AESP Technology Lightning Round

February 29, 2024

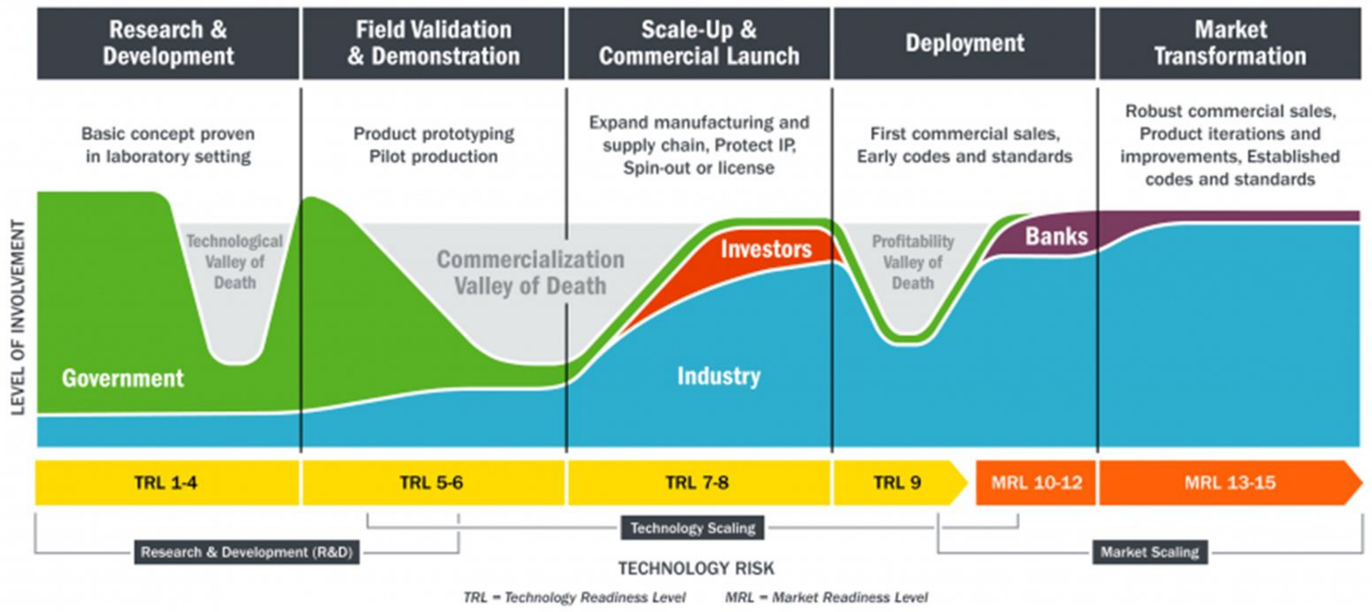
CalNEXT
ENERGIZING CALIFORNIA'S FUTURE

AGENDA

1. **Introductions and CalNEXT Overview**
   10:00 – 10:15 AM PT
2. **Completed Decarb/Load Management Projects**
   10:16 – 10:27 AM PT
3. **Ongoing Decarb/Load Management Projects**
   10:28 – 10:39 AM PT
4. **Q&A**
   10:40 – 11:00 AM PT

What is CalNEXT?

CalNEXT is the California IOU's Statewide **Electric** Emerging Technologies Program. Our program is designed to serve the IOUs with new research to expand the IOU portfolio.



Size: IOU service territory (~2/3 CA residential customers)

Annual Projects: 43, across 3 project types

Energy Solutions veic aesc CELEBRATING 30 YEARS ORTIZ THE ORTIZ GROUP TRC UCDAVIS UNIVERSITY OF CALIFORNIA

Getting to Scale

CalNEXT – ENERGIZING CALIFORNIA'S FUTURE

- New Construction & Custom Programs
- Measure Package Development / IOU Programs
- Market Transformation
- Building Codes (Title 24) & Appliance Standards (Title 20 | DOE | ENERGYSTAR®)

Project Types

Technology Support Research (32 projects/yr)

Technology Development Research (8 projects/yr)

Focused Pilots (3 projects/yr)

Technology Priorities

- Appliances & Plug Loads
- HVAC
- Water Heating
- Process Loads
- Lighting
- Whole Buildings

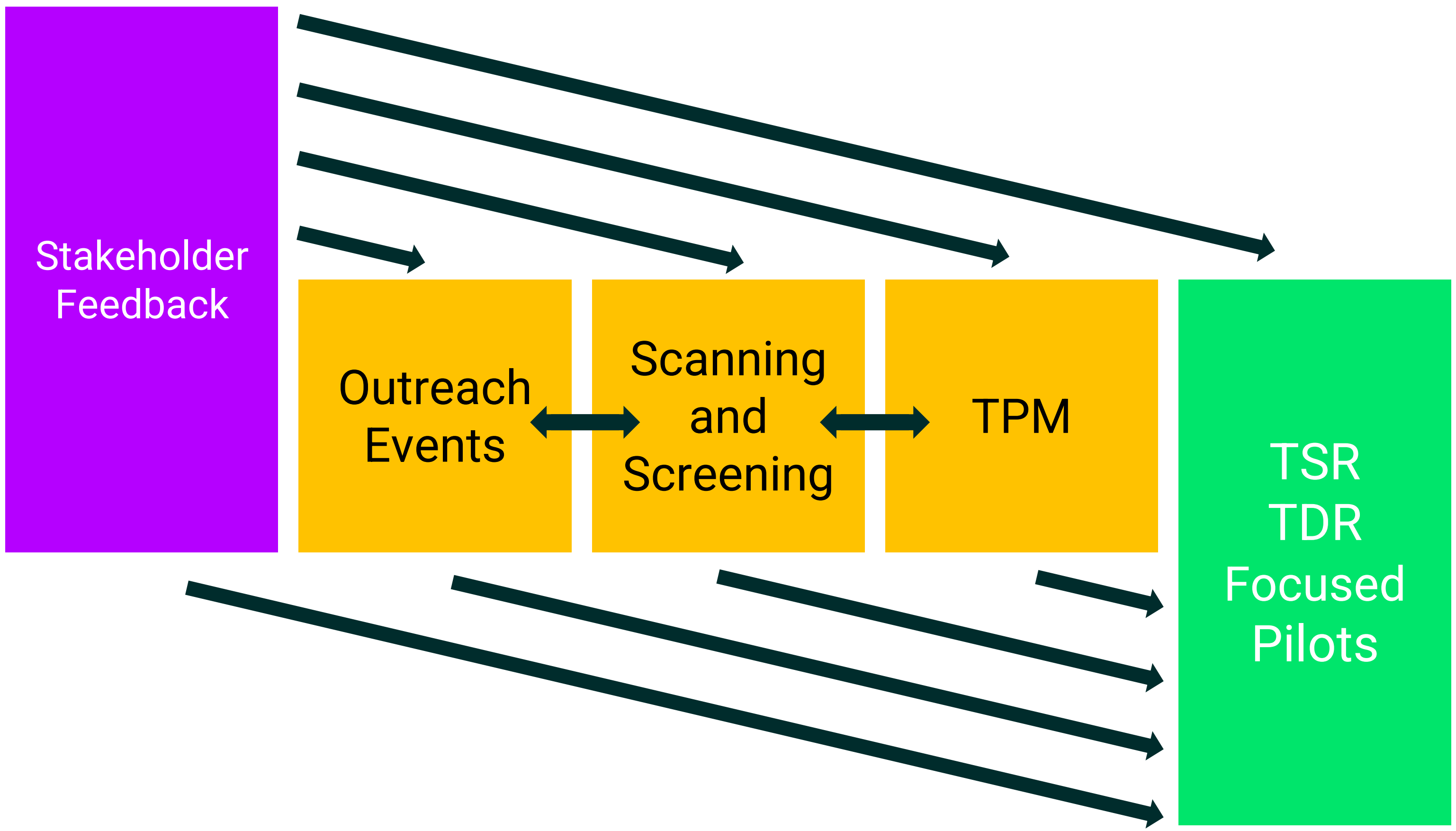
CalNEXT Program Overview

Technology Priority Maps (TPMs):

- HVAC
- Plug Loads and Appliances
- Water Heating
- Lighting
- Process Loads
- Whole Building

Project Types:

- Technology Support Research (TSR)
- Technology Development Research (TDR)
- Focused Pilots



Approved Projects

Projects that have been reviewed by the CalNEXT Program team using our review criteria and accepted by the Program Administrator are listed here. Statuses will be updated at least monthly and Final Reports will be linked when available. Listed Completion Dates are estimates and will be updated if needed.

Projects are filterable by Technology Area (based on the TPMs) and Project Type. They are also sortable by any column and searchable by any keyword.

To view all past and current California statewide emerging technology projects and reports, please visit the Emerging Technologies Program Portal or the Emerging Technologies Coordinating Council websites.

Technology Area | Project Type

Search:

Project Name	Project Number	Technology Area	Project Type	Status	Completion Date
▶ All-Electric Commercial Kitchen Electrical Requirements Study Evaluation	ET22SWE0010	Process Loads	TSR	Complete Final Report	Dec 2022
▶ Commercial and MF CO2-based Heat Pump Water Heater Market Study and Field Demonstration	ET22SWE0017	Water Heating, Whole Buildings	TSR	Complete Final Report	Dec 2023
▶ Market Potential for Heat Pump Assisted Hot Water Systems in Food Service Facilities	ET22SWE0019	Water Heating	TDR	Complete Final Report	Jun 2023
▶ Variable Refrigerant Flow (VRF) Refrigerant Management Market Assessment	ET22SWE0020	HVAC	TSR	Complete Final Report	Nov 2023
▶ Residential Multi-Function Heat Pumps: Product Search	ET22SWE0021	Whole Buildings	TDR	Complete Final Report	Dec 2022

Completed Decarbonization and Load Management Projects

AESC — Industrial Heat Pumps Market Study

TRC — Market Potential for Heat Pump Assisted Hot Water Systems in Food Service Facilities

VEIC / The Ortiz Group — Market Study of Household Electric Infrastructure Upgrade Alternatives for Electrification

ET23SWE0036

Industrial Heat Pumps Market Study

Project Team: Colin Lee (AESC), Derick Baroi (AESC), Akane Karasawa (ASK Energy)

Presenter: Colin Lee, Senior Engineer at AESC Inc.

TPM Domain: Process Loads

Technology Family: Steam & Hot Water Systems

Project Type: Technology Development Research

Project Scope

The scope of the technology and market assessment was to:

1. Size the potential market of industrial heat pumps (in CA),
2. Identify the highest benefit applications and locations,
3. Identify commercial and pre-commercial technologies and manufacturers,
4. Identify technology feasibility including technology and market barriers and opportunities, and
5. Recommend utility interventions to support market adoption.

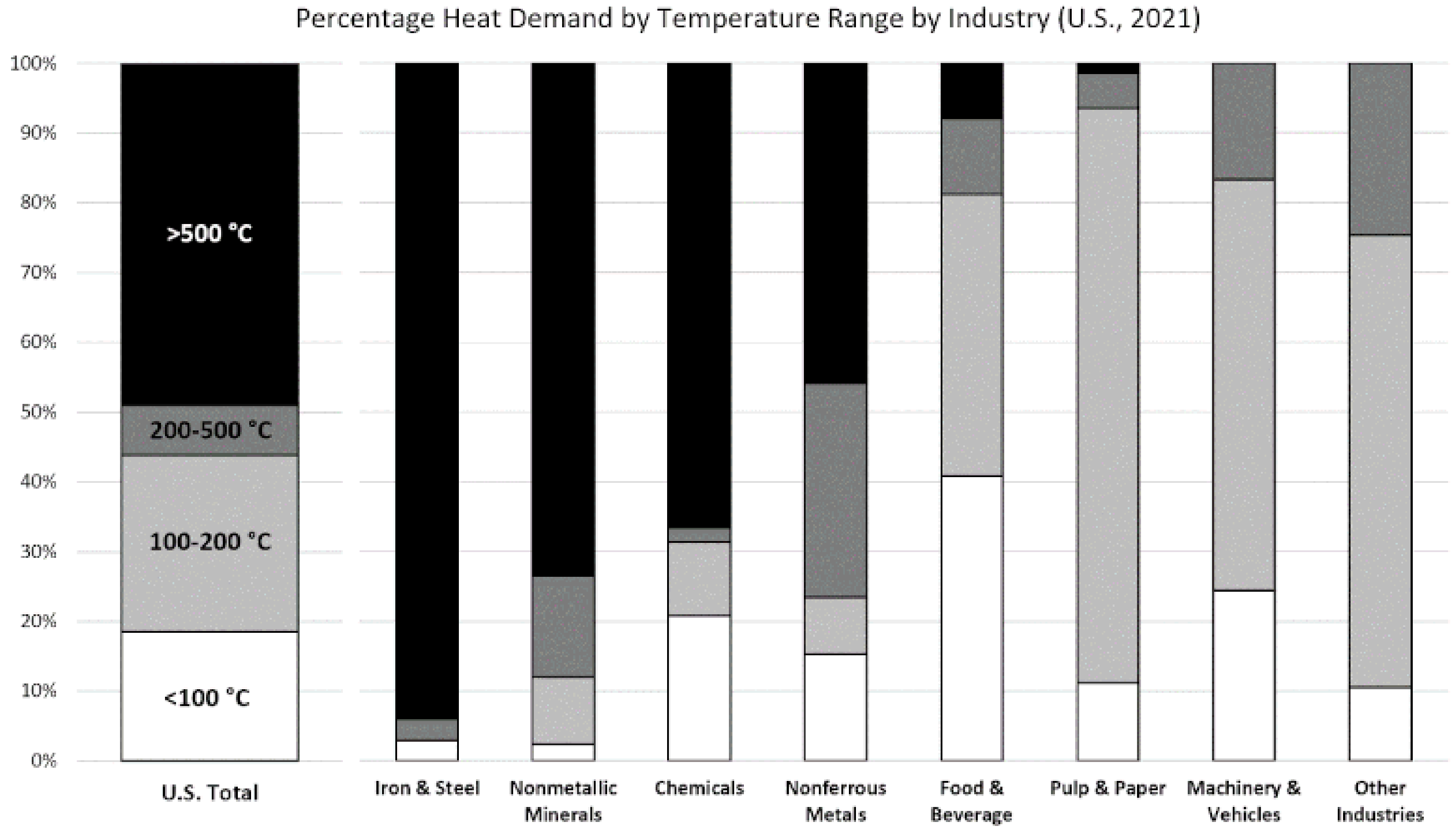
Target Audience: Stakeholders interested in industrial energy efficiency, decarbonization/electrification, technology manufacturers, and/or industrial technology market adoption.

Background

Roughly 35% of industrial heat needs are at temperatures up to 165°C, the maximum temperature that can be supplied by commercialized industrial heat pumps

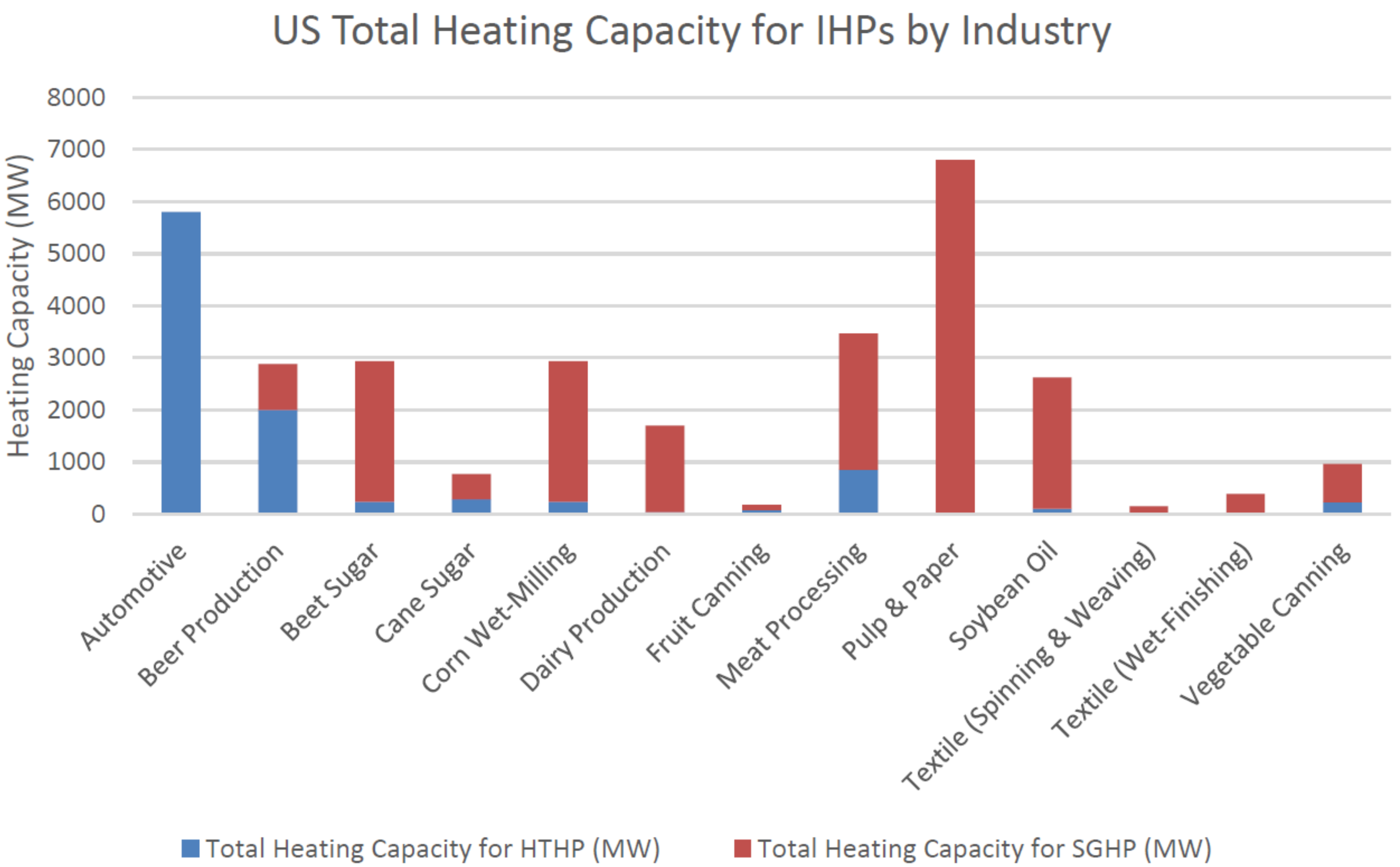
If supplied with electricity from zero-emissions sources, such as solar, wind and nuclear power, this heat can be emissions-free.

This would reduce U.S. CO_2 emissions by 344 million metric tons per year, about 7% of total U.S. energy-related CO2 emissions.



Source: Rissman, J., 2022. Decarbonizing Industrial Heat via Heat Pumps. https://www.industrialheating.com/articles/97313-decarbonizing-industrial-heat-via-heat-pumps
Data sources: Fraunhofer Institute, U.S. EIA

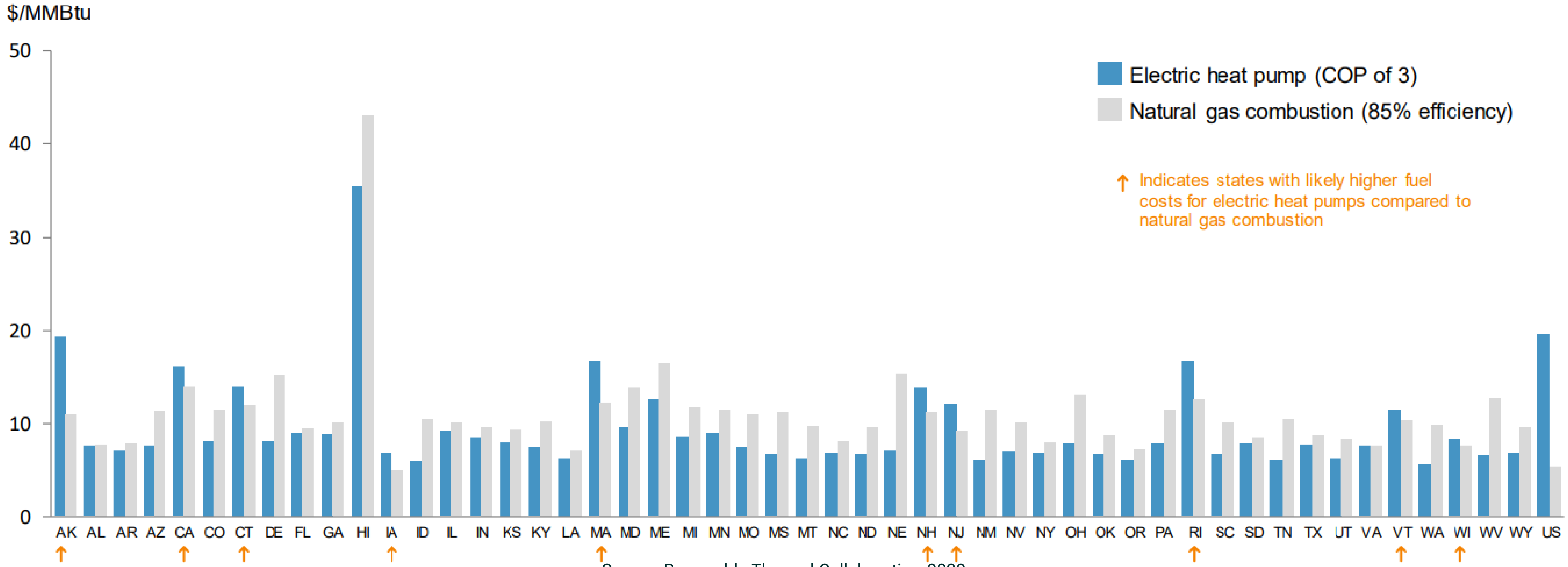
Key Findings



Source: AESC Inc.; Data Source: Zuberi et al., 2022

Key Findings

A higher spark spread signifies higher electricity prices compared to natural gas prices in the region, and therefore lower cost savings when fuel switching from natural gas to electricity.



Source: Renewable Thermal Collaborative, 2022

Key Findings

High Value Applications:

Operational Cost Savings - Due to the greater energy efficiency of IHPs compared to traditional boilers, there are some high value applications that can reduce operational costs enough to achieve a reasonable return on investment. E.g. electric boiler systems, facilities that purchase steam, facilities with high-cost fuel boiler systems, recycle heat from other processes, etc.

…More in the Final Report!

Final Report

Available Here:

- CalNEXT Website: https://calnext.com/wp-content/uploads/2023/12/ET23SWE0036_Industrial-Heat-Pump-Market-Study_Final-Report.pdf
- ETCC Website: https://ca-etp.com/node/13515

Potential Complementary Research

- Pilot deployments and M&V studies on industries never studied before
- Technology R&D on increasing applications of industrial heat pumps (increasing temperature lift, reducing equipment size, low-GWP refrigerants, etc.)
- Studies on niche applications of industrial heat pumps (industries not covered in this project)

Thank you to the AESC Team.

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ET22SWE0019

Market Potential for Heat Pump Assisted Hot Water Systems in Food Service Facilities

Project Team: Marc Fountain, Marian Goebes, Amin Delagah, Grant Marr, Yolanda Beesemyer, Pratap Jadhav (TRC)

Presenter: Abhijeet Pande, TRC

TPM Domain: Water Heating, Commercial

Technology Family: Heat Pump Water Heating

Project Type: Market Characterization

Background

- Commercial Food Service water heating - 90% gas-fired systems at an estimated 340 Mtherms of gas use per year
- Heat pump water heating (HPWH) provides a path to decarbonization
  - Literature review identified appropriate HP technologies, hot water loads in foodservice segments, and related health codes
  - Interviewed owners, designers and experts and identified early adopters
- Market potential for a Heat Pump assisted system that combines HPWH with gas backup systems

Results intended to inform utility programs, industry stakeholders and food service facility designers

Key Findings

Drivers identified - HPWH

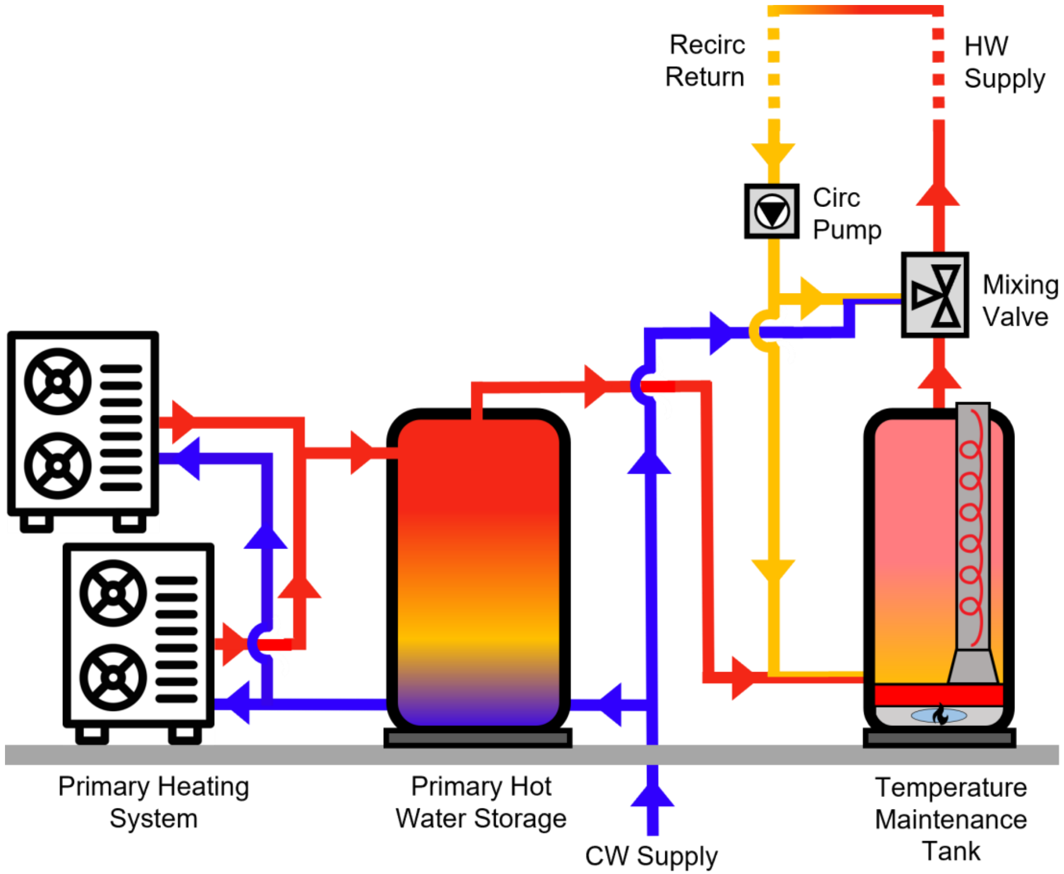
- Lower operating costs in minority of applications depending on local utility rates
- Source and site energy savings
- Discharged cooled air byproduct may be used to cool kitchens
- Increases resiliency

Barriers identified - HPWH

- Higher upfront costs
- Higher space and water storage requirements (footprint, weight)
- Electrical Panel Capacity
- Lack of familiarity
- Health department water heater sizing guidelines may effectively disallow HP only installation (no backup gas or electric resistance)

System Configuration Example

- Using a heat pump and storage tank upstream, in series with the existing gas heater in an “assist” fashion, is one way to overcome HP sizing barrier
- HP may be setup to only operate during off-peak periods between 9pm to 4pm
- In facilities with small hot water loads, there is a regulatory path to use light- commercial integrated HP/electric resistance heaters that meet electrical input power requirements.



Final Report

Final Report available on CalNext website here: Approved Projects - CalNEXT

Using a HP-assist offers a more accessible step closer to full decarbonization

Next steps are to conduct field demonstrations of the approach, and advocacy with health departments through codes and standards efforts to promote HPWH

Thank you to the TRC project team, and our partners, Frontier Energy and Energy Solutions

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ET22SWE0057

Market Study of Household Electric Infrastructure Upgrade Alternatives for Electrification

Project Team: Brian Picariello, Alex Pine, Natasha Baranow, Nick Neverisky, Ben Staub, Christine White – VEIC
Irina Krishpinovich, Stephan Haener – The Ortiz Group

Presenter: Rebecca Rothman, Consulting Manger at VEIC

TPM Domain: Whole Buildings

Technology Family: Electrical Infrastructure

Project Type: Program Support Research

Background

The Problem

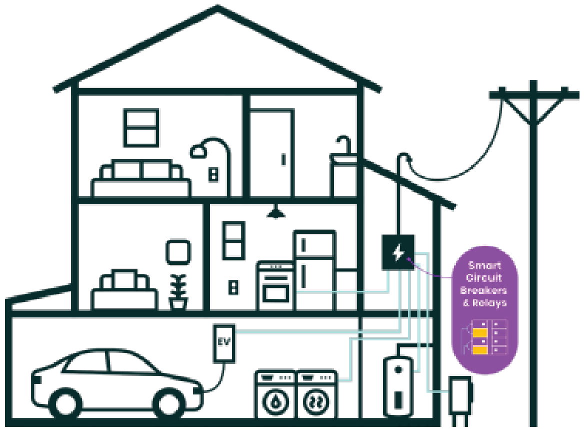
Estimated costs to increase electrical capacity in residential homes varies, but a recent analysis by NV5 Inc. and Redwood Energy estimate that cost may range “**between approximately $2,000 to well over $30,000**” and may require a “**lead time up to 6 months**” if utility work is required.

Potential Solutions

Emerging intelligent power management technologies (“IPMTs”) may avoid the need for costly and time-consuming infrastructure upgrades by optimizing electrified load.

Smart Electrical Panels

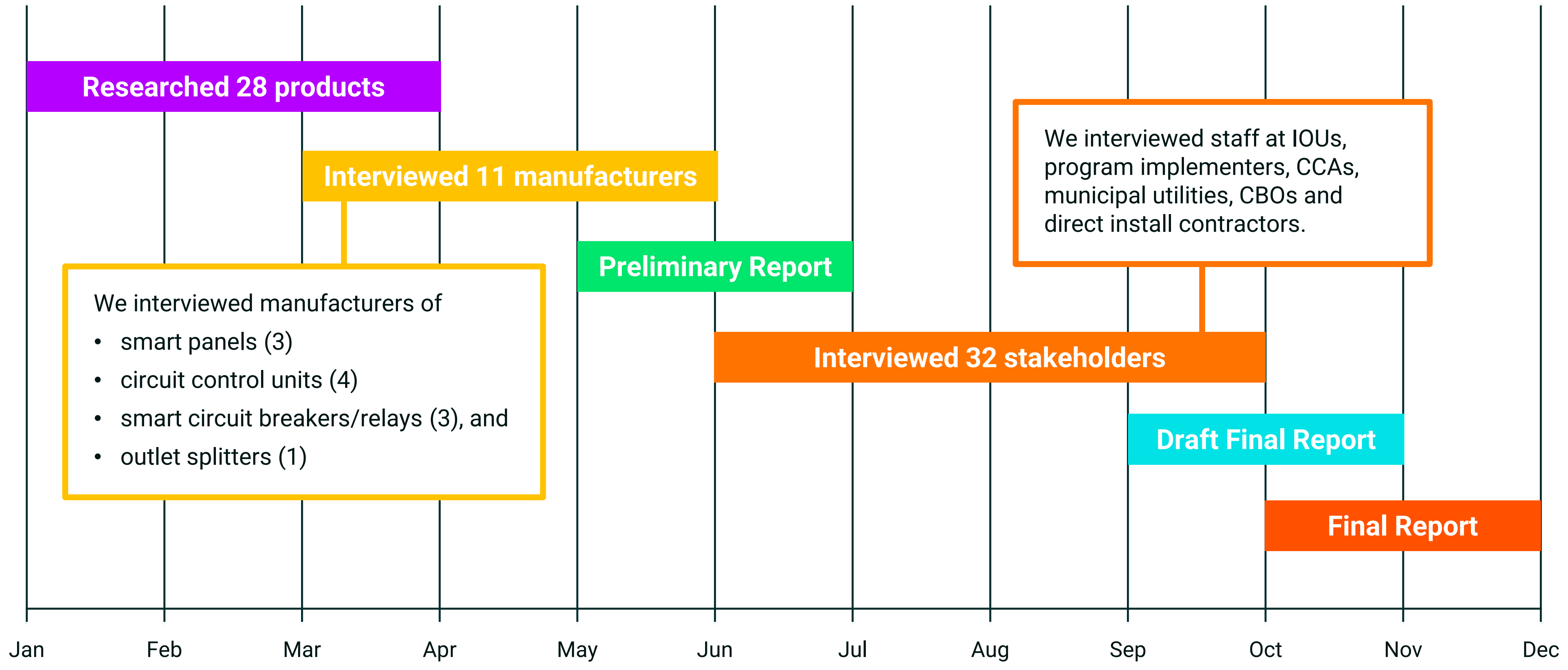
Circuit Control Units



Smart Breakers and Relays

Outlet Splitters

Project Research



Outcomes

What we found

- Not all products can do basic circuit load management
- Stakeholders were generally aware of benefits, but product awareness varied widely
- Barriers include lack of familiarity and install experience, confidence in product/manufacturer support, permitting & inspection uncertainty, and cost

What we recommend

- Increase awareness through educational materials and training for consumers, contractors, electricians and code officials
- Lab/field demonstrations may be conducted to evaluate basic functionality and inform education and training
- Provide incentives, especially for low-cost IPMTs, targeted towards retrofits

Thank you to the VEIC project team, and our partner, The Ortiz Group.

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In-Progress Decarbonization and Load Management Projects

AESC Celebrating 30 Years / ASK energy — Packaged Central CO_2 Heat Pump Water Heater Multifamily Demonstration

TRC — Standardized HVAC Control Sequence Savings Calculator

veic — Technical Evaluation of Air-to-Water Heat Pumps & Propane Air-to-Water Heat Pump Market Study

ET22SWE0028

Packaged Central CO_2 Heat Pump Water Heater Multifamily Demonstration

Project Team: M M Valmiki (ASK Energy); Jon Heller, Treasa Sweek, Madison Johnson, Scott Spielman (Ecotope); David Moell (AESC)

Presenter: M M Valmiki, Senior Engineer, ASK Energy

TPM Domain: Water Heating

Technology Family: Commercial-Duty Water Heaters

Project Type: Technology Support Research

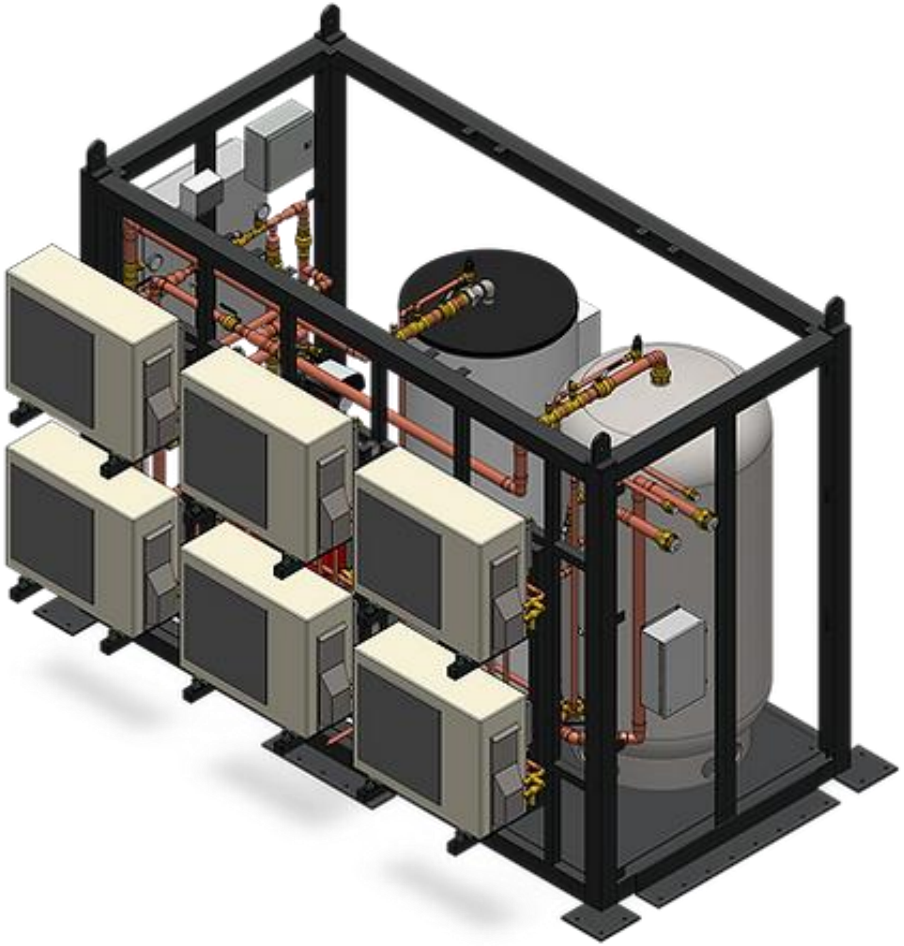
Background

- About 32% of multifamily energy use is consumed for domestic hot water. There has been much recent investment by programs, regulators, manufacturers, and researchers towards market transformation towards heat pump systems.
- Recent study suggests GHG savings of 85% over equivalent gas systems with total existing California multifamily market potential of 1.7 million tons/year and $350 million in total system benefits.
- Low-GWP R744 (CO_2) options are some of the best-in-class available CHPWH solutions operating reliably at high supply temps, in cold weather, and at high COPs.
- Energy costs, cost compression, and optimized load management need attention.

Project Progress

Status

- Two new construction, affordable housing multifamily buildings in Bay Area.
- Installation of packaged WaterDrops nearing completion, two skids equipped with M&V instrumentation.
- Commissioning expected in March with M&V start up and occupancy close behind.
- Load management sequences of operation and test strategies in development.



Source: Small Planet Supply, 2024

Project Progress

Data Collected through Summer 2024

- Temperatures throughout system.
- Heat pump and swing tank powers.
- Supply and recirculation flow rates.

Pending Analysis

- Hot water load profiles.
- Energy usage, demand, energy cost, GHG, and TSB with and without load management controls.
- No pre-existing baseline but may be compared to gas system for sake of impacts analysis.
- Extrapolation to other climate zones and per-unit analysis.

Final Report

- Complete by end of 2024.
- EE, cost, GHG, TSB, and load management analysis results.
- Load management optimization, technology development, and program recommendations.

Thank you to the ASK Energy, AESC, Ecotope, host site, and manufacturer project team

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ET22SWE0043

Standardized HVAC Control Sequence Savings Calculator

Project Team: Justin DeBlois, Rupam Singla, Tharanga Jayarathne, Bilsay Varcin - TRC

Presenter: Abhijeet Pande, TRC

TPM Domain: HVAC

Technology Family: Scalable HVAC Controls

Project Type: Tool Development

TRC

Background

- HVAC control sequences of operation standardized by ASHRAE Guideline 36 have demonstrated potential to reduce energy use by 12–60% in nonresidential buildings compared to typical practice.
- An underutilized opportunity exists for energy savings in building retrofits and retro-commissioning using optimized sequences of operation.
- The project team is developing a calculator to estimate savings from implementing Guideline 36 sequences of operation in existing buildings.
- This web-hosted calculator is based on an energy modeling database that includes variations of climate zone, building size and HVAC system configuration.

Results inform utility programs such as RCx and Custom to provide a simpler path to savings

Project Progress

- The project team developed the calculator based on stakeholder outreach
  - Identified the absence of an offering in efficiency programs that is flexible enough to account for building and system characteristics but simpler than a custom energy modeling approach.
- Tool based on two rounds of parametric energy simulations.
- Extensive testing of energy modeling parameters to determine 13 parameters with the greatest impact.
  - Most of the inputs are optional, allowing for greater accessibility and ease of use.
- The calculator includes an uncertainty analysis that accounts for the added uncertainty from unknown building parameters and returns a dynamically calculated uncertainty range.

Description of Inputs:

Mandatory inputs:

1. Monthly Electric Consumption: Enter 12 monthly values separated by commas.
2. Monthly Gas Consumption: Enter 12 monthly values separated by commas.
3. Climate Zone: Select California Climate Zone. Limited to zones 3, 4, 9 and 12.
4. Building Floor Area: Enter the building conditioned floor area in square feet.

Optional inputs:

1. Zone VAV Average Minimum Flow Fraction: Enter the average zone VAV box minimum flow fraction. This can be calculated by dividing the sum of the minimum airflow rate for all VAV boxes by the sum of the design cooling airflow for all VAV boxes. This input is restricted to up to 0.5.
2. Supply Air Temperature Control Strategy: Select AHU leaving air temperature control as Fixed (constantly maintained at Supply Air Temperature Setpoint) or Warmest (reset up to 5 F when all zones meet cooling setpoint at maximum flow).
3. Supply Air Temperature Setpoint: Enter the design minimum supply air temperature setpoint. This input is restricted to between 50 F and 55 F.
4. Fan Total Static Pressure: Enter The total static pressure (TSP) of supply and return fans (combined). Where multiple AHUs are present, an average TSP may be entered weighted by AHU design supply airflow. This input is restricted to between 1 in. w.c. and 9 in. w.c.
5. Fan Control Strategy: Select 'VAV with Fixed Static Pressure Setpoint' for fan VSDs controlled based on a fixed duct pressure setpoint. For systems with static pressure reset select 'VAV with Static Pressure Reset'
6. Economizer Control Strategy: Select economizer type. The options are 'None' or 'Fixed DB Limit'. Select 'None' if there is no economizer control sequence, and 'Fixed DB Limit' if economizer control is included. Fixed DB controls are modeled per ASHRAE Guideline 36 and to meet the requirements of Title 24 Part 6.
7. Ventilation Rate: Enter the building average ventilation rate, over all conditioned floor area. This input is restricted to between 0.1 cfm/sf and 0.25 cfm/sf.
8. Building Operating Hours: Enter the number of hours the HVAC systems operate on a typical business day. This input is restricted to between 10 and 14 hours.
9. Building Space Types: Enter the distribution of general office and high density spaces such as conference rooms.
   - General Office: Most AHUs serve only office spaces and conference rooms typically do not have separately controlled VAV boxes.
   - Office with Separately Zoned Conference/Meeting Rooms: Most AHUs serve at least one conference room with its own VAV box(es) and controls.
   - Office with large meeting rooms or assembly spaces: Over 25% of the building floor area is dedicated to meeting, conference and/or assembly spaces.

Measures: Select as many measures as are applicable. The results will show the combined effect of the selected measures, including interactive effects.

1. VAV Min/Dual Max Control: Implement minimum flow rates for each VAV box no greater than the flow required for adequate ventilation. Where needed, Dual Max Control will ensure heating loads are still met.
2. Economizer Control: Implement economizer controls per ASHRAE Guideline 36 and meeting the requirements of Title 24 Part 6.
3. Supply Temperature Reset: Implement supply temperature reset of 5 degrees F, based on the cooling demand of the warmest zone per ASHRAE Guideline 36.
4. Static Pressure Reset: Implement Supply Temperature Reset based on the control sequences outlined in ASHRAE Guideline 36.

Final Report

Final Report will be available on CalNext website here: Approved Projects - CalNEXT

- Report and Tool is currently being reviewed by the client and undergoing final improvements
- It describes the statistical methods used to create the back end of the calculator and the team's uncertainty analysis at each stage in calculator development.
- The report also includes documentation of the automated calibration performed by the calculator to reduce error. Furthermore, the report demonstrates the use of the calculator with six example buildings that underwent Guideline 36 sequence of operations measure implementation.

Expected to be released in Summer 2024.

Thank you to the TRC project team

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ET22SWE0050 & ET23SWE0041

Technical Evaluation of Air-to-Water Heat Pumps & Propane Air-to-Water Heat Pump Market Study

Project Team: Brent Weigel, Christine White, Gabriella Broga, Kieran Yater, Zoe Dawson, Melissa Stewart, JT Coneybeer, Tom Kacandes - VEIC

Presenter: Rebecca Rothman, Manager, Consulting at VEIC

TPM Domain: HVAC, Water Heating

Technology Family: Integrated Systems, Low GWP Refrigerant Transition

Project Type: Program Support Research

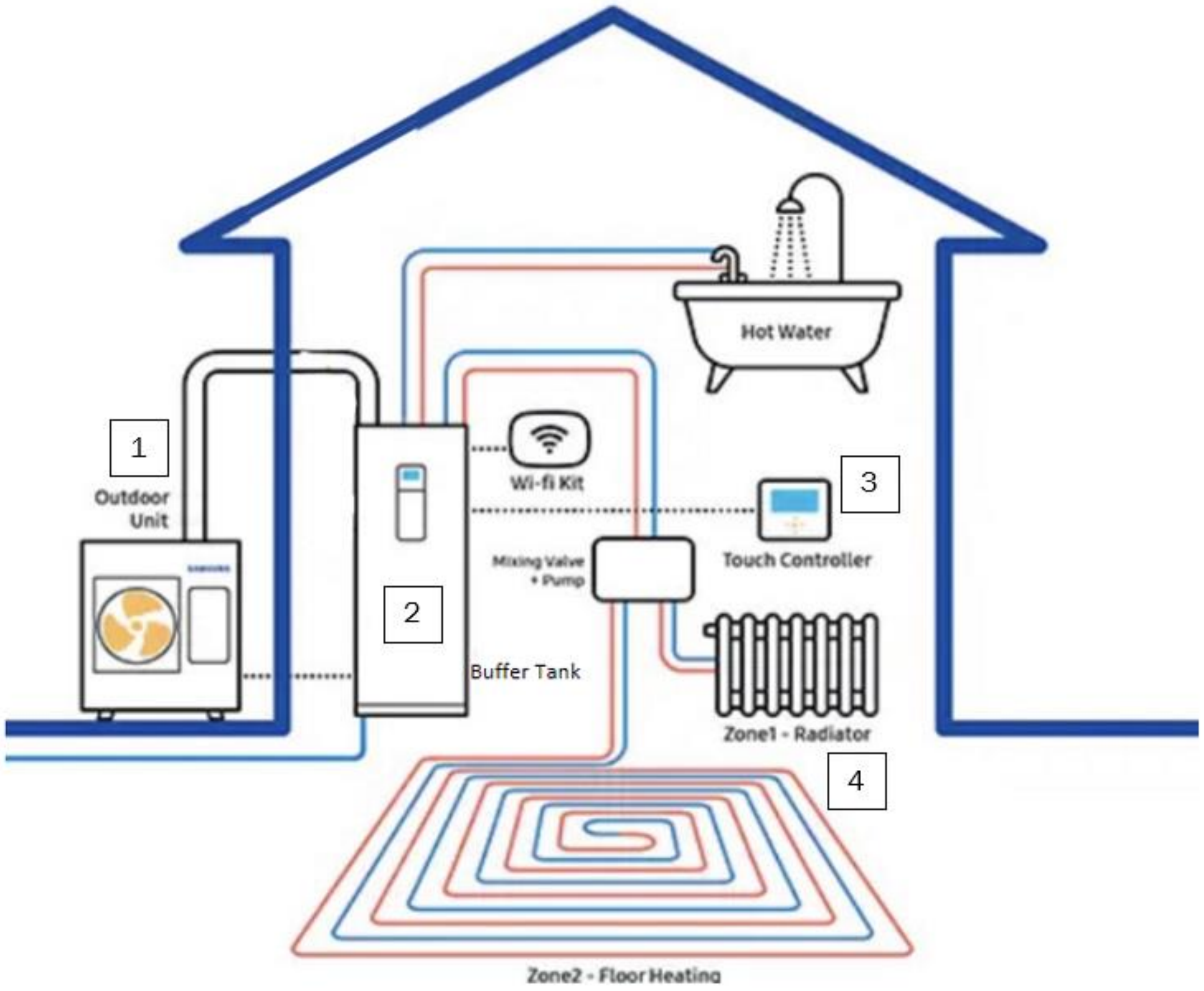
Background

The Problem

Decarbonizing Space and Water Heating will add electric load to the grid AND introduce hundreds of thousands of new heat pumps as regulations seek to transition to low GWP refrigerants.

Potential Solutions

Low-GWP Air-to-Water Heat Pumps paired with Thermal Storage, have the potential to provide Single Family homes with an option to decarbonize that allows homeowners and grid operators to take advantage of peak load shifting, while utilizing Low-GWP refrigerants.



Example: AWHP technology modified for use in this report
Source: Samsung 2023

Project Progress

Propane Air-to-Water Heat Pump Market Study is Complete

State zero-carbon goal x3 CO2e SB 1383 goal

TSB & Climate Benefits GWP <1, high-COP & supports FLM

Grid Benefits AWHP + TES = upstream decarbonization

Environmental Benefits PFAS free

Market Advantages RF & NC for SF Residential

Customer Benefits $$$

Installation Advantages WFD “plumb and play”

Technology Benefit already available

Market Benefit growing exponentially

Safety Benefits IEC 60335-2-40 recognized outside US

Other Benefits future regulation proofed, no patent

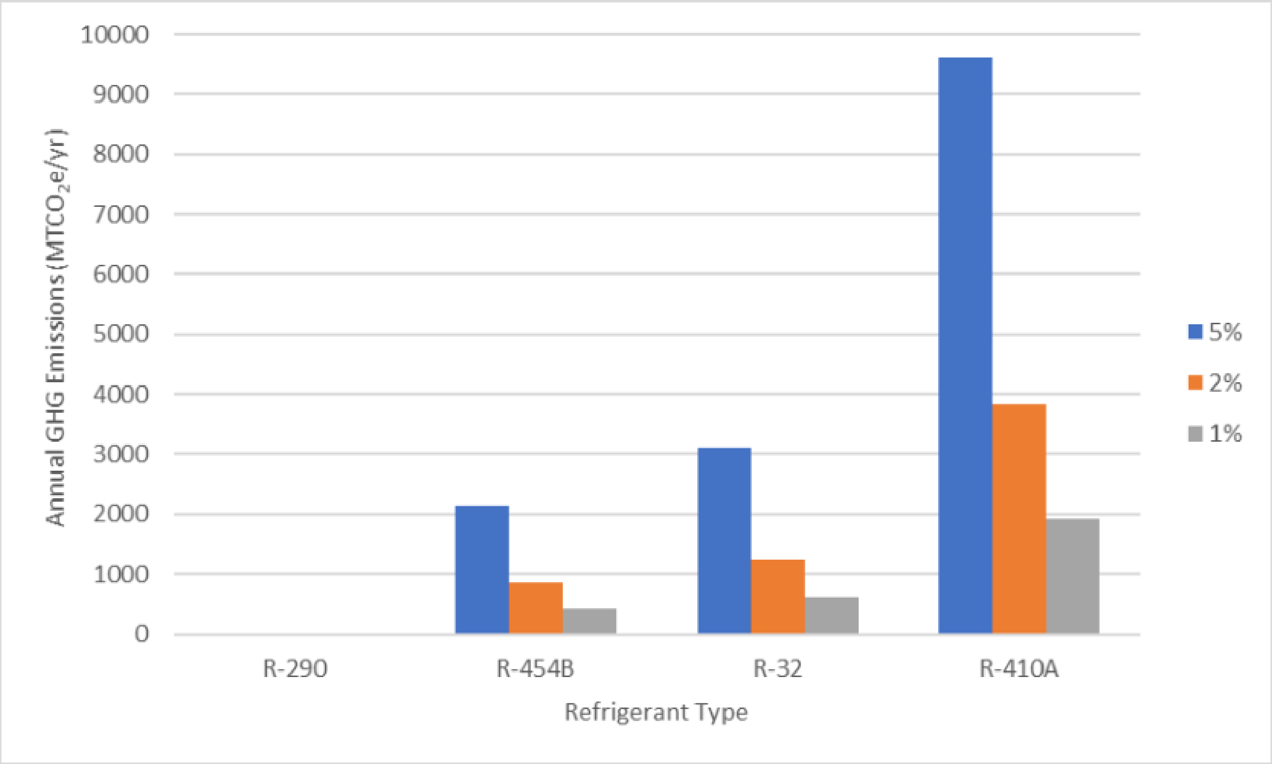


Figure: Annual California GHG Emissions from AWHP refrigerant leaks by the percentage of fossil fuel boiler or furnace replaced with AWHP systems in single-family homes according to refrigerant type, in metric tons of $C0_2$ equivalent.

Project Progress

Installation of Harvest Thermal and M&V meters systems is complete in January.

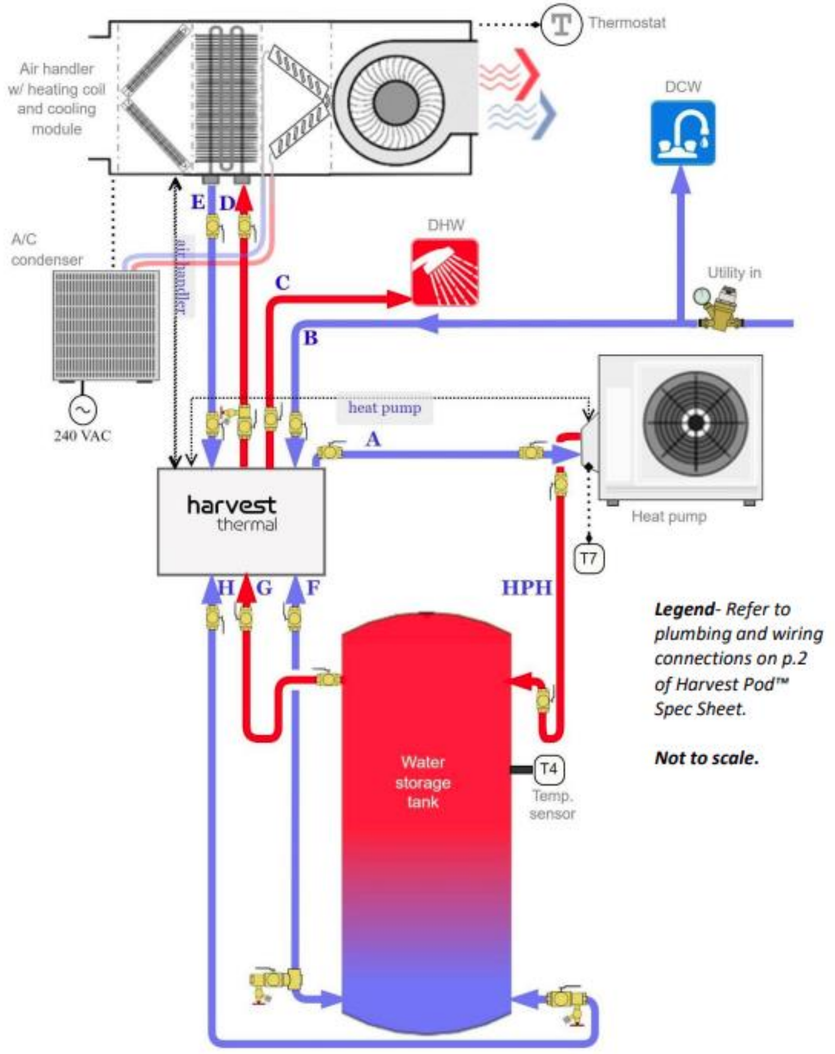
Data being collected

- Power data (Harvest Thermal Heat Pump, Air Handler, and ECOer Heat Pump)
- Temperature (water and air)
- Flow rates
- Cost Data

Pending Analysis

- Linear regressions of predicted performance
- EE and Load Shift Quantification
- Program Recommendations

HARVEST THERMAL SYSTEM™ A/C ADD ON
(CONFIGURATION: P2T1AC)



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harvest-thermal.com

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Thank you to the VEIC project team, and our partner, Harvest Thermal.

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Q&A

Thank You

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