Energy & Store Development Conference

E+Sd 2013

ONE RETAILER'S EXPERIENCE WITH TRANSCRITICAL CO_2 REFRIGERATION

Harrison Horning, PE, CEM
Delhaize America

Outline

- Context
- Project development
- Project experiences
- Q&A

The Role of the Refrigeration Team

- Product preservation and presentation
- Safety and compliance
- “Don’t spend too much money”
- Refrigerant management
- Explore advanced systems

The Changing Landscape of Commercial Refrigerants

From **natural refrigerants** (popular until 1940s),

to **CFCs** (ozone-depleting, greenhouse gases),

to **HCFCs** (ozone-depleting, greenhouse gases),

to **HFCs** (greenhouse gases),

to … **natural refrigerants**?

Refrigerant Options in 2013

(commercial, central systems, direct expansion)

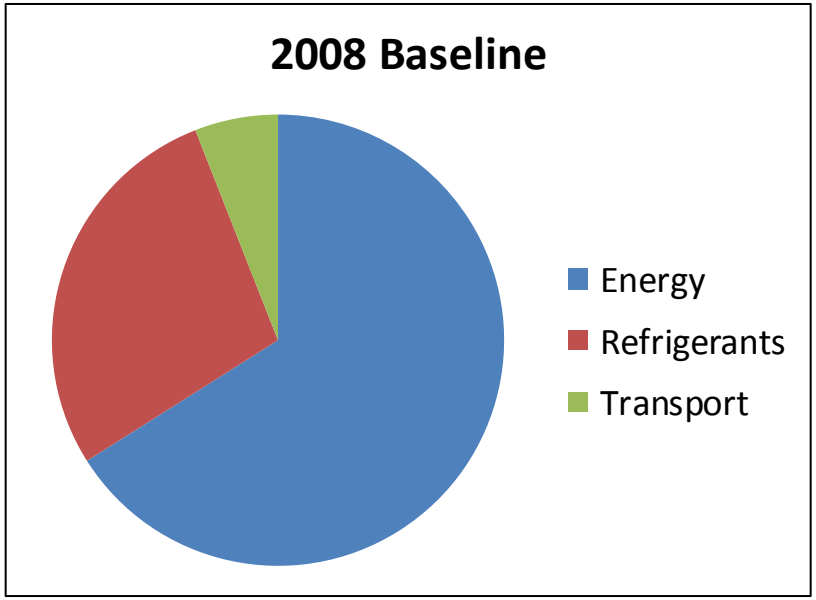
Refrigerant	GWP (100 year)	Notes
R-22 (HCFC)	1700	Being phased out; ozone-depleting substance.
R-507 (HFC)	3850	Popular for energy efficiency; high GWP.
R-407A (HFC)	1990	Good replacement for R-22, but higher GWP than R-22.
CO_2 (Natural)	1	Popular in Europe; gaining in Canada; “new” to US.

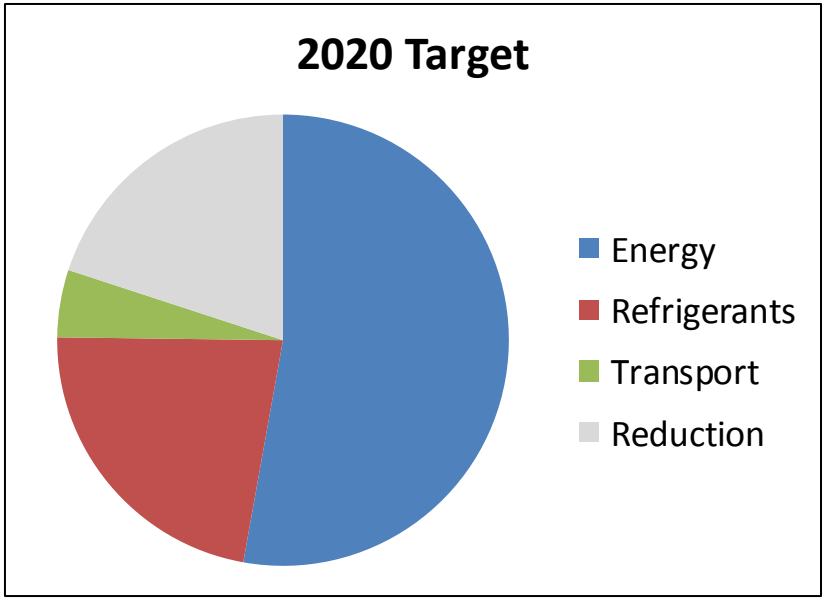
Climate Change Awareness

- Pre – 2005
  - Aware of greenhouse gases; but focused on ozone
- 2005 – 2010
  - Started to focus on greenhouse gases
  - Annual carbon footprint calculations
- Post – 2010
  - Greenhouse gas (GHG) emissions reduction goal
  - CGF resolution to begin phasing out HFCs

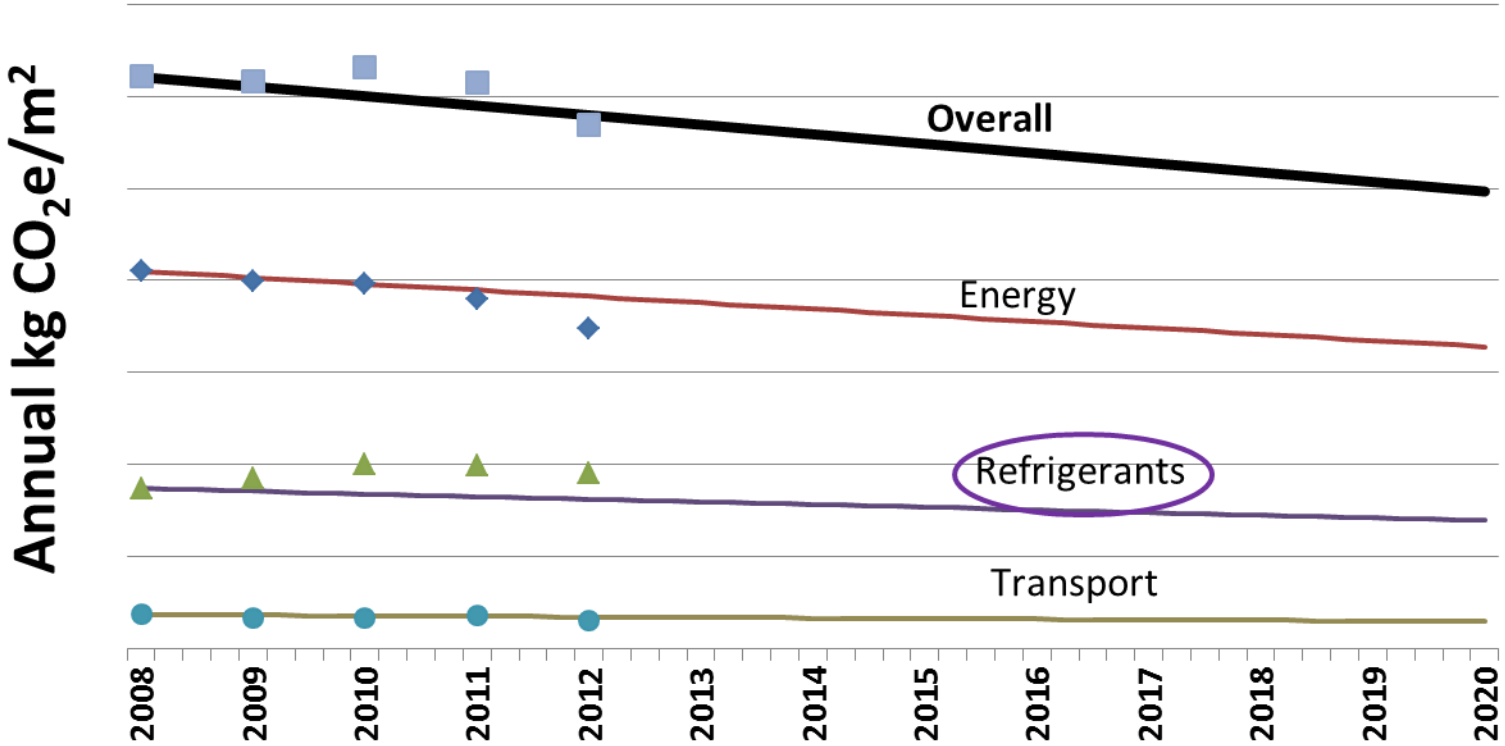
GHG Emission Reduction: Goal

Delhaize Group goal is to reduce GHG emissions intensity 20% by 2020 (vs. 2008).





GHG Emission Reduction: Progress



GHG Emissions from Refrigerants

$kgCO_2e$ **= Charge**

(kg charge)

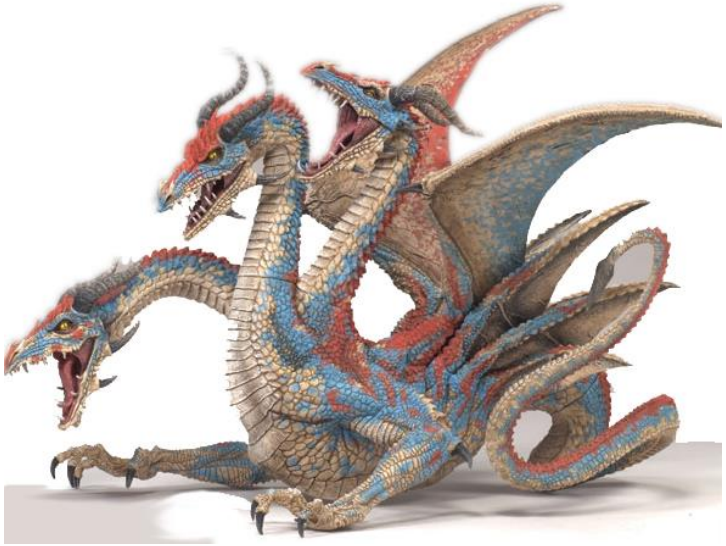
x leak rate

(kg leaked / kg charge)

x GWP

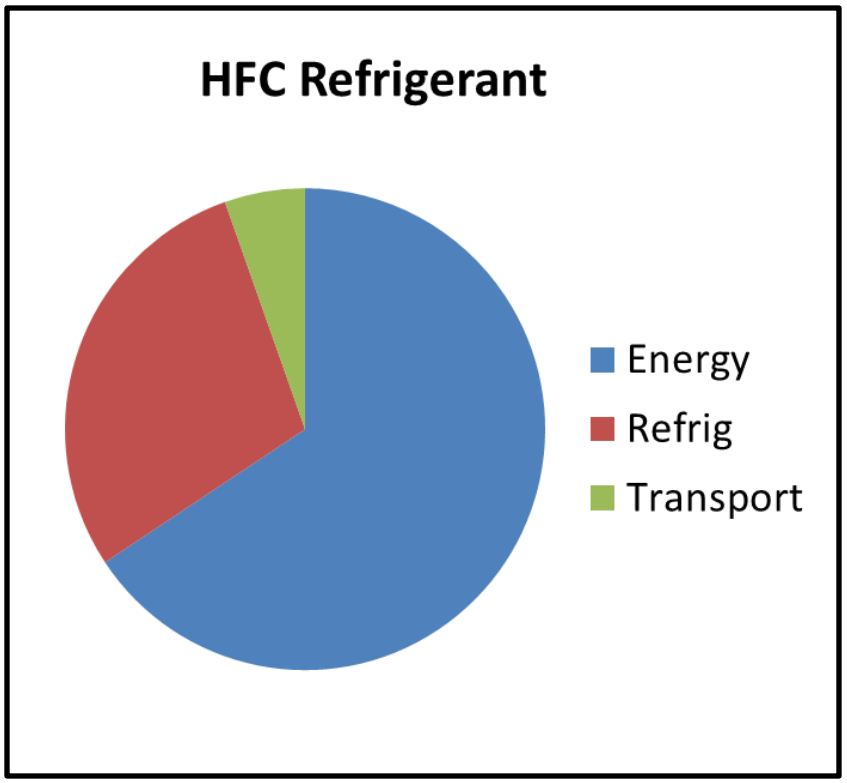
(kg CO2e / kg leaked)

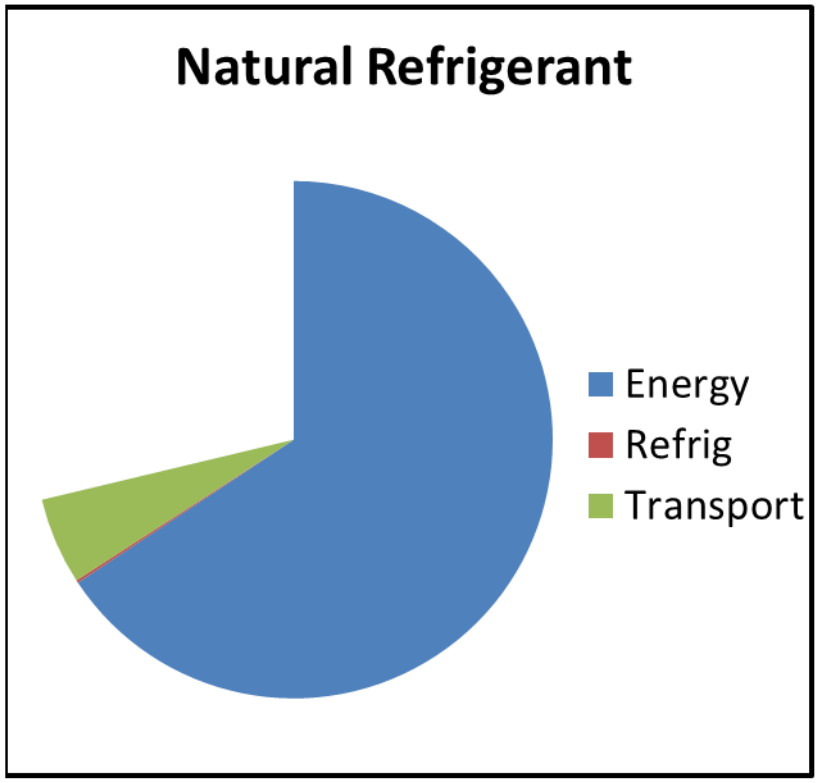
What can we do to slay this many-headed beast?



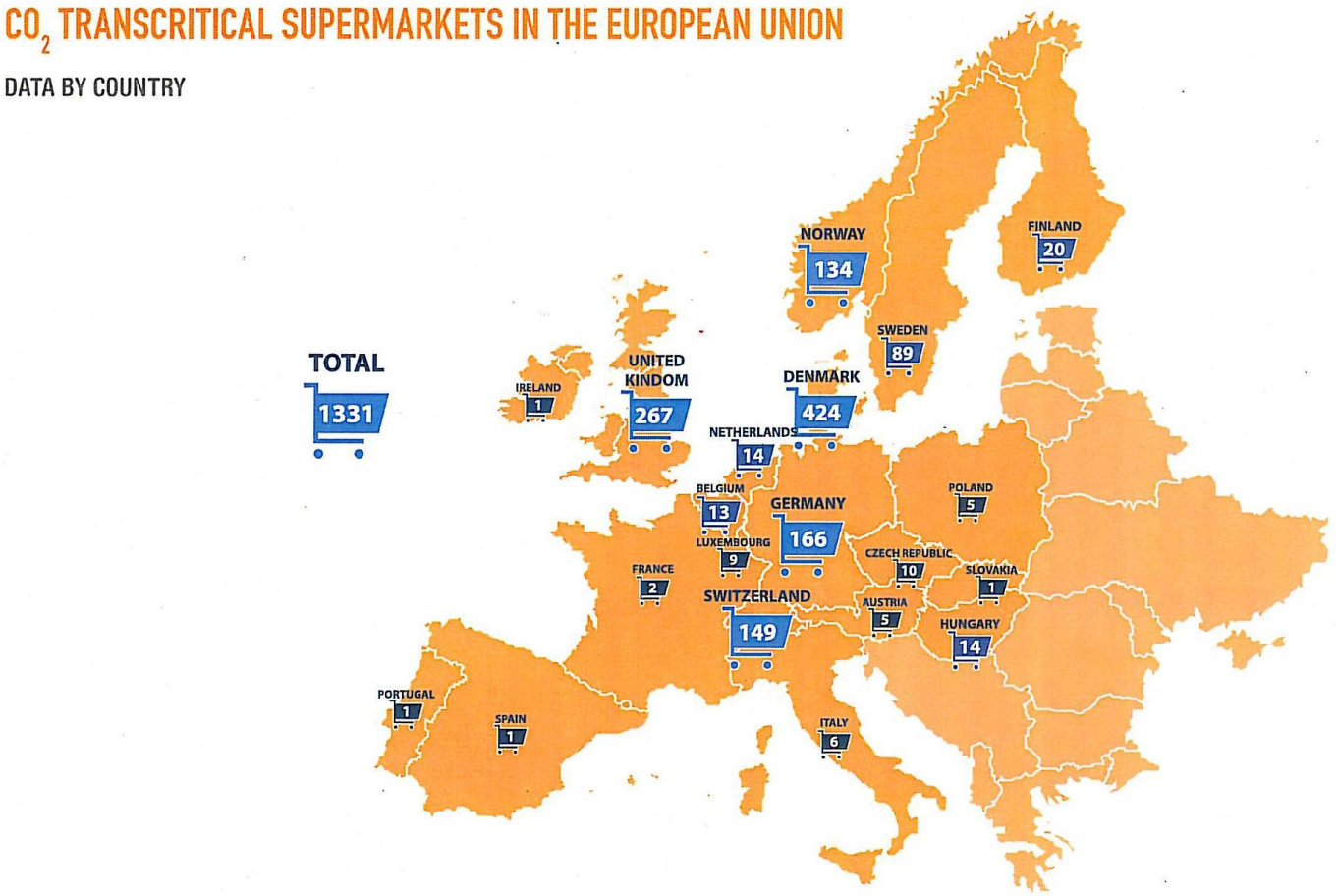
Charge Reduction	Leak Rate Reduction	GWP Reduction
Secondary refrigerants	Leak tracking/reporting	R407A/407F vs. R507/404A
Distributed systems	Supplier collaboration	Natural refrigerants:
Water/glycol condensing	Better leak detectors	• For warehouses
Micro-channel condensers	Accountability for leaks	• For new stores
Self-contained cases	Leak monitoring	• For retrofits

Natural Refrigerants Will Reduce GHG Emissions





What Can We Learn from Europe?



The Consumer Goods Forum (CGF) Resolution

The Board of Directors of the Consumer Goods Forum approved the following resolution at their meeting on 9 November 2010:

"As the Board of the Consumer Goods Forum, we recognize the major and increasing contribution to total greenhouse gas emissions of HFCs and derivative chemical refrigerants. We are therefore taking action to mobilize resources within our respective businesses to ***begin phasing-out HFC refrigerants as of 2015 and replace them with non-HFC refrigerants (natural refrigerant alternatives)*** *where these are legally allowed and available for all new purchases of point-of-sale units and large refrigeration installations.*

We recognize that barriers exist to wide scale adoption of more climate-friendly refrigeration, namely legislative restrictions in some markets, availability, cost, safety, maintenance and servicing. We will work to overcome those barriers by strengthening existing collaborative platforms and initiatives. We also will use our collective influence to encourage our supply base to develop natural refrigerant technologies that meet our business demand under commercially viable conditions."

Setting Context

- Motivation for a pilot project
  - European parent company
  - GHG reduction goal
  - CGF resolution
- Transcritical CO_2 seems like the best option
- More economical in cold climates

Transcritical CO_2 Pilot – Where?

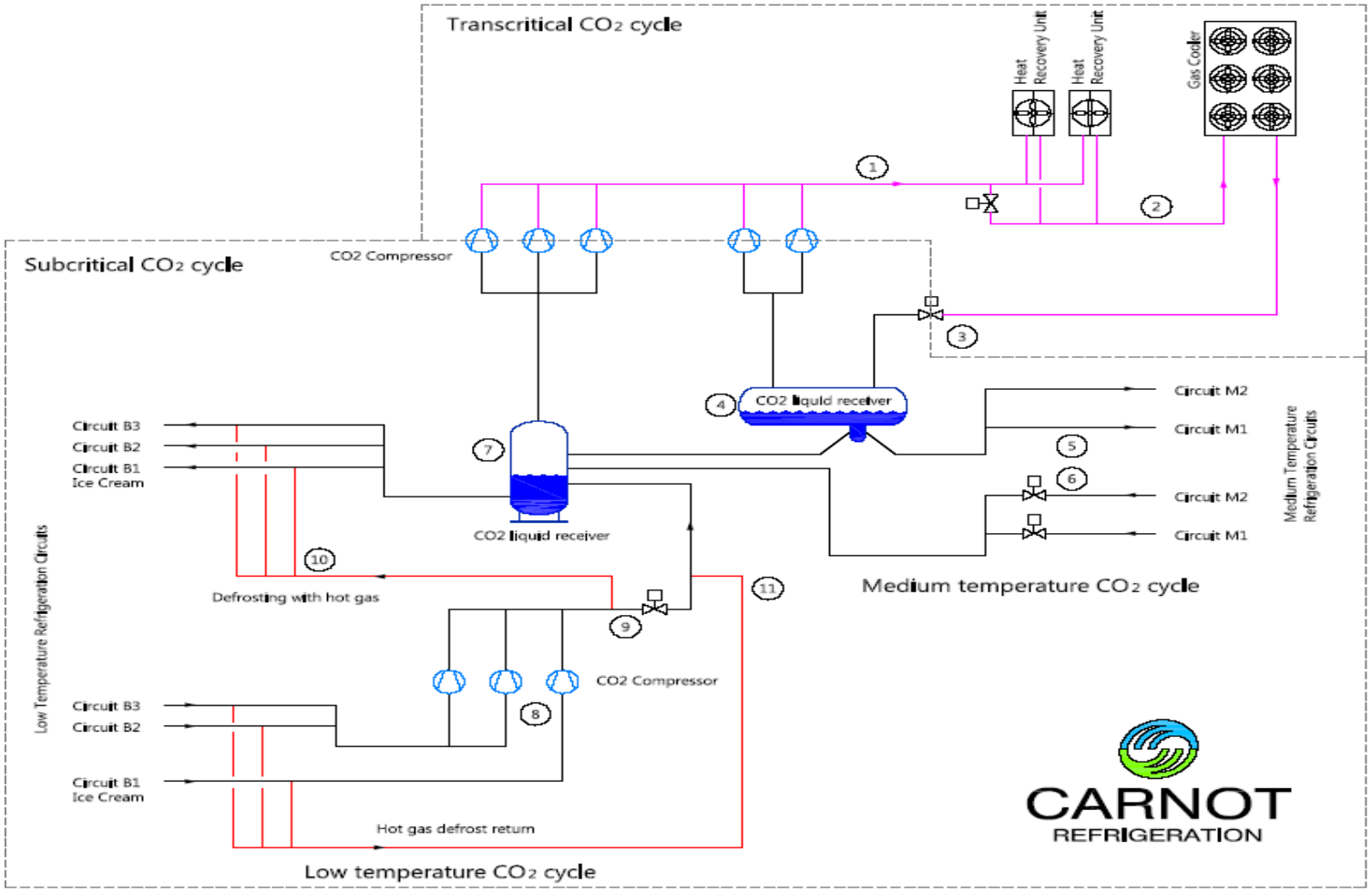
Project Development Themes

- "Pilot" means only one project, until proven
- Assume up-front cost is not prohibitive
- Select one supplier to determine feasibility
- Resist the temptation to re-engineer
- Select a project from construction schedule
- Assume supplier will provide O&M support
- Get "buy-in" from refrigeration team
- Try to stay "under the radar"

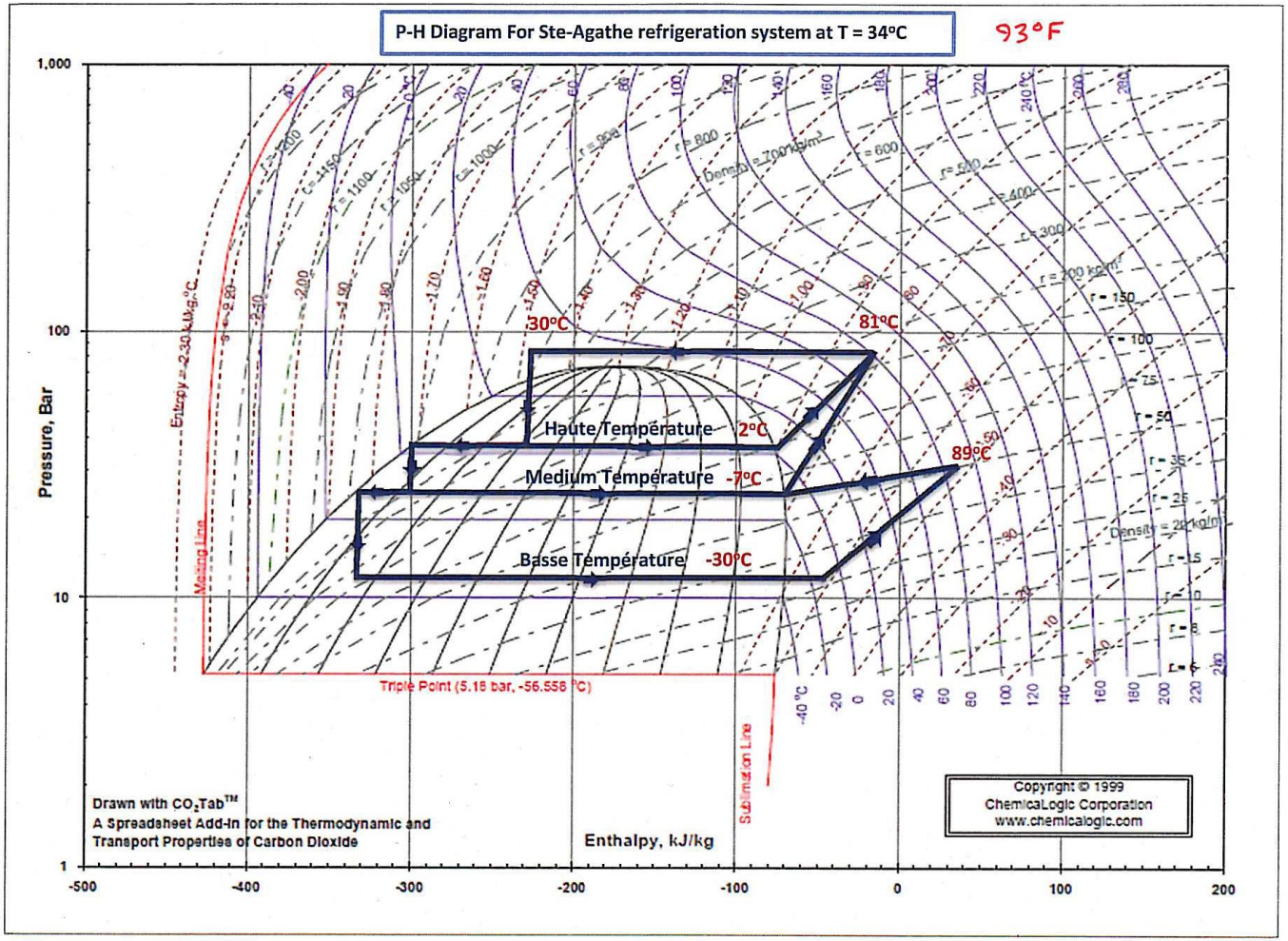
Capital Cost

- Price premium depends on baseline
  - May not be comparing to “vanilla”
- Expect higher capital cost in general; need energy savings (or other incentive) to justify
- Found up-front savings to limit added cost:
  - Eliminated pre-fab “pod”
  - Reduced heat reclaim equipment
  - Eliminated electric defrost

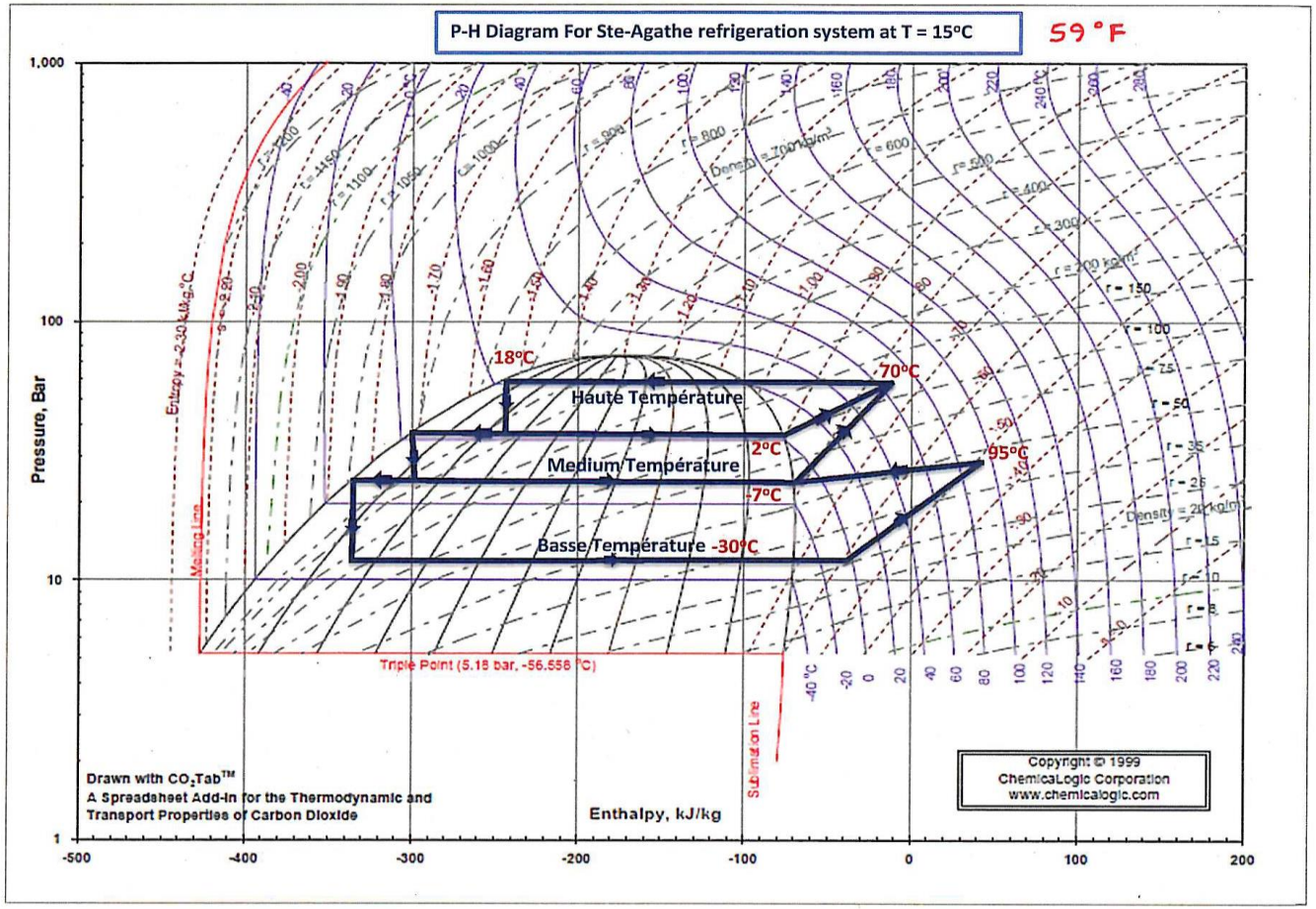
Supplier Selection



Thermodynamics: 93 deg F



Thermodynamics: 59 deg F



Initial Concerns

- High-pressure operation
- Welded steel piping (outsourced)
- Training for in-house technicians
- Power outage recovery
- CO_2 asphyxiation risk (ASHRAE 15 & 34)
- Evaporator design (multiple suppliers)
- Hot gas defrost
- Unfamiliar control system
- IT department

Project Timeline

Fall 2011 – Identified pilot project at Turner, Maine store

Jan 2012 – Interviewed potential suppliers after prelim RFP

Feb 2012 – Selected supplier for concept design/feasibility

May 2012 – Started design; committed to supplier

Jul 2012 – Completed design; formal proposal from supplier

Oct 2012 – Started construction

Nov 2012 – Ordered rack and associated equipment

Mar 2013 – Rack delivered

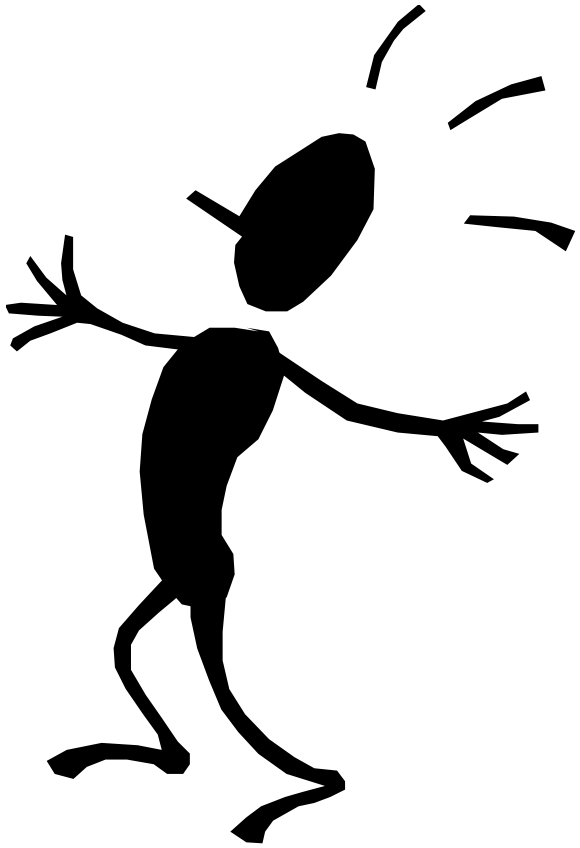
Jan 2013 – Received assurance of UL approvals

Jul 2013 – Store opening

New Store in Turner, Maine

Looks the Same to a Customer

Looks Different to a Technician



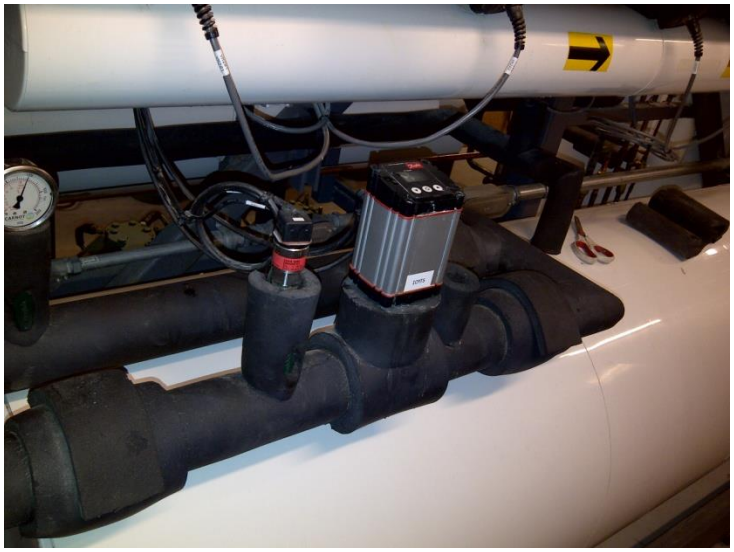
One Large Rack (LT and MT)

Three LT Compressors

Six MT Compressors (Transcritical)

Heat Reclaim System

Gas Cooler



High-Pressure Expansion Valve

Pressure Relief Valve Piping

Intercooler

Electronic Expansion Valve (EEV)

- "Stepper" valve
- Fails as-is
- Can be programmed to shut for case cleaning, etc.

The Control System Makes It Work

Summary of Project Experiences

- Took a lot of time to learn and understand
- Ongoing monitoring by suppliers is helpful
- So far the system is working
- Concept seems fundamentally sound
- Technology is ripe for further advances
- Too early for energy data; no heating season
- DOE Better Buildings Alliance collaboration to analyze energy performance

Ongoing Issues/Concerns

- Fewer filters, therefore more plugged EEVs
- Where to store 2,000 lbs of CO_2 "just in case"
- Heat reclaim heat exchangers not optimized
- Some EEVs seem to be over-sized

"The high density allows crazy things to be done in the evaporator design department."

– Andy Pearson, Ph.D., C.Eng., in *"What's Up With CO2?"*, his Refrigeration Applications column in the August 2013 *ASHRAE Journal*

Continual Learning Process

Thank You!

Q & A