

ET Summit 2021

Presented by



SMUD's Pilot Natural Refrigerant Incentive Program

Investigating Direct GHG Emission Reductions in Commercial Refrigeration

ET Summit

November 17, 2021

Powering forward.
Together.



About SMUD

SMUD is your community-owned, not-for-profit electric service.

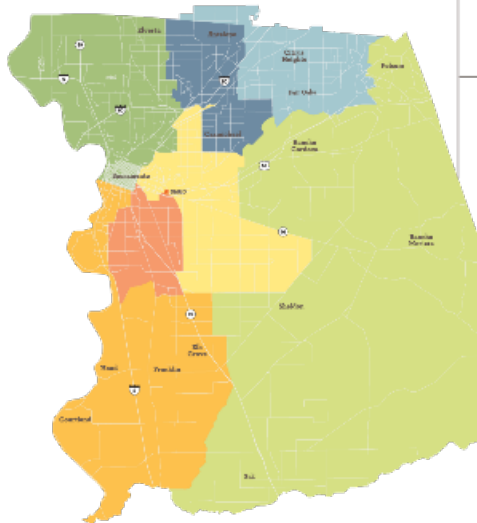
6th largest community-owned in the U.S.

70+ Years
Est. 1946



~**645,000** Customers

~**2,200** Employees



Power mix that's more than **50% carbon-free**

The most ambitious goal of any large utility in the United States



7 member Elected Board of Directors

Rates among the lowest in CA. On average 35% lower than PG&E

Pathway to zero carbon by 2030



CALIFORNIA CLIMATE STRATEGY

An Integrated Plan for Addressing Climate Change



VISION

**Reducing Greenhouse Gas Emissions
to 40% Below 1990 Levels by 2030**

GOALS



**50%
renewable
electricity**

**50%
reduction
in petroleum
use in vehicles**



**Double energy
efficiency savings
at existing buildings**

**Carbon
sequestration
in the land base**



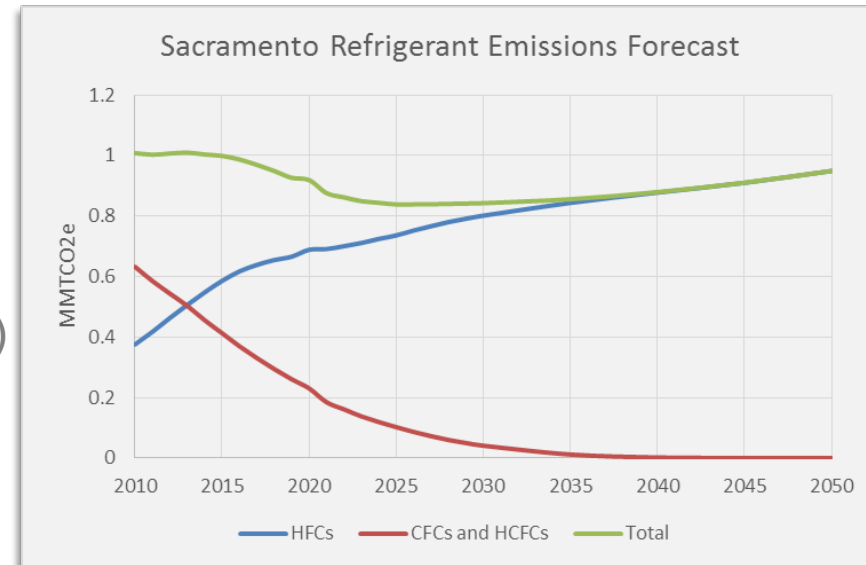
**Reduce
short-lived
climate pollutants**



**Safeguard
California**

SMUD's Pilot Natural Refrigerant Incentive Program

- Launched in March 2017 at NASRC Workshop hosted at SMUD
- Built on SMUD's existing Custom Incentive and Savings By Design programs
 - Maintains incentive for energy (kWh) and demand (kW)
- **Additional incentive for direct GHG emission reductions from new or retrofitted low-GWP systems**
 - SMUD pays for energy performance metering and data collection to understand performance of low-GWP systems



High-GWP refrigerants are projected to result in annual GHG emissions of over 1 million MtCO₂e in Sacramento alone by 2050

Program created with
technical assistance from

SMUD Program Objectives

- Spur market transformation to support SMUD's Environmental Leadership Directive (SD-7)
- Establish a cost-effective pathway for Natural Refrigerants
- Create a model incentive for others to reference
- Build a network of manufacturers, engineers, technicians, and customers
- Position SMUD to leverage potential state funding on our customer's behalf
- Support transition to a carbon metric for program evaluation

“SMUD will provide leadership in the reduction of the region’s total emissions of greenhouse gases through proactive programs in all SMUD activities and development and support of national, State, and regional climate change policies and initiatives.” SMUD Strategic Directive 7

Customer Benefits

- **End the expensive cycle** of refrigeration system upgrades and retrofits due to refrigerant phase outs and replacements with a permanent long-term solution
- **Assist with the initial cost** of new equipment installation
- **Support emerging technologies** that enable customers to improve energy efficiency and reduce direct GHG reductions
- **Lower customer energy bills and refrigerant costs**
- **Eliminate liability** associated with leak inspections, fines, and enforcements
- **Provide Access** to network of equipment manufacturers, engineers, technicians, and successful project implementations

Incentive Eligibility and Structure

Program Parameters	Existing Program Requirements	Refrigerant Incentive Requirements
Retrofit	Meet the existing requirements of the Custom Incentive Program	System uses natural refrigerant (CO2, ammonia, hydrocarbon)
New system	Meet the existing requirements of the Savings By Design Program	System uses natural refrigerant (CO2, ammonia, hydrocarbon)
Required system monitoring	None	Three years, SMUD pays installation/integration
Permanent Change	Permanent physical system change required so operation doesn't revert to the baseline technology	Physical system component or change must be made that prevents reverting to high-GWP refrigerant

Custom Program Incentive	Direct GHG Emissions Reductions Incentive
<p>Incentives are based on decreasing your energy use:</p> <ul style="list-style-type: none"> \$0.10/kWh Energy Reduction Incentive and \$200/kW Demand Reduction Incentive Total incentive limited to 30% of project cost or \$150,000, whichever is less 	<p>Incentives are based on decreasing direct emissions from refrigerants over the system lifetime:</p> <ul style="list-style-type: none"> \$25/MtCO₂e emissions reduction from refrigerants Total incentive limited to 30% of project cost or \$150,000, whichever is less <p>All projects located in disadvantaged communities (with preference for those in the top 10%) and implemented by small-to-medium sized business owners will receive a 25% incentive bonus</p>
<p>Combined incentive limited to 50% of project cost or \$250,000, whichever is less</p>	

Developing an Appropriate Direct Incentive Rate Level

- Direct incentive rate was evaluated in two ways, both supported a valuation of approximately \$25/MtCO₂e
 1. Based on SMUD current energy incentives (Custom Incentive and Saving By Design)
 - \$0.10/kWh converted to \$/MtCO₂e using marginal emission factor for 15 year life
 2. Based on California GHG Allowance Price Floor
 - Average of price floor for 15 years based on annual escalation of 5% plus inflation

Current Status

- Two active projects utilizing the incentive
 - Research plan adapted to leverage unique opportunity for comparison
- APPA DEED grant secured to assist with incremental system cost, support research and technology transfer
- First year of monitoring complete for both systems, continuing for another year
- Demand is strong – new projects have been proposed in Sacramento County and around the State from interested parties (stores, food processors)
- New system funding on hold
 - New Zero Carbon Goal prioritized plus awaiting final findings

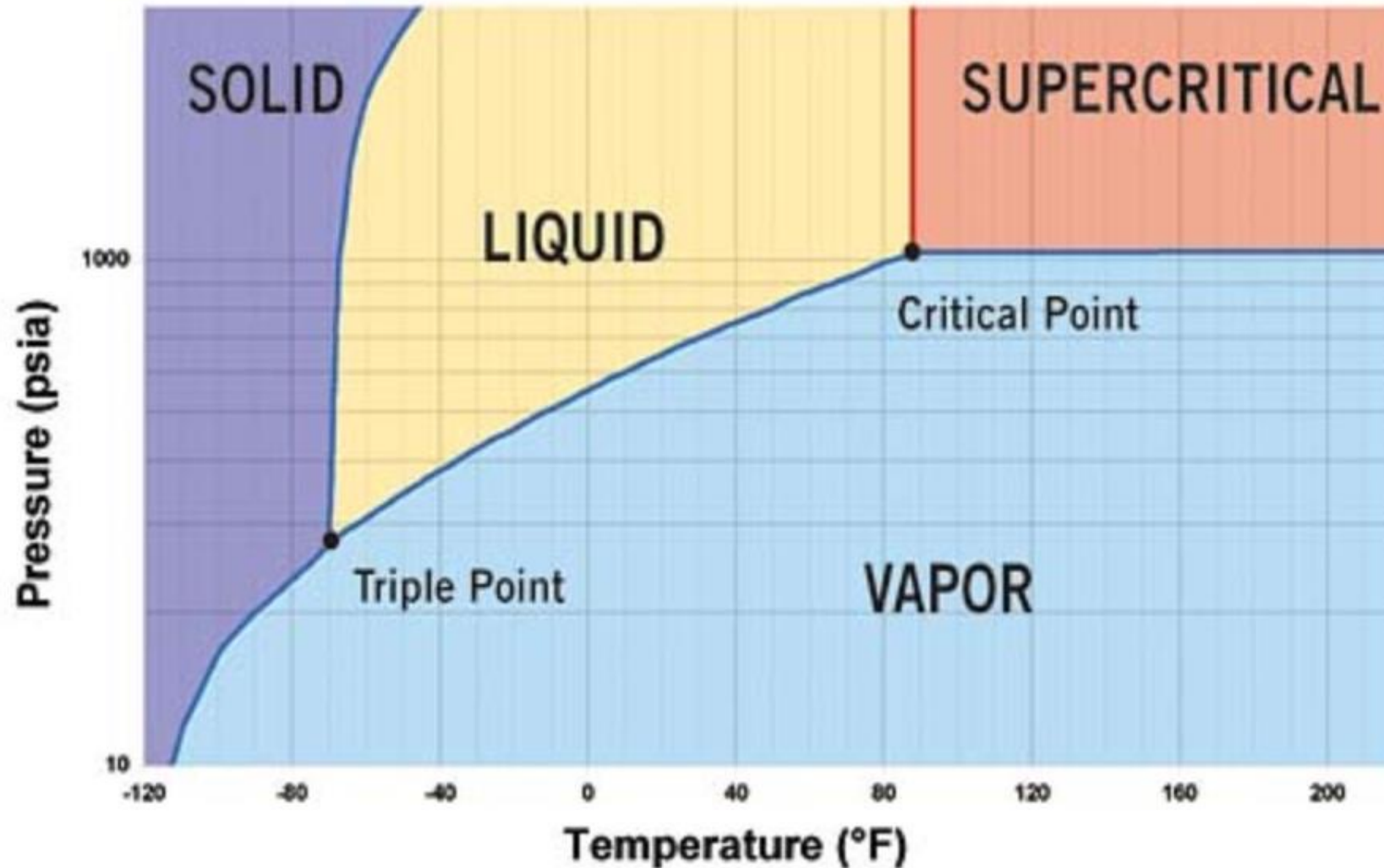
Grocery Outlet Pair



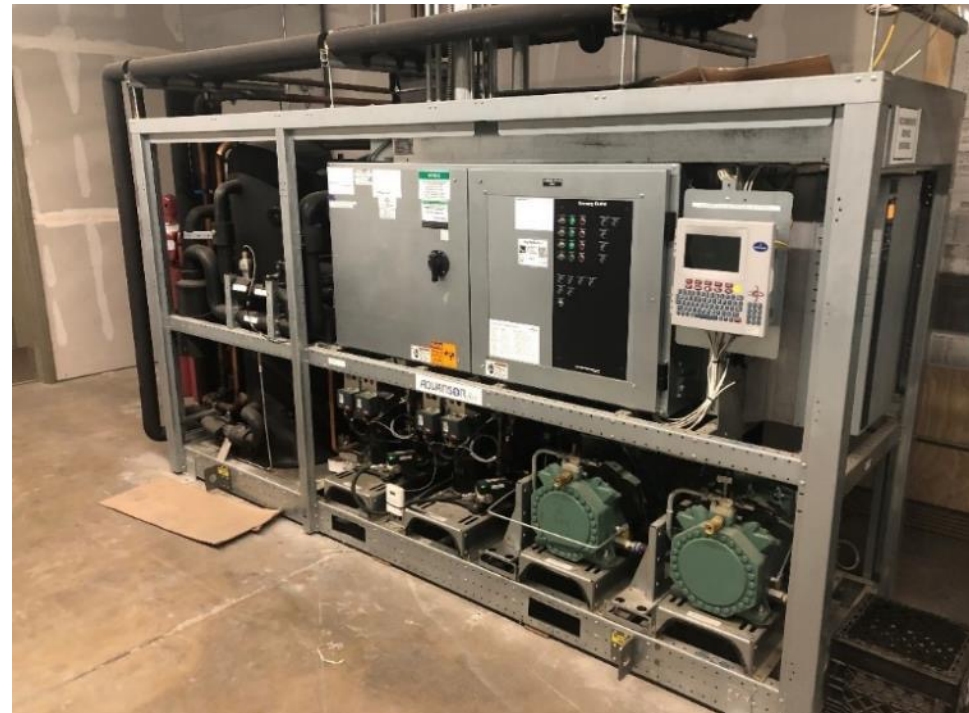
Raley's Pair



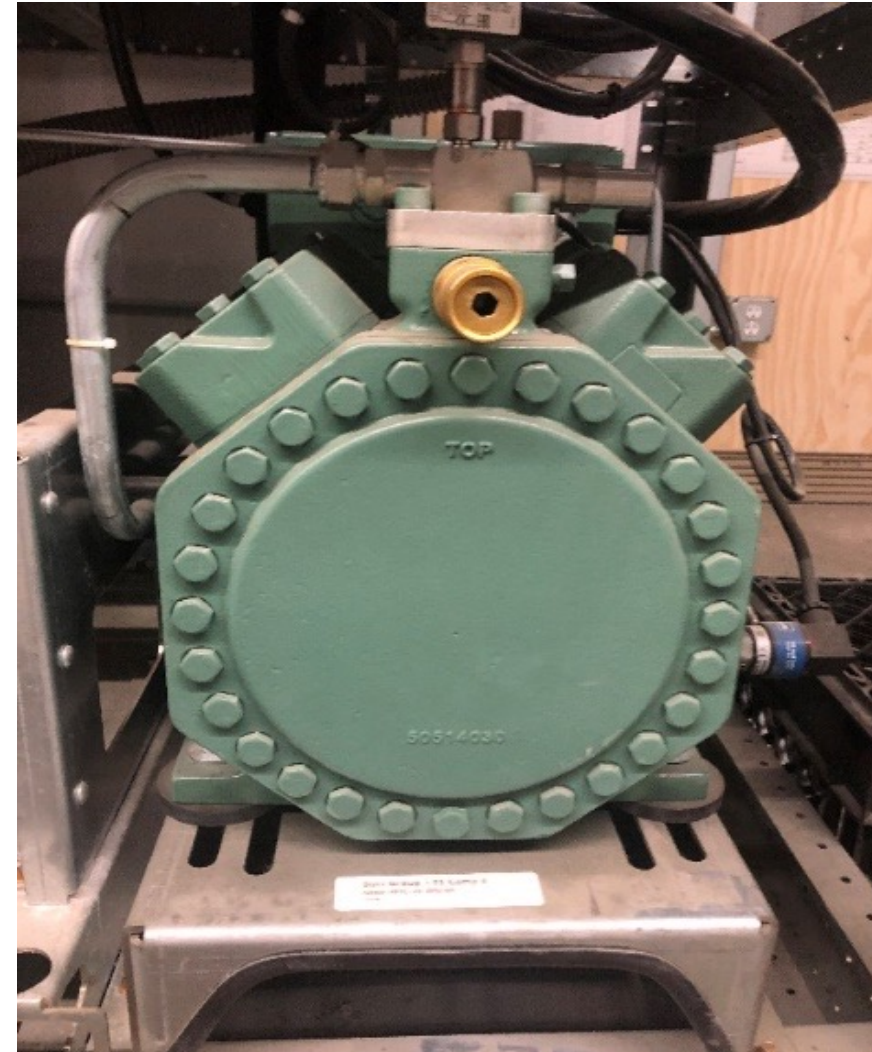
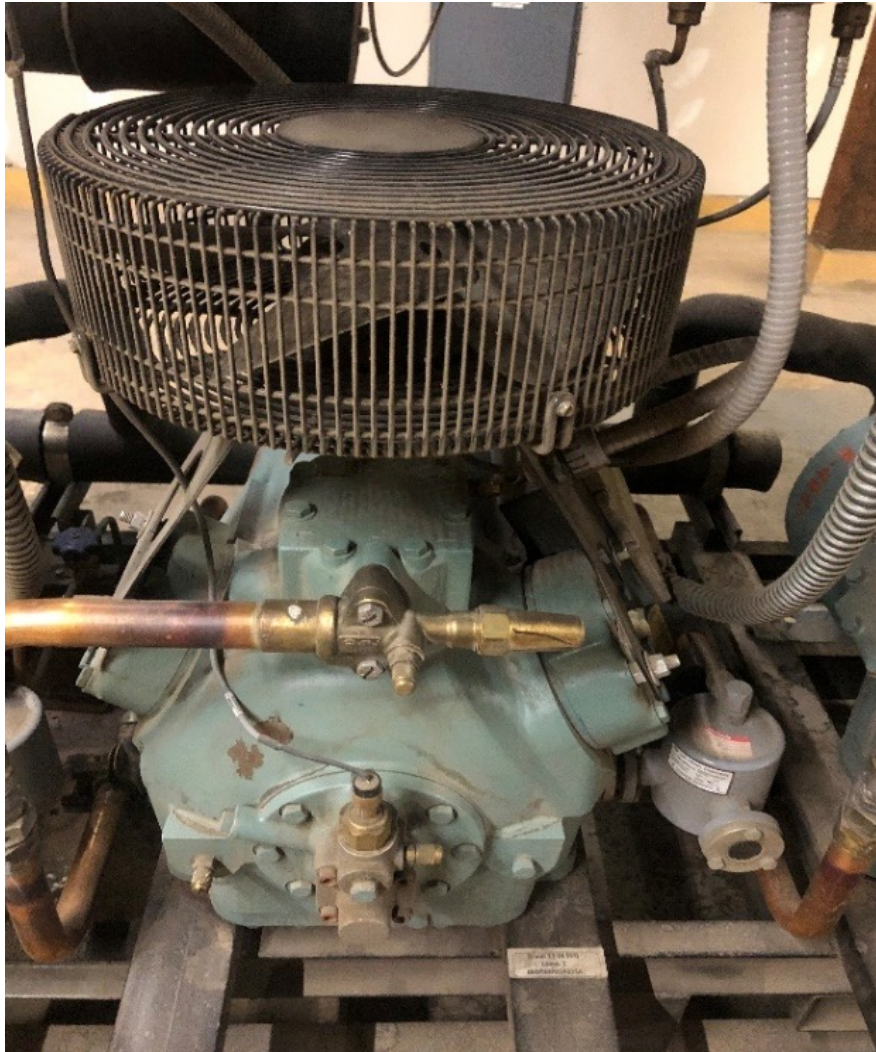
Natural Refrigerant: CO₂



Refrigerant Racks



Compressors



Ammonia Compressors



Energy Monitoring



Data Collection: Energy Monitoring



Data Collection: Other Resources

- Control System
- Staff interviews
- Thermal Imaging

Grocery Outlet Technical Specs

Store	Refrigeration Load (MBH)	Combined Compressor Capacity (MBH)	Combined Compressor Power (HP)	Condenser Capacity (MBH)	Refrigerant	System Age (Years)
Natural Refrigerant Grocery Outlet	240.9	284.4	41.5	433.4	R-744	1
Reference Grocery Outlet	404.5	447	45.5	547	R-404A	8*

* Equipment varies in age by decades.

Raley's Technical Specs

System Comparison	Raley's (2-year-old system)		Bel-Air (13-year-old system)		
	Mid temperature	Low temperature	High Temperature	Mid temperature	Low temperature
Rack type	Mid temperature	Low temperature	High Temperature	Mid temperature	Low temperature
Refrigerant type	R-717	R-717	R-449A	R-449A	R-449A
Number of compressors	4	2	2	2	2
Compressor Capacity (BTUH)	1,870.4	344.8	1,409.2	761.1	263.3
HP	50	15	75	50	20

Year 1 Results:

- Energy Consumption: 28% savings shown for Grocery Outlet pair, 16% loss for Raley's pair. It's complicated...
- Emissions: 62% Reduction, dominated by normal leakage rather than energy impact. This is for a 1-year time period which doesn't include decommissioning.
- Equipment Costs: -9% for GO to + 16% for Raley's

Results Discussion

- Water & natural gas savings not quantified in this study
- Focus on refrigeration system performance (especially compressors)
- Control group of 1 is very small. Normalized by refrigeration capacity and traffic, but a larger control group would reduce uncertainty

Whole-Building Approach:

- Raley's Freeport store: Large solar array, no natural gas usage, hot water heated with process heat, minimal water consumption compared to evaporative cooler
- Higher up-front cost. Potential for higher maintenance, but equipment is still new.

Anecdotes

- Leakage reporting: Odd experience collecting data, but huge (3000x) influence on global warming potential
- Maintenance: new and different psychology, fear of ammonia
- CO₂ as heat transfer media: can lose it all. No compressor, just a pump.

Thank you for listening!

For More Information:

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