



ATMO
sphere

business case

natural refrigerants

16 May, 2016 — Melbourne



An Industry in Change

Lennox International

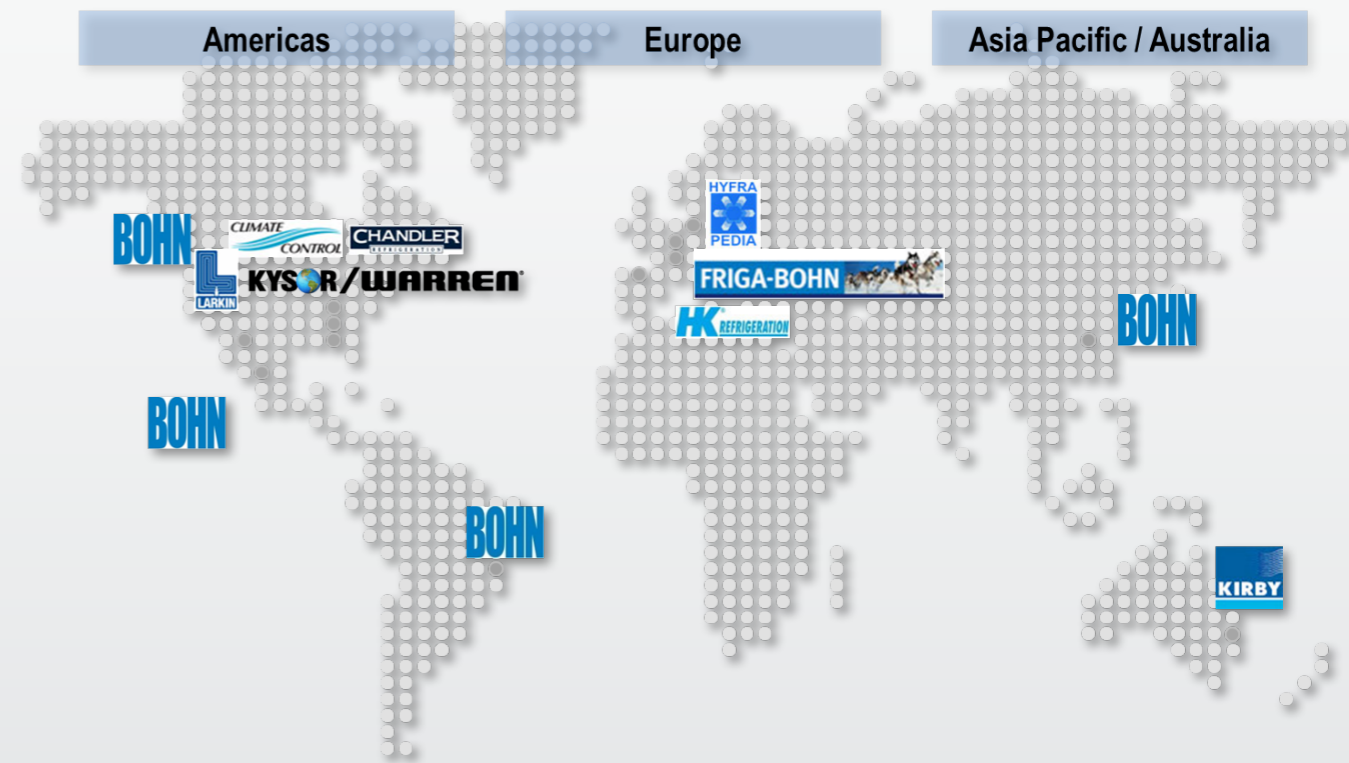


- U.S.-based Lennox International was founded in 1895
- Listed on the NYSE with US\$3.5B annual revenue
- Over 12,000 employees globally
- 18 state-of-the-art manufacturing facilities globally
- Six dedicated global R&D facilities
- Global training network for contractors, engineers and end users in all business regions

- Operations in North America, South America, Europe, Asia, and Australia / New Zealand
- Natural refrigerant system applications
 - 249 HFC/CO₂ hybrid systems and counting
 - 11 transcritical CO₂ systems (additional in process)
 - 2 ultra-low-charge ammonia-CO₂ cascade installed in the U.S.



Heatcraft Global Footprint



- High GWP refrigerants on chopping block short term
- Mid GWP refrigerants unlikely to persist long term
- Natural and other low GWP refrigerants gaining share
- Natural refrigerants immune to regulatory mandated GWP caps

	Refrigerant	GWP
High GWP	R-507A	3985
	R-404A	3922
	R-407A	2107
Mid GWP	R-407C	1774
	R-134a	1430
	R-449A	1397
	R-448A	1273
Low or Zero GWP	HFO Blends (A2L)	TBD
	HFOs	<1 - 4
	R-290	3.3
	R-744 (CO ₂)	1
	R-717 (NH ₃)	0

Refrigerant GWP Global Limits

F-gas (E.U.)
 In force May 20, 2014



Commercial Application	GWP Limit	Date
Self-contained refrigeration	2,500	2020
Stationary refrigeration	2,500	2020
Self-contained refrigeration	150	2022
Centralized refrigeration	150	2022
⌘ except top side of cascade	1,500	2022

California Air Resources Board (CARB)
 Short-lived Climate Pollutant Reduction
 Strategy – Proposed April 2016

Commercial Application	GWP Limit	Date
Non-residential refrigeration	150	2020

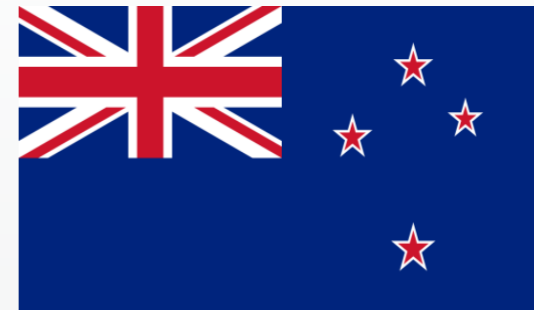


Australia



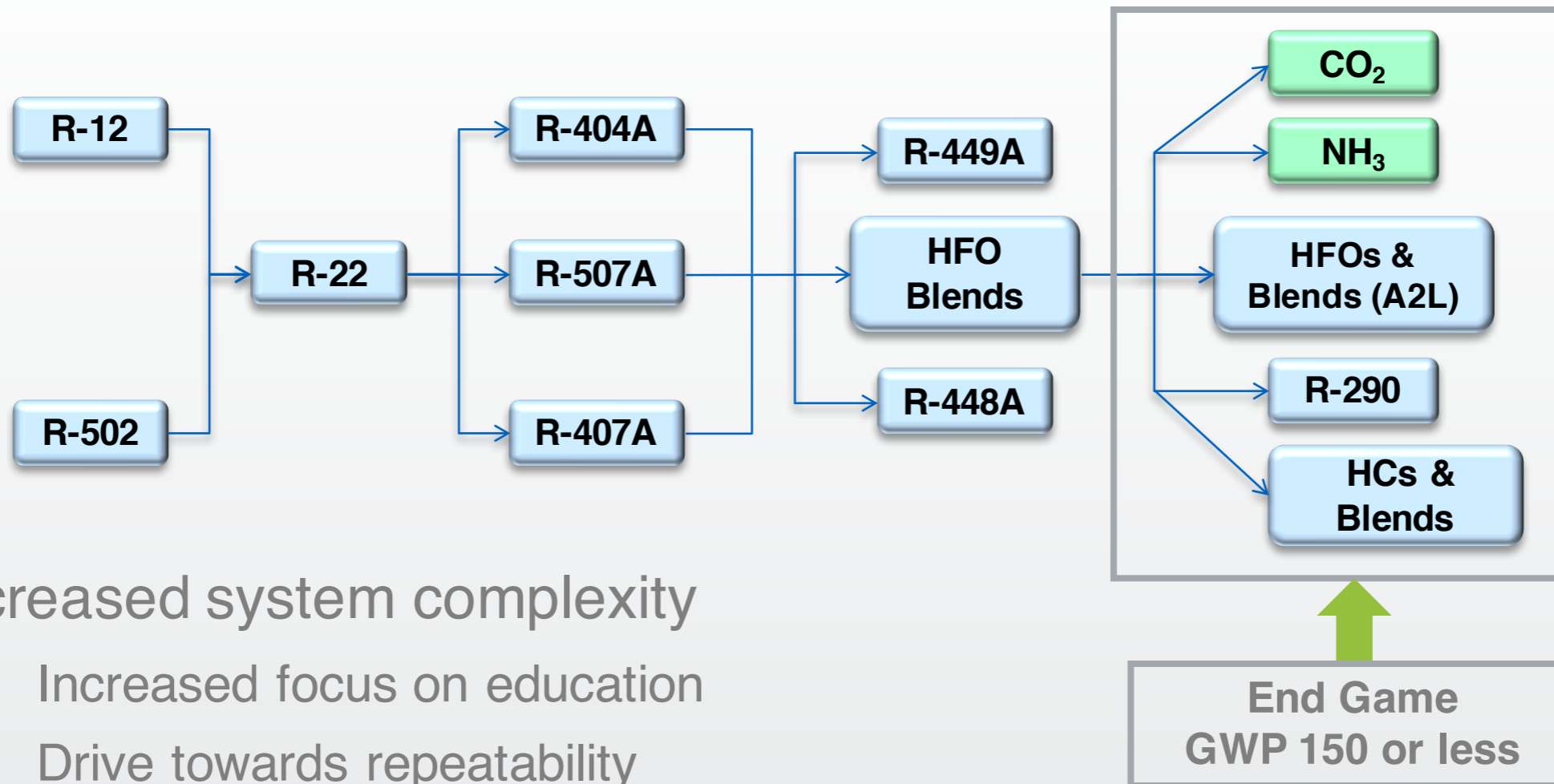
HFC Phase Down
Via Quota
Proposed to commence
2018/2019

New Zealand



Emissions Trading
Scheme
Changes under review
2016

- Anticipate multiple platforms/solutions to meet customer needs
 - Must consider retailer strategy, priorities, and total cost of ownership



- Increased system complexity
 - Increased focus on education
 - Drive towards repeatability

Heatcraft has a portfolio of solutions catering to our customer needs and regulatory landscape

NH₃/CO₂ Supermarket

- Ammonia (NH₃) top cycle (24 kg / 35 L)
- CO₂ low temperature direct expansion
- CO₂ medium temperature liquid overfeed

Benefits

Optimized LCCP

- HFC-free system
- Low NH₃ Charge
 - Typically 0.13 kg/kW refrigeration
 - 20 to 45 kg per store
- Up to 20% reduction in total cost of ownership (TCO)
- Store opened September 2015



CO₂ Applications A/NZ

Technology is driving market pull, and traditionally there has been limited push to broaden application / customer base.

This has limited the speed of acceptance of natural refrigerant solutions.

Component availability and technology is now allowing DX cascade systems to move into mainstream offering.

2005	<p>Liquid Overfeed – Dormant Technology</p> <ul style="list-style-type: none"> • Predominantly supermarket >10kW • Some cold storage
2009	<p>Medium - Large DX Cascade – Mature Technology</p> <ul style="list-style-type: none"> • Predominantly supermarket >10kW • Limited cold storage
2013	<p>Transcritical / Booster – Emerging Technology</p> <ul style="list-style-type: none"> • Predominantly supermarket >10kW • Some cold storage
2016	<p>Small Format Cascade – Emerging Technology</p> <ul style="list-style-type: none"> • Convenience / food service 2-15kW

Main Challenges

- Technician skill level / education
- Local regulatory codes
- Component supplier / cost reduction

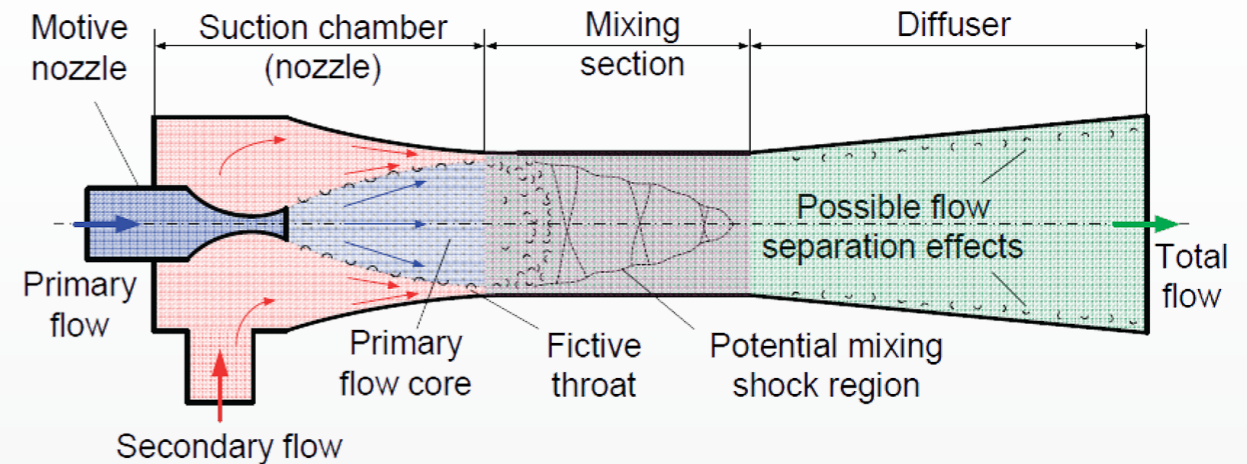


Necessary Next Steps

- Technician skillset
 - Work with industry to expand training and certification to include CO₂ systems.
 - Work with stakeholders to emphasize the need for an industry-wide educational program
 - Leverage global presence to promote training and spread best practices to and from around the globe.
- Component supplier base
 - Heatcraft is continuously looking for and qualifying new suppliers for alternative systems to improve system cost and payback.

Transcritical Booster with Ejector

- Warm climate solution
- Demonstrated energy efficiency
- Lab validation complete



Next Step

- Identify field trials in Australia and New Zealand: Q3/Q4 2016





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