



State of The Industry

Heatcraft Worldwide Refrigeration

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Global Leader of Center of Excellence for Alternative Systems



Lennox International

OVERVIEW (2014)



Heating & Cooling

Residential



Commercial



Refrigeration



Products	Split Systems Indoor Air Quality	Rooftop Package Split Systems	Rooftop Package Chillers / Terminal Split Systems	Food Preservation Industry Cooling
	US / Canada	US / Canada	Europe MEA	Global



Americas

Europe

Asia Pacific / Australia

BOHN



CLIMATE CONTROL

CHANDLER
REFRIGERATION

KYSOR/WARREN

HYFRA
PEDIA

FRIGA-BOHN

HK REFRIGERATION

BOHN

BOHN

BOHN

KIRBY



Regulatory Landscape: Natural Refrigerants

STATE OF THE INDUSTRY

2014

U.S. – California: CARB Climate Change Scoping Plan Update

- Collaborate with EPA to align with EU f-gas rules
- Set a mitigation fee on high-GWP gas sale or pre-charged equipment

2014

Europe: F-gas Regulation

- HFC phase down
- Place-on-market bans with GWP limits

2012

Australia: Synthetic Greenhouse Gas Levy

- Levy placed on SGGs in 2012
- A\$23 per tonne CO₂e
- Slated for repeal along with other parts of the Carbon Tax

Key Milestones

- Banned HFC > 2500 GWP Nov. 2012
- Vote in EU ENVI Jan. 2013
- Parliament / Council Votes Mar/Apr 2014
- Publication Q2 2014

Key elements

- HFC phase down to 79% by 2030
- Service and maintenance ban
 - For CO₂eq > 40 t, HFC GWP > 2500 2020
- New equipment bans
 - Domestic refig. HFC 2015
 - Self-contained disp. case HFC GWP > 2500 2020
 - Self-contained disp. case HFC GWP > 150 2022
 - Stationary refig. HFC GWP > 2500 2020
 - Centralized commercial refig. (> 40 kW)
 HFC GWP > 150, except cascade primary
 loop can use HFC GWP < 1500 2022
 - Moveable AC HFC GWP > 150 2020
 - Split AC HFC GWP > 750 2025

Refrigerant Choices

- Many alternatives are demonstrating feasibility for near term
 - R32, R1234yf, HFOs, etc.
- The choices cause uncertainty in near term solutions
- CO2 is current choice in EU and finding its way in NA.
 - CO2 is often installed at a cost premium
- CO2 continues to show growth
 - Supplier base and product offerings continue to grow
 - CO2 transcritical demonstrates cost and performance parity in some regions
 - Solutions for warmer climates will lead to widespread adoption

HFOs

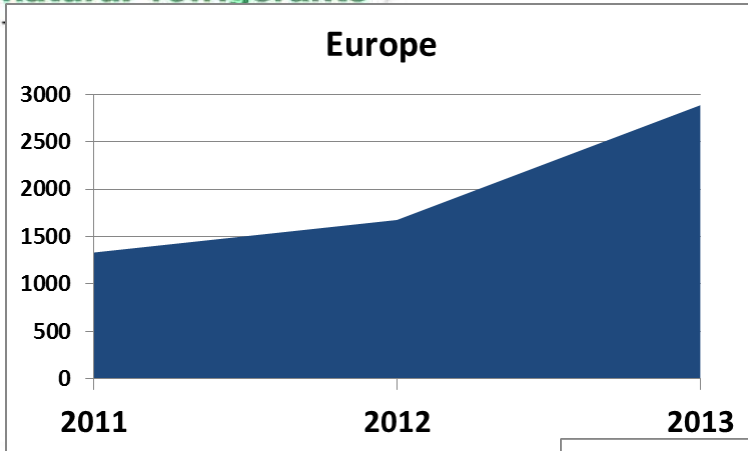
- DR-7
- DR-33
- ARM-30
- ARM-32
- N40
- N41
- L40

CO2 as a Refrigerant continues to generate news

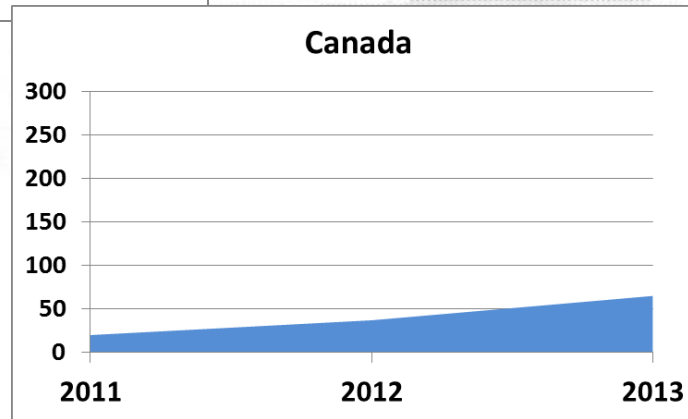
Number of Transcritical Systems

6

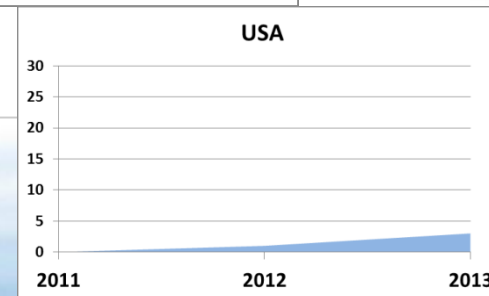
2011 - 2013



~3000 Installations
~80,000 Outlets
~ 4%



~65 Installations
~15,000 Outlets
~0.4%

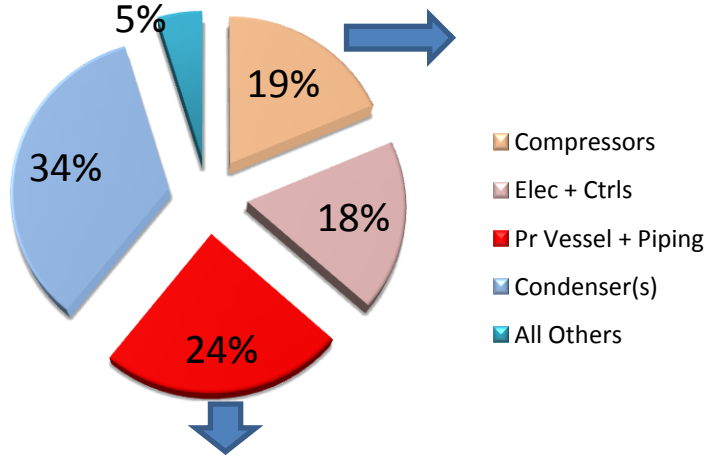


~3 Installations
~110,000 Outlets
~0.003%

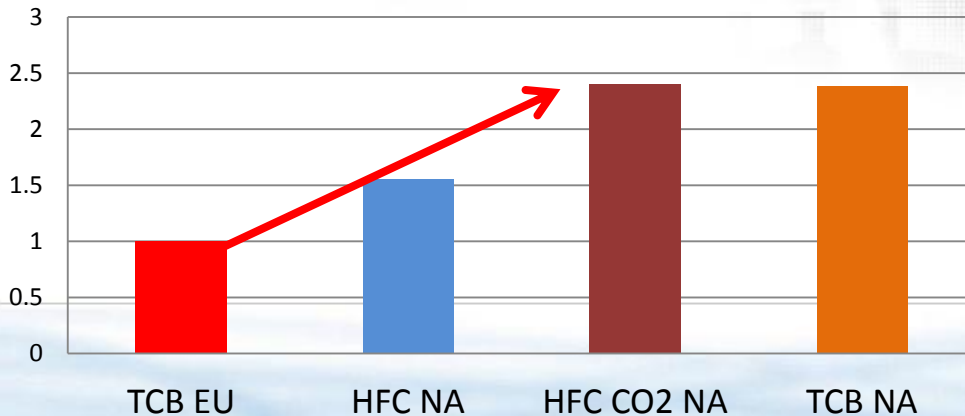


High Cost Premiums + Unfavorable Regulatory Compliance Costs

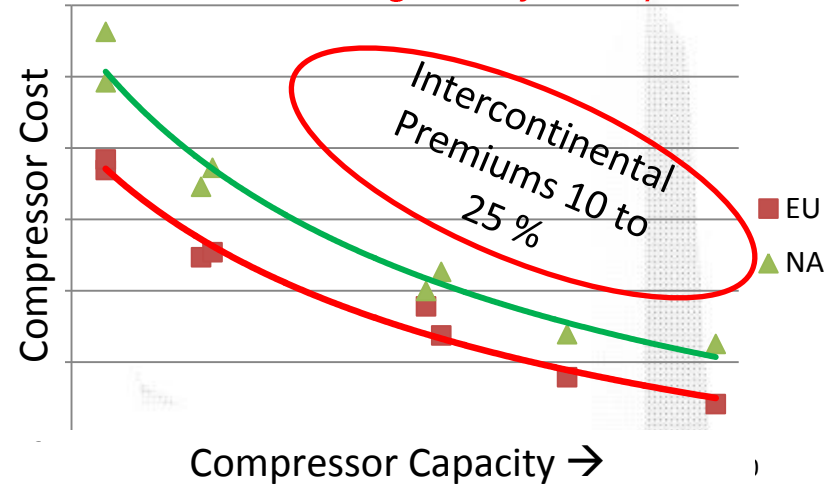
Typical System Cost Breakdown



Influence of Un-harmonized Regulatory Standards – on Pressure Vessels + Piping



Legend : TCB – Transcritical Booster, NA – North America, EU – European Union



- Limited supplier base – high component costs.
 - NA subdued by intercontinental premiums
- Lack of harmonization of Regulatory standards
 - System costs dramatically higher in NA
 - UL versus PED

Harmonization efforts underway. Heatcraft proposal to CANENA for harmonizing UL 1995 in aligning with IEC has been favorably received and under consideration

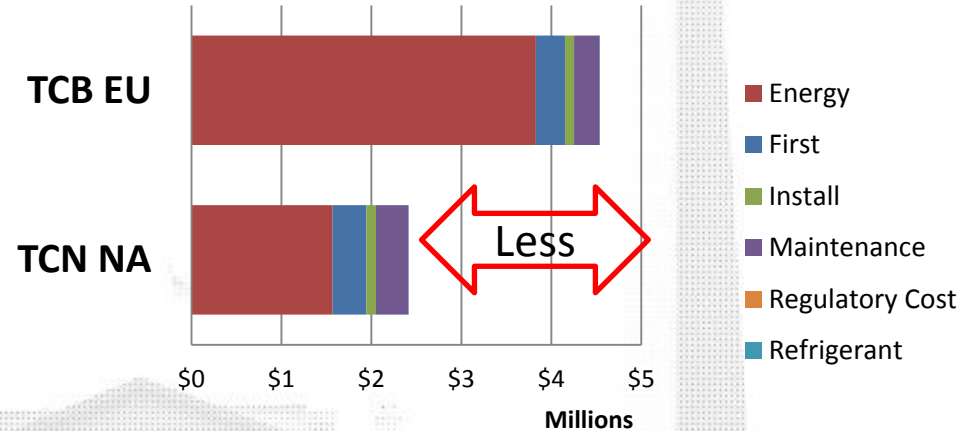
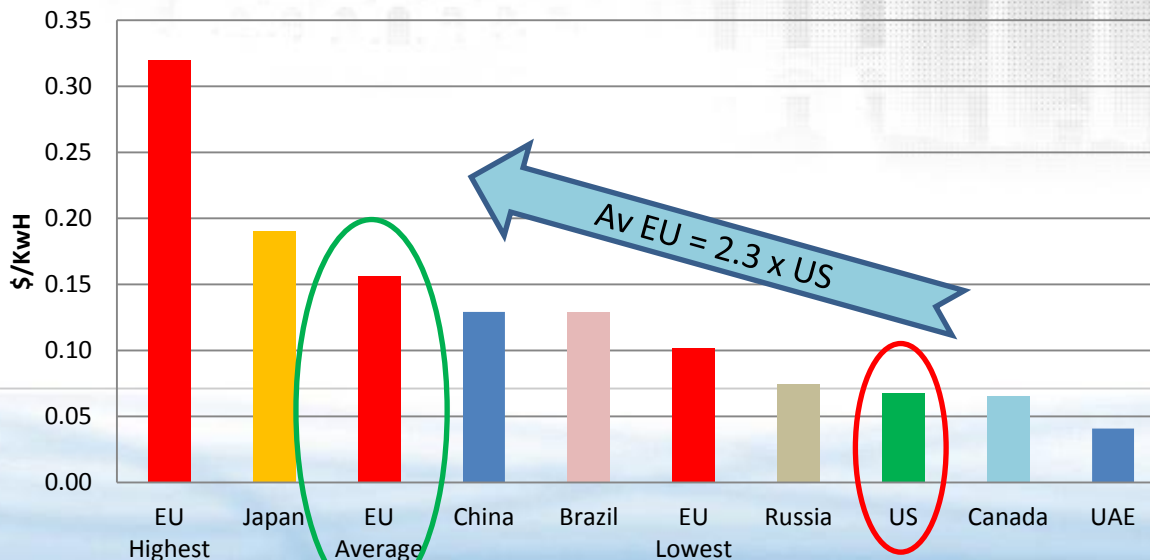
- Strength requirements from 5x to 3x



#8 Barrier to Commercialization - NA

Low Energy Prices – Longer Payback
TCO - North America versus Europe

- Low energy prices coupled with high cost premiums in North America
 - Longer payback period
 - TCO Model impacted by energy prices
 - Operating costs are 70 to 80%
- World Electricity Prices**



- Alternative refrigerants are inevitable
- It is not the first cost that matters...
- Total cost of ownership (TCO) is the key
 - Energy costs are significant

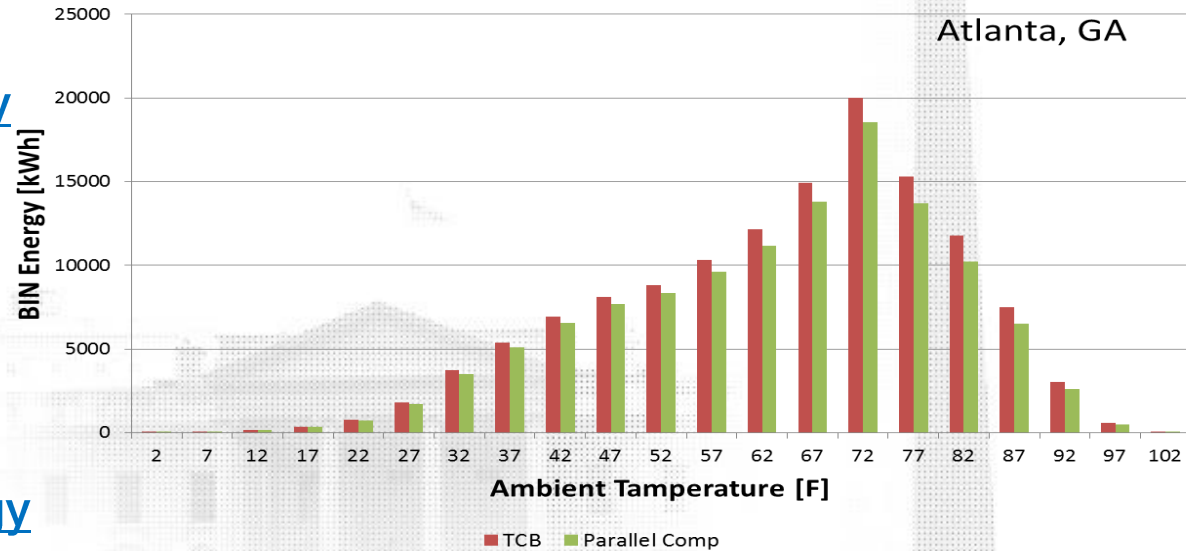
Natural refrigerants hedges against future rise in energy costs and regulatory levies



#9 Energy Efficiency is the Key

- Parallel compression is validated in lab
 - Predicted annual [energy savings by 11%](#)
 - Payback = 2.1 Years
- Low charge NH3-CO2 Cascade system
 - Offers [20 to 25% energy efficiency](#) in all climates

Standard TCB vs Parallel Compression





Transcritical Booster System with Parallel Compression for Supermarkets

- Though there are technical and sourcing challenges....
- The gaps are closing quickly as the technology moves close to mainstream

1. **Heating** (Heat Reclaim)
2. **Integrated Air Conditioning**
3. **Refrigeration - Medium Temp.**
Cases, Unit Coolers
4. **Refrigeration - Low Temp.**
Cases, Unit Coolers



Energy Efficient Low Charge Ammonia CO2 Cascade System for Supermarkets



Thank you!