



A Case Study of the CO₂ System at Whole Foods Market, Castro

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Agenda

- Owner's Expectations
- Project Delivery Method
- System Schematic
- Comparative System Cost
- Comparative Energy Use
- Lessons Learned
- Future Development

Owner's Expectations

- Refrigerant Reduction (GreenChill Partner)
- Low Energy Consumption
- Advancing Natural Refrigerant Technology
- Minimal Change Orders
(no surprises)
- Stable System Operation

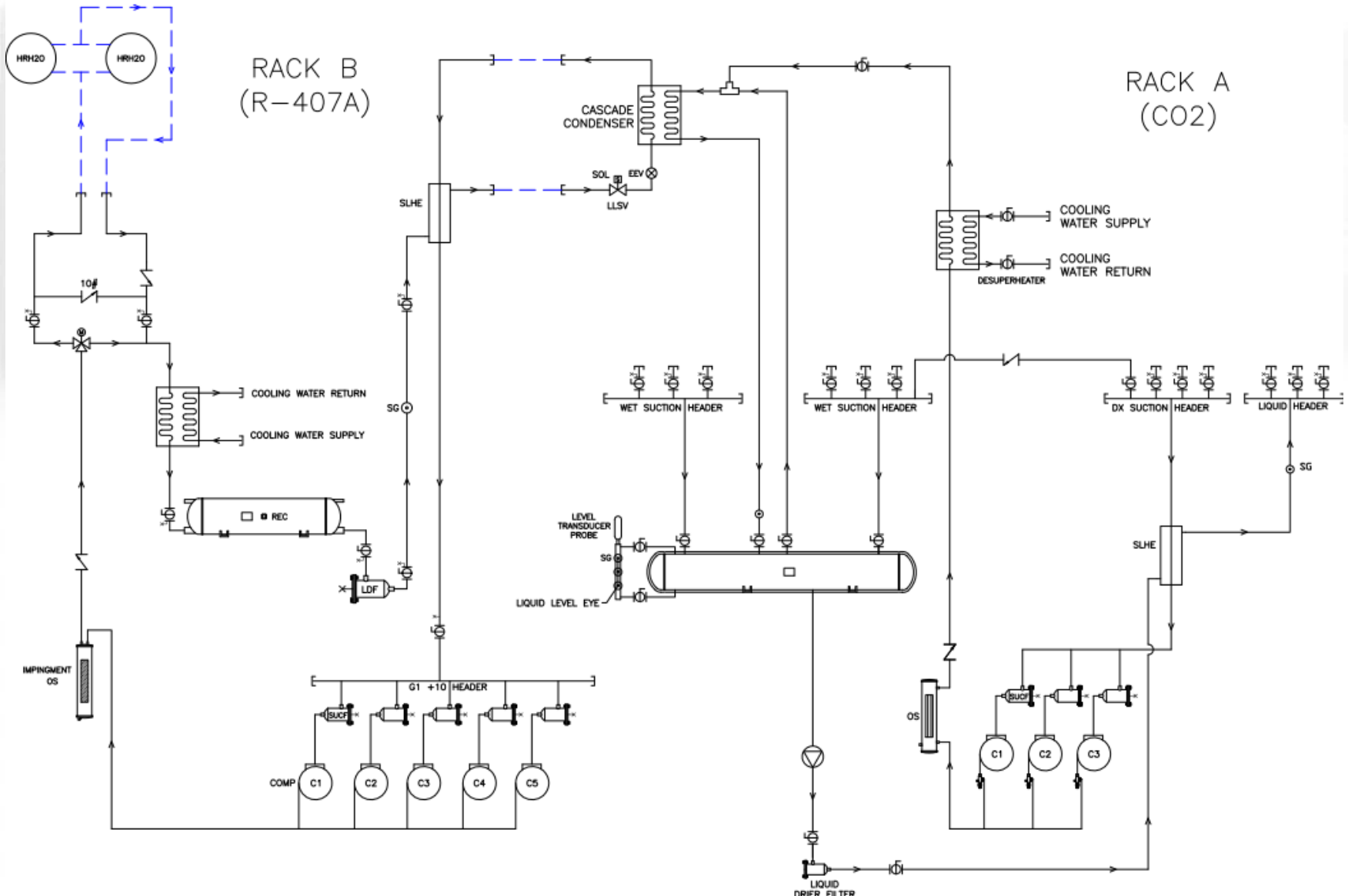
Project Delivery Method

- Modified Integrated Project Delivery (IPD)
- General Concept Provided
- Partners Identified Early
 - Engineers
 - Rack OEM
 - Control Vendor
 - Commissioning Agent
- Collaboration Throughout

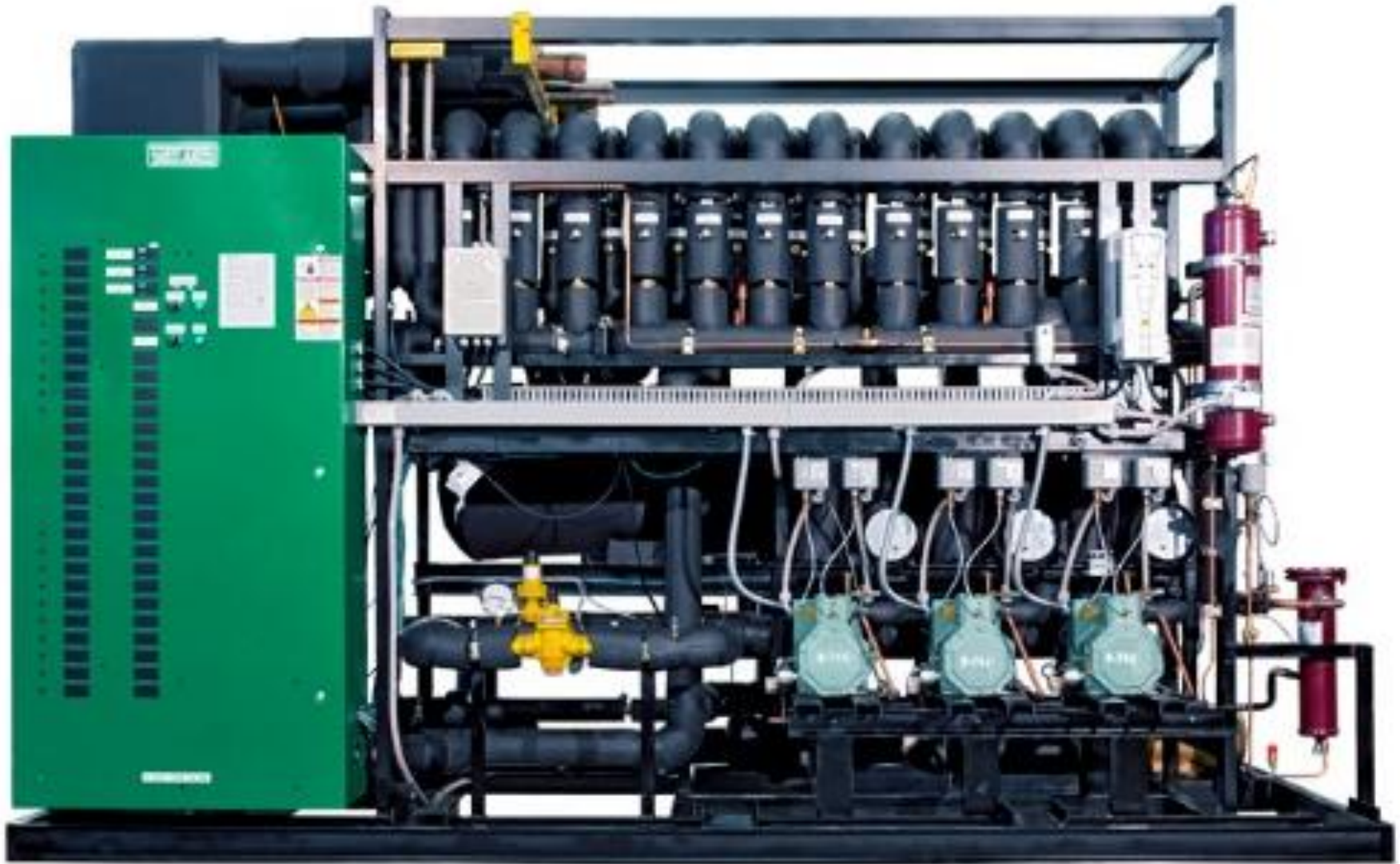
System Schematic

- Mixed-Use Mid-Rise
- Closed Loop Fluid Cooler
- Racks and HVAC Heat Pump Loop
- High Side 407A
- Med-Temp CO₂ overfeed
- Low-Temp CO₂ DX

System Schematic



System Schematic



System Schematic



System Schematic



System Cost

Equipment (BTUs equalized)

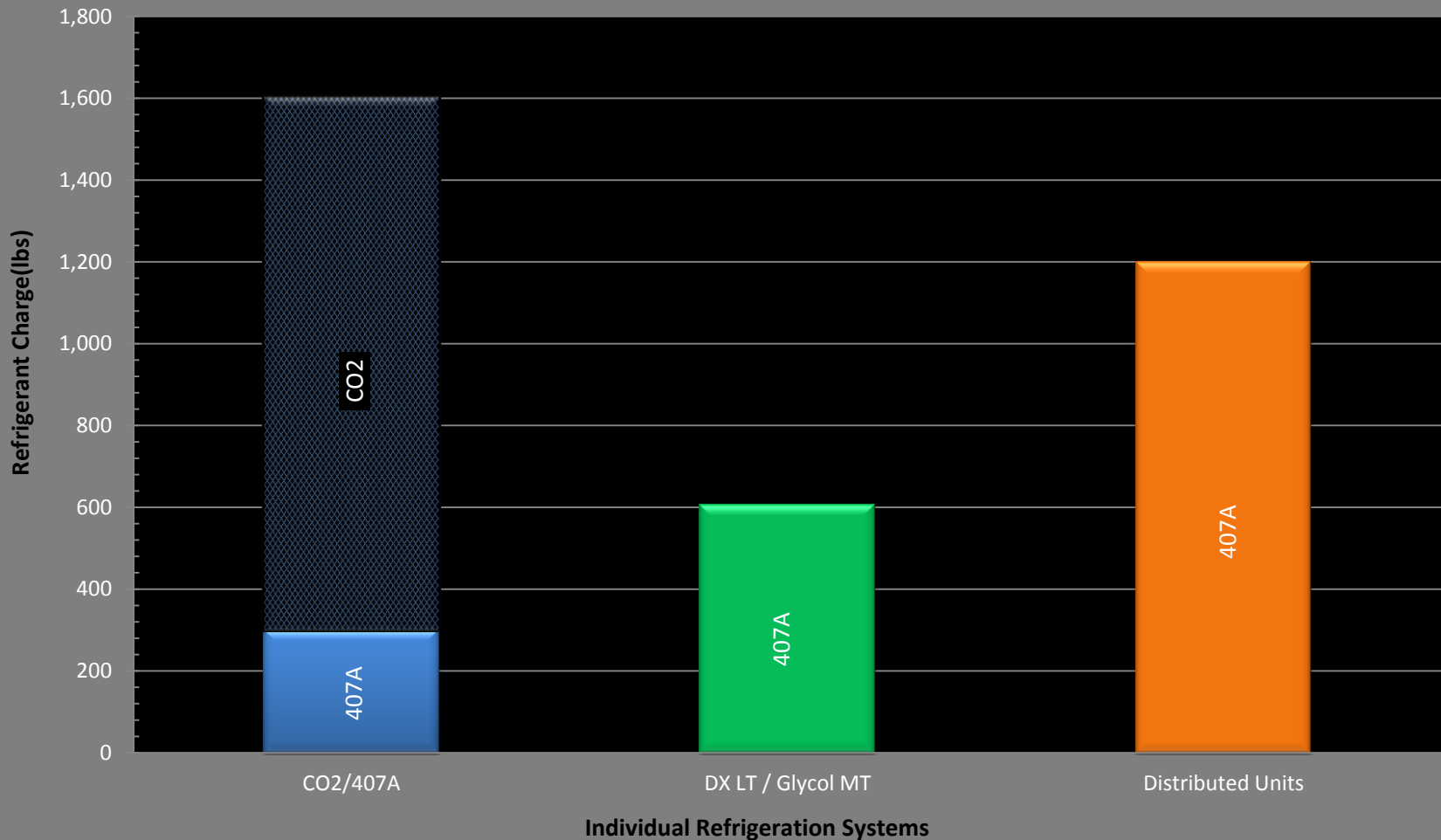
- Cascade CO₂/407A: baseline 100
- LT DX / MT Glycol: 93%
- (4) DX Distributed Units: 112%
- *Fluid Cooler/pumps excluded from CO₂ & Glycol stores. Plate Hx condensers included.*
- *Hybrid condensers excluded from Distributed.*
- *Distributed does include insulated enclosures.*

Installation (actual stores)

- Cascade CO₂/407A: baseline 100
- LT DX / MT Glycol: 95%
- (4) DX Distributed Units: 80%

Refrigerant Charge

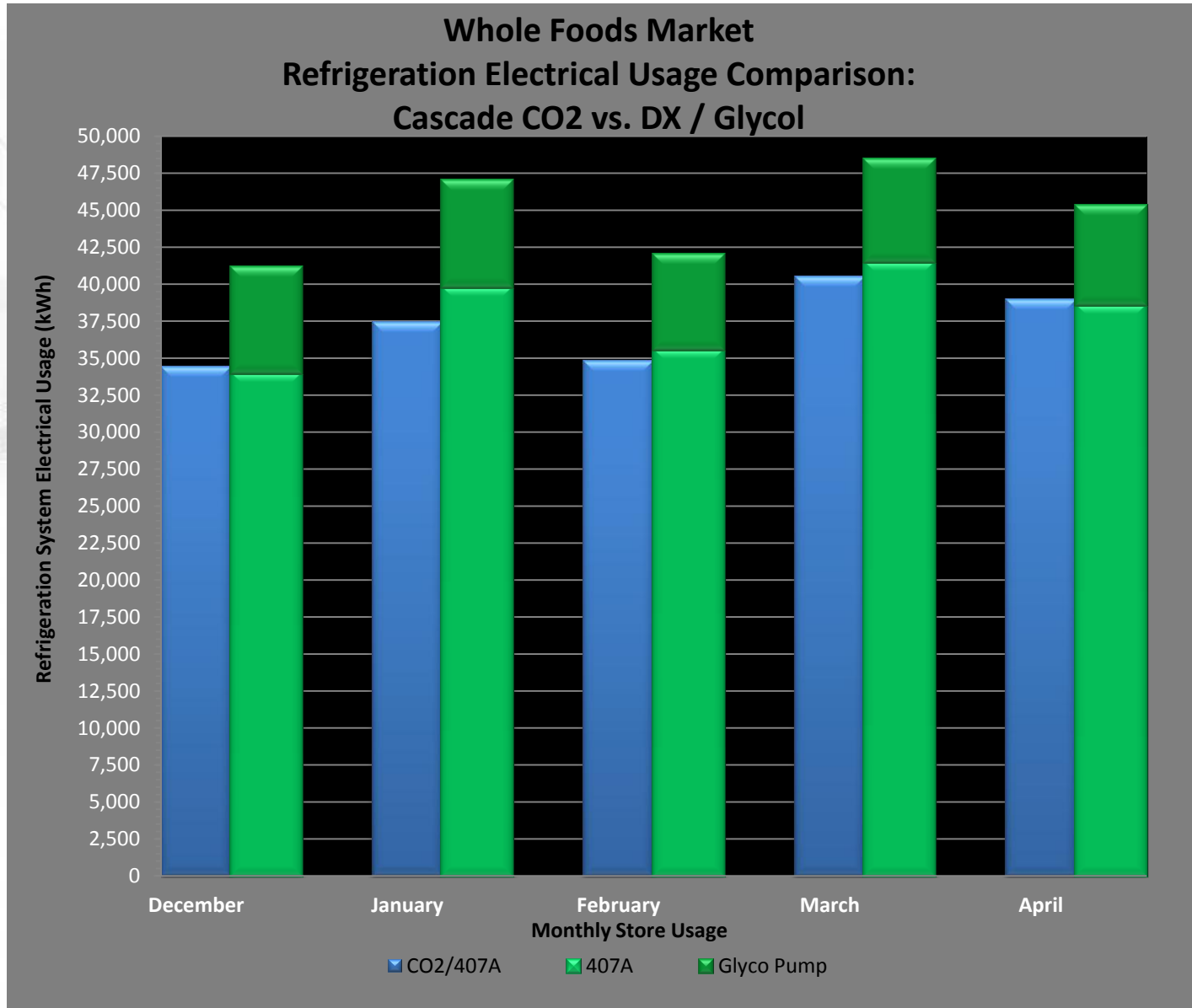
Whole Foods Market Individual Store Refrigerant Charge



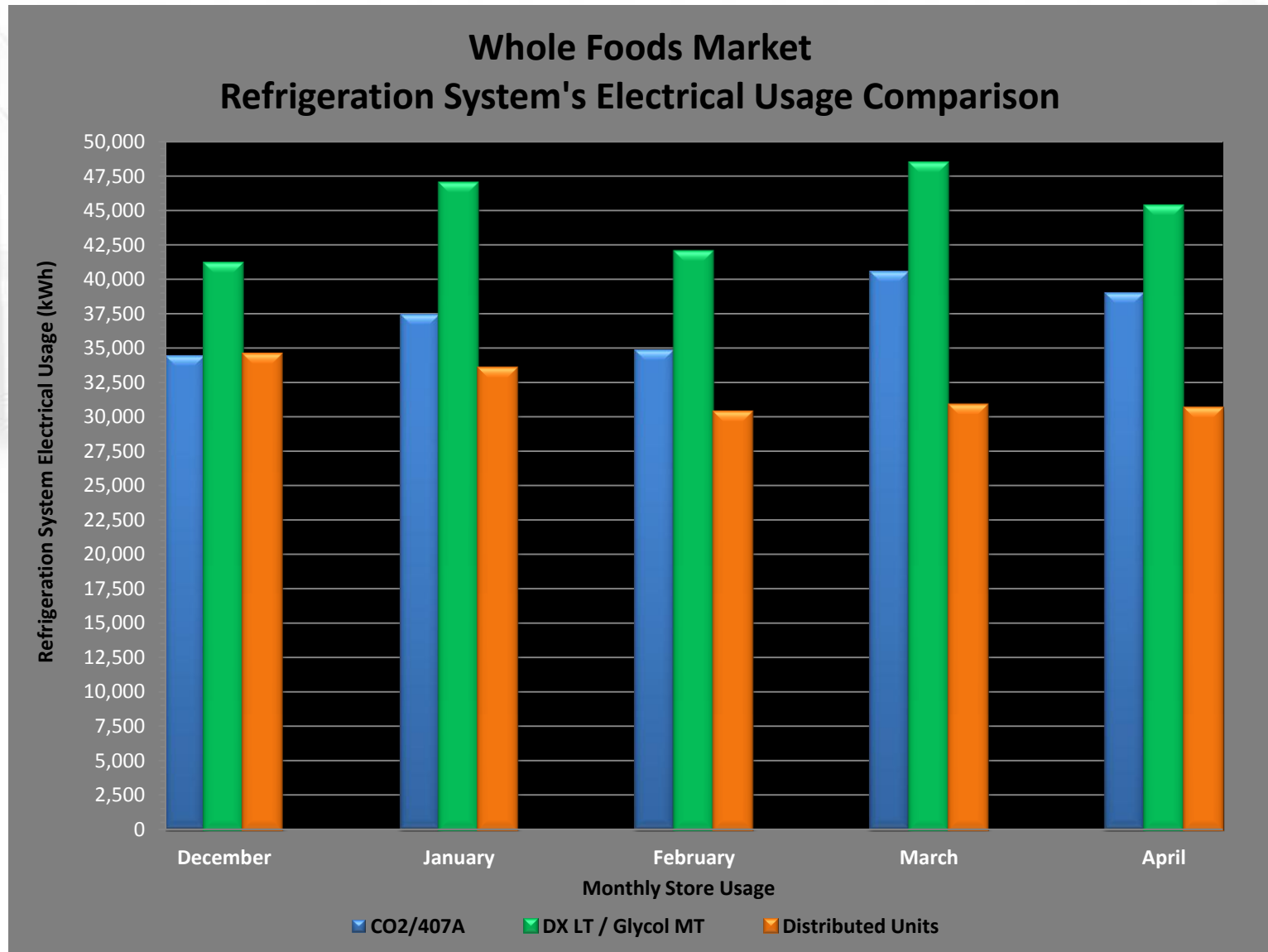
Energy Use

Store	System	Sq Feet	MBH	Description
CAS	Cascade CO2	33,030	735	CO ₂ /407A cascade, closed loop heat pump fluid cooler system
OCN	LT DX / MT Glycol	26,632	731	Med Temp Glycol and 407A Low Temp DX, closed loop heat pump fluid cooler system
FRE	Distributed	39,026	847	(4) Distributed 407A units, hybrid condensers

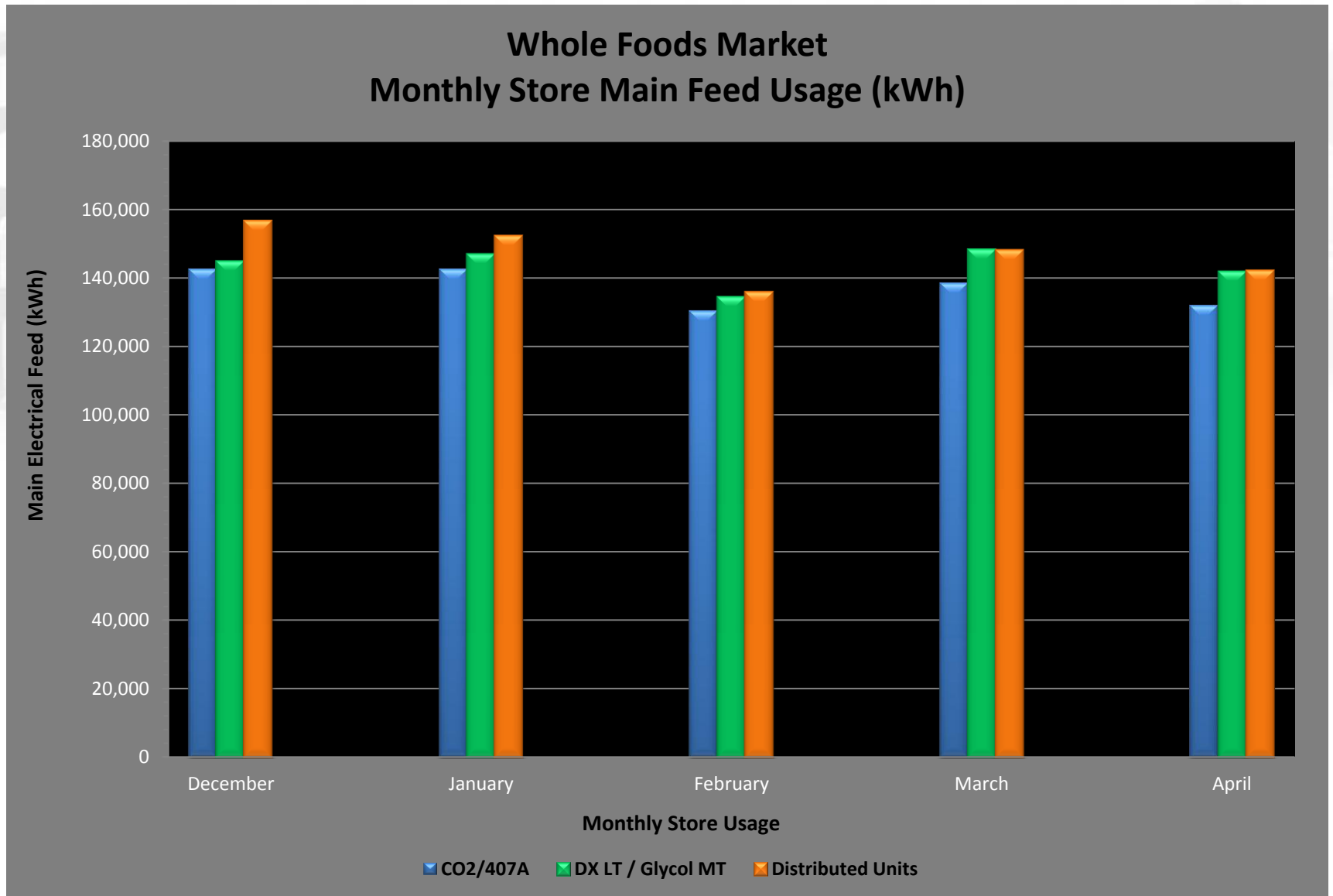
Refrigeration Energy Use



Refrigeration Energy Use



Whole Store Energy Use



Lessons Learned

- Controls collaboration is key
- VFD application offers significant benefits
- CxA, EOR, OEMs, and contractors all work together
- High grade CO₂ not immediately available (stocking on-site, bottle disposition)
- Training of Service Technicians
- Anticipated energy penalty does not apply
- Overall experience has been good

Future Development

- Continued focus on Natural Refrigerant solutions
- Transcritical CO₂
- Subcritical/cascade CO₂
- Ammonia
- Propane

Both energy and refrigerant reduction are very high priorities for Whole Foods.



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