shecco
SUSTAINING OUR ATMOSPHERE

world supermarket trends

natural refrigerants in commercial refrigeration

ATMO sphere ASIA
technology & innovation

Tokyo, February 3, 2014

Nina Masson, Head of Market Research

shecco Japan

a world of opportunities for natural solutions

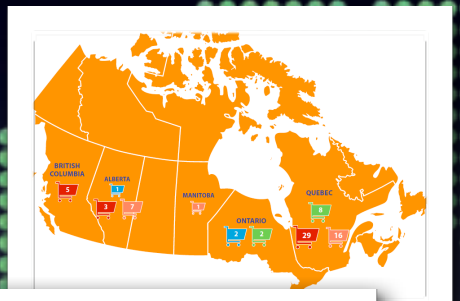
north america: huge potential still untapped

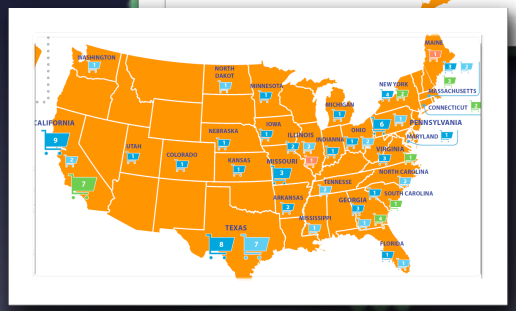
japan & asia: innovators & serious contenders

europe: the world leader

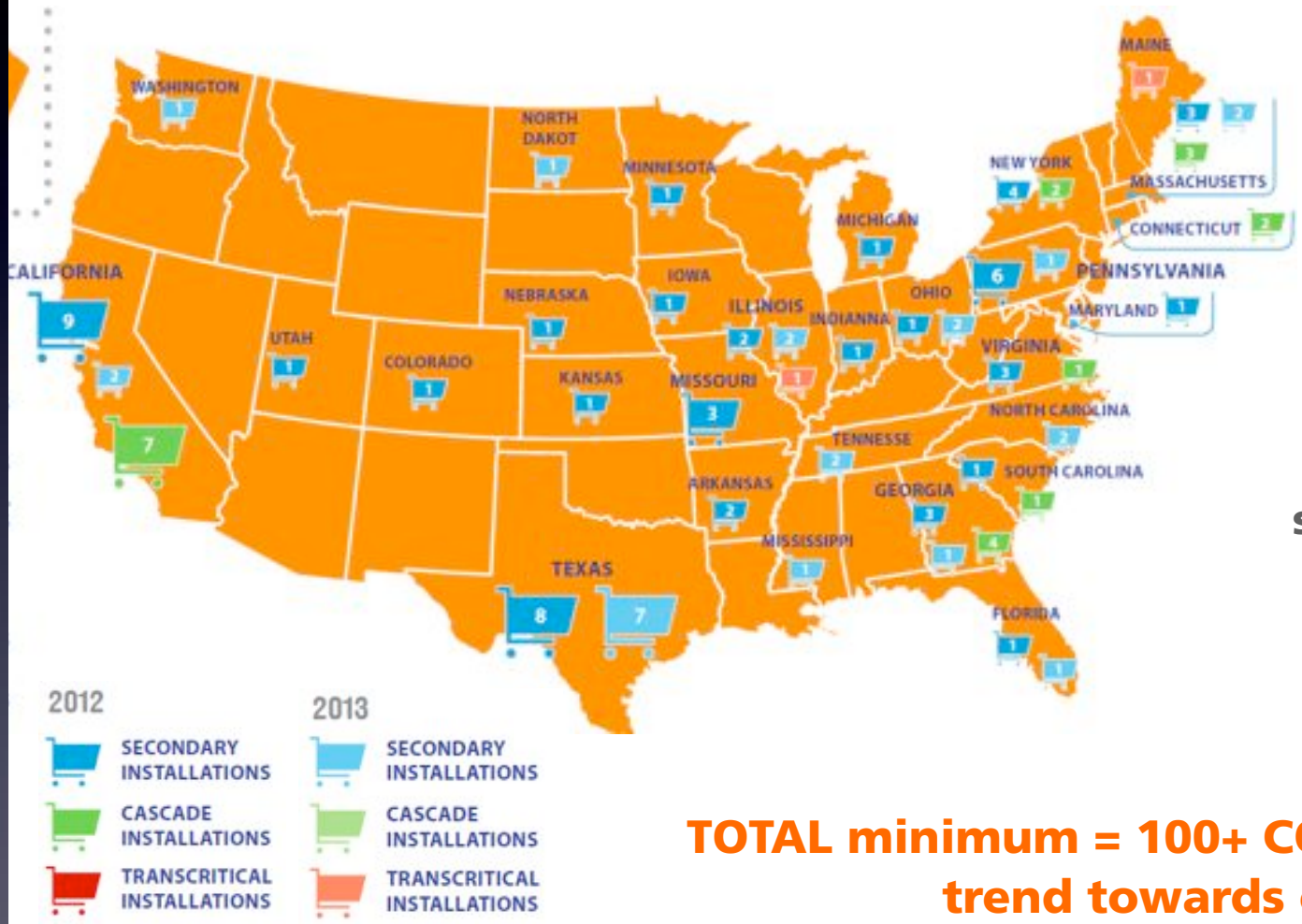
world: market drive in selected countries

north america: huge potential still untapped





usa: CO_2 refrigerant stores



4 stores with CO_2 TC systems were planned for 2013 - 4 are open now

75 stores with CO_2 cascade & secondary systems in 2012; 25 were planned for 2013 - 102 are open now

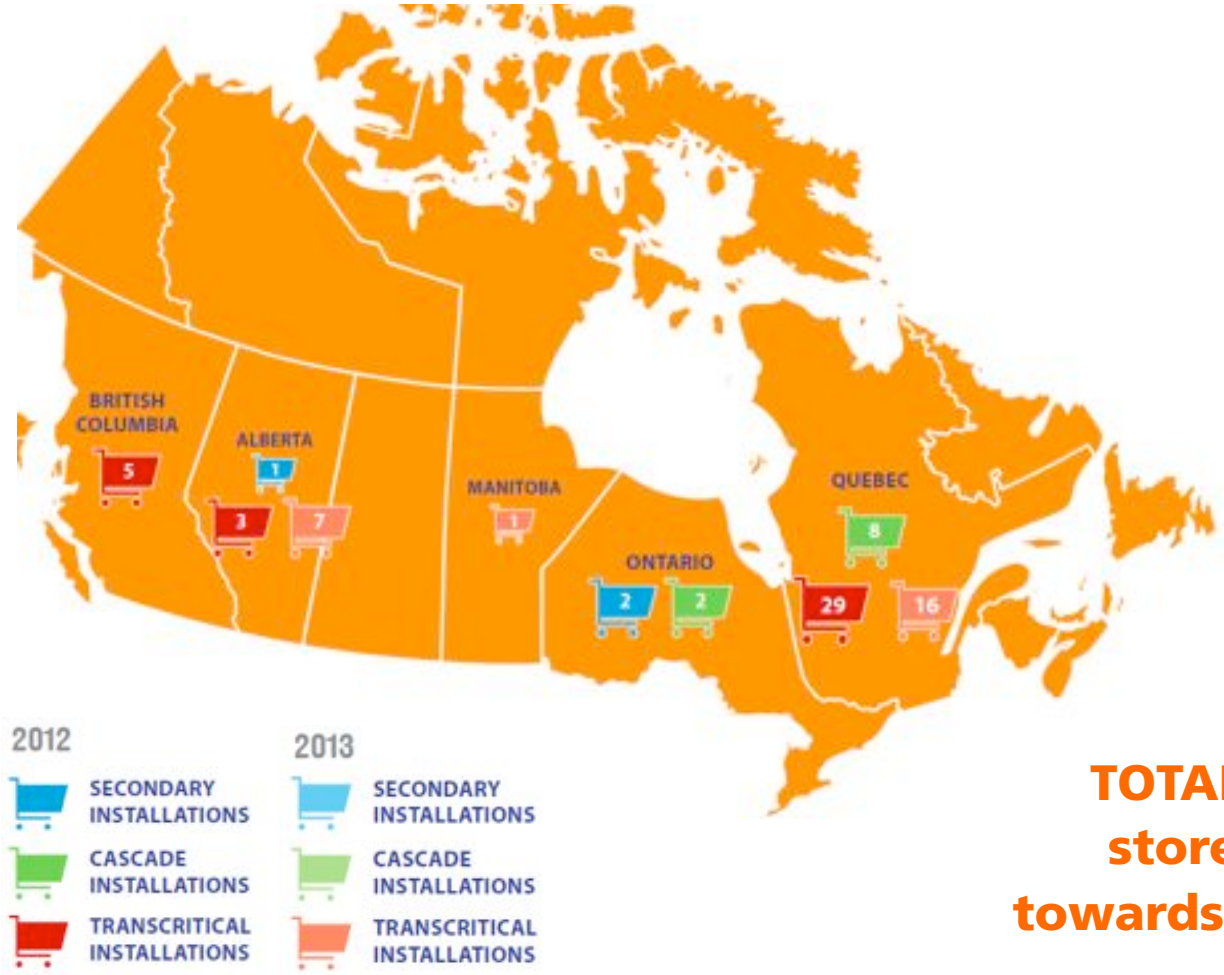
TOTAL minimum = 100+ CO_2 stores today - trend towards cascade systems

source: shecco, status Feb 2013 (graphic) - GUIDE 2013: Natural Refrigerants - Market Growth for North America); and Nov 2013 (text with updated figures)

CO_2 refrigerant stores: usa brands

source: shecco, GUIDE 2013: Natural Refrigerants - Market Growth for North America, Feb 2013

canada: CO_2 refrigerant stores



37 stores with transcritical CO_2 systems in 2012; 24 were planned for 2013 - 65+ open today

13 stores with CO_2 cascade & secondary systems in 2012

TOTAL minimum = 80+ CO_2 stores today + clear trend towards transcritical systems

source: shecco, status Feb 2013 (graphic) - GUIDE 2013: Natural Refrigerants - Market Growth for North America); and June 2013 (text with updated figures)

CO_2 refrigerant stores: canada brands

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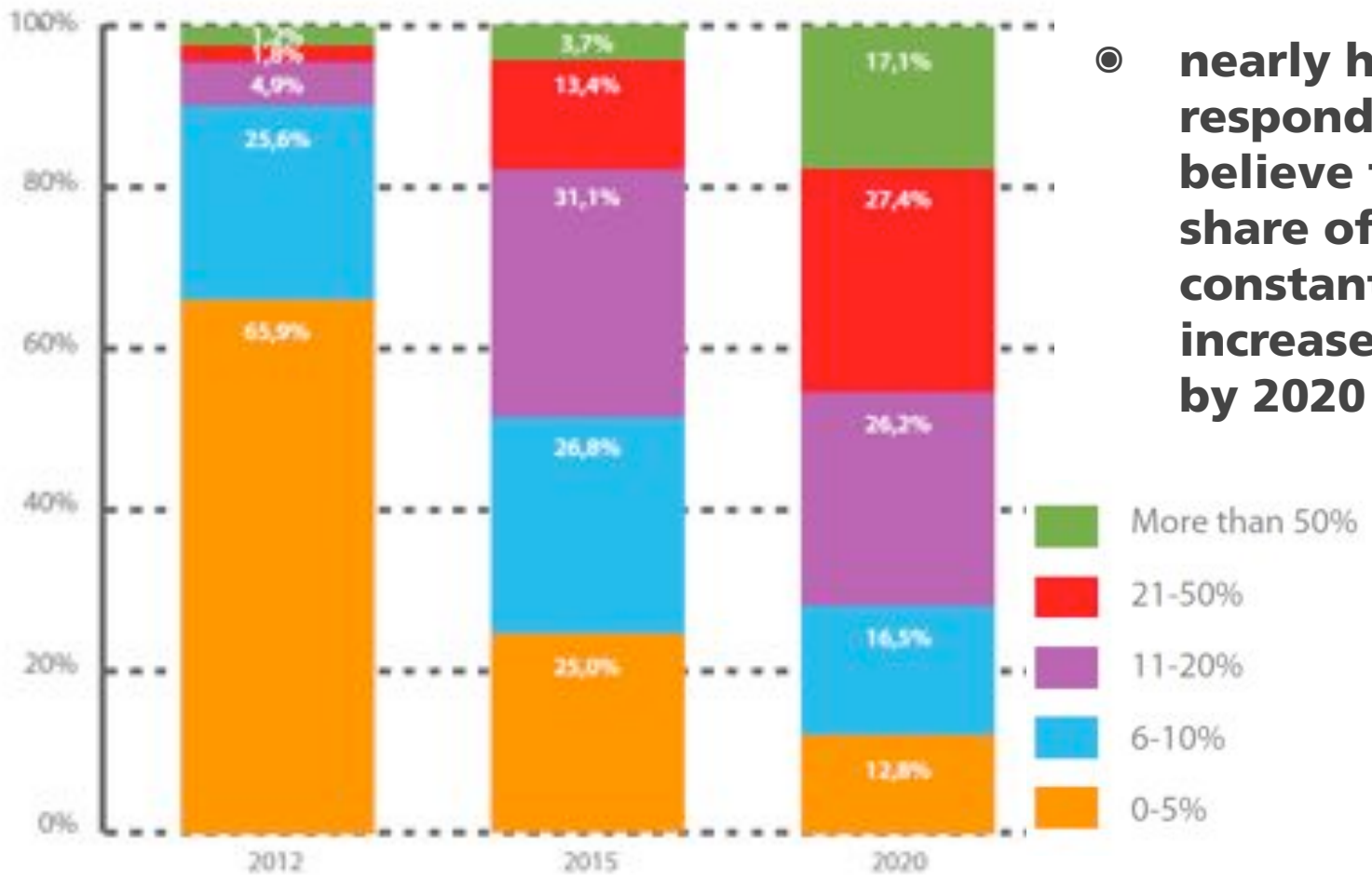
north america: market outlook CO_2 commercial refrigeration



- **nearly half of all respondents believe the market share of CO_2 will constantly increase to 21%+ by 2020**

source: shecco, GUIDE 2013: Natural Refrigerants - Market Growth for North America, Feb 2013, 164 respondents

japan & asia: innovators & serious contenders

japan: CO_2 TC stores

approx. 180 stores with transcritical CO_2 systems today;

clear focus on transcritical systems

strong focus on convenience stores

market growth expected: NR subsidies, more competition, rising awareness, F-gas law discussion

source: shecco Japan, status Feb 2014

CO_2 TC refrigerant stores: japan brands

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source: shecco Japan, status Dec 2013

GUIDE Japan 2014

- 1st dedicated report on the market trends for natural refrigerants in Japan
- expected launch: Q3 2014
- **highlights:**
- market outlook: industry expectations for the years to come - trend analysis
- case studies: best practice examples
- technology & market maps: info graphics and trend charts for successful NR technologies
- voice of key players: in-depth interviews with end-users, policy makers

europe: the world leader

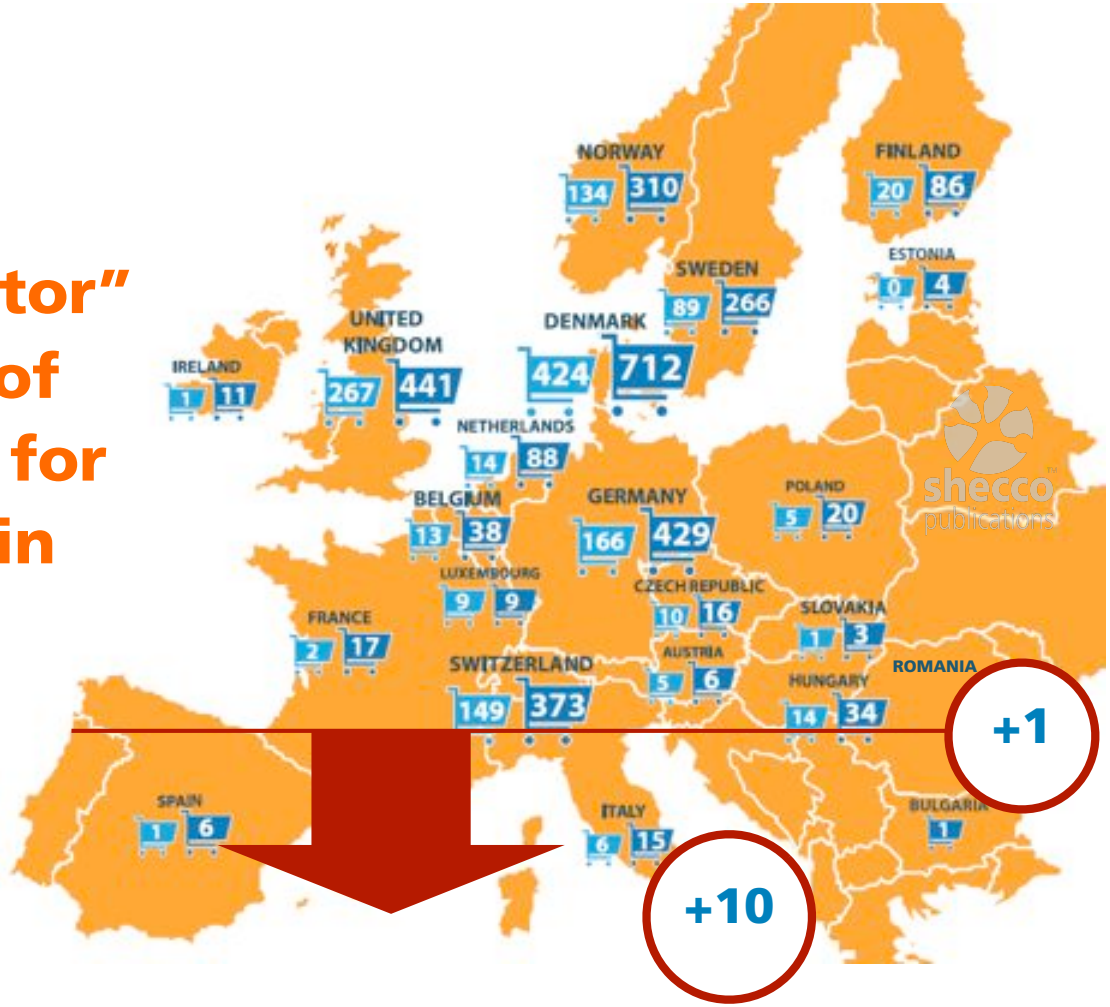
europe: CO_2 TC stores

market change can happen very fast

source: shecco, status Nov 2013, data from 14 system suppliers / contractors, 11 food retailers

europe: CO_2 TC stores

"CO_2 efficiency equator" disappears - variety of solutions developed for increased efficiency in warm climates

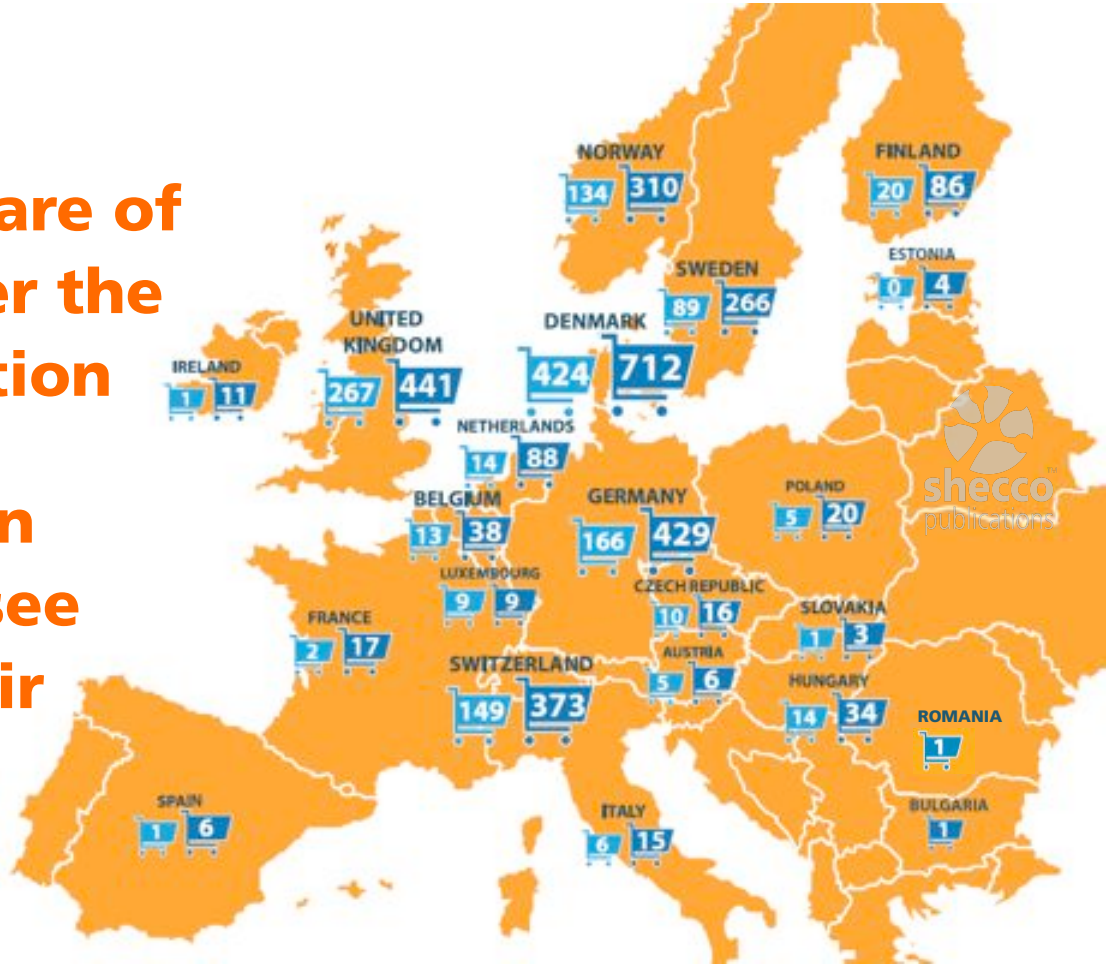


source: shecco, status Nov 2013, data from 14 system suppliers / contractors, 11 food retailers

europe: CO_2 TC stores

food retailers are aware of future HFC bans under the revised F-Gas Regulation

BUT: market leaders in natural refrigerants see no need to adapt their strategy anymore = secure investments



source: shecco, status Nov 2013, data from 14 system suppliers / contractors, 11 food retailers

CO_2 TC stores: europe 2011-13 (est.)

	2011	2013	Increase in 2 years
Denmark	424	712	+68%
United Kingdom	267	441	+65%
Germany	166	429	+158%
Switzerland	149	373	+146%
Norway	134	310	+131%
EU	1331	**2885**	**+117%**

NR refrigerant stores: europe brands

world: food retail brands using CO_2

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min. 131 brands

approx. 3,100 CO_2 transcritical stores

source: shecco, Nov 2013

(HFC-free) commercial refrigeration

TOTAL
CO_2 TC SUPERMARKETS
3080+

TOTAL
CO_2 CASCADE/ SECONDARY SUPERMARKETS
2020+

case: 17 CO_2-only supermarkets in South Africa

- Woolworths and Makro show leadership with combined 17 stores using transcritical CO_2 systems
- reduction in power consumption: 45%
- currently 12% higher installation costs than R404a system

17 TRANSCRITICAL CO_2 STORES IN SOUTH AFRICA SAVE UP TO 45% ENERGY USE

South Africa

In South Africa, 8 Woolworths stores and 9 Makro stores are currently running with trans-critical CO_2 systems using a common liquid line to the chillers and freezers with individual suctions lines back to each section on the multiplex system i.e. freezer rack and chiller rack.

With all of the the controls being Danfoss with electronic expansion valves, pack controllers, heat exchangers and plate heat exchangers a reduction in power consumption of up to 45% was recorded. At this stage because of the size of some of the plants the CO_2, as opposed to a 404 system, is costing about 12% more on installation costs. Each Makro store has two equal systems of 300KW each, 200kw chiller and 100kw freezer with a total refrigeration capacity per store of approximately 600kw. Woolworths has an average 300kw of refrigeration capacity per store.

17 stores in South Africa now use a CO_2 transcritical system, with the result of up to 45% reduction in power consumption as compared to an R404 system.

source: GUIDE UNIDO 2013 - Natural Solutions for Developing Countries, Nov 2013

CO_2 TC systems in food retail - today

National ranking (estimate):

1. **Denmark (700+)**
2. **United Kingdom (440+)**
3. **Germany (420+)**
4. **Switzerland (370+)**
5. **Norway (300+)**
6. **Sweden (260+)**
7. **Japan (180+)**
8. **Canada (65+)**

CO_2-HFC cascade / secondary in food retail - today

National ranking:

1. **Germany (300+)**
2. **Switzerland (240+)**
3. **the Netherlands (240+)**
4. **Italy (190+)**
5. **Australia (160+)**
6. **Norway (130+)**
7. **France (120+)**
8. **USA (100+)**
9. **Brazil (40+)**
10. **New Zealand (40+)**

warm climates

- challenge: find cost-effective natural solutions for hot climates
- challenge: adapt CO_2-only technology to two situations
  - 1. short-lived, high peak temperatures
  - 2. high temperatures for long periods of time
- previously there has been an “efficiency equator” that constantly moved down to Northern Spain and Italy - everything above was more or equally efficient than HFC-based solutions all year around
- development 2011-13: introduction of different ways by a variety of European suppliers to remove the “efficiency” equator

warm climates - technology options

- economizers
- mechanical sub-coolers
- high-pressure sub-coolers
- ejectors
- expanders
- CO_2 integrated systems: parallel compression and flash gas valve synchronization
- auxiliary compressors for flash vapor compression
- evaporator overfeed
- energy recovery from throttling process
- CO_2 pump circulation system

source: ATMOsphere Europe 2013 (www.ATMO.org/Europe2013)

warm climates - cases

- **Location:** Northwest Spain + 2 more stores around Madrid and Southeast Spain
- **Supplier:** Carrier Commercial Refrigeration
- **Technology:** CO_2 TC booster concept with add-on, roof-top mounted Hydrocarbon subcooler for warm climates
- MT refrigeration capacity: 310 kW
- **Energy Savings:** equal to HFC systems in Southern European climates
- electrical power savings: 14% at 38°C (100.4°F)
- CO_2 MT rack gains more than 30% in capacity
- installed cost EUR/kW MT is equal to existing CO_2 range
- serviceability equal to established CO_2 technologies
- has been operating successfully for one year

Carrefour

source: ATMOsphere Europe 2013 (www.ATMO.org/Europe2013)

warm climates - cases

- **Location:** Bulle, Switzerland
- **Partners:** Frigo-Consulting, SINTEF, Enex, alpiq, Swiss Energy Agency
- **Technology:** MT capacity 120 kW, LT capacity 55 kW
- CO_2 TC booster system with ejector; one of the MT compressors shifted to a parallel compressor; low pressure receiver added
- ejectors recover throttling losses in the system, allow liquid or vapor to be sucked out of the low pressure receiver and fed back into the medium pressure receiver
- flooded evaporators show a much higher heat exchange efficiency and the evaporation temperature can be increased by 6.5K
- advantages over standard booster system: 1. evaporation temp can be increased; 2. part of the vapor shifted from MT compressors to the parallel compressors, to reduce work on the other compressors
- **Energy Savings:**
- 12% less energy consumption in Central Europe; 16% less in Southern Europe (compared to CO_2 booster system with parallel compression)

MIGROS
Neuchâtel Fribourg

source: ATMOsphere Europe 2013
(www.ATMO.org/Europe2013)

warm climates - cases

- **Location:** Ningbo, China
- **Supplier:** Carrier Commercial Refrigeration
- **Technology:** CO_2 cascade system
- **Energy Savings**: the R744 system + other measures lead to 25% less energy use of the store = 9.7 million kWh in power
- savings of 1560,9 tons in carbon emissions
- Tesco China: "in the near future, let's say 3-5 years, all new Tesco stores will adopt natural refrigerants"

- **Location:** Salaya, Thailand
- **Supplier:** Frigrite
- **Technology:** CO_2 cascade system
- **Features**: system was built in Melbourne, Australia, then shipped to Thailand ready for installation

http://www.r744.com/news/view/4422
http://www.ammonia21.com/web/assets/link/gcc_presentation.pdf

convenience stores

- challenges:
  - natural refrigeration systems for smaller stores
  - limited space, optimized installation of systems needed
  - higher cost from slower pay-off from energy savings
  - develop standardized (mass-market) solutions for a large and still increasing number of small stores in operation

convenience stores - technology options

- system compactness reduction
- increased efficiency: new CO_2 scroll and digital scroll technologies
- heat recovery, integrated systems

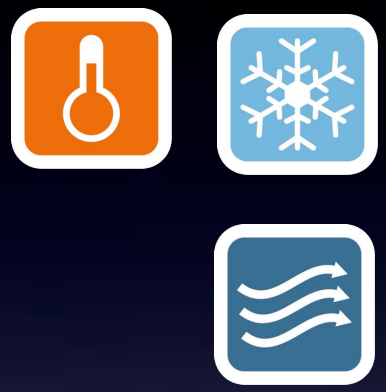
convenience stores - cases

- **Location:** Haslucks Green, Solihull, UK
- **Supplier:** EPTA
- **Technology:** small CO_2 TC system
- **Features / Energy Savings:** UK's most environmentally friendly convenience store
- first small transcritical CO_2 system used in a Sainsbury's store
- reducing carbon emissions by 33% and minimizing energy use for refrigeration
- Sainsbury's now has 530 convenience stores in the UK - its renewed target is to convert 250 stores of all sizes to natural refrigerant by 2014
- as a result of this investment the costs of CO_2 have been greatly reduced and are now competitive with HFC system costs

Sainsbury's

http://www.r744.com/news/view/4320

integrated systems



- challenges:
  - reduce total energy consumption of stores for:
    - heating
    - cooling
    - refrigeration
    - air-conditioning

integrated systems - cases

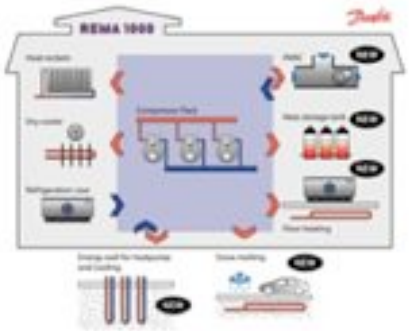
- **Location:** Tocksfors, Sweden
- **Supplier:** Advansor
- **Technology**: one system to supply supermarket's entire thermal needs (refrigeration, A/C, heat recovery)
- combines parallel compression, heat pump function and artificial loads on the cabinets
- **Energy Savings**:
- 6.3% for refrigeration purpose only (compared to a standard CO_2 booster solution)
- 11% for refrigeration & heating purposes

http://www.atmo.org/presentations/files/302_1_KALLESOE_ADVANSOR.pdf

integrated systems - cases

- **Location:** Trondheim, Norway
- **Supplier:** SINTEF, Danfoss
- **Technology**: CO_2 solution for floor heating, ventilation, air-conditioning, snow melting and storage of thermal energy
- refrigeration and heat pump functions have been combined, as well as the control of the air handling unit the various heat storage devices
- 170 meters deep energy wells obtain free cooling in the summer and provide a heat source for the heat pump in winter
- energy sub-systems are interconnected and controlled to minimize the entire power consumption of the store
- **Energy Savings**:
- store is expected to reach 30% savings - more Norwegian supermarkets are expected to use the system

REMA 1000



http://www.r744.com/news/view/4748

first all-natural refrigerant store USA

- **Location:** Carpinteria, California
- **Supplier:** Source Refrigeration, CTA Architects, Hill PHOENIX, Mayekawa, Danfoss, Eleven Western Builders
- **Technology**: ammonia primary system with approx. 113 kg of ammonia located in an outdoor enclosure that condenses CO_2
- water cooled system that allows for a reduction in refrigerant charge
- CO_2 refrigeration system with one vessel that contains liquid pumped to the low and medium temperature display cases and walk-in cabinets
- R290 spot display case

SUPERVALU

http://www.r744.com/news/view/3443

shecco - useful links

Industry Platforms:

http://www.hydrocarbons21.com

http://www.R744.com

http://www.ammonia21.com

http://www.R718.com

GUIDES (Europe 2012; Europe 2014; North America 2013; CO_2/ NH_3 industrial refrigeration 2013; GUIDE UNIDO 2013) + ATMOsphere Summary Reports

http://publications.shecco.com

ATMOsphere conferences, side-events & network meetings:

http://www.ATMO.org

contact details:

Nina Masson
nina.masson@shecco.com
office: +32 2 230 3700
mobile: +32 473 468 194