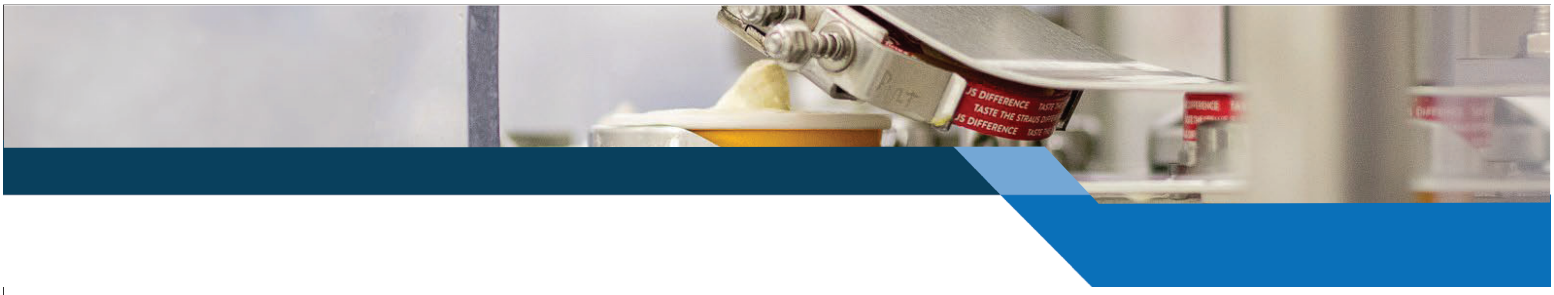

Sustainable Commercial Refrigeration

Webinar - November 13, 2024

nbi new buildings institute

SAN DIEGO LEARN

This webinar was developed in partnership with The LEARN Program.

The LEARN Program is a San Diego-based workforce education and training program that has partnered with New Buildings Institute (NBI) and Advanced Water Heating Initiative (AWHI) to offer free energy efficiency and electrification webinars.

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Sustainable Commercial Refrigeration

In today's webinar we'll discuss:

Project Case Study
- Team
- Challenges and solutions

Technology: Refrigerants, Defrost, Simultaneous Heat Cool with Storage
- Refrigerants and where regulations are going
- How we can defrost with minimal additional energy
- Storage of Industrial Cold

Grid Integration and Load Shifting
- Dollars and cents
  Load shift ability Grid Edge Control
- Possibilities for incentivization

Q&A

Image courtesy Straus Family Creamery

Today's Panelists

Doug Davenport

Prospect Silicon Valley

Sean Jarvie
Flow Environmental Systems

Rongxin Yin

Grid Integration Group, Lawrence Berkeley National Laboratory

Refrigeration & Cold Storage: The Potential

Courtesy Straus Family Creamery, Craig Cozart Photography

- Refrigeration accounts for ~ 1/3 of the total electricity usage for the food processing industry
- Demand for cold storage is expected to increase
- Potential for reducing electrical grid stress:
  - Significant power demand
  - Refrigeration load is a significant portion of a facility's total energy usage
  - # of processes are limited
  - Products are not sensitive to short-term power reductions

Advancing Innovation in Commercial Cold Storage

- Rigorous system demonstration, with 3rd party verified data
- Leading advisors and design engineering reviews
- Design guidance and reference information
- Contractor and engineering training
- Outreach to the industry
- A direct path to project opportunities

The Team

ProspectSV

Flow Environmental Systems Inc

DMG

BERKELEY LAB

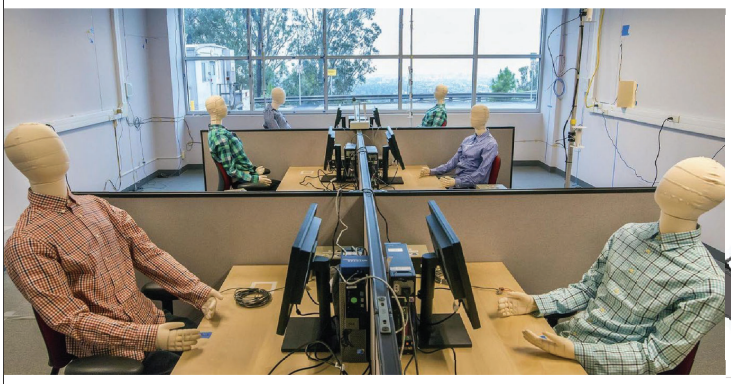
STRAUS FAMILY CREAMERY ORGANIC™

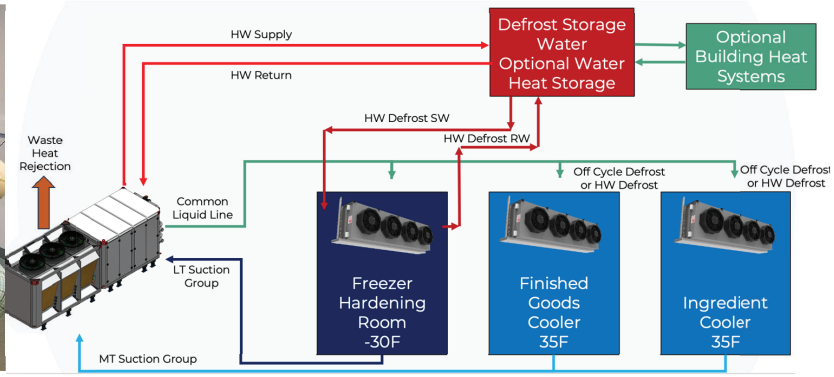
Alter Engineers

IDeAsC

AVIDA ENERGY

Two Heat Pump Demonstrations





HVAC in Large Commercial Buildings

FlexLab – Berkeley CA

- *Simultaneous Heating/Cooling/HW*
- *Advanced HVAC Controls*
- *Model Predictive Grid Response*

Commercial Cold Storage

Straus Family Creamery – Rohnert Park, CA

- *Multiple Facility Cold Rooms*
- *Supplemental Process HW*
- *Advanced Defrost Controls*
- *Model Predictive Grid Response*

Heat Pump Demo: Commercial Cold Storage

Goal: Demonstrate a Commercial Cold Storage solution that will reduce GHG emissions, save cost, improve energy efficiency and demand flexibility, apply advanced defrost controls, and improve process control.

Demonstration Site: Straus Family Creamery – multiple cold storage sites, -30F to +35F

Technology: 60-ton ANSWR heat pump system + thermal energy storage & advanced defrost controls

M&V: Independently verified performance by LBNL

Industry Engagement: Testing results, modeling work & products, ANSWR performance factors ($, kW, CO2), DMG Training Program

Courtesy Straus Family Creamery

Stay Involved

- **Outreach Campaign** – Building owners, operators, engineers, contractors, public and private sector
- **Performance Data** – Results of testing program, financial analysis
- **Design Resources** – Performance curves, BIM HP model, Modelica model
- **Controller Beta** – System specs and control sequences, public domain downloads

ProspectSV | PATHWAYS

Flow

Environmental Systems Inc

Who We Are

US company bringing commercially viable and environmentally responsible HVAC&R technologies to market.

Our Purpose

1. Decarbonize and Detoxify
2. Eliminate the need for fossil fuels
3. Serve harder to electrify end-use cases

Our Mission

To leave the planet in a better state than we found it.

The Problems

The EXISTING Built Environment contributes to ~40% of all greenhouse gas (GHG) emissions.

How do we retrofit existing systems?

The NEW global building stock is expected to double by 2060.

How do I build a better building?

We need to reduce building emissions.

- Voluntarily
- Regulatory

Heat Pumps

Refrigerants

Right Size The Load

Energy Efficiency

Stop Burning Things

Refrigerants

GWP 700 Nationally Starting 2025, End Goal GWP 10 or Less

Phase Downs on the Production of High GWP Refrigerants

HVAC

		Naturals			Synthetic High Pressure			Synthetic Low Pressure				
	Regulation Targets	**R-744 CO2**	R-290 Propane	R-717 Ammonia	R-410A	R-32	R-454B	R-134A	R-513A	R-1234YF	R-1234ZE	R-1233ZD
GWP_{100}	<700	**1**	4	0	1924	677	467	1300	575	1	1	1
ODP	0	**0**	0	0	0	0	0	0	0	0	0	0.00034
Safety Class	A1	**A1**	A3	B2L	A1	A2L	A2L	A1	A1	A2L	A2L	A1
PFAS	No	**No**	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

** GWP is defined by the Intergovernmental Panel on Climate Change (IPCC). There are different edditions. The latest approved is AR5.*

Refrigeration

		Naturals			Industrial and Supermarket						
	Regulation Targets	**R-744 CO2**	R-290 Propane	R-717 Ammonia	R-404A	R-507A	R-407A	R-407C	R-407F	R-448A	R-449A
GWP_{100}	<150	**1**	4	0	3942	2985	1923	1624	1674	1273	1282
ODP	0	**0**	0	0	0	0	0	0	0	0	0
Safety Class	A1	**A1**	A3	B2L	A1	A1	A1	A1	A1	A1	A1
PFAS	No	**No**	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

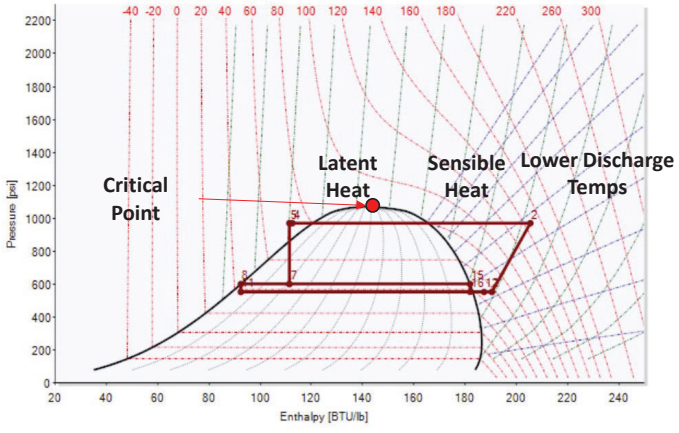
** GWP is defined by the Intergovernmental Panel on Climate Change (IPCC). There are different edditions. The latest approved is AR5.*

Transcritical | Subcritical

What is different with a CO2 Heat Pump?

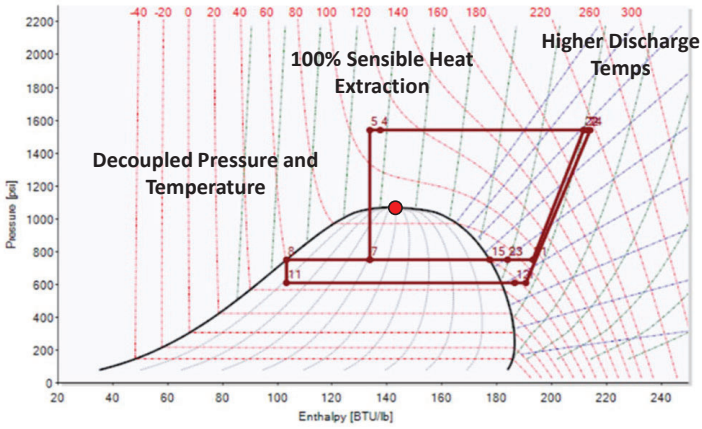
Subcritical

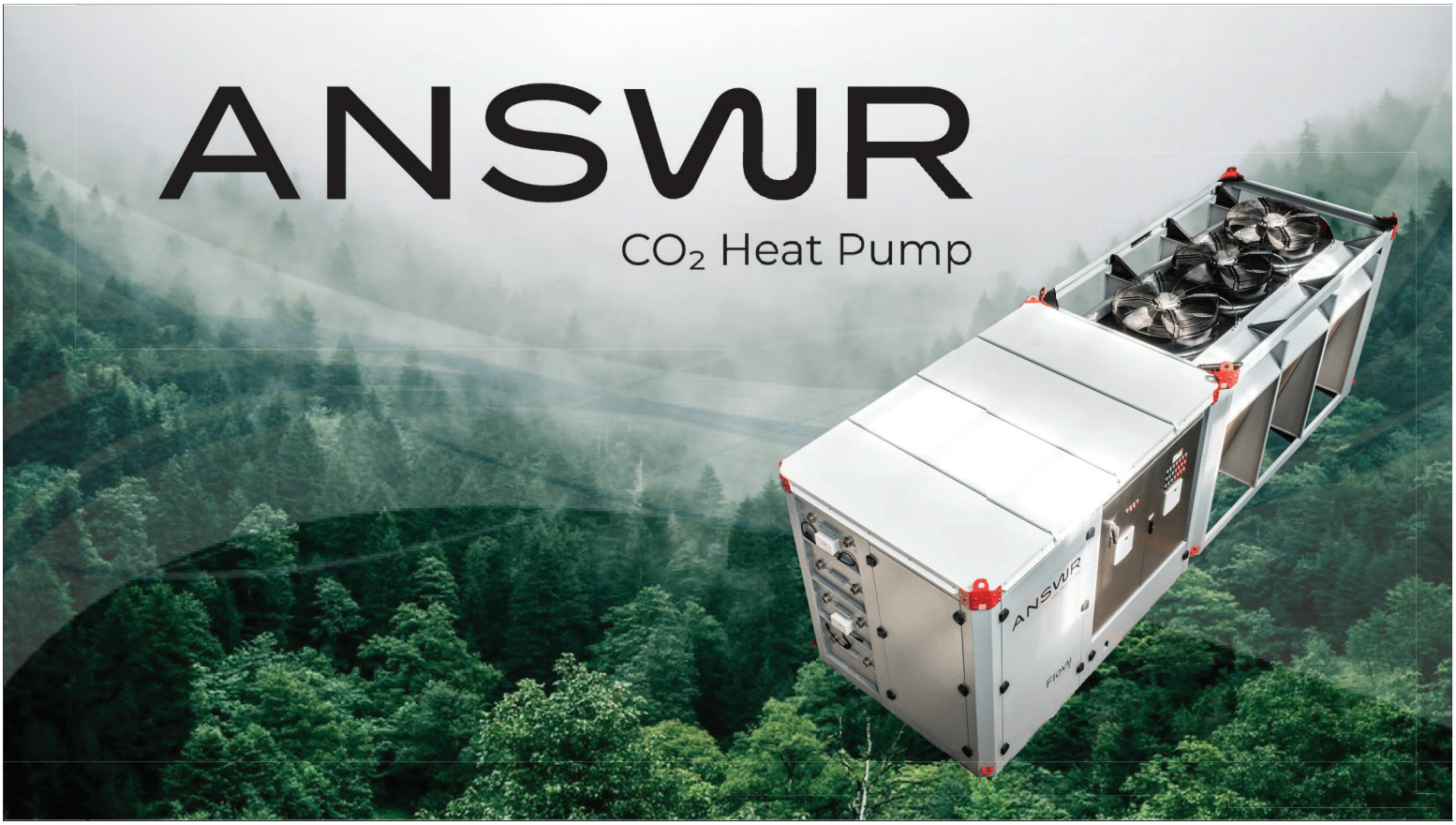
Refrigerant condenses in the condenser



Transcritical

Refrigerant does NOT condense in the gas cooler





ANSWR

CO_2 Heat Pump

Air-to-Water and Water-to-Water

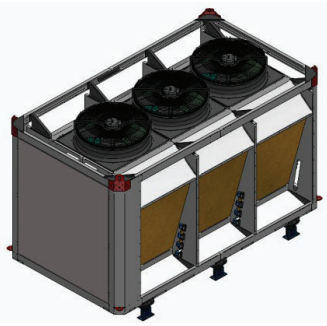
HVAC Heating and Cooling

Simultaneous Heating and Cooling

Split System

Heat Pump

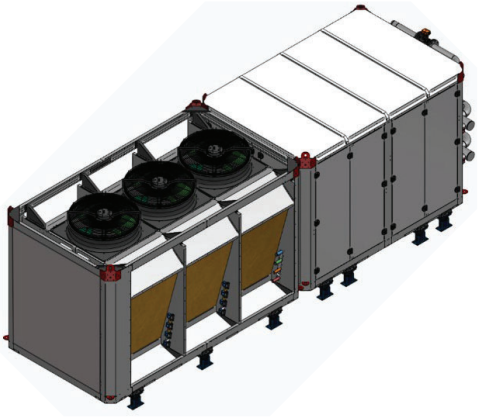
Gas Cooler



Domestic Hot Water Production

Hot Water Boilers

Packaged

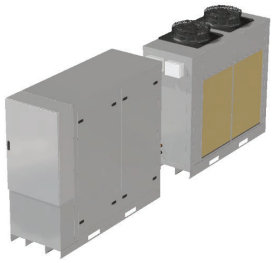


ANSWR

Heat Pumps Are Configurable

Nominal Sizes: 20, 60, 90, 120 Tons

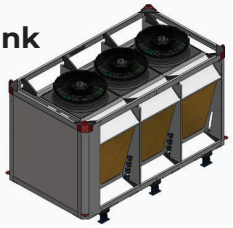
20TR Model
(fits through door and elevator)



Heat Pump(s)

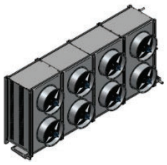
Gas Cooler(s)

V-Bank



Horizontal

Vertical

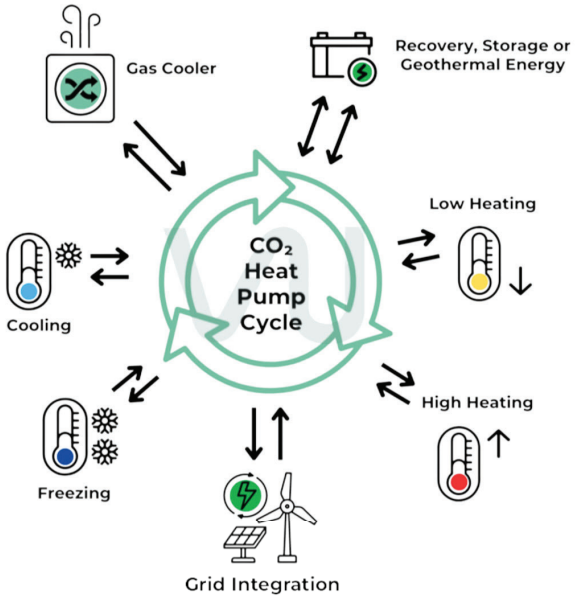


Modules are designed for parallel installation

Key Benefits

- Environmentally friendly natural refrigerant (CO2/R744)
- Simplified system design and installs
- High delivery temperatures (up to 180°F)
- Cold climate performance (down to -40°F)
- Efficient (High COP, no defrost, no derates, etc...)
- Seamless transition between heat, cool, and simultaneous heating and cooling
- Robust supply chain
- Low carbon emissions
- Low total cost of ownership
- Minimal infrastructure changes
- Future proof (Regulations)

Energy Optimization



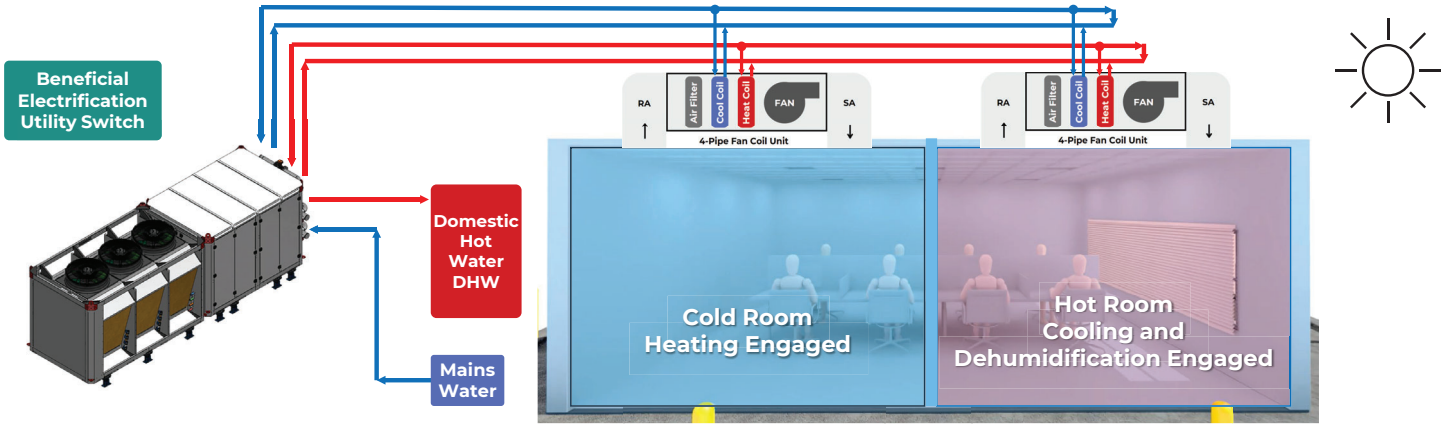
Example HVAC

Baseline

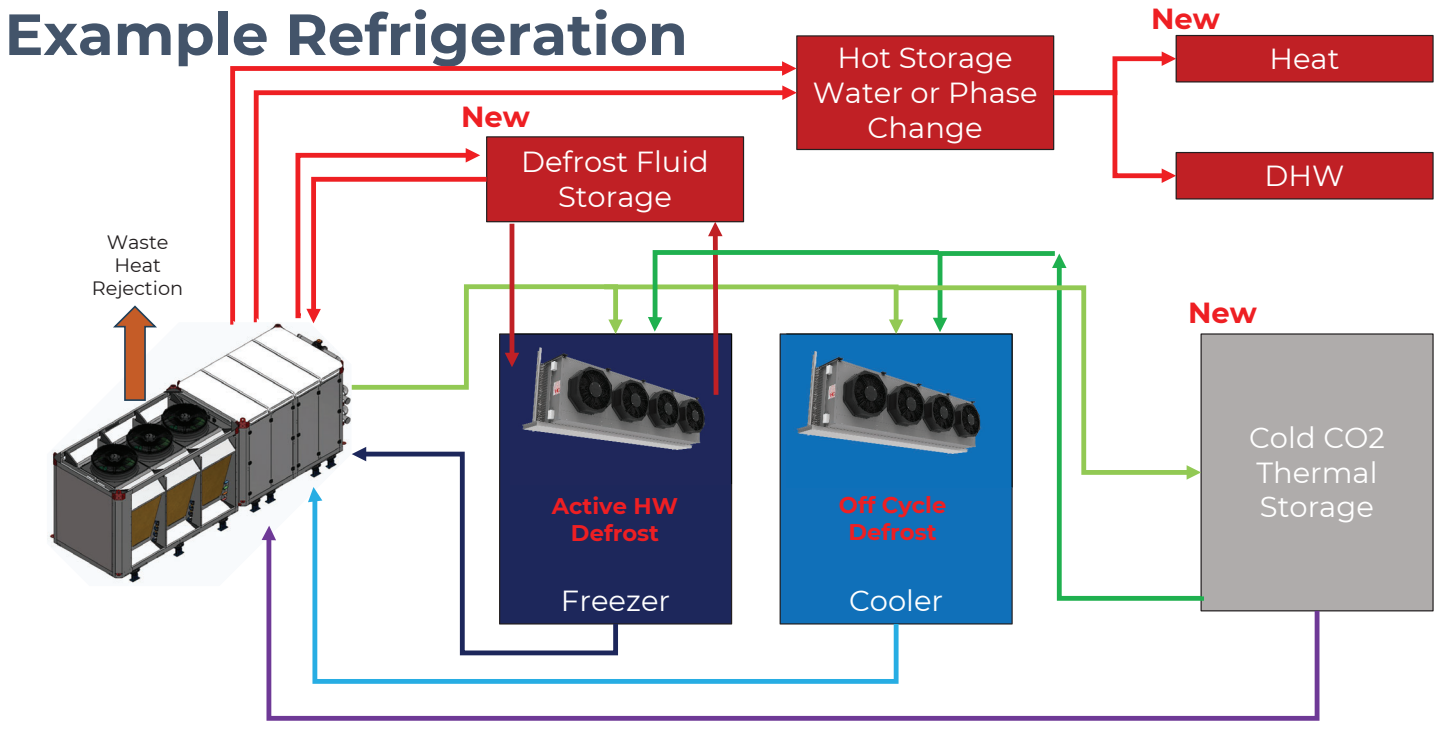
- 3 Independent Systems (Chiller, Boiler, DHW)
- No thermal sharing between systems
- No simultaneous heating and cooling
- Defrost concerns

Solution – Answr CO2 Heat Pump

- Simplified design: 1 Heat Pump replaces 3 systems
- Thermal energy sharing with high COP_{SCH}
- Optimization of energy balance and setpoints (minimize over-cool and over-heat)
- 100% electric that meets current and future regulations
- Advanced defrost design
- Designed for grid flexibility and resiliency



Example Refrigeration

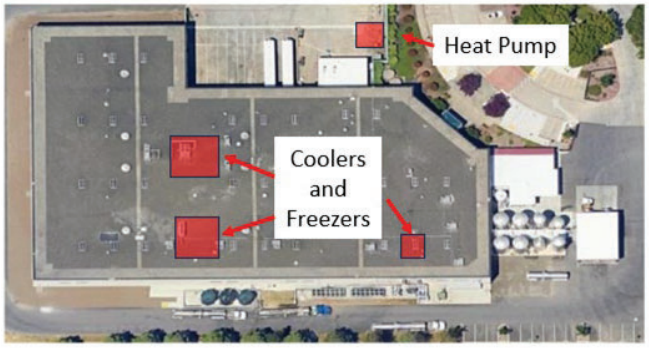


Energy and Demand Performance

Commercial Cold Storage Demonstration Site

Demonstration Site - Straus

- A total of 2,638 square feet of separate refrigerated spaces
- Freezer and cooler spaces
- Currently uses the high-GWP refrigerant R448a



Storage Type	Floor Area (sq ft)	Setpoint (°F)
Freezer	840	-30
Finished Goods Cooler	1,305	35
Ingredient Cooler	493	35

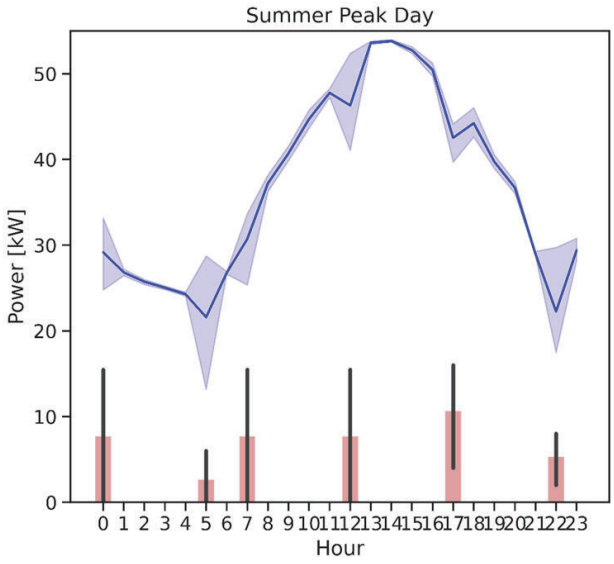
Low Temperature refrigeration system capacity: 206 MBH

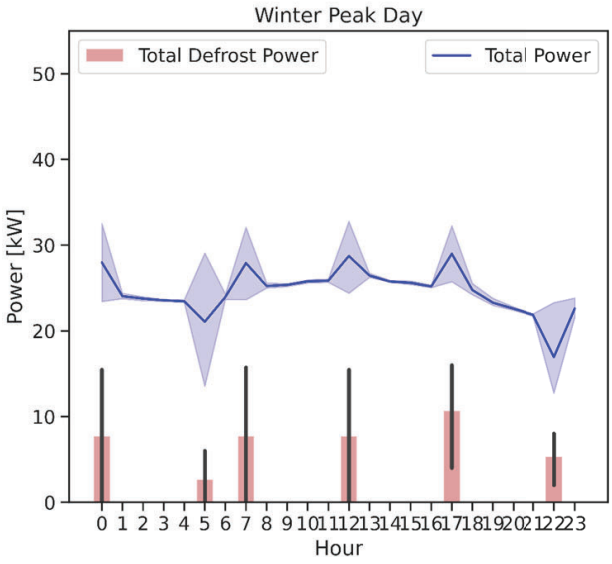
High Temperature refrigeration system capacity: 350 MBH

R448a Charge (lbs): 450 lbs in total

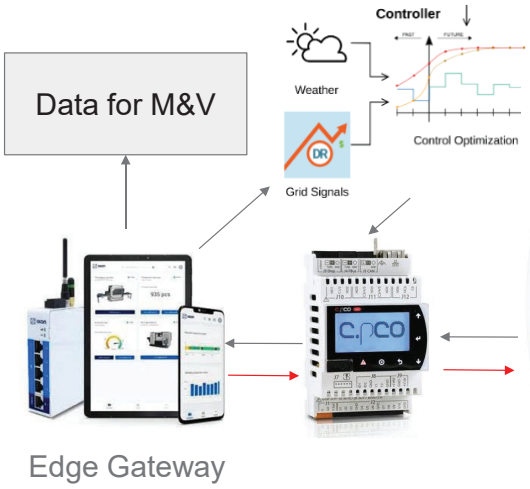
Electric Defrost: 32.9 kW in total

Electric defrost has a higher impact on the total system peak demand during the winter season, with variations observed between summer and winter peak days.

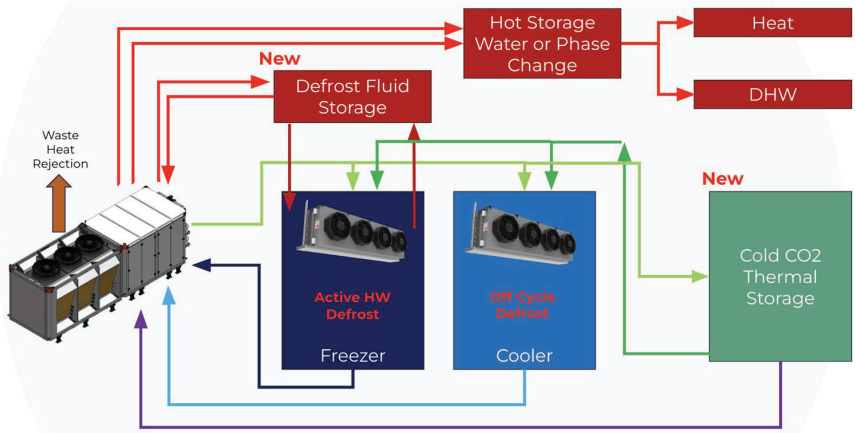




Proposed Flow CO2 Heat Pump + Thermal Energy Storage System



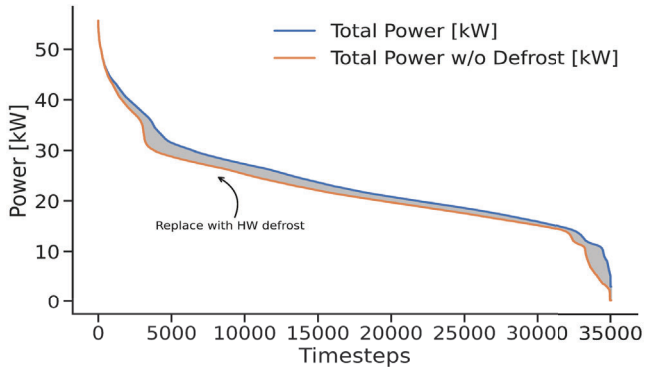
Advanced defrost control and TES operation sequences based on real-time monitoring refrigeration system performance

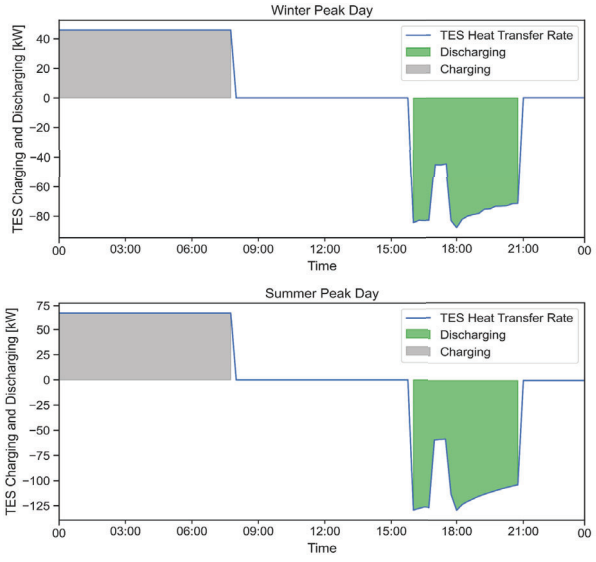


Packaged defrost and TES control can completely shift refrigeration system load from peak hours (e.g., 4-9 PM) to off-peak hours.

Defrost control algorithm

- Ensures defrosting is triggered as soon as evaporator performance begins to degrade
- Prevent synchronized defrost power surges

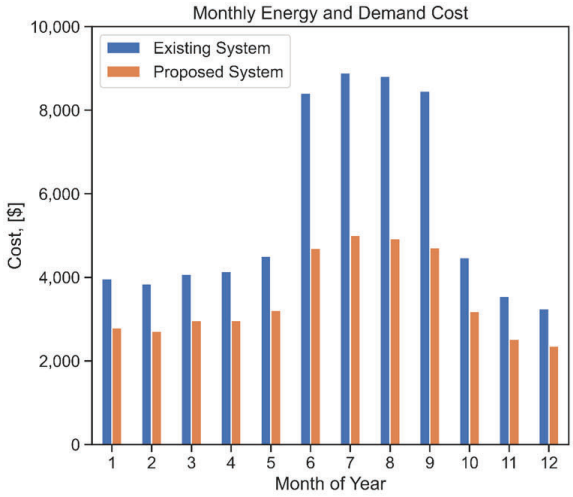


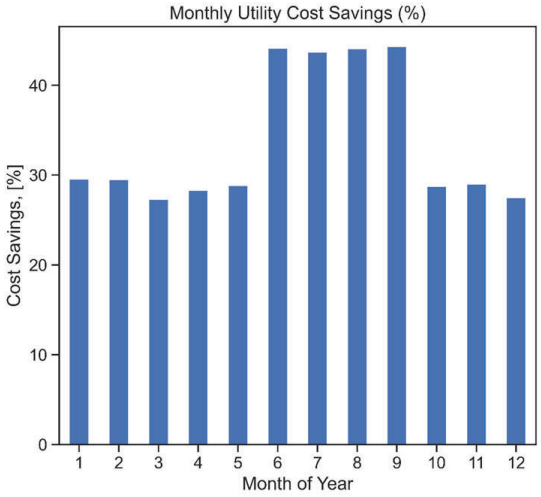


The proposed system significantly reduces monthly energy and demand costs compared to the existing system, resulting in substantial utility cost savings by 28~44%.

Cost savings
$9.2/ft^2

Carbon emission savings
15.1 MTCO2e





Energy Technologies Area
BERKELEY LAB

PANEL DISCUSSION