

CalNEXT Knowledge Sharing Webinar

Industrial Solutions

September 22, 2026



Agenda

Introduction	Energy Solutions	5 min
11:05 – 11:14 a.m. Comparative Field Assessment of CO2 System Performance vs. HFC Refrigeration in Supermarkets		10 min
11:15 – 11:24 a.m. Compressed Air End-Use Air Management System		10 min
11:25 – 11:34 a.m. Datacenter Liquid Cooling Market Characterization		10 min
11:35 – 11:44 a.m. Central HVAC Advanced Electric Motor Lab Evaluation		10 min
11:45 – 11:54 a.m. Wastewater Energy Transfer (WET) Heat Recovery Systems Market Study		10 min
Wrap-up Q&A	Energy Solutions	5 min

Presenters



Greg Barker

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Energy Solutions



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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



Upcoming CalNEX Knowledge Sharing Webinars

October 7, 2026 at 10:00 a.m. PT

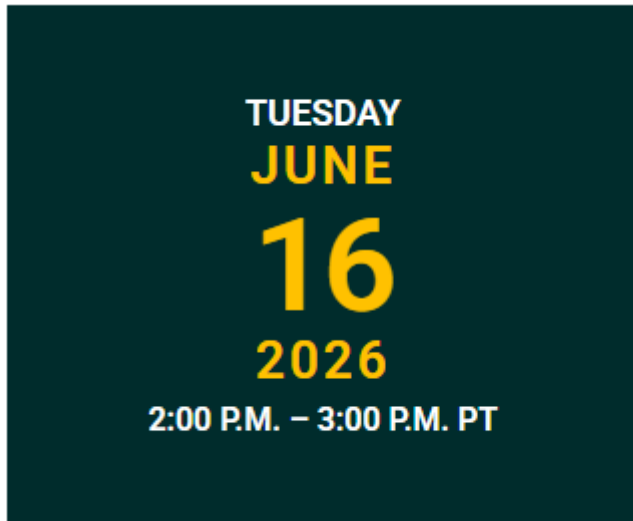
CO₂ Refrigerants, Refrigerant Charge, EVSE, and HVAC and Daylighting Controls

November 2026 (TBD)

Refrigeration, Grocery and Heat Pumps

Previous CalNEXt Knowledge Sharing Webinars Available Online

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WEBINAR

Knowledge Sharing Webinar

Commercial HVAC

Our second Knowledge Sharing Webinar, which focused on commercial HVAC, was held on Tuesday, June 16, 2026. We showcased several 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 Microsoft Teams 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.

Comparative Field Assessment of CO₂ and HFC Refrigeration System Performance in Supermarkets



Field Assessment of CO₂ and HFC Refrigeration



Project Summary

Supermarket refrigeration is nearly half of grocery electricity use. As CARB's low-GWP rules push a shift from HFCs to CO₂ (R-744), this CalNEXT field study compared two CO₂ and two HFC refrigeration systems in California Climate Zones 10 and 11 over four months. Result: CO₂ showed no net energy savings and a ~30% installed-cost premium versus HFC. Regulatory compliance and GHG goals, not payback, are driving adoption.

~0%

Net energy savings, CO₂
vs. HFC

+30%

CO₂ installed cost
premium

7–19%

CO₂ annual leak rate
(vs. 0% HFC)

1 vs 3,922

GWP: CO₂ vs. R-404A

Bottom line:

In these warmer climate zones, CO₂ adoption may not be currently justified by direct energy or cost savings alone. Regulatory compliance, corporate GHG goals, and potential utility incentives — not payback economics — are the leading adoption drivers.

Refrigeration Field Assessment – Purpose

Evaluate whether CO₂ (R-744) systems deliver measurable energy and demand benefits under real-world conditions that offset their higher first cost and inform future market adoption.

Secondary objectives:



Report on installation and operational challenges of CO₂ systems



Capture stakeholder feedback on operational risks and their perceptions



Inform utility incentive program design and CARB compliance efforts



Inform EE managers about potential load impacts of CO₂ refrigeration



Project Stakeholders

- Store chain refrigeration management
 - Stated adoption primarily by regulatory compliance and sustainability goals, not ROI
- Host site facility/operations staff
 - Provided access, operational history, performance observations, outages/leaks info
- Equipment suppliers and OEM contacts
 - System availability, component compatibility, pricing, and installation requirements
- CalNEXT/IOU program managers
 - Program oversight, funding, and technical review

Baseline & Methodology

Baseline: Incumbent R-404A (HFC) systems — GWP $\approx$ 3,922, stable operation, well understood by technicians

Drivers: CARB's Short-Lived Climate Pollutant (SLCP) Reduction Strategy targets a 40% cut in HFC emissions below 2013 levels by 2030 (Title 17 CCR §95374–95377). Title 17 also bans refrigerants with GWP > 150 in new systems with a charge over 50 lbs, effective 2022, driving new installations toward CO₂ (R-744) trans-critical systems, with different cost, efficiency, and reliability profiles than incumbent systems

Method: IPMVP Option B: calibrated three-phase power monitoring combined with regression analysis and weather normalization, per the project's M&V plan

- Instrumentation: Powersite® power monitors + HOBO® loggers captured power and temperature data at 4 sites over 4 months, at 30-minute intervals, converted to hourly values
- Regression models correlating outdoor temperature with hourly kW achieved $R^2 > 0.97$ at all four sites
- Analysis process: bin data in 5°F increments → regression/trendline per system → apply to five-year historical weather → annualize demand and energy → compare system performance → estimate GHG and ROI impact

4 sites, 4 mo.

Powersite® power monitors + HOBO® loggers

30-min intervals

Power & temperature data, converted to hourly

$R^2 > 0.97$

Regression fit at all four sites

Site Information

Four California supermarkets were monitored over four months: two CO₂ (R-744) and two HFC (R-404A) systems, matched in pairs by comparable refrigeration load (within 10%) in the same climate zone.

Site	City	Climate Zone	Refrigerant	Year Installed	Installed Cost
T1	Ontario, CA	CZ 10	CO ₂ (R-744)	2023	\$1,500,000
T2	Fontana, CA	CZ 10	HFC (R-404A)	2012	\$1,125,000
T3	Grass Valley, CA	CZ 11	CO ₂ (R-744)	2023	\$1,500,000
T4	Auburn, CA	CZ 11	HFC (R-404A)	2011	\$1,125,000

Map source:
<https://gis.data.ca.gov/documents/CAEnergy::building-climate-zones/about>

Market Context: Cost and Adoption Landscape

Est. 20–40%

CO₂ upfront cost premium vs. HFC systems (industry-wide, NASRC/ATMOsphere)

Est. 30%

of European grocery stores use CO₂ systems (~90,700 stores, 2024)

Est. 4–6%

US/North American CO₂ adoption share by comparison

Where the cost premium comes from:

- Higher-pressure rated components: compressors, piping, valves
- Added system complexity and controls for transcritical operation
- Specialized installation and contractor training requirements



Prior lab study (e.g., SCE's ET19SCE7070) suggested 10–25% potential energy savings, but climate-specific US field data remained scarce prior to this study.

Summary of Findings — Energy

Little to No Net Savings

CO₂ vs. HFC, after load
and efficiency adjustment

- After adjusting for design-load differences and equipment age (a 94% efficiency factor was applied to the older HFC units), CO₂ systems showed essentially no net annual energy savings versus HFC systems in CZ 10 and CZ 11.
- CO₂ system efficiency can decline above roughly 95°F outdoor temperature due to transcritical operation — a key limiting factor in these warmer climate zones.
- Regression models correlating outdoor temperature with hourly kW achieved R² values above 0.97 at all four sites, confirming temperature as a strong predictor of system load.

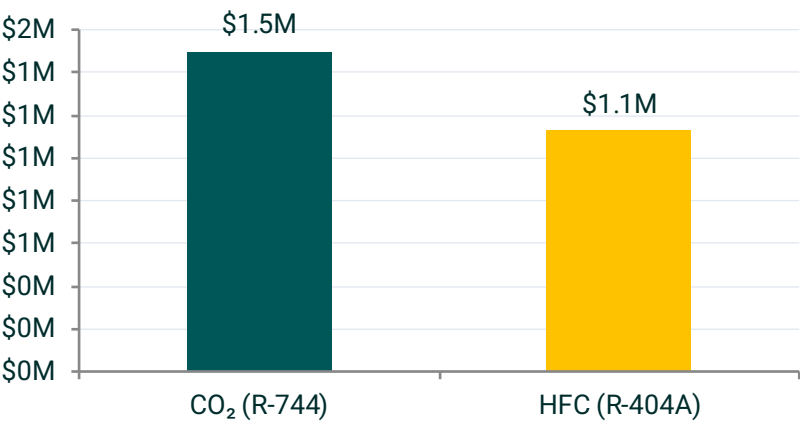


*Transcritical efficiency loss
intensifies above an estimated
95°F*



Summary of Findings — Installed Cost / Payback / Environment

Installed Cost per Site



Est. 30% cost premium for CO₂ systems (\$1.5M vs. \$1.125M)

Negative

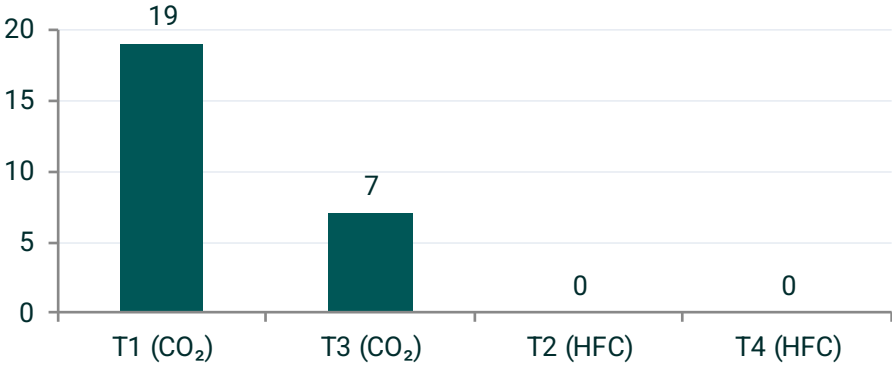
Simple payback —
Ontario (CO₂)

866 yrs

Simple payback —
Grass Valley (CO₂)

With minimal avoided energy and a est. 30% installed-cost premium, simple payback based solely on energy savings is unfavorable at both CO₂ sites. This narrow, energy-only view does not capture the broader value proposition of CO₂ adoption— regulatory compliance, GHG reduction goals, and potential utility incentives.

Monitored Refrigerant Leak Rate



Chain-wide (larger sample): Est. 58.7% avg. annual leak rate for CO₂ vs. est. 16.9% for R-404A

Illustrative: a 10% leak from a 2,000 lb charge

0.09 t

CO₂e released —
CO₂ (R-744) system

354 t

CO₂e released —
R-404A system

≈ annual emissions
of 75+ passenger
cars

Despite higher observed leak rates, CO₂'s GWP of 1 (vs. 3,922 for R-404A) means its climate impact from leaks is minimal by comparison — even modest HFC leaks carry an outsized greenhouse-gas footprint.

Summary of Findings — Field Observations / Operational



System Age Disparity

CO₂ systems were newly installed (2023); HFC systems were an est. 14–15 years old, requiring an efficiency adjustment in the analysis.



Mounting and Configuration

Three of four systems are roof-mounted. The Ontario (CO₂) unit was ground-mounted with VFDs on each compressor.



Restart Sensitivity

Staff at both CO₂ sites asked that power not be interrupted during instrumentation setup, citing restart reliability concerns.



Major Outage

The Ontario (CO₂) site experienced a high-pressure R-744 leak during monitoring, resulting in an est. \$50,000 in refrigerated product loss.



Why Retailers Adopt CO₂ Despite Uncertain ROI



Regulatory Compliance

CARB's GWP cap ensures future-proof compliance and avoids retrofit costs later.



New Construction Rules

New builds and major remodels must meet current refrigerant requirements.



Incentive and Pilot Funding

Programs like CalNEXT, IOU incentives, and CEC/EPIC can help defray upfront costs and reduce risk.



Brand Sustainability

CO₂ aligns with corporate climate pledges and enhances brand image.



Operational Learning

Early installations build internal expertise ahead of broader rollout.



Technology Maturation

Costs are expected to decline and reliability to improve as the market matures.

Conclusions and Next Steps

 **Project Conclusion:** This limited field assessment (2 CO₂ vs. 2 HFC systems, Climate Zone 10 and 11) suggests that in warmer California climates, CO₂ adoption may not be justified by direct energy or cost savings alone.

- Informs the CalNEXT Technology Priority Map for low-GWP commercial refrigeration.
- Gives California IOUs objective, field-based evidence for program design and CARB compliance alignment.

Next Steps

1



Expand Field Data

Monitor CO₂ systems across more climate zones (CZ 3–6), other system formats, and additional low-GWP refrigerants for a representative dataset.

2



Targeted Incentive Frameworks

Design incentives around carbon reduction and lifecycle emissions value, not kWh savings alone.

3



Workforce Training

Invest in technician training and standardized commissioning to reduce leak rates and restart issues.

4



Manufacturer Collaboration

Convene OEMs, manufacturers, and retailers to share performance data and design improvements.

5



Continue Market Research

Track CO₂ deployment costs, leak rates, new hybrid system configurations, energy trends as the market matures.

6



Inform CalNEXT TPM

Fold appropriate findings into the Technology Priority Map and custom measure development pathways.



Project Final Report

Thank You!

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*Cal***NEXT**

Compressed Air End-Use Air Management System

Project Outcomes and Tech Transfer

Project Summary

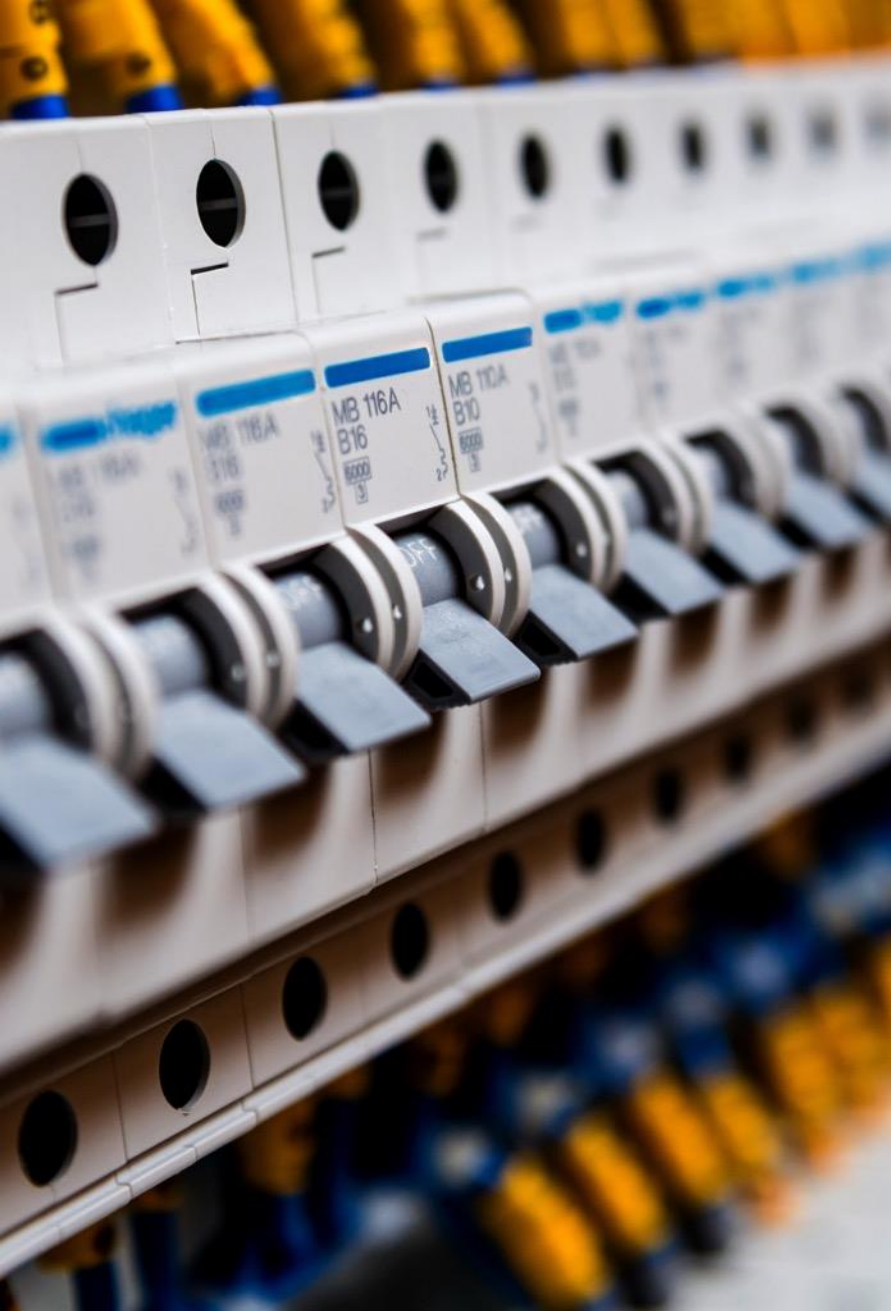
A new product line with customizable filter, lubricator, regulator, and control components can help reduce compressed air waste in manufacturing facilities.

The team installed and tested the product at a packaged food production facility.

Energy impacts were calculated for a range of conditions to establish expected savings and cost-effectiveness that could define a useful application boundaries.

Future study and a workpaper can fully transfer this new product to deemed programs.





Stakeholders

Manufacturing Facilities

- Packaged food manufacturer host site

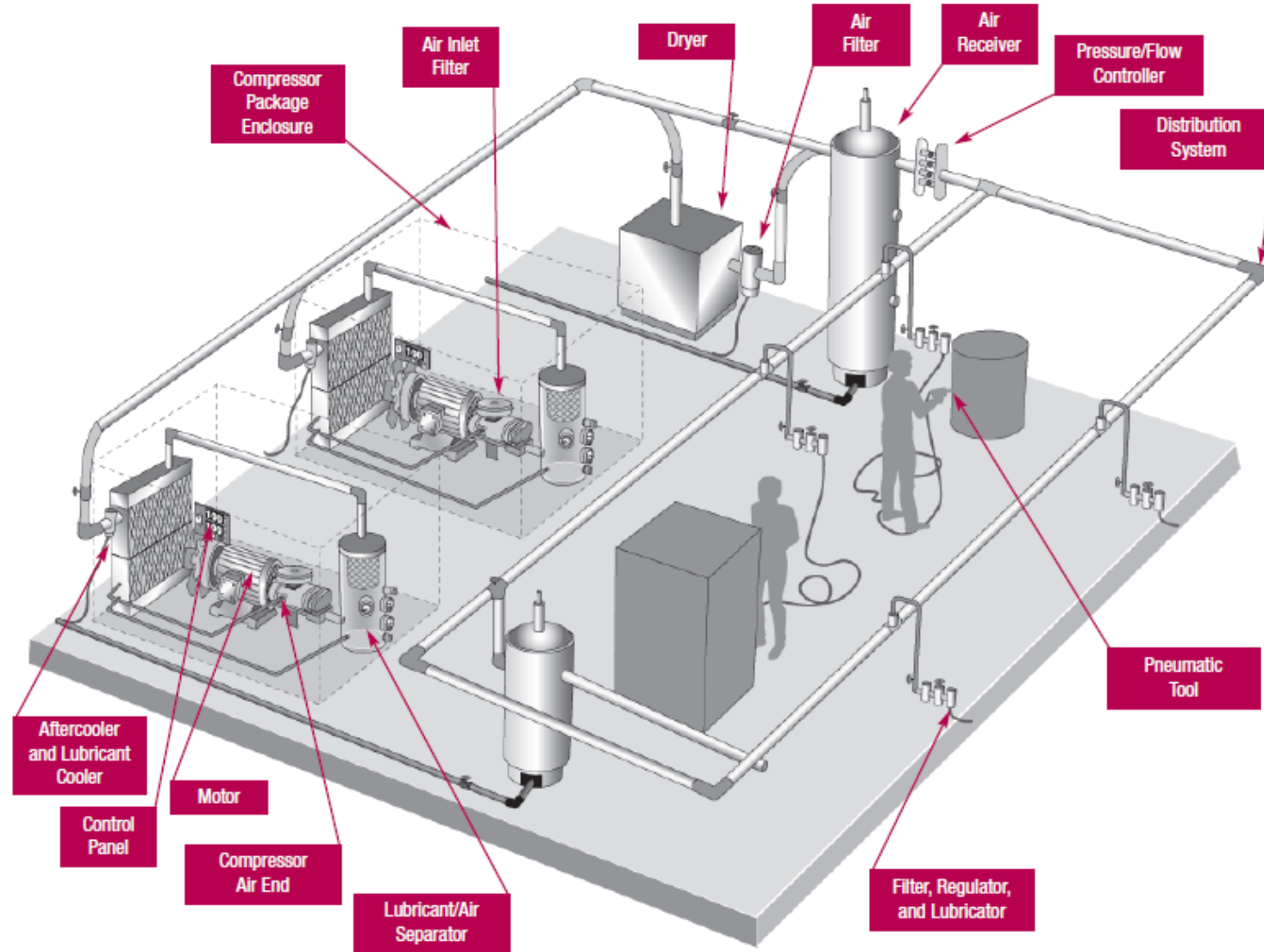
Compressed Air Industry

- Air compressor manufacturers
- Compressed air system designers
- Pneumatic equipment market actors
- Compressed air service providers

Other Stakeholders

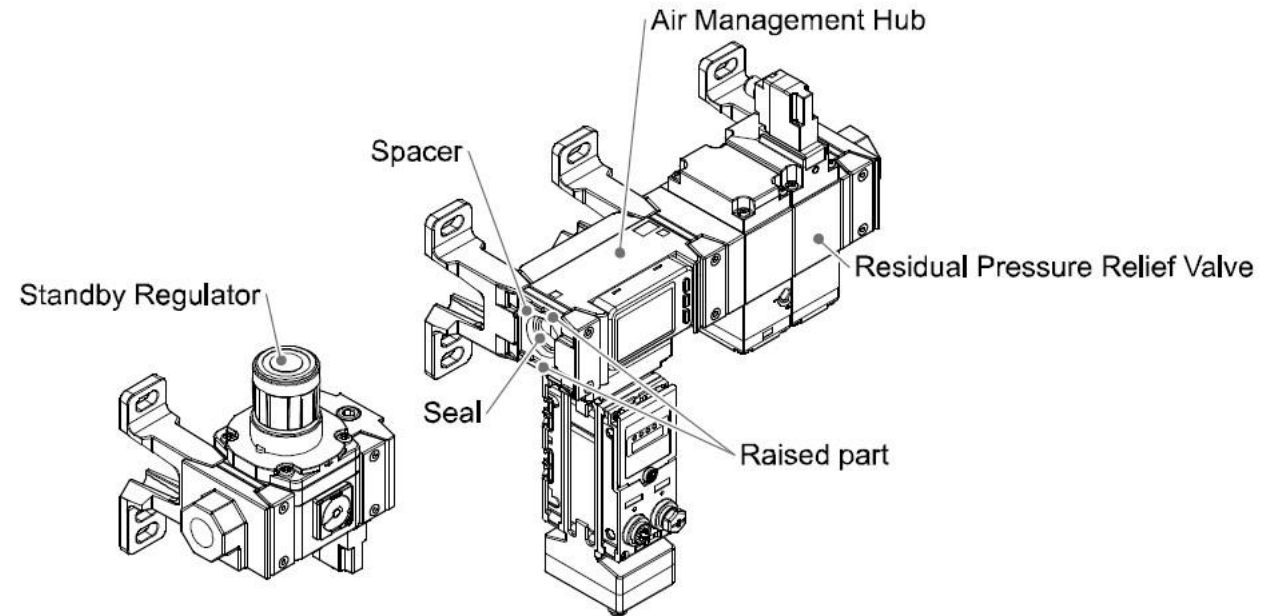
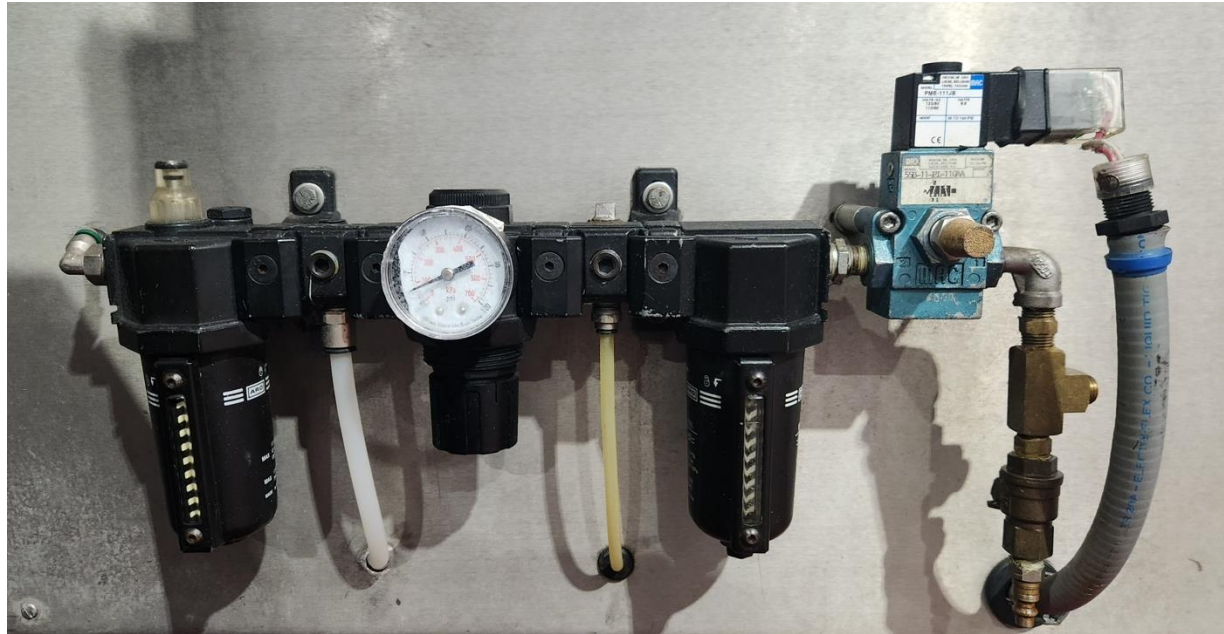
- Program implementers and administrators

Background – Compressed Air Systems



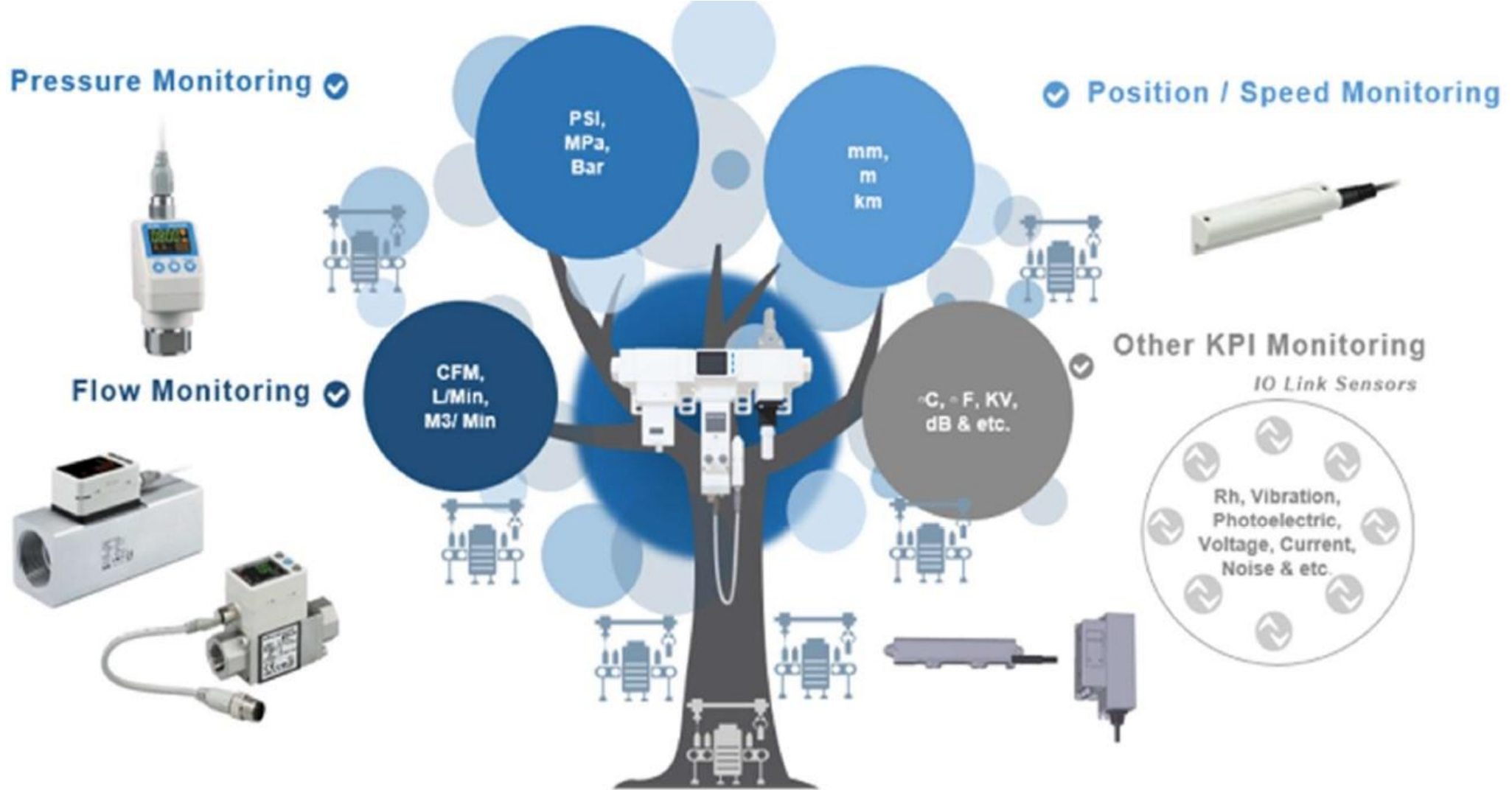
Source: DOE

Background – Air Management System (AMS)



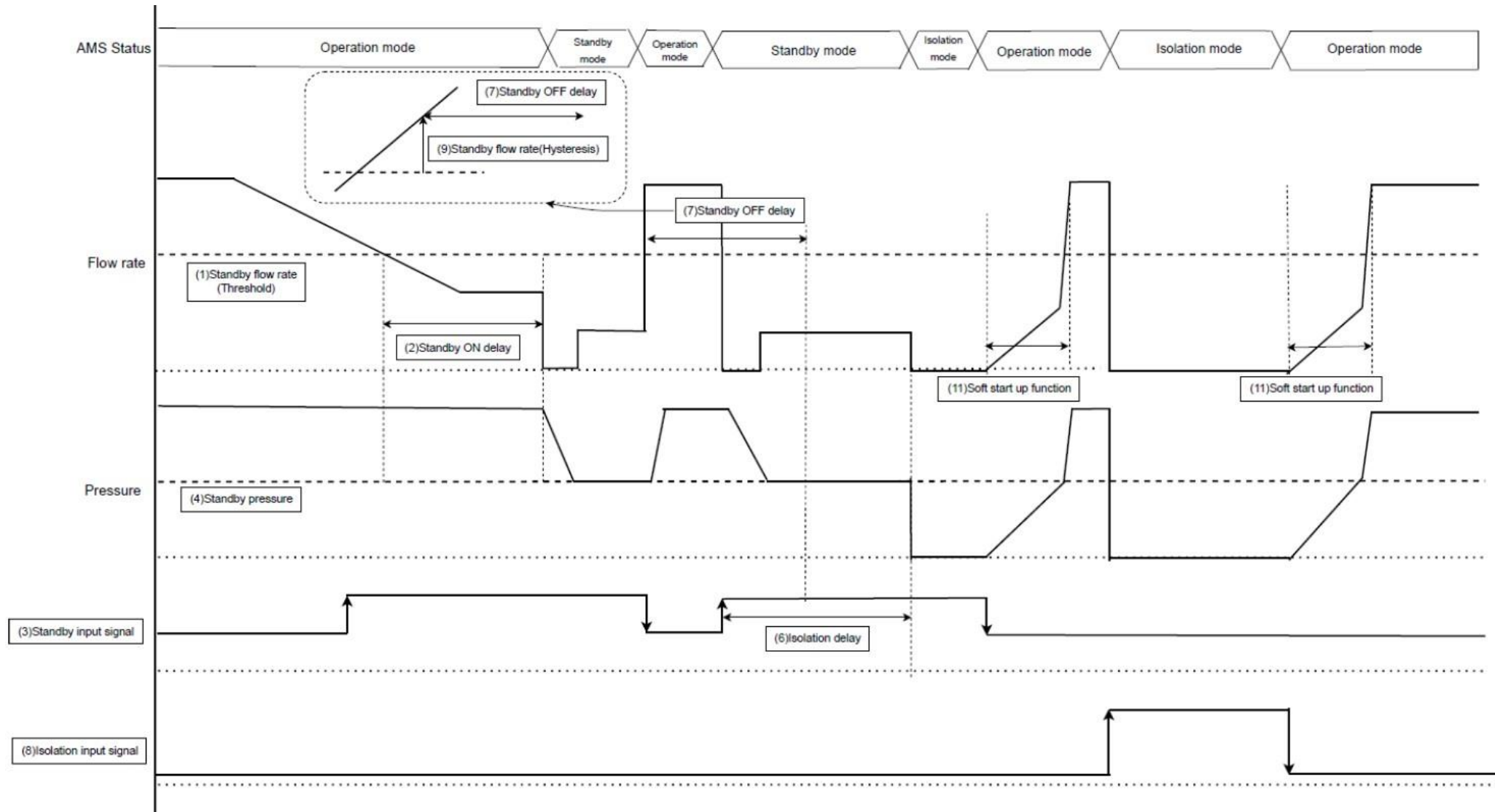
Source: AMS Manufacturer

Background – Communications and Metering



Source: AMS Manufacturer

Background – Control Logic

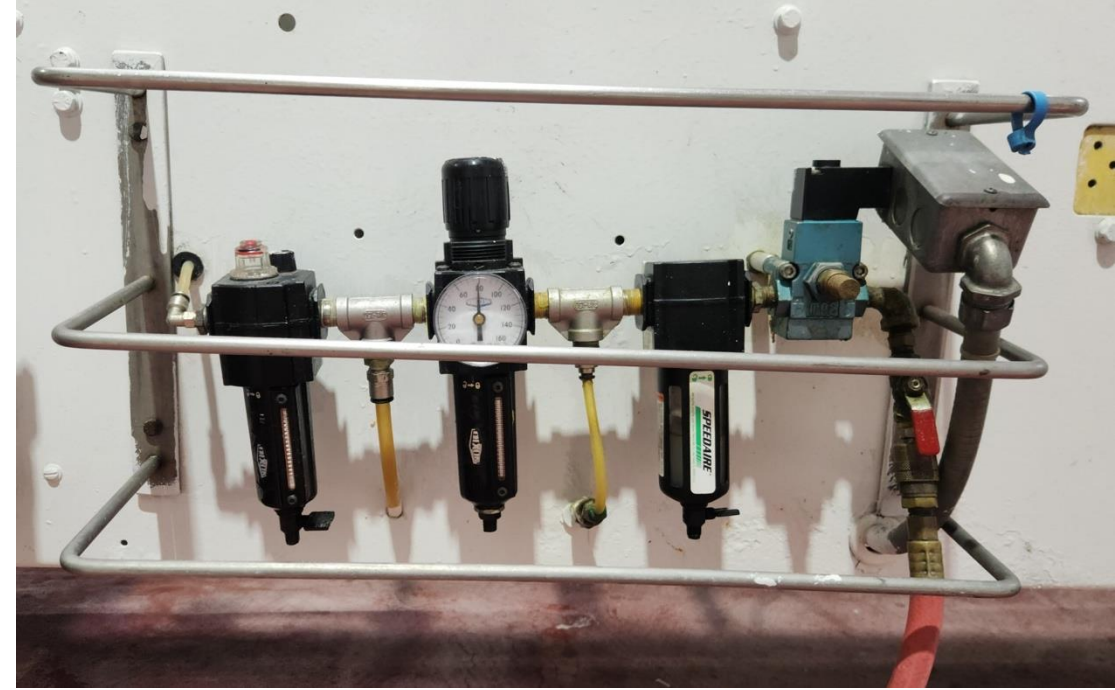


Source: AMS Manufacturer

Findings

Four air management systems (AMSs) were installed along with metering of power, pressure, and airflow of the air compressor plant. These were installed in packaging lines comprising of various pneumatic end-uses sharing a common air supply line and Filter/Regulator/Lubricator (FRL).

Although the full set of AMS features were not fully commissioned, the team was able to calculate savings for the site's conditions and a range of applications.



Findings

Parameter	Value
Nonproductive Load Reduction (CFM)	5.0
Percent Idle Time	25%
Production Time (hours/year)	4,848
Annual Savings (kWh/yr)	1,223
Annual Energy Cost Savings (\$/yr)	432
Per Unit Installed Cost (\$)	4,567
Estimated Customer Payback Time (yr)	10.6
GHG Emissions Reduction (tons/yr)	0.1
TSB (\$/yr)	128

Findings

Energy Savings (kWh/yr)

Machine Size ->		10	20	30	40	50	60	70	80	90	100	110	120	130	140
Idle Flowrate ->		2	4	6	8	10	12	14	16	18	20	22	24	26	28
Idle Time (%)	5%	75	150	224	299	374	449	524	598	673	748	823	898	972	1,047
	10%	150	299	449	598	748	898	1,047	1,197	1,346	1,496	1,646	1,795	1,945	2,094
	15%	224	449	673	898	1,122	1,346	1,571	1,795	2,020	2,244	2,468	2,693	2,917	3,142
	20%	299	598	898	1,197	1,496	1,795	2,094	2,394	2,693	2,992	3,291	3,590	3,890	4,189
	25%	374	748	1,122	1,496	1,870	2,244	2,618	2,992	3,366	3,740	4,114	4,488	4,862	5,236
	30%	449	898	1,346	1,795	2,244	2,693	3,142	3,590	4,039	4,488	4,937	5,386	5,834	6,283
	35%	524	1,047	1,571	2,094	2,618	3,142	3,665	4,189	4,712	5,236	5,760	6,283	6,807	7,330
	40%	598	1,197	1,795	2,394	2,992	3,590	4,189	4,787	5,386	5,984	6,582	7,181	7,779	8,378
	45%	673	1,346	2,020	2,693	3,366	4,039	4,712	5,386	6,059	6,732	7,405	8,078	8,752	9,425
	50%	748	1,496	2,244	2,992	3,740	4,488	5,236	5,984	6,732	7,480	8,228	8,976	9,724	10,472

Payback (years)

Machine Size ->		10	20	30	40	50	60	70	80	90	100	110	120	130	140
Idle Flowrate ->		2	4	6	8	10	12	14	16	18	20	22	24	26	28
Idle Time (%)	5%	172.9	86.5	57.6	43.2	34.6	28.8	24.7	21.6	19.2	17.3	15.7	14.4	13.3	12.4
	10%	86.5	43.2	28.8	21.6	17.3	14.4	12.4	10.8	9.6	8.6	7.9	7.2	6.7	6.2
	15%	57.6	28.8	19.2	14.4	11.5	9.6	8.2	7.2	6.4	5.8	5.2	4.8	4.4	4.1
	20%	43.2	21.6	14.4	10.8	8.6	7.2	6.2	5.4	4.8	4.3	3.9	3.6	3.3	3.1
	25%	34.6	17.3	11.5	8.6	6.9	5.8	4.9	4.3	3.8	3.5	3.1	2.9	2.7	2.5
	30%	28.8	14.4	9.6	7.2	5.8	4.8	4.1	3.6	3.2	2.9	2.6	2.4	2.2	2.1
	35%	24.7	12.4	8.2	6.2	4.9	4.1	3.5	3.1	2.7	2.5	2.2	2.1	1.9	1.8
	40%	21.6	10.8	7.2	5.4	4.3	3.6	3.1	2.7	2.4	2.2	2.0	1.8	1.7	1.5
	45%	19.2	9.6	6.4	4.8	3.8	3.2	2.7	2.4	2.1	1.9	1.7	1.6	1.5	1.4
	50%	17.3	8.6	5.8	4.3	3.5	2.9	2.5	2.2	1.9	1.7	1.6	1.4	1.3	1.2

Conclusions and Next Steps



Project Conclusion

- AMS product presents a novel and unique opportunity to address leaks and artificial, unproductive loads in large pneumatic machinery.
- The product is very cost-effective when applied properly. Applications need wise selection.
- Physical install is easy, assuming power and communications available.
- Commissioning is added labor and knowledge required by maintenance staff, well above baseline FRL needs. First install could be challenging, subsequently much easier.
- Visibility into compressed air usage gives site staff insight into plant and equipment health that is otherwise invisible. Compressed air usage can serve as a useful metric and indicator for non-energy purposes.



Next Steps

- Follow-up laboratory or field testing, if necessary.
- Workpaper development with boundaries around end-use conditions to ensure cost-effectiveness.
- Institute a statewide compressed air survey.



Project Final Report

Thank You!

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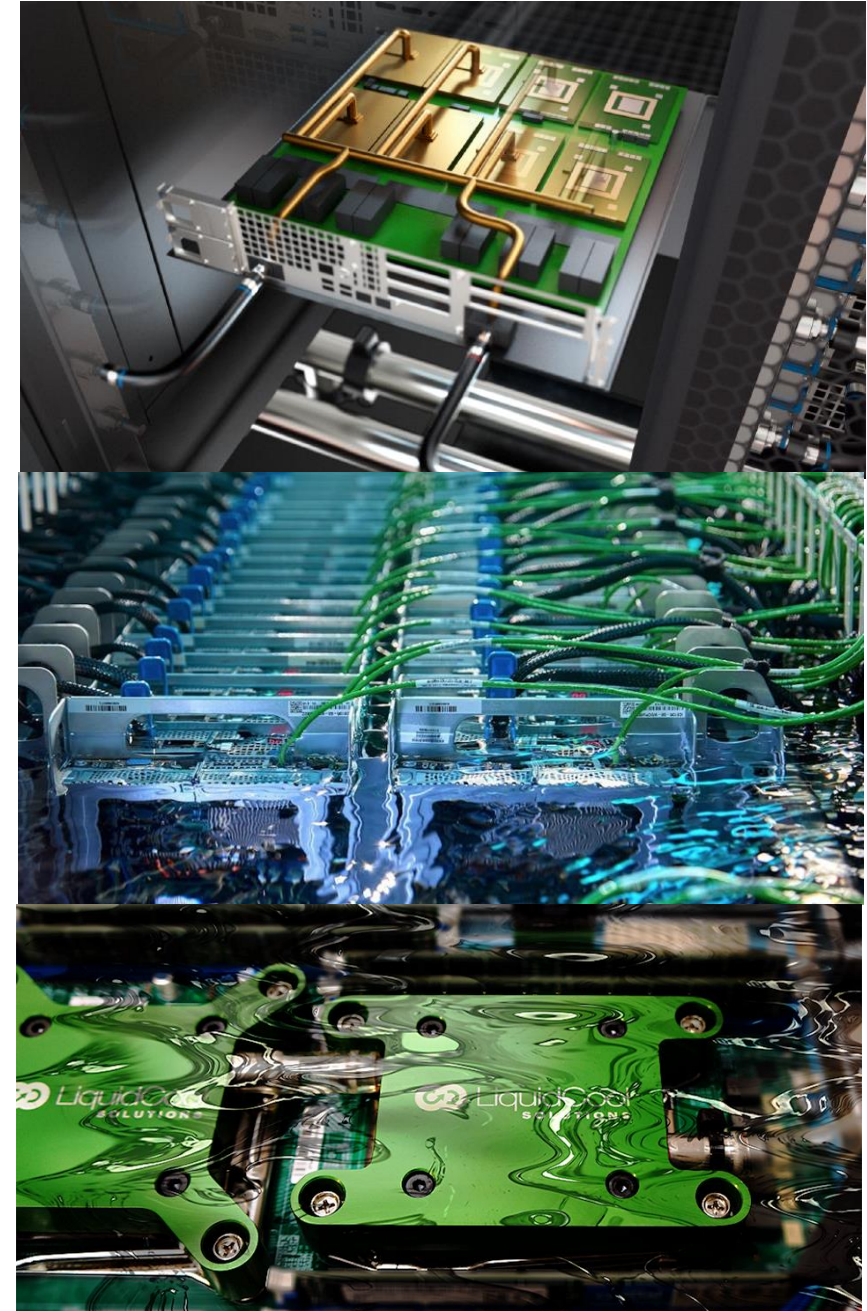
Datacenter Liquid Cooling Market Characterization

Project Outcomes and Tech Transfer



About Data Center Liquid Cooling Market Characterization

- CEC estimates that the peak load from data centers will increase from 2% (1GW) in 2026 to 9% (4.5 GW) by 2040.
- Almost every watt of electrical energy into the data center is dissipated as heat that needs to be removed efficiently.
- Traditional air-cooled server rooms require large energy use for cooling and/or water use for evaporative cooling.
- Modern AI servers are performance limited by air cooling
- Liquid cooling is hence becoming imperative for AI data centers. Several options exist for liquid cooling. Questions that we address:
 1. What are the different types and how can we classify them?
 2. How does it compare to traditional air cooling?
 3. Which liquid cooling solution is the “best”?



Data Center Liquid Cooling Market Characterization – Objectives

- (a) Categorize liquid cooling solutions.
- (b) Assess performance metrics using physics-based modeling, published data, and manufacturer specifications.
- (c) Identify non-energy benefits and potential risks.
- (d) Gather qualitative feedback from industry stakeholders across the supply chain.
- (e) Provide actionable recommendations for program implementers and utility partners.

Baseline: Traditional Air Cooling





Stakeholder Category	Organization Name	Feedback and Recommendations
Utilities/Program Implementers	SCE/Energy Solutions Silicon Valley Power/ DNV PG&E/2050 Partners and Redcar Analytics	Examined utility preparedness for high-density data centers, assessed liquid-cooling and hybrid retrofit pathways, and considered future efficiency program and code-readiness efforts. Informed stakeholder insights section of report.
Tribal Communities	Colusa Indian Energy	Excited about potential for liquid cooling and efficient data centers in tribal communities. Informed stakeholder insights section of report.
Rural Electric Co-Ops	UC Davis Extension	Excited about modular liquid cooled datacenter in rural electric co-ops due to: - Water use is eliminated - Internet fiber to the entire community - Higher security near substations Informed stakeholder insights section of report.



Stakeholder Category	Organization Name	Feedback and Recommendations
Datacenter Designers	Black and Veatch Seibold Systems	Discussed reliability of liquid cooled datacenters and guided the team on designs for reliability.
Silicon Providers	Intel AMD NVIDIA	Discussed trends of CPU and GPU compute densities and auxiliary heat dissipating components within the server. This information was used by the team in developing server architectures for the study.
Server Integrators	Dell Supermicro	Discussed power density trends, liquid cooling solutions available. Recommendation was to model the highest compute density available, and this informed our decision to model GB300 servers. This information was used by the team in developing server architectures for the study.
Datacenter Operator (Colocation)	Equinix	Discussed current server compute densities; enterprise servers will not have compute densities that warrant liquid cooling currently or in the future. Liquid cooling is going to be needed for AI training servers and potentially some inference AI; cost of liquid cooling is high and hence it makes sense to use it for GPUs and not other components. Informed stakeholder insights section of report.



Outreach Activities

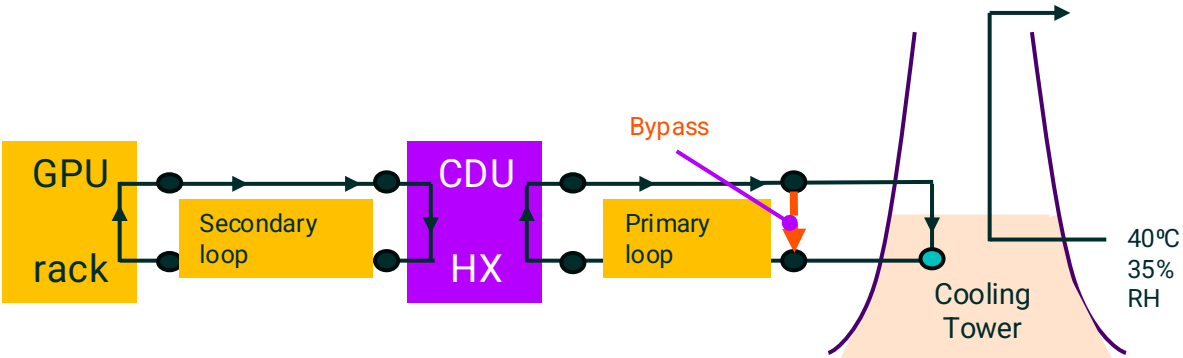
- EEI board meeting (6/25 and 12/25)
- Interviewed with Nova Safo at NPR Marketplace for a short segment on datacenter cooling, marketplace.org/story/2026/01/07/new-ai-chips-will-need-less-cooling-says-nvidia-ceo
- Interviewed with Sukham Sahota, journalist with Build Better (Instrumental-Inc, [Build Better News - Instrumental](#)) which covers manufacturing news & emerging technologies for executives
- Presented a talk at the Energy and Efficiency Institute's Board meeting on "Energy, Cooling, and Water Demand for Datacenters," on June 9, 2026
- Narayanan, "Assessment of Cooling Strategies for High Compute Density Data Centers-Performance, Energy Use and Non-energy Benefits," 2026 Industrial Process EmergIng Technologies (IPER) workshop in San Antonio, TX (Feb 10-11 2026)
- "Voices" contribution (opinion piece) on "Cooling for AI Data Centers: Sustainability Opportunities and Challenges" for Cell Reports-Sustainability (forthcoming in October 2026)
- Met with US House congressional staffer on the House Committee on Science, Space and Technology and explained the different types of datacenter cooling systems and nuances and challenges of AI datacenter cooling (9/4/26)
- ACEEE Summer study 2026: Wrote paper and presented on the topic of the CalNEXT report

Summary of Savings

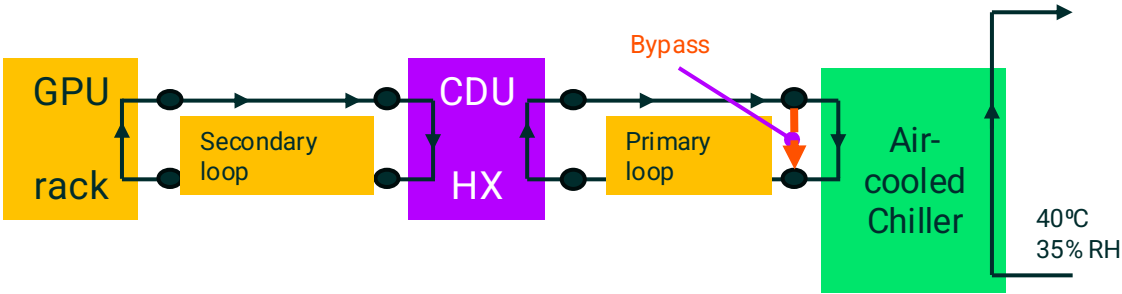
Cooling Mode	SCCP _{ratio} (%)	C _{density} (kW/m ²)
Traditional CRAH air-cooling (baseline)	2.00	5.4
D2C with cold plates	0.14	82.7
Full Immersion tank	1.08*	16.3**
D2C cold plate + traditional air-cooling	0.65	18.9
D2C cold plate and liquid-to-air CDU + traditional air-cooling	4.14***	5.4
D2C cold plate + RDX for traditional air-cooling	0.89	18.9
D2C cold plate + immersion cooling	1.08*	63.4

*Based on CDU pump power with secondary side dielectric oil flow and GPU throttled to 1100 W.
 ** Calculated from product brochure (Green Revolution Cooling 2025) using FWS of 32°C
 *** GPU needed to be throttled to 1300 W to maintain case temperature of 70°C

Baseline metrics for FWS at 30°C



WUE = 1.48 L/kWh for evaporative cooling



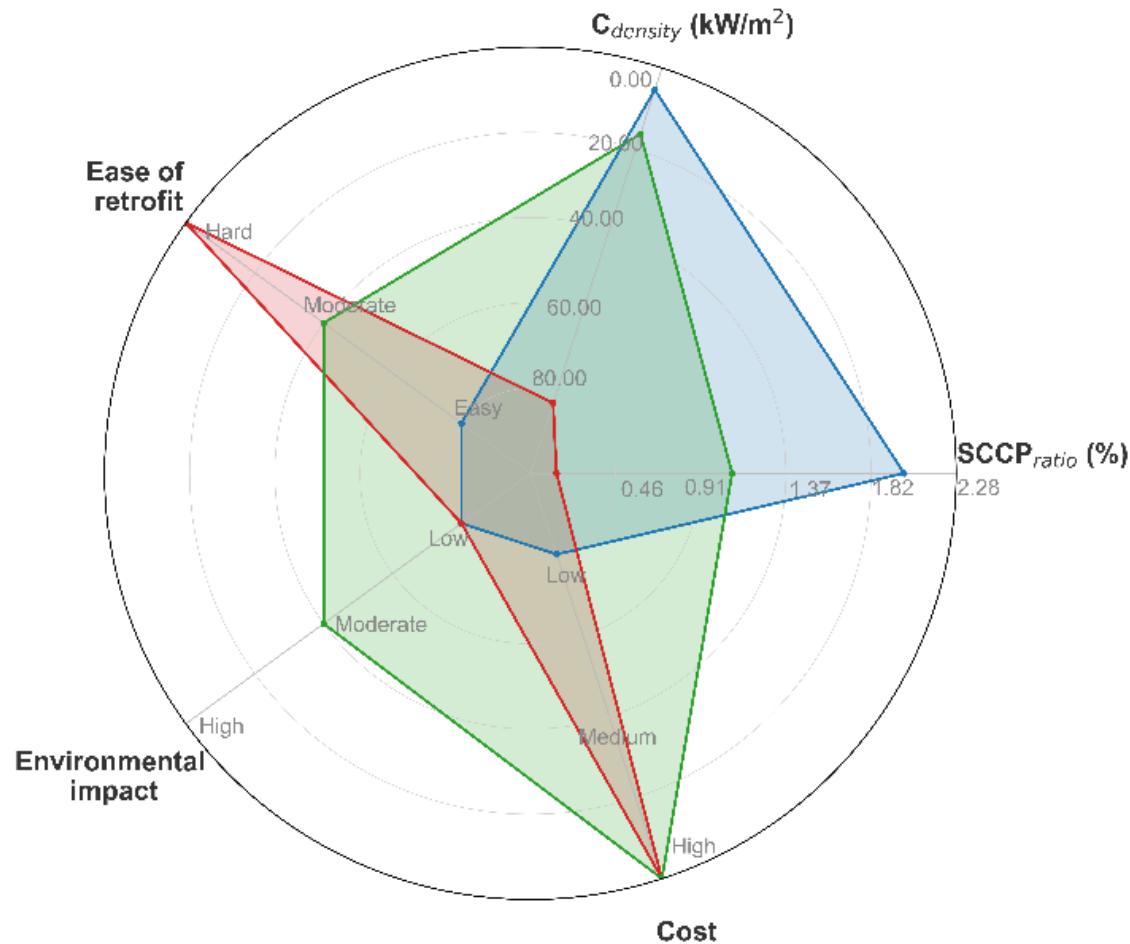
pPUE = 1.37 for air-cooled chiller

$$SCCP_{ratio} = \frac{\text{Secondary loop input electrical power}}{\text{Total IT compute power}}$$

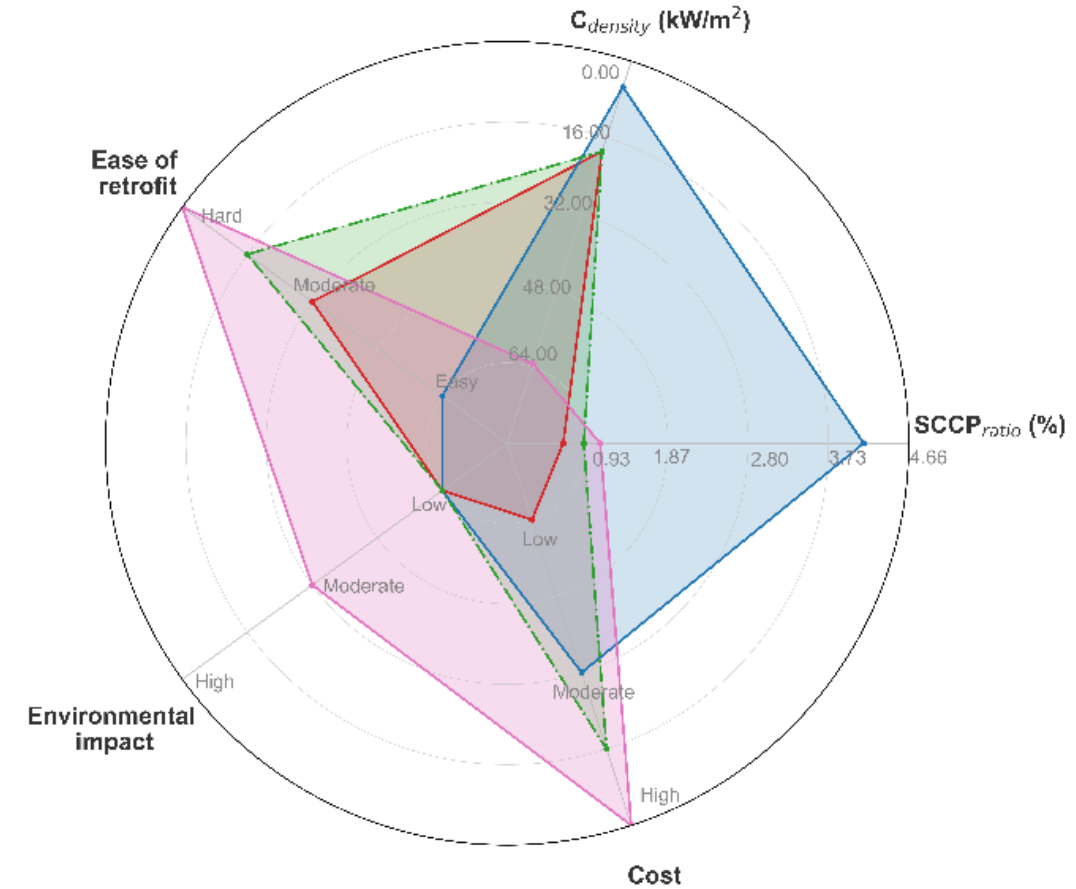
$$C_{density} = \frac{\text{IT compute power supported}}{\text{Total floor area of datacenter}}$$

Comparison of Cooling Strategies

- Traditional CRAH air-cooling (baseline)
- D2C with cold plates
- Full immersion tank



- D2C cold plate + traditional air-cooling
- D2C cold plates and liquid-to-air CDU + traditional air-cooling
- D2C cold plate + RDX for traditional air-cooling
- D2C cold plate + immersion cooling



Summary of Findings



New builds- prioritize all-D2C liquid cooling as the baseline strategy for AI and HPC workloads.



Retrofits- adopt hybrid approaches tailored to facility constraints: CRAH-assisted D2C where auxiliary loads are manageable, RDX where CRAHs are insufficient, and liquid-to-air CDUs where liquid distribution is infeasible.



Lower-density or modular deployments- consider immersion cooling, with hybrid immersion-D2C for higher TDP chips.



Utilities and policymakers- align incentive programs with technologies that deliver low $SCCP_{ratio}$, higher facility water supply temperature (enables waste heat recovery), and higher rack density.



Market- encourage vendor collaboration on interoperability, expand service models to address operational concerns, and accelerate the transition from hybrid to fully liquid systems in high-density environments.

Conclusions and Next Steps



Project Conclusion

- Datacenter and Enterprise Computing, Process Loads TPM
- Market study of available liquid cooling technologies and their energy and non energy benefits



Next Steps

- [ET25SWE0051](#) – Datacenter Liquid Cooling Lab Evaluation
- [ET25SWE0046](#) – Datacenter Liquid Cooling Case Study



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Thank You!

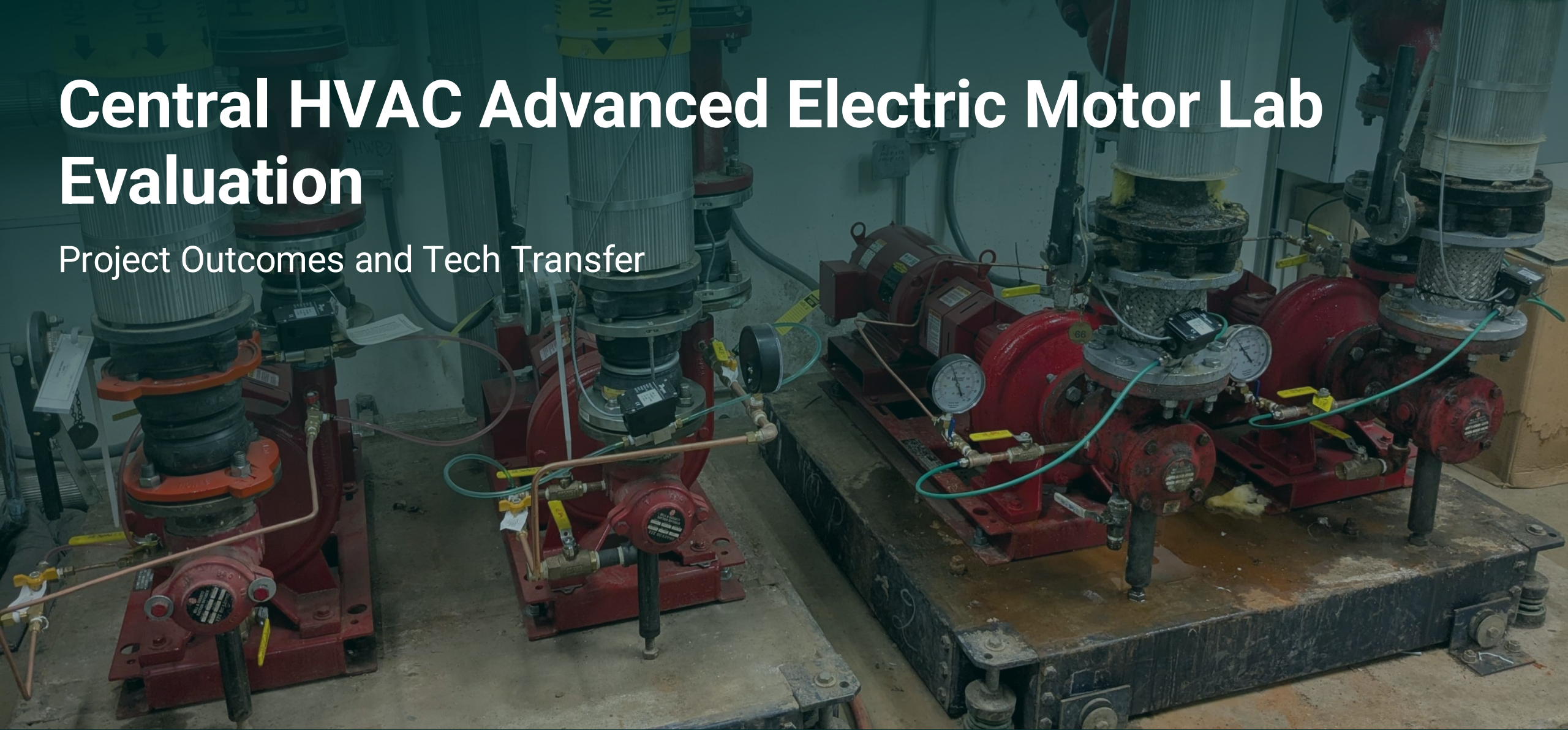
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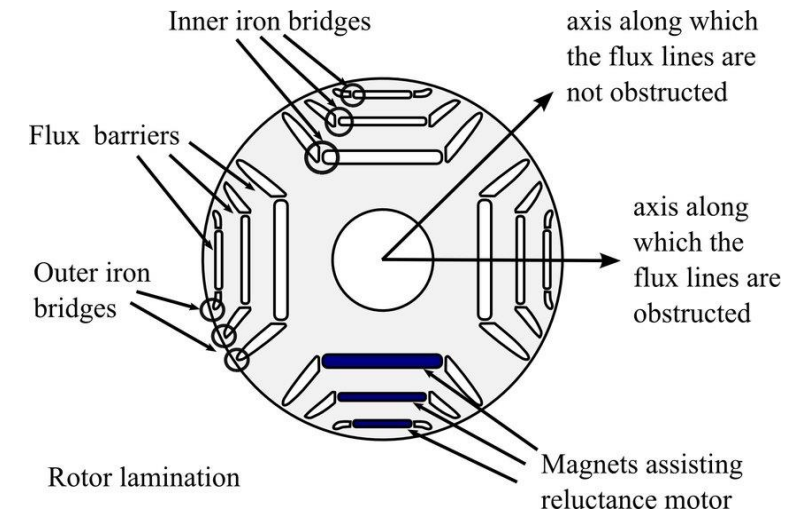
Central HVAC Advanced Electric Motor Lab Evaluation

Project Outcomes and Tech Transfer

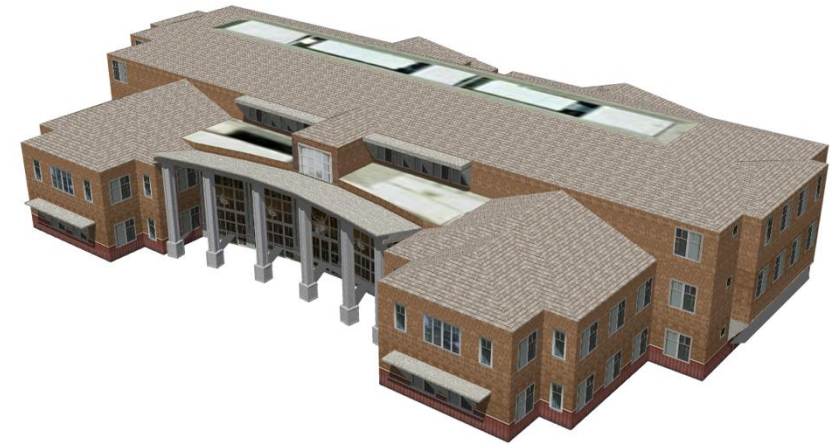


About Central HVAC Advanced Electric Motor Lab Evaluation

- Electric motors consume approximately 46% of global electricity demand, making motor efficiency one of the largest opportunities for energy savings.
- Previous project with CEC evaluated several motor types and found significant advantages of ferrite-assisted synchronous reluctance (FASR) motors.
- Evaluated ABB Baldor EC Titanium against standard NEMA Premium induction motors.
- Installed side-by-side in heating hot water (HHW) and chilled water (CHW) hydronic pump systems at Dutton Hall, UC Davis.



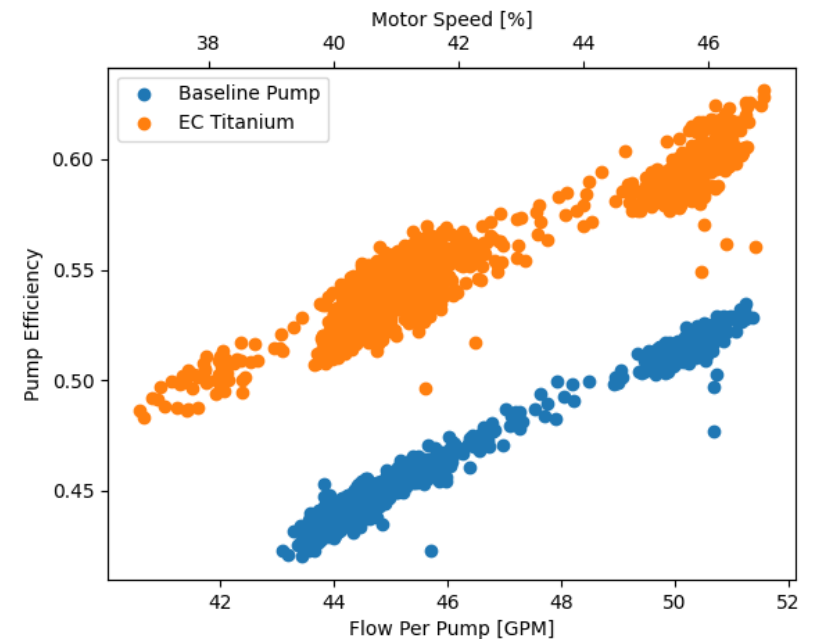
Cross section of FASR rotor

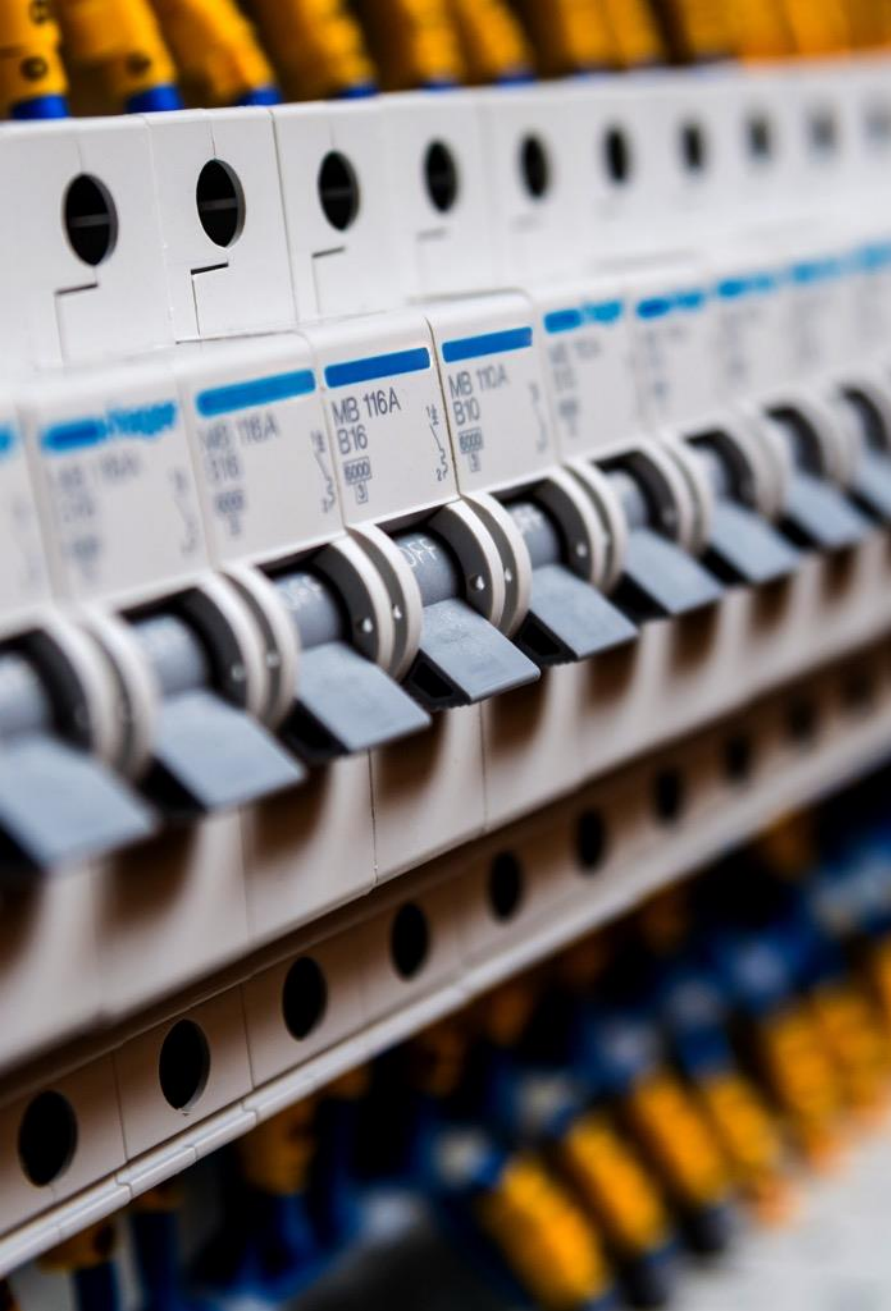


Dutton Hall

Central HVAC Advanced Electric Motor Lab Evaluation

- Field testing confirmed significant energy savings compared to baseline NEMA Premium induction motors.
- The field demonstration validated that the superior part-load performance observed in prior lab testing translates to real-world HVAC applications.
- Installation was largely a drop-in replacement with only minor VFD configuration changes and no special tools or training required.





Stakeholders

- UC Davis facilities and building owners
 - Assisted with project and provided feedback on installation and integration
- HVAC contractors, distributors, and installers
- OEMs including ABB, Bell & Gossett, Taco, Weg
- Utility program implementers
- California Technical Forum (CalTF)
- Engineers, designers, and energy-efficiency researchers

Motor Efficiency Curves

- At full load most NEMA Premium motors have similar efficiency
- Advanced motors, like FASR, are much better at part load
- Studies show many HVAC systems run at part load most of the time

Load	Induction 1	Induction 2	Permanent Magnet	Switched Reluctance	FASR
100%	86.40%	86.20%	89.50%	91.90%	90.00%
65%	80.40%	80.00%	86.90%	87.40%	88.00%
30%	42.60%	43.00%	62.90%	67.30%	73.00%

Summary of Savings

- Payback realized in a reasonable amount of time
- System could have benefited from further controls changes

System	Motor Type	kWh/Day	Simple Payback (motor only)	Simple payback (w/ VFD)
HHW	Baseline	13.5		
	FASR	11.1	4 Months	3.3 years
CHW	Baseline	26.7		
	FASR	25.3	2 Years	5 Years

Summary of Findings

- Validated 18% to 28% energy savings versus baseline NEMA Premium induction motors, demonstrating a clear efficiency improvement opportunity.
- Confirmed straightforward deployment, with standard installation practices and minimal changes required for contractors and facilities staff.
- Provided real-world performance and payback data to support future utility incentives, efficiency programs, and broader market adoption.

Conclusions and Next Steps



Project Conclusion

- Directly addressed the advanced motors TPM category
- Shows simple payback in a reasonable amount of time
- Could be applied in many other systems, not just hydronics



Next Steps

- Follow-up project to develop data for a deemed measure package is ongoing



Project Final Report

Thank You!

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Wastewater Energy Transfer Market Study

Project Outcomes and Tech Transfer

About WET

Wastewater Energy Transfer (WET) technology leverages the heat energy in wastewater for useful purposes. Wastewater can serve as a heat sink or heat source. WET systems enhance efficiency of cooling systems by rejecting heat from building systems to wastewater. WET systems also recover heat from wastewater to preheat water or other fluids for water heating, space heating, or process loads. This study explored WET market potential for California non-residential buildings via literature review, surveys, interviews, and site visits. Field audits identified promising cooling applications for industrial food processing facilities and barriers for adoption at facilities far from sewer lines with low sanitary flows.



WET Market Study

This project assessed WET technologies and their relevance to the California nonresidential buildings market to better understand the landscape and program impacts and how to scale the market for nonresidential WET systems.

- Electric chillers are the baseline for cooling savings.
- Natural gas condensing boilers are the baseline for space heating savings.
- Natural gas domestic hot water heaters are the baseline for DHWH savings.





Stakeholders

Market actors were engaged throughout the study:

1. Manufacturers
2. Design engineers
3. Facility owners/managers

Summary of Findings

The initial energy savings model establishes a path forward for technology transfer. A field demonstration at an industrial facility, wastewater treatment plant, or large multifamily building would provide data for savings verification and measure package development.

The project identified key barriers for program intervention:

1. Customer education and training
2. Design assistance for building-level and sewer-line applications
3. Incentives to accelerate electric savings and decarbonization benefits

Conclusions and Next Steps



Project Conclusion

- The research team recommends continuing WET research and accelerating technology transfer with a WET system field demonstration.
- This field demonstration can measure and verify the electricity savings of building-level WET heat exchanger in cooling applications at an industrial or commercial building in California. Site visits from this market assessment uncovered promising opportunities for electricity savings for food processing, office, and healthcare chiller systems.
- The research team is working with WET system manufacturers to locate and recruit potential participants.



Next Steps

- Calibrate initial energy savings model with cooling electricity data from California customer technology demonstration.



Project Final Report

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