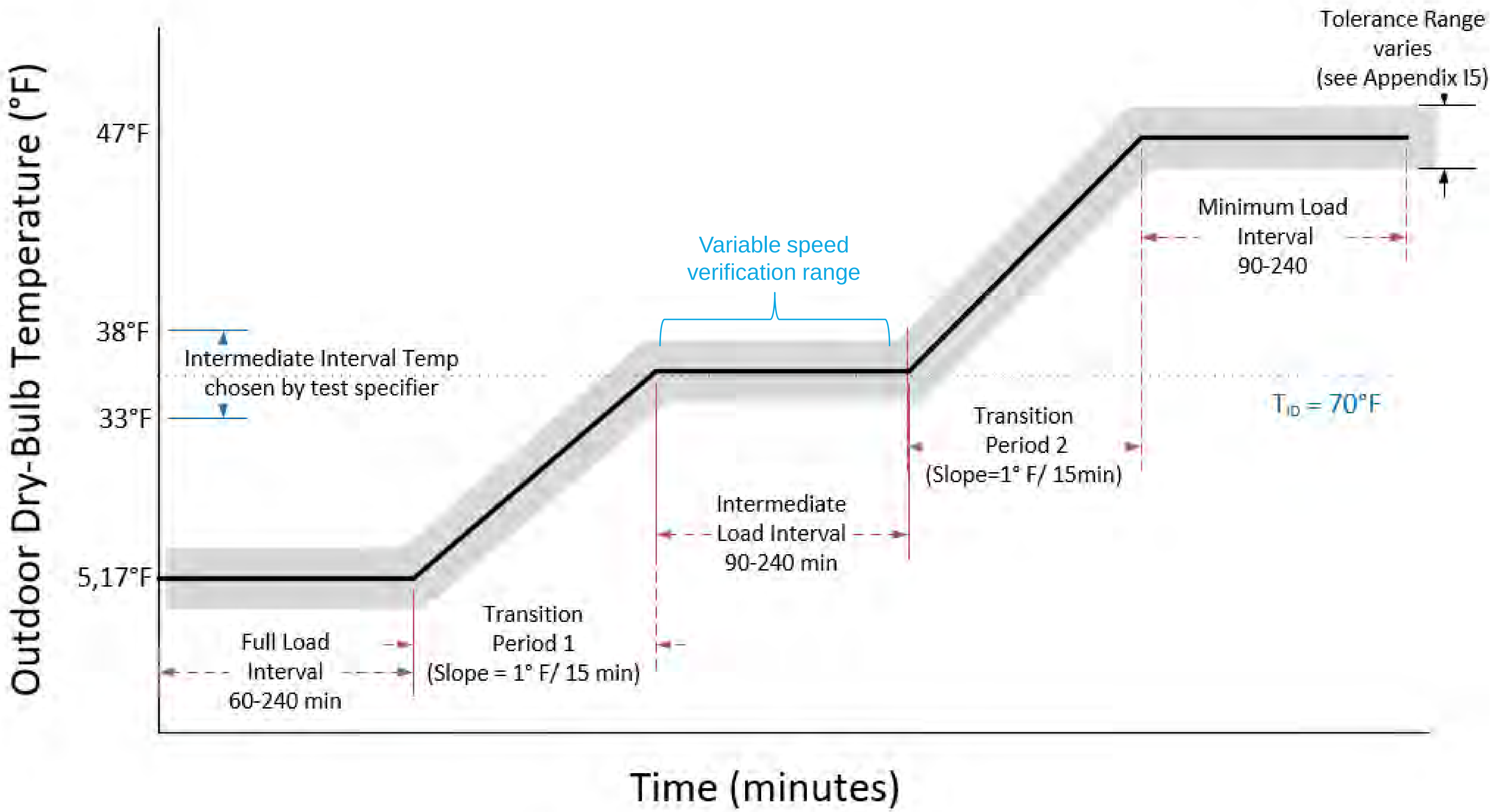
2025 Impact

Controls Verification Procedure



2025 Impact

CVP Load Based Testing of Controls - Heating



2025 Impact

Dual Fuel Metric

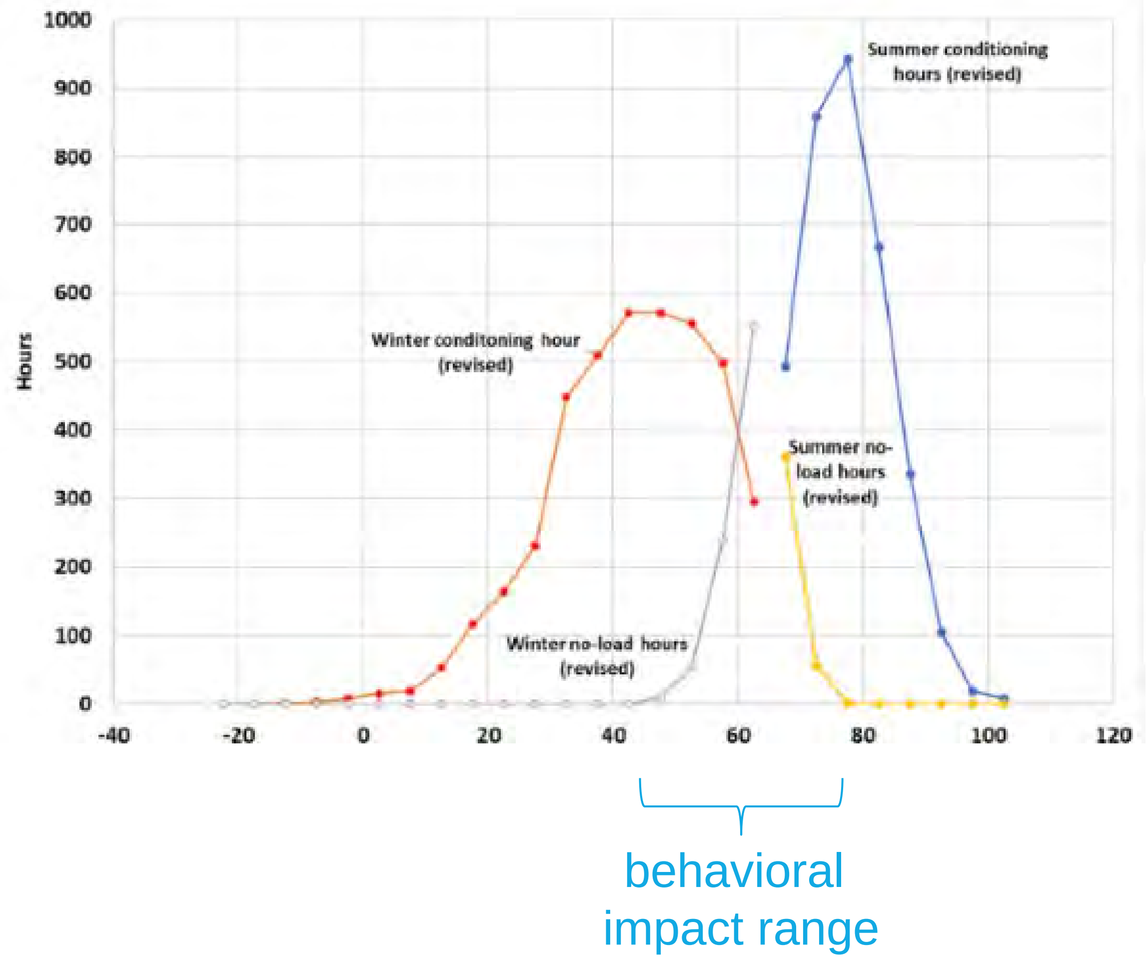
$$DFUE = \frac{TQ_{Furn} + TQ_{HP}}{(TGE_{Furnace} + TBE_{Furnace} + TE_{HP}) \cdot 3.412} \cdot F_{def}$$

- Uses HSPF and AFUE values to generate a “DFUE” which is a dual fuel AFUE approximation
- Switchover point is calculated when the heat pump can not meet 100% of the load
- The load line that determines the switchover point is based on furnace size. Smaller furnaces will therefore have larger DFUE values
- Intended to provide customer guidance, not be representative of any specific application

2029+ Impact

Full Season Metric

- More accurate accounting of Standby & Off-Mode Power, Crankcase Heaters & Other Auxiliary Components
- Drain Pan Heater still excluded
- Updated bin-hour weightings to be based on national averages
  - United States Climate
  - Canadian Climate



E-Heat during Defrost Heat

- Extra Heat
  - 1-7% decrease in HSPF
  - Based on Daikin modeling
- Overrun Heat
  - 1-10% decrease in HSPF
  - Based on BPA field data

Daikin Plot

These are estimates for systems that run the indoor fan, if fan is not run, there would be 0% decrease in HSPF

Defrost Impact Added To Test Procedure

- Applied to seasonal metric like the demand defrost modifier (Fdef) based on manufacturer attestation of how their system runs

F_{def} = 1.03 — If demand defrost criteria is met

- F_H = 0.98 — If ER is used during defrost mode (fan could be on)
- F_O = 0.98 — If ER is used during defrost and continues more than 60 seconds after the compressor starts in heating mode
- HSPF = HSPF x F_{def} x F_H x F_O
- This will encourage default settings to avoid ER and enable data gathering that can refine future (post 2029) versions of the test procedure and rating

Sensible Heat Ratio – Max Fan Setting

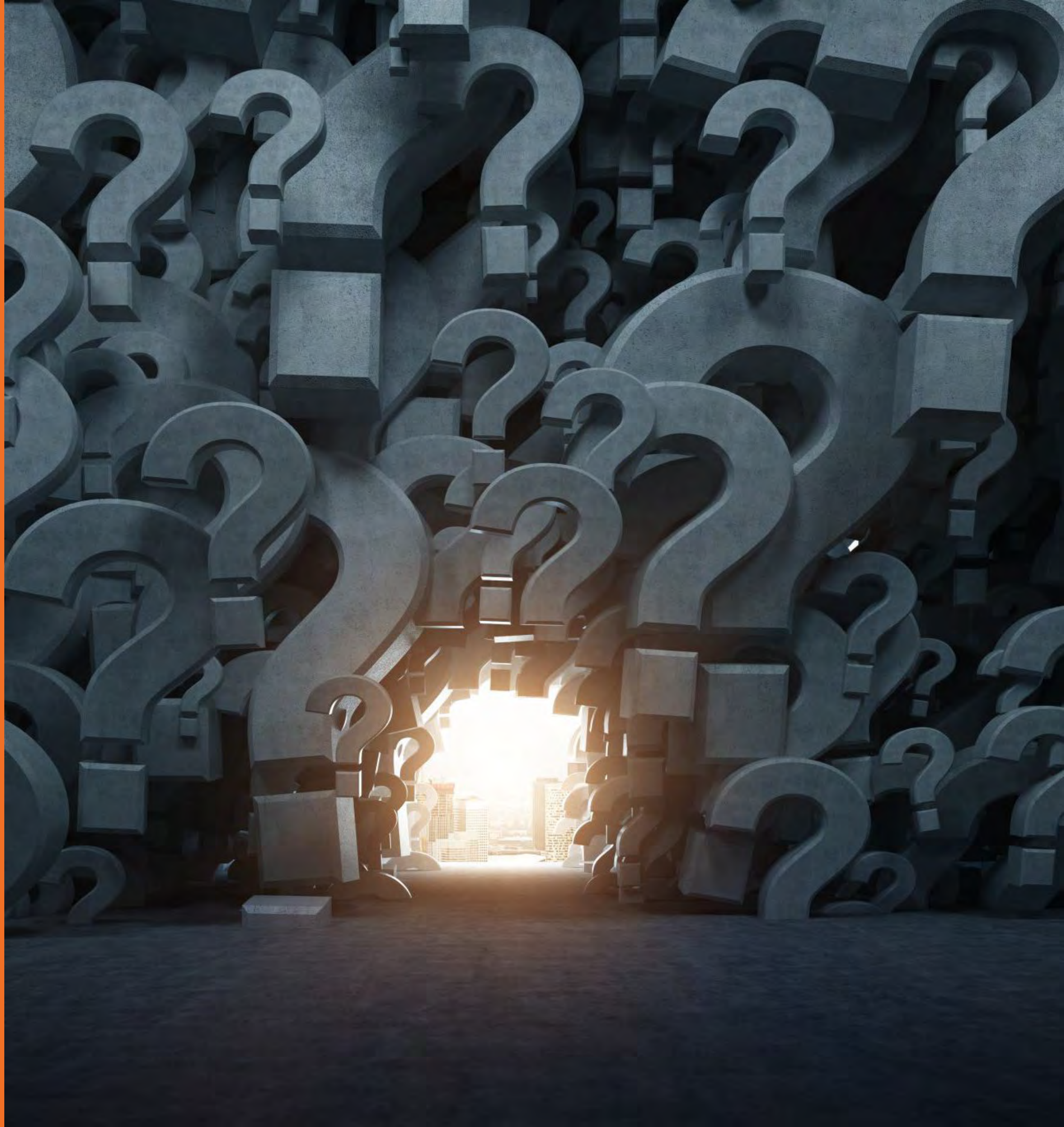
- Currently - some variable speed currently test at low load with fan at full speed (>1000 cfm/ton) which distorts SEER values and tests with very high sensible heat ratios
- The proposed fix to the test procedure is to limit the maximum airflow during Full load 450 cfm/ton, all other loads are limited to 600 cfm/ton
- Likely Impact – SEER values will be compressed a bit – this is good because in reality:
  - Fans generally do not run at max power a full during low loads
  - Customers lower the setpoint when they want dehumidification (they don't turn down the fan speed)

New Test Procedure and Rating

- Future standard will be called AHRI 1600
- Future ratings will likely be called (not finalized)
  - SCORE = Seasonal Cooling Efficiency
  - SHORE = Seasonal Heating Efficiency
  - DFUE = Dual Fuel Seasonal Efficiency
  - EER3 = Energy Efficiency Ratio at 95F full load

https://www.csagroup.org/store/product/2705295/ (view access for Canadians)

Questions and Discussion



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CLOSING

- ❑ *Public Comments/Q&A*
- ❑ *Poll Questions*

How did we do this quarter?

1. **What's one thing you appreciated about this meeting?**
2. **What would you like to see at a future meeting?**

If the poll didn't work for you, please let us know in the chat box what the problem was: if you used the app or browser, and the error message you got, if any.

Thank You!!