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A Case Study of the CO_2 Systems in Whole Foods Market Northern California Region

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WHOLE FOODS MARKET

A Case Study of the CO_2 Systems in Whole Foods Market Northern California Region

Tristam Coffin, LEED AP
Sustainable Facilities Coordinator, Whole Foods Market

Tom Wolgamot, PE, LEED AP BD+C, CPMP
Principal, DC Engineering

Agenda

- Whole Foods Market (WFM) & Natural Refrigerants
- Systems Employed
- Performance Comparisons
- Summary & Lessons Learned

WFM & Natural Refrigerants

- Refrigerant Reduction (GreenChill Partner with 10 Platinum, 5 Gold, and 6 Silver Certifications)
- Energy efficiency and overall reduced consumption
- Stable System Operation
- Reviewing all options available
- Different climate zones may call for different solutions

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System Details

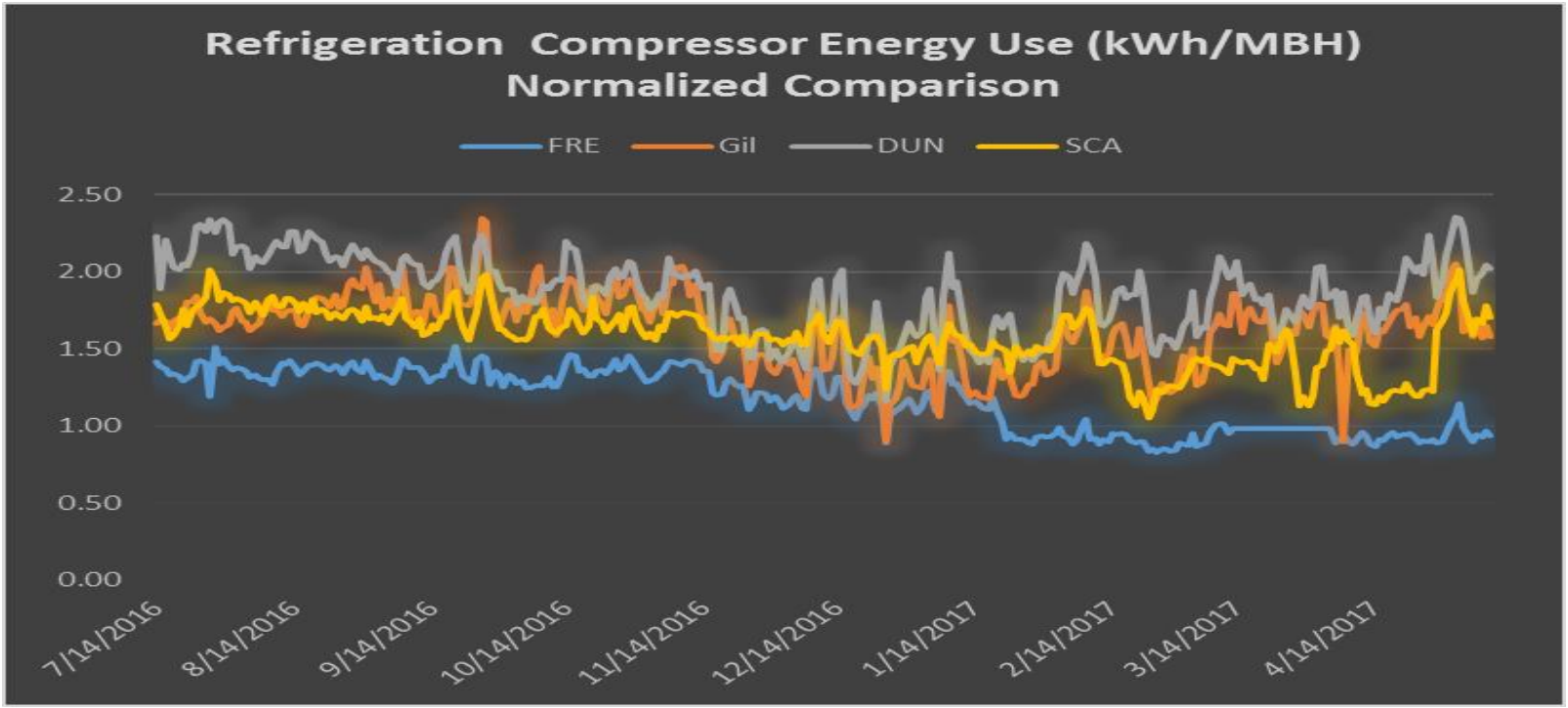
Store ID	Size (Ft^2)	Refrigeration Load (MBH)	Refrigerant Charge (LBS)	System Type
FRE	39,026	847	R407A (1,225)	Distributed 407A scroll units, hybrid condensers
GIL	47,805	650	CO_2 (1,200)	CO_2 Transcritical, Gas Cooler (air cooled)
DUN	40,072	605	CO_2 (1,440) NH_3 (250)	Low-Temp DX CO_2,/Medium temp liquid overfeed CO_2, cascaded to R717 (NH_3) system, hybrid condensers
SCA	50,198	750	CO_2 (1,730) Propane (231)	Low-Temp DX CO_2,/Medium temp liquid overfeed CO_2, cascaded to R290 (Propane C_3H_8) system, air cooled condensers

System Cost*

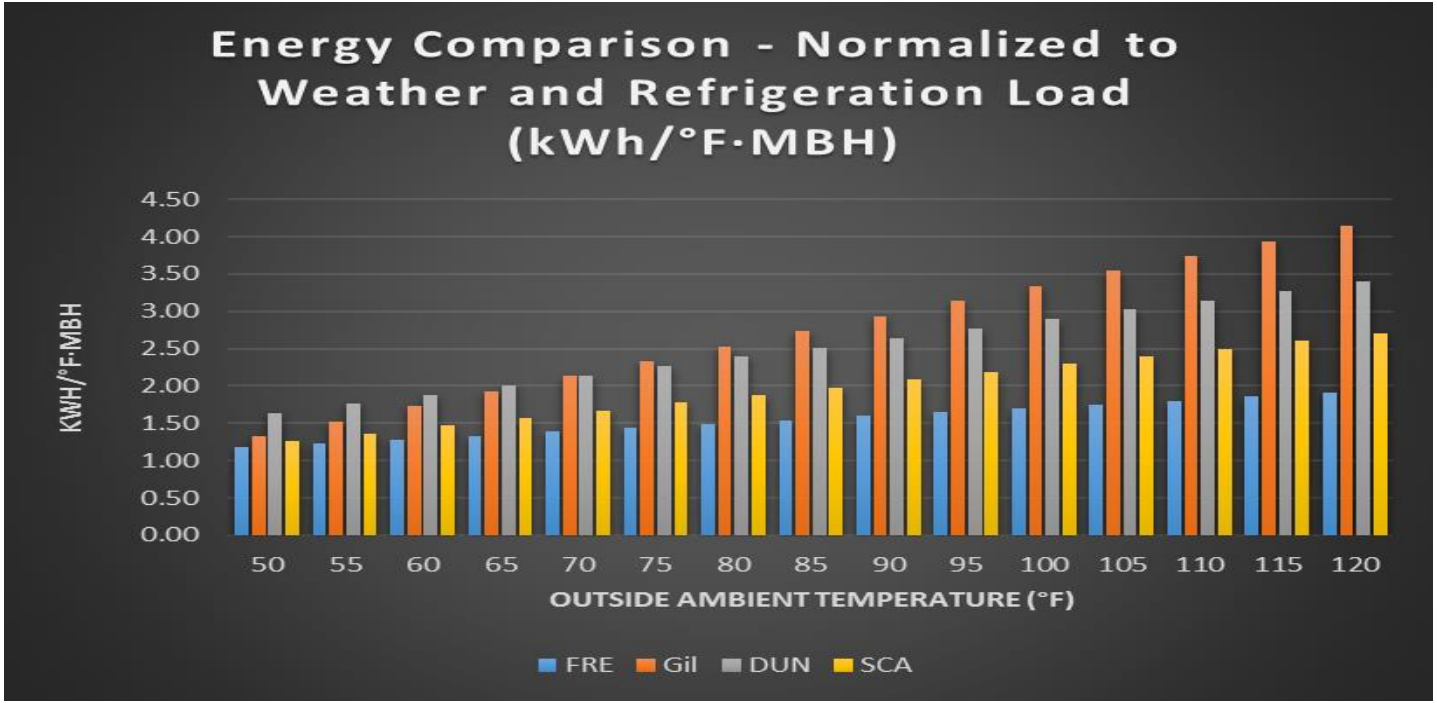
Store	Type	System Cost	Install Cost	Total	Percent Increase Over Baseline
FRE	Baseline DX	1	1	2	0%
GIL	CO_2 Transcritical	1.22	2.01	3.23	61%
DUN	Low-Temp DX CO_2,/Medium temp liquid CO_2, Cascaded R717 (NH_3) System	2.45	1.58	4.03	101%
SCA	Low-Temp DX CO_2,/Medium temp liquid CO_2, Cascaded R290 (Propane C_3H_8) System	2.06	2.66	4.72	136%

***Normalized to Refrigeration Load**

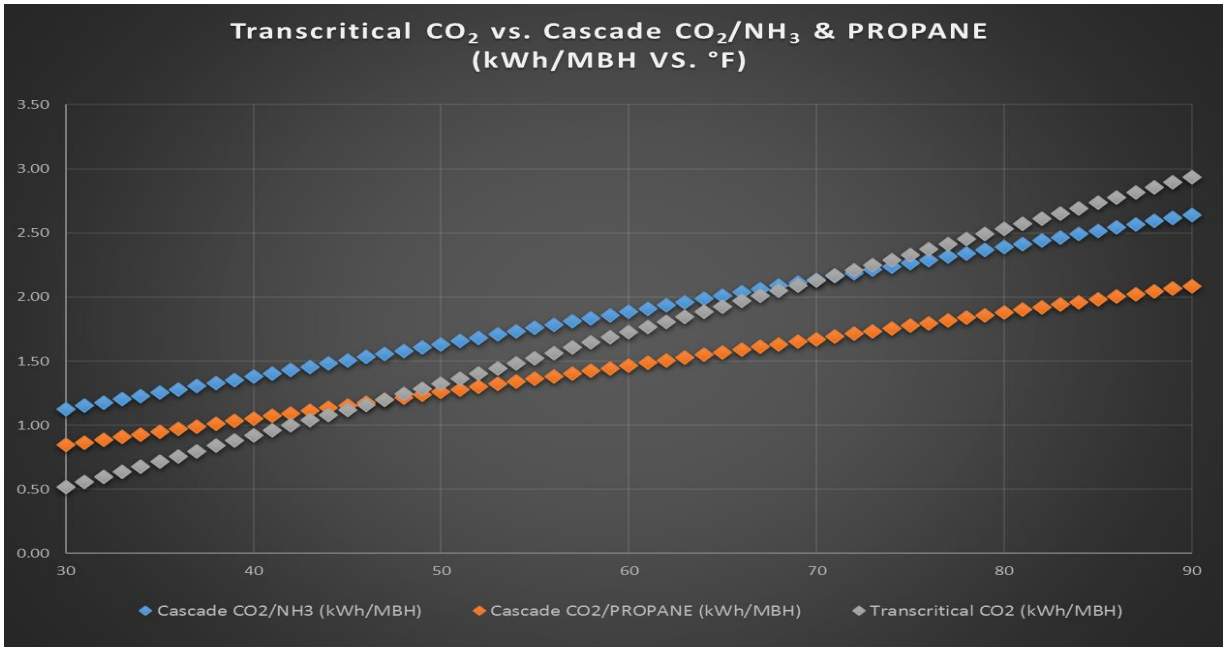
Refrigeration Energy Use



Projected Refrigeration Energy Use

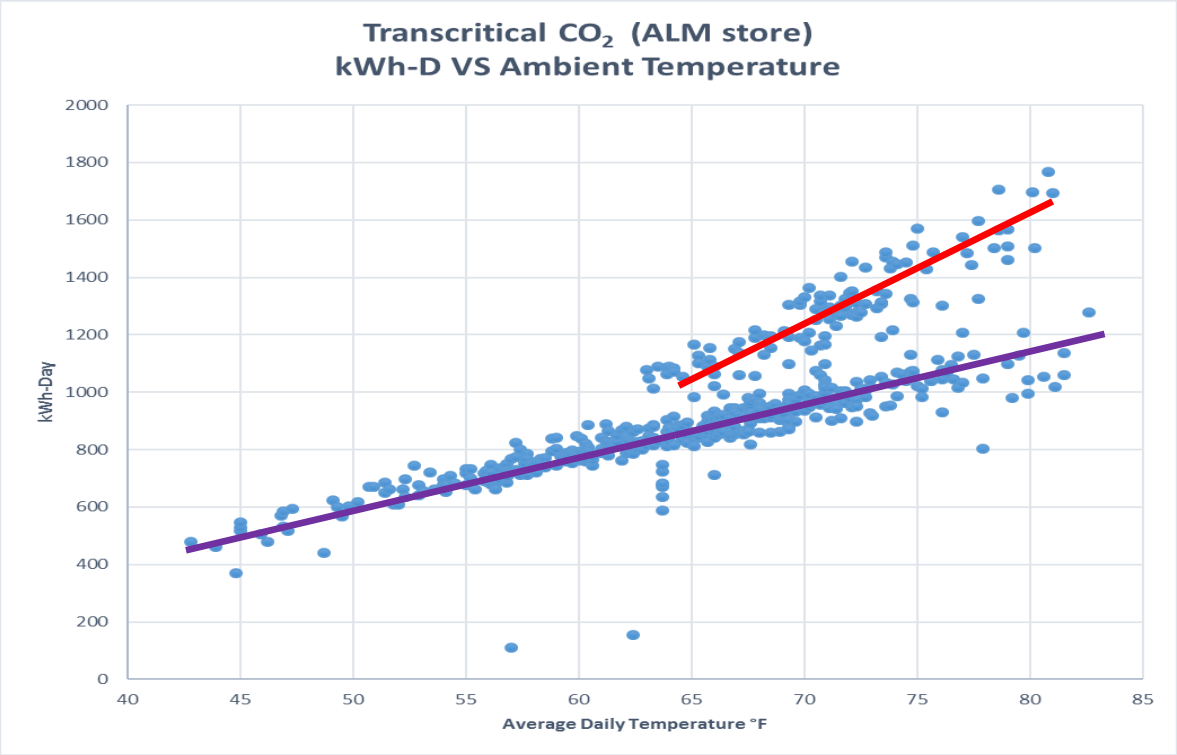


Energy Performance – Normalized to Case Design Load



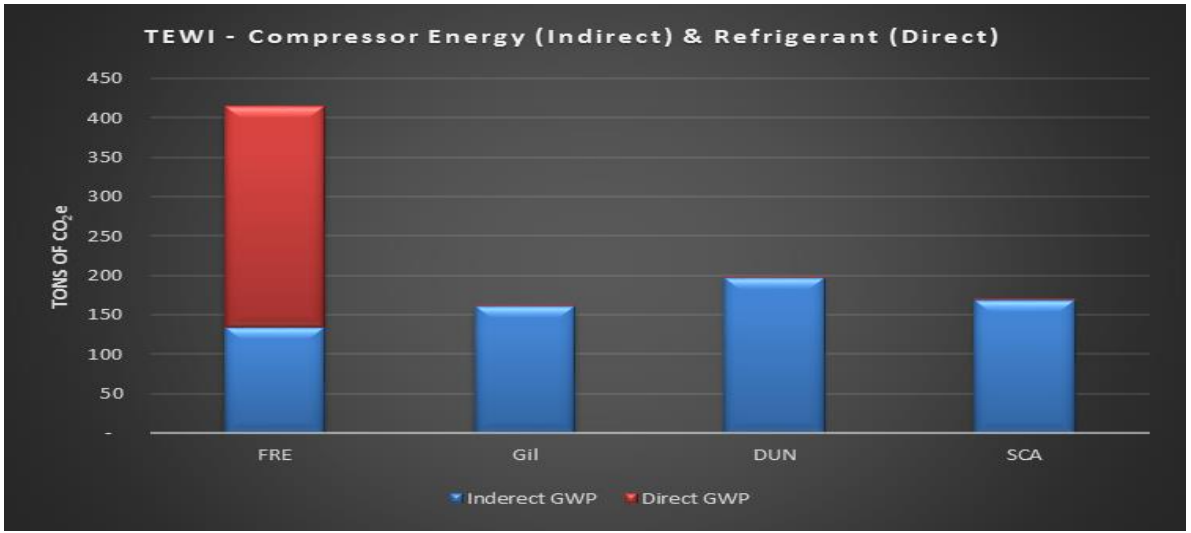
- Daily kWh divided by design case load
- Plotted vs Ambient temperature
- Crossroads is 72° for Ammonia and 48° for Propane

Energy Performance



- Transcritical CO_2 refrigeration system
  - Absorption Chiller
  - Maximize Sub-Critical operation
- Operates in “Sub-critical” and in Transcritical modes

TEWI – Refrigeration Comparison



- Tons of CO_2e Emissions
- Includes Refrigeration Compressors Energy Usage (Indirect emissions) and Refrigerant Leaks (Direct)
- Natural refrigerants Emit 1,500 times less CO_2e than the 407A (FRE store)
- Assumes:
  - 621 Lbs. CO_2e/MWH for California (source: EIA)
  - R407A GWP of 2,107
  - Standard Leak Rate
  - Energy use normalized to FRE

Lessons Learned

- Custom systems come at a premium, but standardization & wider adoption is driving cost down
- Controls collaboration and commissioning are key
- Collaborative design/implementation – who drives the process (OEM, EoR, Owner, Installer)?
- Authority Having Jurisdiction (AHJ) Engagement
- Natural Refrigerant Accessibility
- Contractors/technicians are becoming more comfortable, but training is still very necessary
- Safety – procedures, contractors, store personnel
- Industrial vs. commercial applications
- Anticipated energy penalty doesn’t apply, but TEWI says it all

A Case Study of the CO_2 System at Whole Foods Market, Castro

Tristam Coffin, LEED AP
Sustainable Facilities Coordinator, Whole Foods Market
Tristam.Coffin@wholefoods.com

Tom Wolgamot, PE, LEED AP, CPMP
Principal, DC Engineering
(406) 829-8828 x201
twolgamot@dcengineering.net

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Thank you very much!