ET Summit 2022

Presented by

Low-GWP Refrigerants Session

CARB's Pilot for Reducing Super Pollutants in Supermarkets

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SOUTHERN CALIFORNIA EDISON®
Energy for What's Ahead℠

CALIFORNIA AIR RESOURCES BOARD

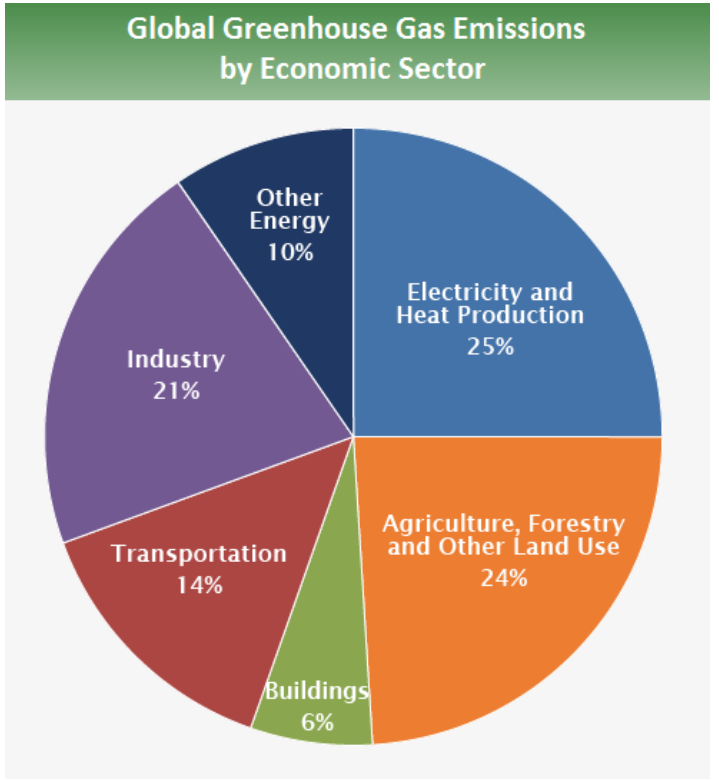
State of the Industry

- The California Air Resources Board (CARB) is regulating the use of hydrofluorocarbon refrigerants that are currently used for refrigeration systems in most commercial refrigeration applications and implementing a "phase down" of those with higher global warming potential (GWP).
- The use of refrigerants in California is changing rapidly in response to policy changes to reduce the use of short-term air pollutants and greenhouse gases.
- In partnership with California's Air Resources Board and Southern California Edison, kW Engineering is conducting a measurement and verification (M&V) study covering 15 low GWP grocery refrigeration systems using various refrigerants including CO2 (R-744), Propane (R-290), and HFO blends (R448-a).
- The objective of the study methodology is to determine the potential energy impact and direct greenhouse gas (GHG) contribution of each system considered.
- This study presents a unique opportunity to inform energy efficiency policymakers and industry stakeholders as to the impact of design choices on the energy use and overall global warming potential of both direct and indirect emissions of global warming gases (GHG's).

Goals of the Study

To assess the energy impacts of low-GWP and reduced charge refrigerant remodel projects on supermarket refrigeration systems:

- Determine the relative impact of system types, design choices and technologies
- Determine the energy performance of system types and technologies by climate zone
- Assess the relative potential of direct GHG contributions (in equivalent CO2 emissions due to leaks and retirement of refrigerants).



Site Summary

Application	Store Size	Location	Climate Zone	Baseline	New System
1	148,000	Pleasanton	12	N/A	CO2 transcritical
2	20,444	Ventura	6	N/A	CO2 transcritical
3	TBD	Carlsbad	7	N/A	CO2 transcritical
4	TBD	San Diego	7	N/A	CO2 transcritical
5	89,760	whittier	9	N/A	CO2 trans, booster
6	15,000	San Francisco	3	R-407A	R-448A/CO2 cascade
7	20,000	San Francisco	3	R-507A	R-448A/CO2 cascade
8	20,000	Petaluma	2	R-404A	R-448A/CO2 cascade
9	10,000	Sebastopol	2	R-404A/R-407A	R-448A/CO2 cascade
10	40,958	thousand Oaks	8	N/A	CO2 transcritical
11	19,152	Murrieta	10	N/A	R-290
12	20,788	Ramona	10	N/A	CO2 transcritical
13	20,067	Torrance	6	N/A	CO2 transcritical
14	28,400	Palmdale	14	R-404A	R-449A
15	28,500	Lancaster	14	R-404A	R-449A

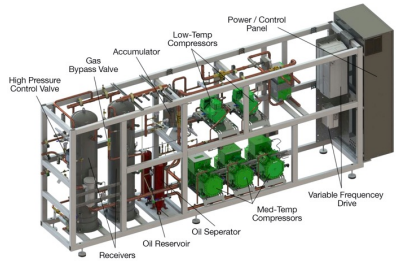
Technologies to be Examined

Baseline

- Base case technologies, Common in California
  - R-404a Parallel racks
  - R-407a Parallel racks
  - R-507a Parallel racks
- Additional Technologies
  - Adiabatic condenser
  - Adiabatic gas cooler

Proposed

- Natural Refrigerant Systems
  - CO_2 Transcritical
  - CO_2 Transcritical with booster
  - R-448A/CO2 cascade
  - R-290 (Propane) Micro-distributed



- Common Intermediate GWP Retrofit
  - R-448a Parallel racks
  - R-449a Parallel racks

Measurement and Verification

At the onset of the study, the store population included multiple stores with no baseline – including both new construction and already-completed retrofit projects. kW Engineering developed four monitoring approaches to reflect the population diversity and project constraints:

Conventional Submetering with Pre/Post Retrofit Metering and Whole Building Metering	Customer-Owned Submetering with Pre/Post Retrofit Metering and Whole Building Metering	New Stores with Post-Installation Submetering, Whole Building Metering, and Modeled Baseline	New Stores with Whole Building Metering and Normalized Baseline from Energy Models in Scenario 3
(2 facilities)	(4 Facilities)	(3 stores)	(6 stores)

We'll highlight the key considerations related to developing the M&V plan and our novel approach to approximate the refrigeration load. We'll also discuss how we anticipate normalizing the data to a full year.

Approach to M&V and Analysis

Site Level Monitoring

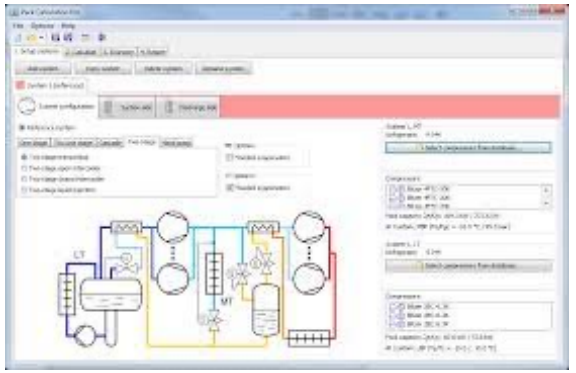
- Onsite visits will be performed for each participating store to inspect/verify equipment, operating conditions, controls, capacities.
- Installation of system-level meters for detailed site visits
- Ongoing data downloads of system data
- Analysis and data cleaning to remove erroneous or missing data
- Collection of whole building metered data

Whole-building Regression Modeling

- Statistical models will be developed to correlate whole building energy use to time-of-week, and temperature for each site.

Refrigeration System Modeling

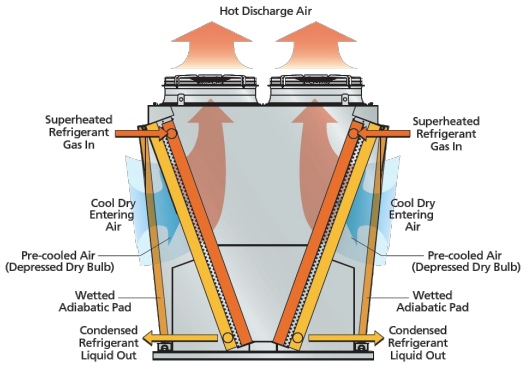
- Pack Calculation Pro will be used to create refrigeration system models for each of the participant sites.
- Those models will be calibrated to fit the M&V data for the detailed sites.
- The refrigeration system models will then be run for those same store designs in each of the other climate zones.
- This wider pool of data will then be used to estimate relative system efficiencies statewide and provide a basis for system-level benchmarks by type and climate zone.



Results Analysis

The analysis will be aimed at providing the following results:

- **Benchmarked Energy Performance for Each California CZ**
  - Annual Weighted EER – based on nominal loads
- **Case-by-Case GHG Reduction Estimates**
  - Direct GHG reduction (vs. std refrigerants, using reported and average leak rates)
  - Indirect GHG impacts (increase or decrease) due to energy consumption
  - Total Equivalent Warming Impact aka "TeeWee" (Mtons CO_2-e)
- **Energy Analysis and Savings Estimates**
  - R-448a
  - R-449a
  - Adiabatic Condensers
  - Adiabatic Gas Coolers



Our team is thrilled to be working on this study with CARB and SCE.
We can't wait to present actual results in the upcoming ETCC Summits.

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