

CalNEXT Knowledge Sharing Webinar

CO₂ Refrigerants, Refrigerant Charge, EVSE, and HVAC and Daylighting Controls

October 7, 2026

Agenda

Introduction	Energy Solutions	5 min
10:05 – 10:14 a.m. Improving HVAC Refrigerant Charge Value Estimates for Residential and Commercial Systems		10 min
10:15 – 10:24 a.m. Field Study of HVAC Cost Optimized Supply Air Temperature Reset (CORE)		10 min
10:25 – 10:34 a.m. V2X Round-Trip Efficiency Market Study		10 min
10:35 – 10:44 a.m. Refrigeration Capacity Load Matching		10 min
10:45 – 10:54 a.m. Performance Assessment of Integrated Core Daylighting Technology		10 min
Wrap-up Q&A	Energy Solutions	5 min

Presenters



Greg Barker

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CalNEXT Partners



Presentations

1. Project Summary
2. Study Objectives
3. Stakeholders
4. Demonstration Sites
5. Summary of Savings
6. Summary of Findings
7. Conclusions and Next Steps

All presentations and completed projects' final reports are available at calnext.com/approved-projects

CalNEXT at ETCC Summit 2026

October 20 – 21

Davis, California

etcc.swoogo.com/etsummit26/12118189



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TUESDAY
SEPTEMBER
22
2026

11:00 A.M. – 12:00 P.M. PT

WEBINAR

Knowledge Sharing Webinar

Industrial Solutions

The third CalNEXT Knowledge Sharing Webinar focused on industrial solutions. We showcased five completed CalNEXT projects and shared their results and supporting research.

🎥 Missed the event? [Watch the recording.](#)

📄 [View the presentation slides.](#)

Questions Encouraged

Ask the presenters your questions via the Zoom Q&A panel during the webinar.

- Presenters will monitor the Q&A as possible after their presentations.
- The hosts will read and answer questions as time allows during each presenters' time slot and in the final minutes of the hour.
- The CalNEXT team will poll the audience during the second half of the webinar to ask what you would like to see in future emerging technology presentations.

Improving HVAC Refrigerant Charge Value Estimates

Project Outcomes and Technology Transfer



About Improving HVAC Refrigerant Charge Value Estimates

Project Objectives

- Improve refrigerant charge assumptions used in the Refrigerant Avoided Cost Calculator (RACC tool).
- Reflect current equipment designs and refrigerant transitions.
- Support accurate greenhouse gas emissions and fuel substitution analysis.

Methods

- Identify equipment manufacturers that actively participate in programs.
- Collect refrigerant type and factory charge values.
- Identify refrigerant charge trends by refrigerant type, equipment type, and equipment rated capacity.

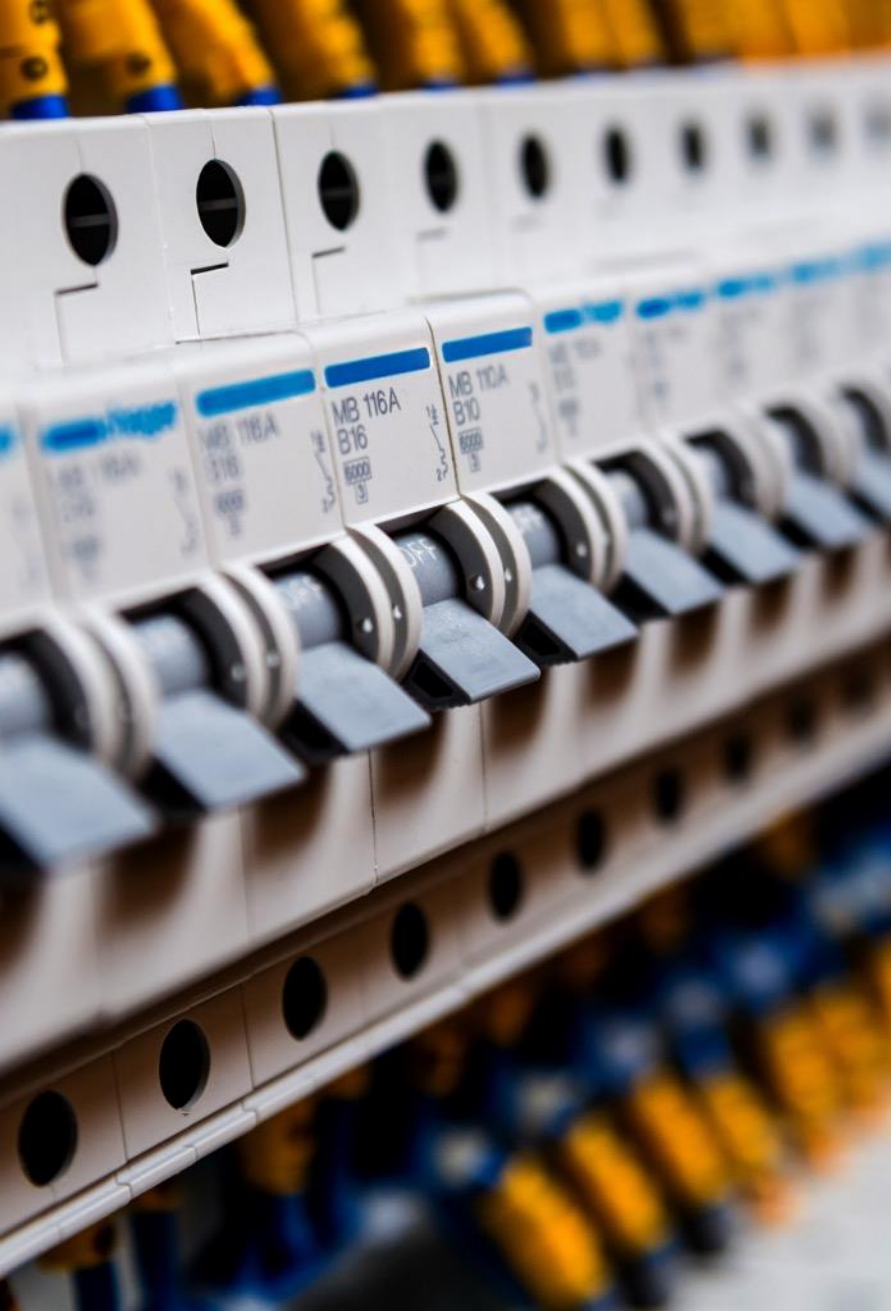


Improving HVAC Refrigerant Charge Value Estimates – What Is Its Purpose?

- GWP phase-down changes cost effectiveness calculations.
- Current refrigerant charge assumptions were largely based on older studies and inventory data.
- The project serves to improve the accuracy of calculations using the RACC tool.

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Stakeholders

CPUC

- Owner of RACC tool.

California Investor-Owned Utilities

- Programs rely on cost-effectiveness calculations.

HVAC Equipment Manufacturers

- Validated data sources.
- Provided feedback on equipment classifications.

Summary of Findings

New equipment categories
defined from stakeholder input

Nominal refrigerant charge
calculated for each category

Identified Trend: Low GWP
equipment typically has less
refrigerant charge per ton of
equipment capacity

HVAC Equipment Category	Recommended Refrigerant Charge per unit (R-32/R-454B)	Recommended Refrigerant Charge per unit (R-410A)	Existing Refrigerant Charge per unit (R-410A)
Residential Split System AC	2.11 lb/ton	2.46 lb/ton	3.2 lb/ton
Residential Packaged AC	1.98 lb/ton	1.87 lb/ton	3.2 lb/ton
Ductless Mini Split AC	2.50 lb/ton	2.30 lb/ton	3.2 lb/ton
Window AC	0.87 lb/ton	0.93 lb/ton	1.54 lb each
Portable AC	0.96 lb/ton	N/A	1.54 lb each
Packaged Terminal AC (PTAC) Units	1.47 lb/ton	N/A	1.54 lb each
Residential Split System HP	2.62 lb/ton	3.19 lb/ton	3.5 lb/ton
Residential Packaged HP	2.30 lb/ton	3.02 lb/ton	3.5 lb/ton
Ductless Mini Split HP	2.39 lb/ton	2.45 lb/ton	3.5 lb/ton
Packaged Terminal HP (PTHP) Units	1.93 lb/ton	2.19 lb/ton	1.54 lb each
Window HP	2.54 lb/ton	N/A	1.54 lb each
Portable HP	0.99 lb/ton	1.41 lb/ton	1.54 lb each
Dehumidifiers	0.76 lb each	0.45 lb each	1.00 lb each

Refrigerant charge per unit for recommended new residential HVAC categories.

Summary of Findings

New equipment categories
defined from stakeholder input

Nominal refrigerant charge
calculated for each category

Identified Trend: Low GWP
equipment typically has less
refrigerant charge per ton of
equipment capacity

HVAC Equipment Category	Recommended Refrigerant Charge per unit (R-32/R-454B)	Recommended Refrigerant Charge per unit (R-410A)	Existing Refrigerant Charge per unit[1]
Large Chiller	0.63 lb/ton	1.28 lb/ton	3,978 lb each
Medium Chiller	1.01 lb/ton	1.36 lb/ton	526 lb each
Large Commercial Split AC [≥135 kBtu/h]	1.67 lb/ton	2.02 lb/ton	70 lb each
Medium Commercial Split AC [135 kBtu/h > Capacity ≥65 kBtu/h]	1.35 lb/ton	1.94 lb/ton	3.20 lb/ton
Small Commercial Split AC [≤65 kBtu/h]	1.74 lb/ton	1.80 lb/ton	3.20 lb/ton
Large Commercial Packaged AC [≥135 kBtu/h]	1.11 lb/ton	1.58 lb/ton	70 lb each
Medium Commercial Packaged AC [135 kBtu/h > Capacity ≥65 kBtu/h]	1.03 lb/ton	1.34 lb/ton	3.20 lb/ton
Small Commercial Packaged AC [≤65 kBtu/h]	1.15 lb/ton	2.75 lb/ton	3.20 lb/ton
Large Commercial Split HP [≥135 kBtu/h]	1.57 lb/ton	3.53 lb/ton	70 lb each
Medium Commercial Split HP [135 kBtu/h > Capacity ≥65 kBtu/h]	1.96 lb/ton	3.17 lb/ton	3.50 lb/ton
Small Commercial Split HP [≤65 kBtu/h]	2.40 lb/ton	3.14 lb/ton	3.50 lb/ton
Large Commercial Packaged HP [≥135 kBtu/h]	2.10 lb/ton	2.33 lb/ton	70 lb each
Medium Commercial Packaged HP [135 kBtu/h > Capacity ≥65 kBtu/h]	2.13 lb/ton	2.55 lb/ton	3.50 lb/ton
Small Commercial Packaged HP [≤65 kBtu/h]	1.83 lb/ton	N/A	3.50 lb/ton
PTAC	1.47 lb/ton	N/A	1.54 lb each
PTHP	1.93 lb/ton	N/A	1.54 lb each

Refrigerant charge per unit for recommended new commercial HVAC categories.

Conclusions and Next Steps



Project Conclusion

- Recommended updates to RACC tool HVAC refrigerant charge values and equipment categories.
- Improved HVAC refrigerant charge values increases accuracy of:
 - Greenhouse gas calculations
 - Avoided cost estimates
 - Fuel substitution analysis
 - Energy efficiency program evaluations



Next Steps

- Improved HVAC refrigerant charge values to be adopted into RACC tool.



Project Final Report
RESIDENTIAL



Project Final Report
COMMERCIAL

Thank You!

Parker Wall

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Field Study of HVAC Cost Optimized Supply Air Temperature Reset (CORE)

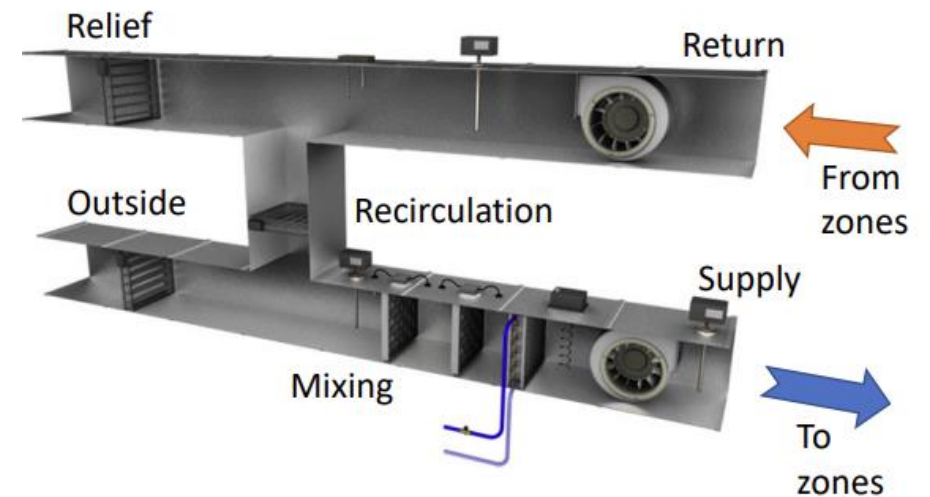
Project Outcomes and Tech Transfer



Background

- Multi-zone variable air volume (VAV): widely used, often underperforms.
- Supply air temperature (SAT) reset method influences energy, cost, and comfort.
 - Common strategies have overcooling issues and waste energy due to not considering interactions between sources.
- Current SAT reset strategies are suboptimal.

Big opportunity to improve energy/cost efficiency.



About CORE Project

Project Objectives

- Refine Cost Optimized Reset (CORE) for broader applications.
- Implement in a real building in California.
- Assess energy/cost savings and implementation challenges.

Methods

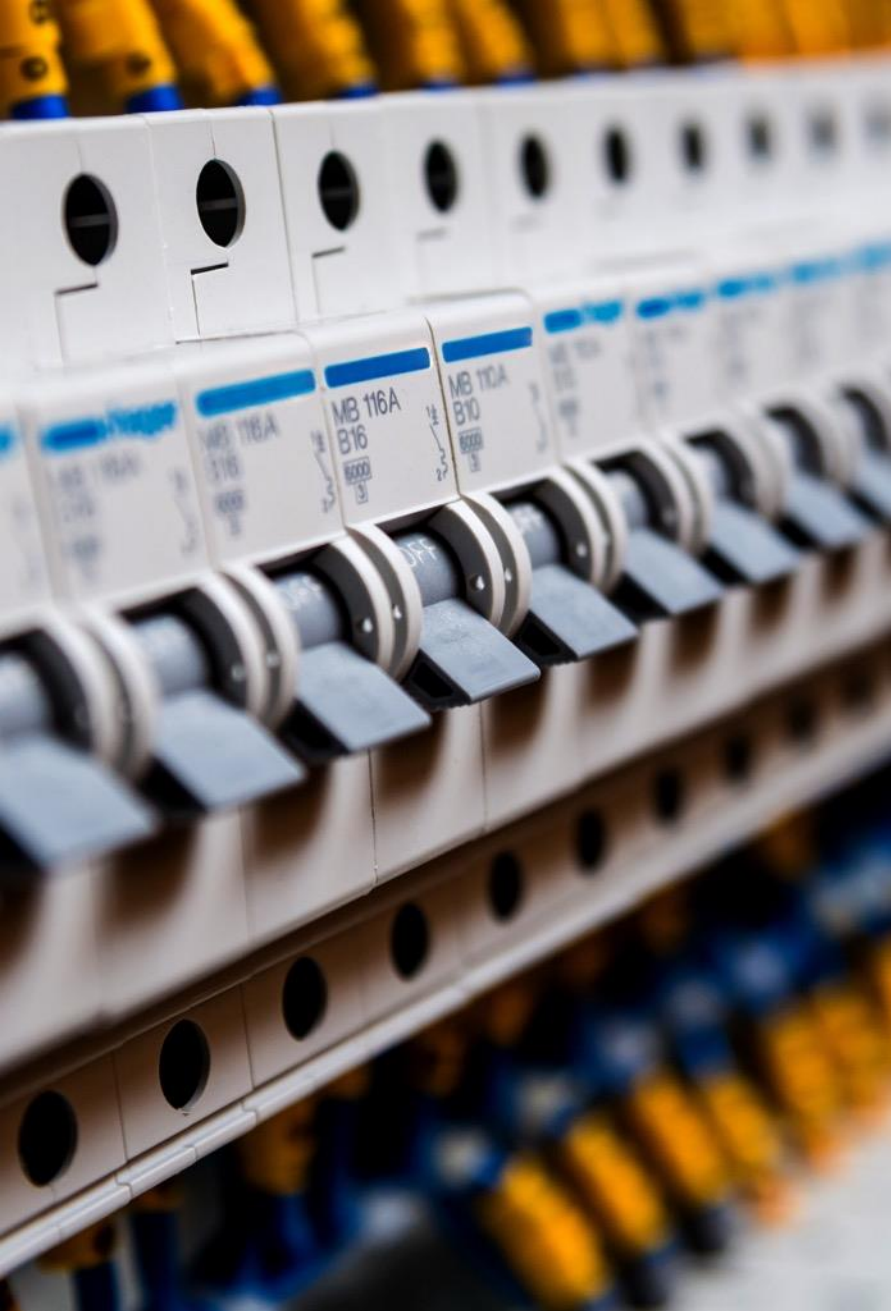
- CORE refinement
 - Added smoothing function for stability, developed simplified algorithm versions.
- Field demonstration
 - Four medical office buildings (MOBs) in California.
- Measurement & verification (M&V)



MOB-2 demonstration site

Project Team

- TRC
- UC Berkeley – CBE
- Taylor Engineers



Stakeholders

HVAC Controls Contractor – Program and commission CORE.

Site Owner – Participate in the field demonstration.

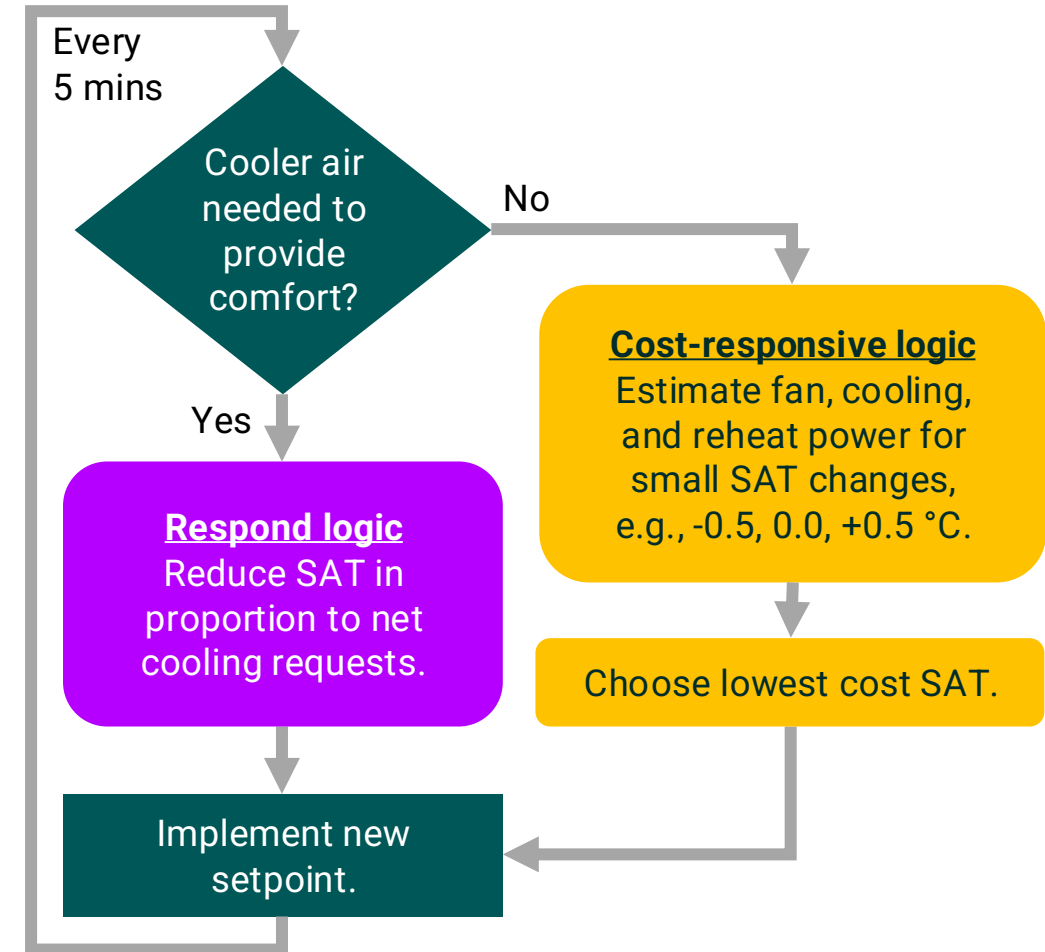
ASHRAE Guideline 36 committee – Include CORE in the guideline for high-performance control sequence.

BAS Manufacturers – Adopt CORE as part of their product offerings.

How CORE Works

- Adjusts SAT based on zone cooling demand **and** cost tradeoffs.
- Uses time-of-use (TOU) utility rates and real-time load conditions.
- Humidity-based limit for SAT reset range.
- Designed to be simple: implement in existing BAS.
 - Simplified CORE algorithm: needs less data.

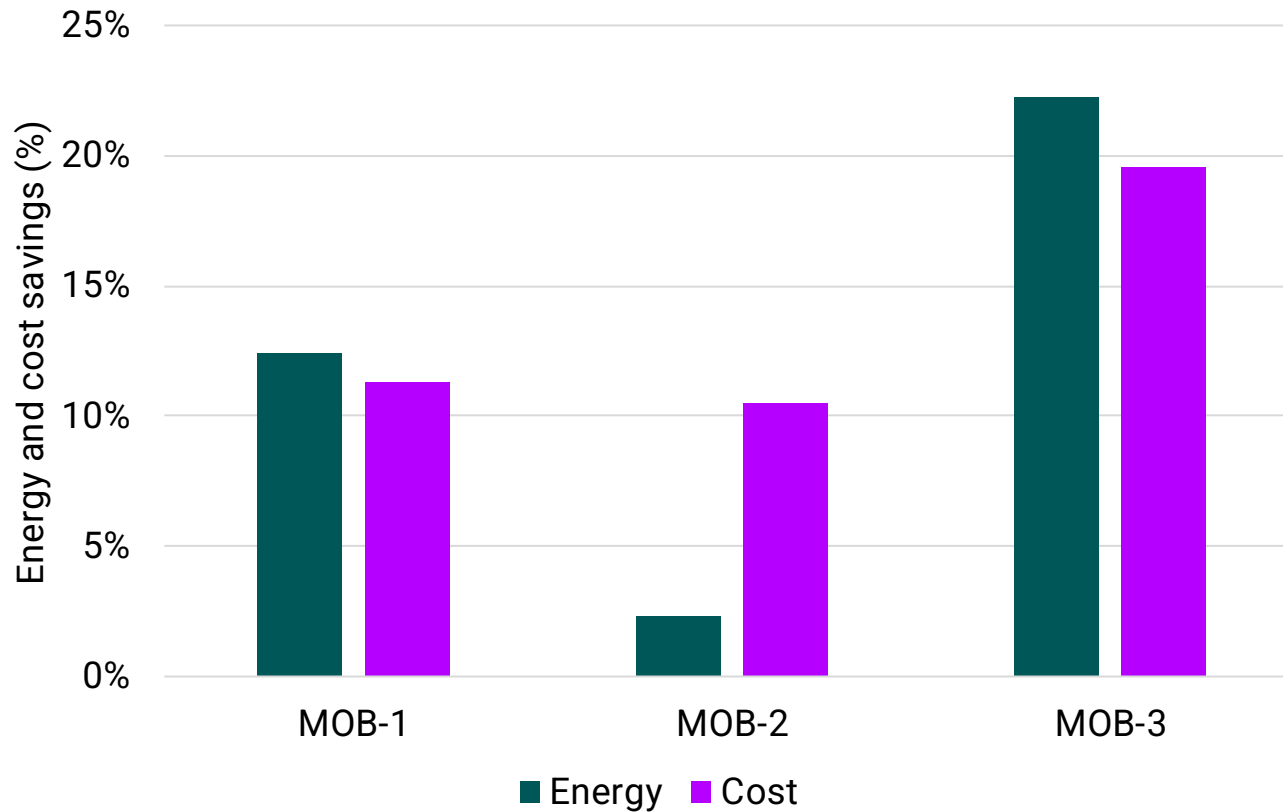
CORE is smarter than traditional resets because it **actively optimizes cost across all loads.**



CORE Operation Schematic

Summary of Findings

CORE saved **HVAC** energy and costs in all three buildings.



2-22% Savings
in heating, cooling, and fan
energy.



10-20% Savings
in heating, cooling, and fan
energy costs.

Lessons Learned and Challenges

Implementation Barriers

- **Algorithm complexity** for controls contractors.
- Legacy **HVAC system issues** and **BAS limitations**.
- Opportunity to save energy.

Lessons Learned

- **Simplified algorithm** versions and standardized **programming libraries** could **speed adoption**.
- **Thorough evaluation of existing systems** and existing building commissioning (EBCx) **is critical** for CORE performance and saves energy.

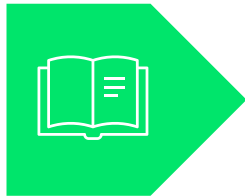
Next Steps



NYSERDA funded project to evaluate CORE's performance in different climate conditions.



ASHRAE Guideline 36 committee – CORE adoption



Continue stakeholder involvement – Manufacturers, Controls Contractors



Project Final Report

Thank You!

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V2X Round-Trip Efficiency Market Study

Project Outcomes and Technology Transfer

About: V2X Round Trip Efficiency (RTE) Market Study

What and Why

- Vehicle-to-Everything (V2X) technology enables EVs to act as distributed energy resources, providing resilience, load flexibility, and grid services.
- Rapid growth in bidirectional EV adoption increases the need to understand energy losses, efficiency performance, and market readiness.

Bottom Line

V2X Technology is positioned to deliver significant resilience, load flexibility, and grid benefits, but broader energy savings impacts will require standardized efficiency evaluation, improved interoperability, and additional real-world validation.



V2X RTE Market Study – What Is Its Purpose?

Baseline	Questions Answered	Project Updates
Limited data on real-world V2X energy losses.	Most market-ready use cases: resilience, load shifting, and peak shaving.	Established a common framework for V2X classification, technical requirements, and efficiency terminology.
No consistent framework for performance comparison.	Power level and ambient temperature are the primary drivers of efficiency performance.	Identified AC-to-AC round trip efficiency as key metric for stationary V2X applications.
Limited guidance on integrating V2X into energy efficiency programs.	Efficiency-aware charging and dispatch strategies can reduce energy losses and improve system performance.	Developed recommendations for utilities, OEMs, and standards bodies to support adoption and standardization.

Stakeholders

Project Team (AESC / Franklin Energy)	Led research and recommendations.
OEMs	Provided V2X technology and market insights.
Utilities / Program Administrators	Evaluated program and grid integration opportunities.
Aggregators & Software Providers	Advised on V2G, smart charging, and grid services.
Industry Groups	Contributed technical and market expertise.
Standards Bodies	Guided interoperability and standards considerations.

Summary of Savings

Target Achieved: The study quantified energy loss reduction from efficiency-aware V2X charging control.

Charging Strategy	Performance Result	Savings Impact	Why It Matters
Efficiency-Aware Frequency Regulation ¹	8.5% Lower Energy Loss	2.74 kWh Saved 10 EVs / 8 Hours	Grid Service Maintained
Efficiency-Aware Energy Arbitrage ²	~50% Lower Revenue Losses	168 kWh Fleet Benefit 1.68 kWh / Session	Benefits Owner and Utility

1. E. Apostolaki-Iosifidou et al. 2017. "Measurement of power loss during electric vehicle charging and discharging." *Energy* 127 (2017) 730e742.
2. Jian-Tang Liao, Hao-Wei Huang, Hong-Tzer Yang, Desheng Li. 2021. "Decentralized V2G/G2V Scheduling of EV Charging Stations by Considering the Conversion Efficiency of Bidirectional Chargers." *Energies*.

Summary of Findings

- Defined the technical and operational factors that most influence V2X efficiency and energy losses.
- Demonstrated that efficiency-aware charging and dispatch strategies can deliver measurable energy savings beyond standard V2X operation.
- Provided a foundation for future efficiency standards, utility programs, and product improvements to accelerate V2X market adoption.

Conclusions and Next Steps



Project Conclusion

- **Impacted Technology Priority Map:** Lighting, Plug Loads, and Appliances.
- **Benefit to End Users:** Validated strategies to reduce energy losses, lower operating costs, improve resiliency, and increase the value of V2X participation.
- **Next Steps:** Field demonstrations, refine efficiency standards, and support integration into energy efficiency portfolio.



Project Final Report

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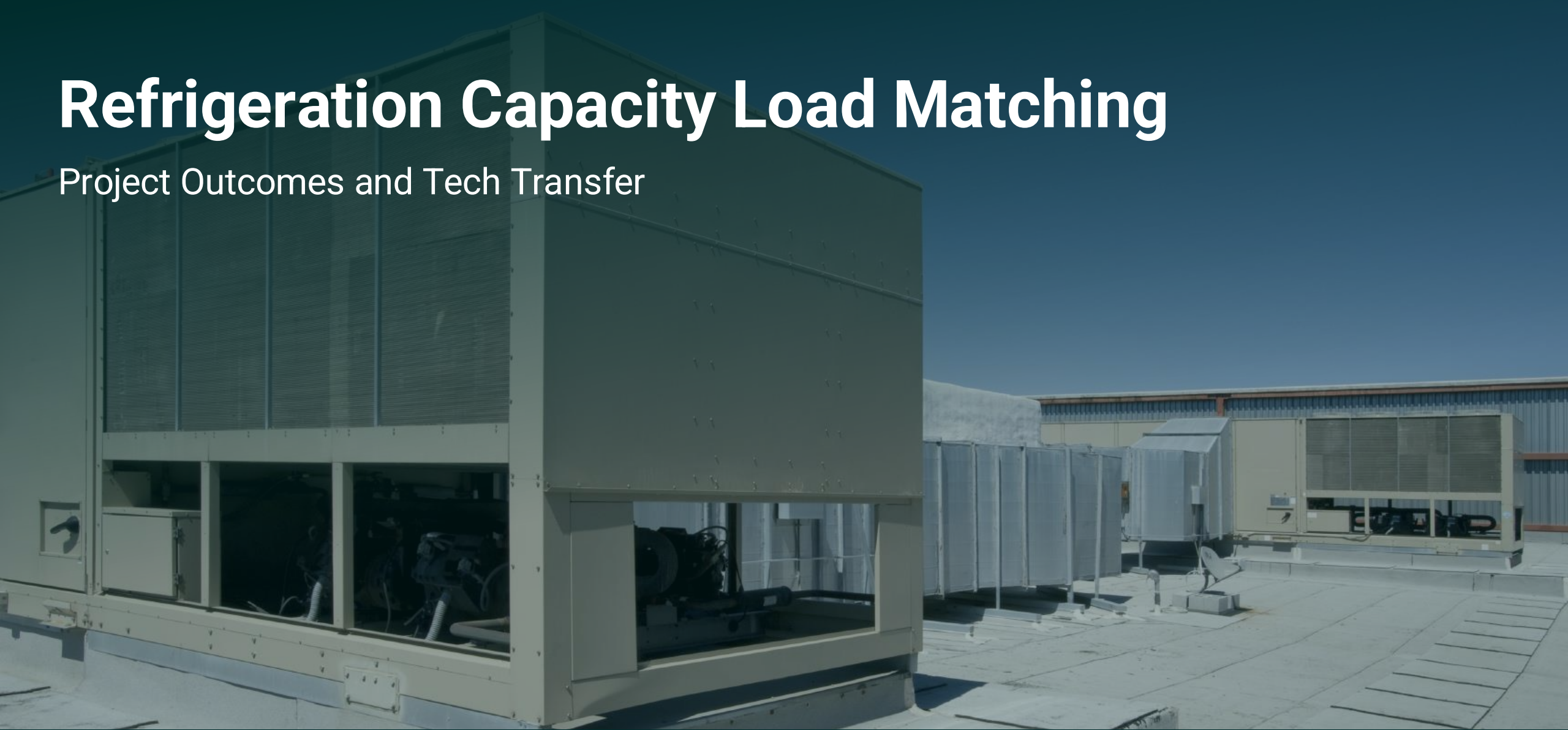
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Refrigeration Capacity Load Matching

Project Outcomes and Tech Transfer

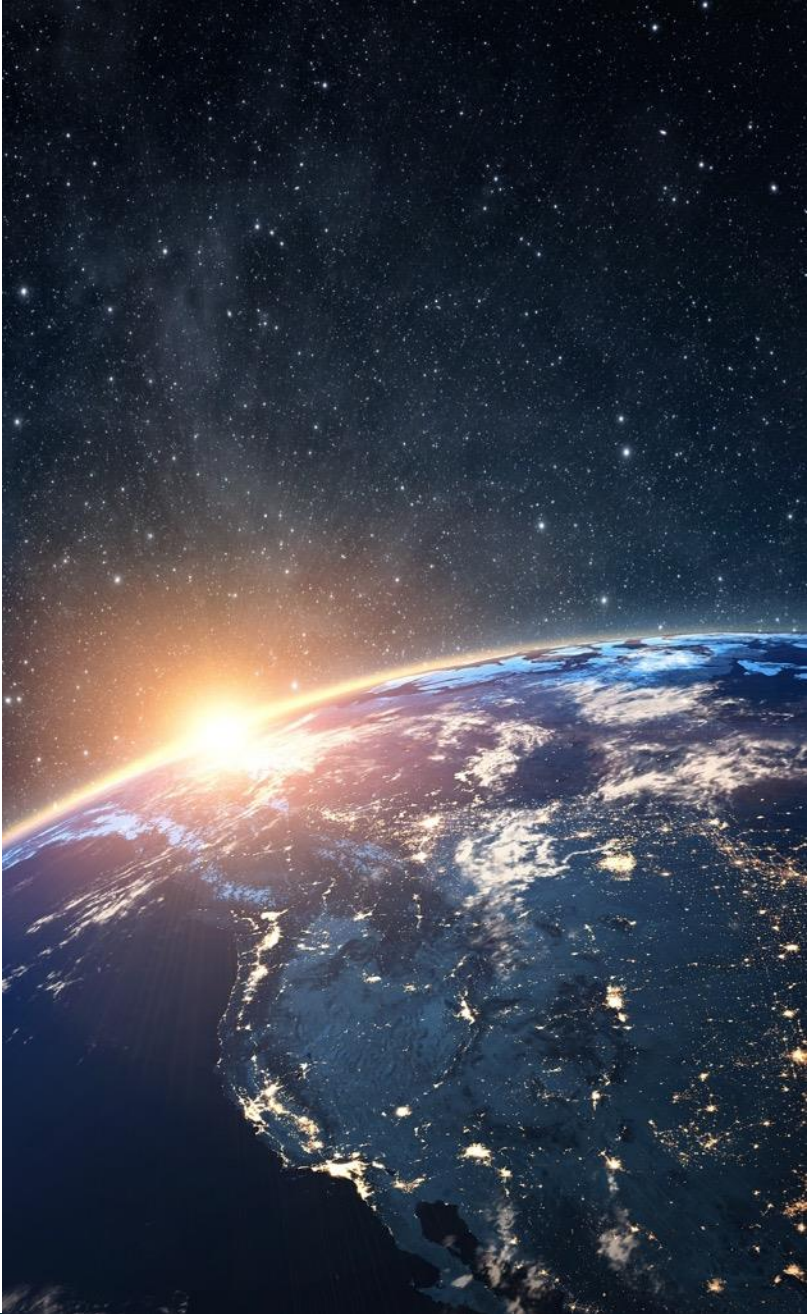


About Refrigeration Capacity Load Matching

This study evaluates a retrofit emerging technology (ET) comprising a smart compressor control (SCC) system, a variable frequency drive (VFD), and temperature sensors. Unlike traditional pressure-based modulation, the SCC algorithm dynamically adjusts compressor operation based on suction and discharge temperatures, enabling more precise load matching. Field demonstrations were conducted at two refrigerated produce warehouses located in disadvantaged communities within California Climate Zones 9 and 10. The retrofit included four 40 horsepower (HP) compressors at Site 1 and four 25 HP compressors at Site 2, which were all fixed-speed reciprocating units. Compressor real power, compressor run time, outside air temperature (OAT), and space temperature were monitored during the summer season. Performance was normalized using temperature bins and regression modeling.

Change = Baseline - Post Install	Site 1 (4 compressors)	Site 2 (2 compressors with savings)	Site 2 (2 compressors without savings)
Normalized kW change (%)	25 - 30	5 - 7	(-35) - (-37)
Normalized kWh change (%)	20 - 22	12 - 22	(-39) - (-51)
GHG reduction in CO ₂ e tons	10 - 11	4 - 7	(-7) - (-10)

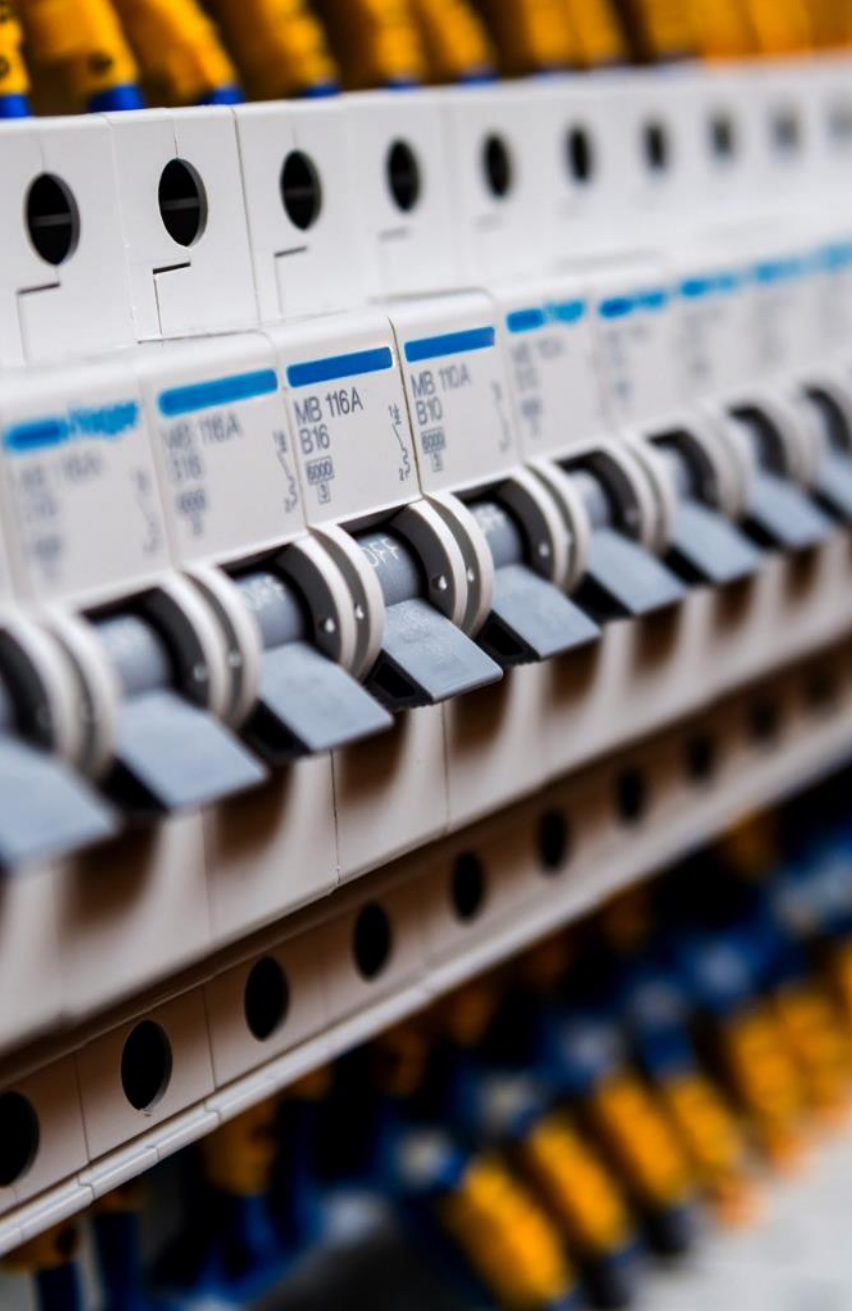
Source: Project team.



Refrigerant Capacity Load Matching – What Is Its Purpose?

This report presents the findings of a field demonstration of an emerging technology for refrigeration system capacity control in Southern California. The technology includes an intelligent compressor controller with a variable frequency drive that can be retrofitted with compatible fixed-speed compressors. Conducted under the CalNEXT program, the study aimed to assess energy efficiency, peak demand reduction, greenhouse gas reduction potential, cost-effectiveness, and user experience of the technology.





Stakeholders

This is an externally submitted project by the emerging technology manufacturer.

Customers: Top stakeholders to allow us to test the emerging technology at their live business sites. Provided baseline and post-installation performance experience feedback.

Refrigeration Service Contractors: Provided system operational , performance and maintenance feedback of the emerging technology.

Emerging Technology Manufacturer: Shared about the technology, application, and compatibility.

Customer 1 (Large fresh produce distribution warehouse): The customer sought greater control over compressors and fans and was concerned about energy use. Following installation, they reported no issues, were satisfied with the system, and noted reduced energy concerns.

Service Contractor 1: The service contractor observed improved performance and reduced compressor runtime, recommended broader deployment and EMS integration, and requested additional training and manufacturer support.

Customer 2 (Large fresh produce distribution warehouse): The customer was dissatisfied with the baseline system due to design and capacity concerns. After installation, they were satisfied with system capacity but remained concerned about CU6 achieving the 31°F setpoint. Their focus shifted from reliability and payback to long-term performance and lifecycle cost.

Service Contractor 2: The service contractor reported improved performance, no change in maintenance requirements, and identified mechanical issues unrelated to the technology. They recognized the technology's energy-saving potential and requested additional training and communication to support wider adoption.

Summary of Savings

Table 22: Cost-benefit analysis summary.

Site	ET Quantity	Capital Cost	Install Cost	Total Cost	kWh Savings per Year	Cost Savings per Year	Simple Payback Period in Years
1	4	\$75,200	\$35,200	\$110,400	127,904	\$63,952	1.73
2	2	\$26,800	\$17,600	\$44,400	43,069	\$21,535	2.06

Source: Project team.

Summary of Findings

- Expand testing across a wider range of facilities, refrigeration systems, and operating conditions.
- Collect year-round data to capture seasonal performance impacts.
- Improve monitoring, data quality, and analysis of key operating parameters.
- Standardize baseline system selection and comparison criteria.
- Provide enhanced training and technical support for installers, operators, and technicians.
- Ensure proper system integration and programming to achieve expected energy savings.
- Continue field validation to optimize deployment strategies and support broader adoption.

Conclusions and Next Steps



Project Conclusion

- Technology Priority Map 2023 – Process Load – Refrigeration, Commercial.
- The benefit to end users – This report will introduce readers with the field test results of an emerging technology that is applicable to fixed-speed, three-phase induction motor-driven open or semi-hermetic compressors ranging from scroll, reciprocating, and screw types. The emerging technology will benefit the end users achieving energy efficient and safe control over their refrigeration system compressors.



Next Steps

- Project team to identify recommended next steps for technology transfer.
- Expand incentive programs and pilot projects to validate performance across diverse applications and climates.
- Standardize equipment sizing, installation practices, and cost structures to improve cost predictability.
- Establish clear compressor compatibility criteria to maximize savings and identify suitable applications.



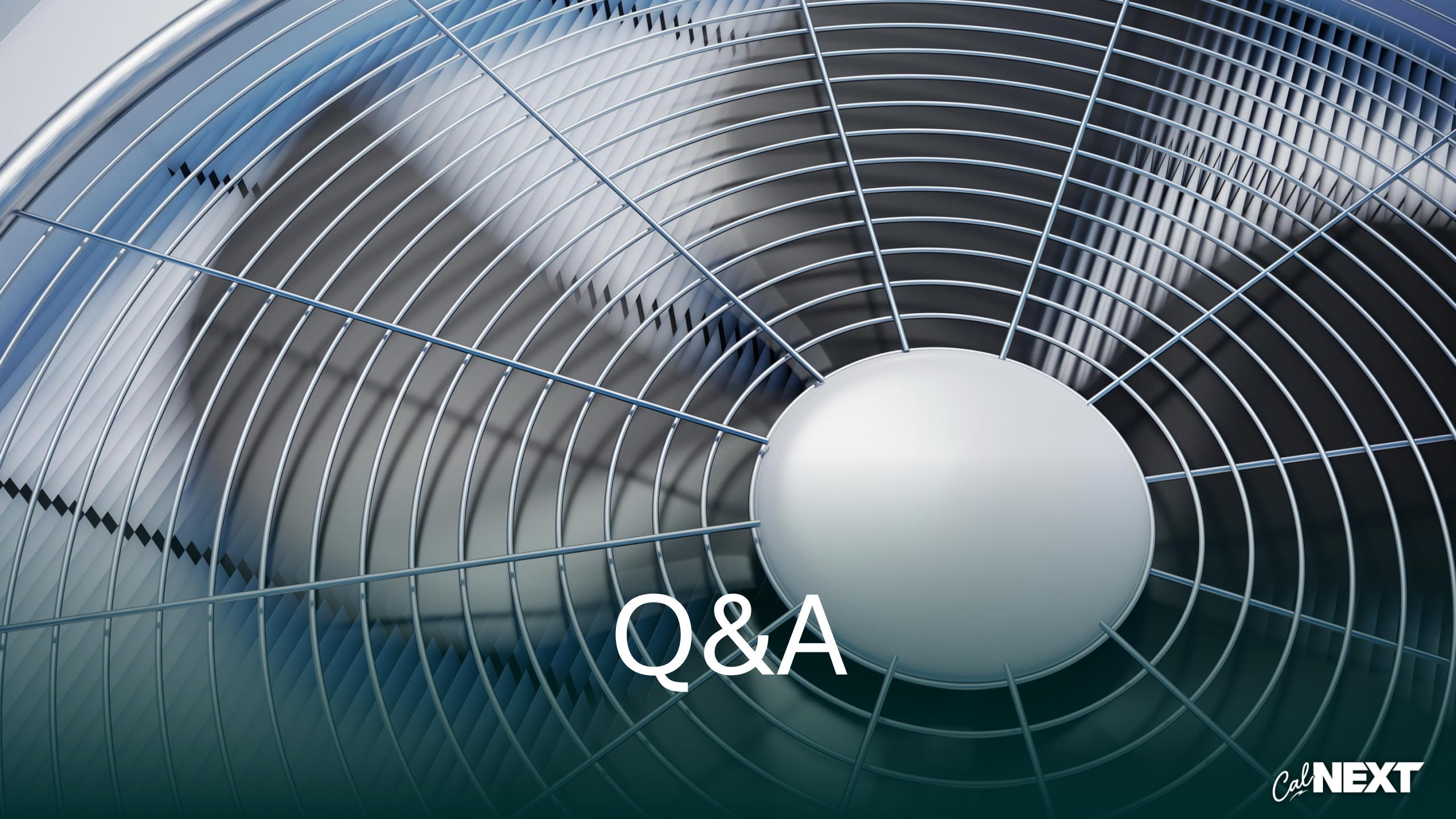
Project Final Report

Thank You!

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Q&A



Thank You!

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