sheccoBase Market Trends Update

ATMOsphere Europe

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DOMESTIC REFRIGERATION

Biggest success story so far of Natural Refrigerants

Over **1.5 billion** domestic refrigerators already use hydrocarbons today

HC is the standard for 50% global production of new domestic refrigeration equipment

By 2020, 75% of new production globally will use R600a / R290

LIGHT-COMMERCIAL REFRIGERATION

CONSUMER BRANDS CHOOSING NATURAL REFRIGERANTS

5.5 million units using natural refrigerants (HC & CO_2) collectively installed

=> 33 million tonnes of avoided CO_2 (equivalent emissions of more than 6.7 million passenger cars over one year)

Increasing number of consumer brands choosing HCs for their point of sale equipment - often targeting global procurement 100%

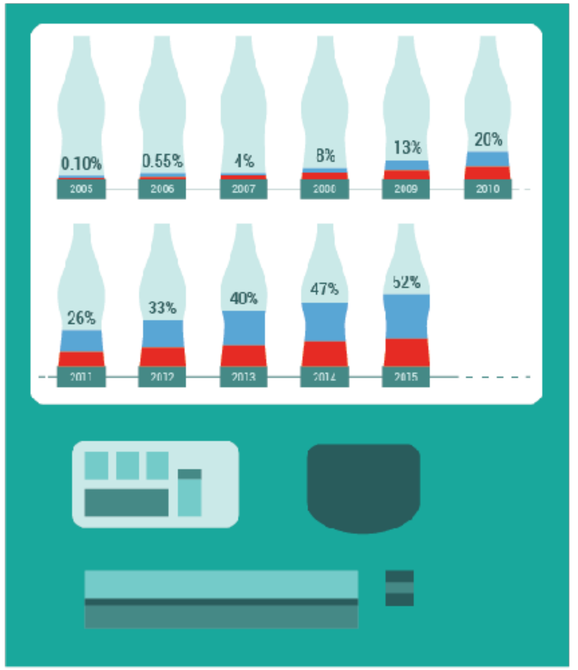
HC VENDING MACHINES IN JAPAN

1.35+ million beverage vending machines in Japan use either hydrocarbons or CO_2 - world's highest number per capita

800,000+ CO_2 vending machines in the market

natural refrigerants make up over **50% of the market**

from 0.1% to 52% market share in just 10 years



HYDROCARBONS GROWTH - AHT

Plug-in Units in Supermarkets with R290: A reality today

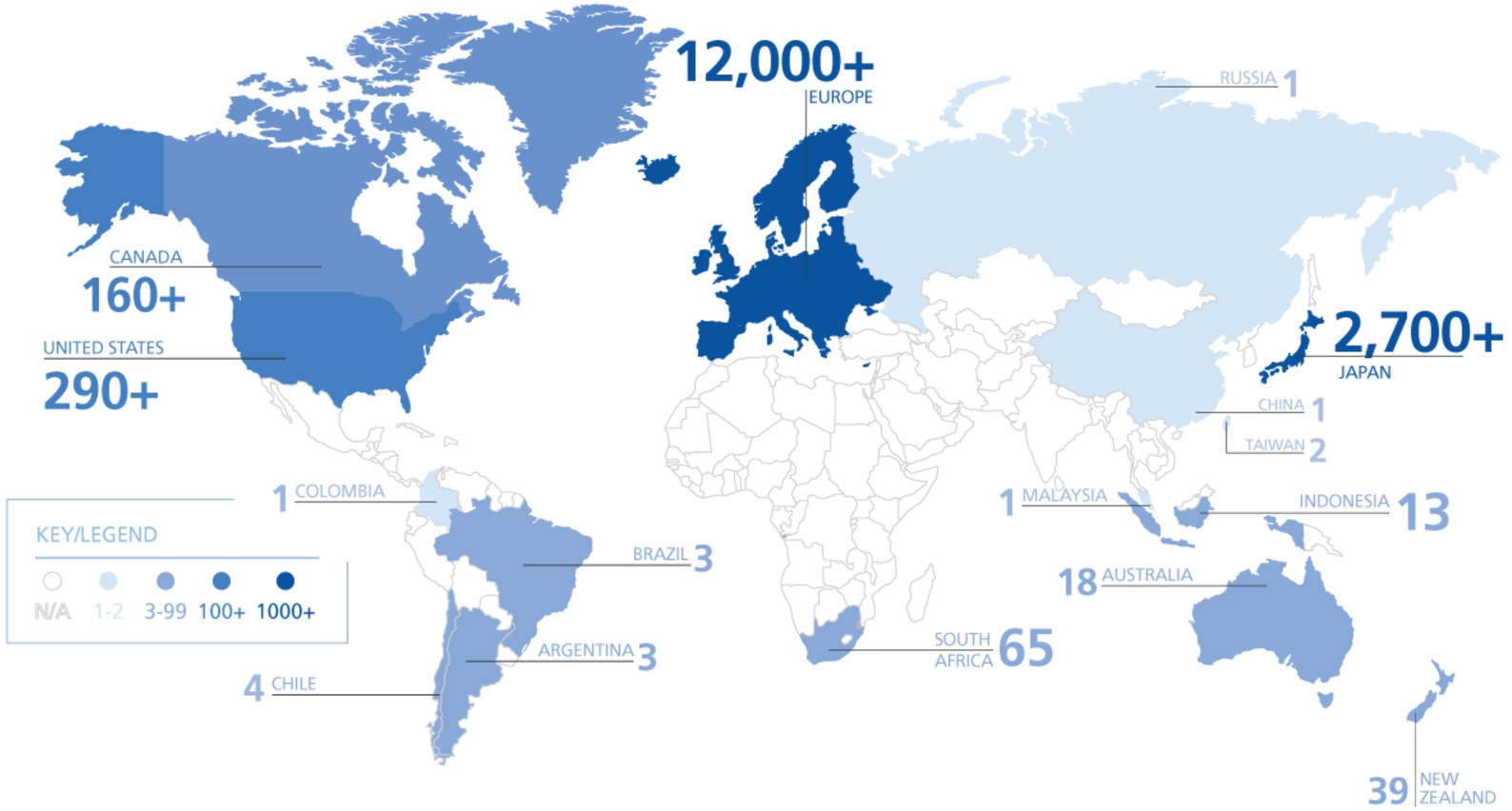
Market estimate by early 2017 - Figures reported by AHT (market leader):

1,500,000+ units worldwide

- over 300,000+ units manufactured per year

COMMERCIAL REFRIGERATION

CO_2 TC STORES GROWING GLOBALLY (SEPT 2017)



CO_2 TC MAJOR MARKETS: GROWTH TRENDS

	2015	2017	Growth
Europe	5.500	12.000	**118%**
USA	52	290	**458%**
Canada	139	160	**15%**
Japan	1.500	2.700	**80%**

Other regional markets also emerging as a result of individual **food retailers' efforts**

CO_2 IN CHINA (JULY 2017 UPDATE)

- **First major CO_2 transcritical** store to be completed in 2017
- Currently **40 subcritical CO_2 supermarkets** in China (HFC/CO_2 cascades)
- Majority operated by Metro China, first ever installed by Tesco
- Market opening up to natural refrigerants. Potential identified in:
    - CO_2 in commercial and industrial; heat pumps

AUSTRALIA: CO_2 INNOVATIONS (MAR 2017 UPDATE)

Expansion of CO_2 in Australia from a cooperation of AJ Baker & EPTA:

- Currently over 300 cascade CO_2 installations
- 6 CO2 liquid recirculation plants
- 10 trancscritical CO_2 installations

Key New Tech => Epta's Full Transcritical Efficiency

13 systems operating already in Europe and Australia; most testing done in Australia

Proven efficiency on high ambient for CO_2 TC in simplified format

EUROPE: KEY TRENDS & INSIGHTS (EUROSHOP 2017)

- On-the-spot **survey to 33 companies**, including major players of the sector
- Ejectors, parallel compression and waterloop systems identified to be the main technology trends
- Approximately **15-20% increase in production** of natural refrigerant systems expected for the period 2017-2018
- **R290 dominating plug-ins**, showing the greatest potential
- Even higher growth expected by 2020 and beyond, with a few companies claiming that they will be ready to have their **entire production moving to only natural refrigerants**
- **Regulation** and mainly **customer demand** are the reasons for the expectations, especially for Europe

KEY TREND: CONDENSING UNITS / SMALLER SYSTEMS

Japan - leader in CO_2 condensing units for smaller store formats

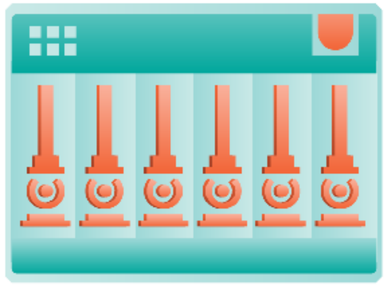
Europe traditionally working with large capacity CO_2 racks, but **several manufacturers** introduced small systems

Competition increasing: more efficiency, lower prices

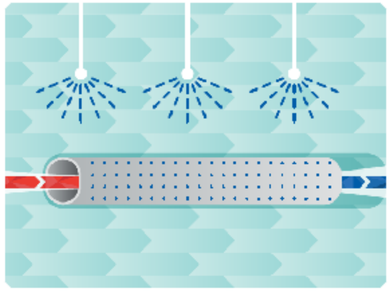
KEY TREND: SMALLER NH_3/CO_2 SYSTEMS

Growing line up of small size NH_3/CO_2 systems - potential to serve supermarkets?

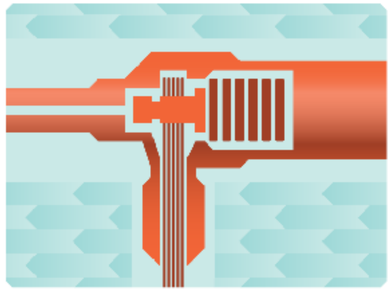
KEY TREND: SOLUTIONS FOR EFFICIENCY IN WARM CLIMATES



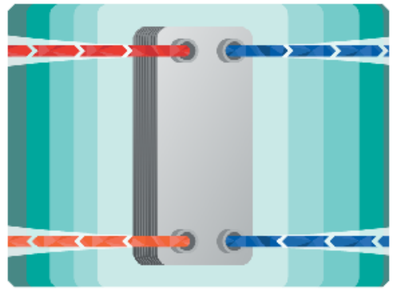
Parallel Compression



Adiabatic Cooling



Ejector



Sub coolers

KEY TREND: DISSIPATING BOUNDARIES

Limits between “light-commercial” and “commercial” refrigeration become vague: HC pushing into larger store formats, and CO_2-based systems into smaller formats

= internal competition between different NR systems has increased

INDUSTRIAL REFRIGERATION

COMPETITION BETWEEN DIFFERENT NR SYSTEMS HAS INCREASED

market traditionally dominated by **ammonia** and HFCs

NR cutting edge technologies becoming strong trend and competing:

- **ammonia low charge**
- **CO_2 transcritical**
- **NH_3/CO_2**

Key drivers:

increased safety - lower risk

higher efficiency

easier servicing

return on investment for the end user

growing competition - prices pushed down, technology becoming more available

KEY TREND: INDUSTRIAL APPLICATIONS WITH CO_2 & NH_3

JAPAN: INDUSTRIAL REFRIGERATION WITH CO_2 & NH_3

The market is changing, from a strong reliance on R22 to a renewed uptake of (lower charge) NH_3 systems

Estimated **450+ installations** use secondary NH_3-CO_2 systems

CHINA: INDUSTRIAL REFRIGERATION WITH CO_2 & NH_3

Estimated **150+ refrigeration projects** in industrial sector with **CO_2 & NH_3**

EUROPE: CO_2 IN INDUSTRIAL APPLICATIONS - CASE STUDY

World's biggest CO_2 industrial plant (vegetable processing plant in the Netherlands by Advansor for Staay Food group):

- 3,36 Megawatt (MW) total cooling capacity

- 7 transcritical CO_2 racks

- 45 compressors (28 medium temp., 14 parallel, 3 frost)

- 600 kW of heat recovery, providing "free" heating for the office facilities

- Installation in 2016, in operation since early 2017

- Lower capital, installation & maintenance costs.

ALSO HYDROCARBONS? CASE STUDY IN COLOMBIA

- R290 tested in cold storage for post-harvest flower processing and export in **Colombia (with support by Ozone unit)**
- Colombia's flower sector: 31.1 million kW of cooling capacity, 99% of which is R22
- Opportunity to increase efficiency by switching to R290
- Challenges: lack of expertise, training, lack of technical standards, insurance policies or legal structures

AIR-CONDITIONING

INDIA MOVING TOWARDS R290 RAC

India showing strong trend towards R290 RAC

- Currently **400,000+** units installed in the market

Major leader: **Godrej Appliances**

- Replaced CFC, HFC and HCFC as early as 2002
- Efficient and green ACs using R290; first in the world
- **India's first ACs with 7-star performance**
- Earliest brand to opt for voluntary energy labelling of its refrigerators

R290 AC IN CHINA

Chinese market showing an interest towards R290 RAC

- **1,300+ units** installed already
- Major players: Midea, Gree, Haier

Midea case study:

- Nanyang Vocational and Technical College in Jiaxing, (the country's northern Zhejiang province).
- **1,060 R290** based ACs in the dormitories
- Installed in November 2016, no problems in operation so far
- Completed additional projects in warm ambient regions, including Seychelles University in the Seychelles.
- Demonstration projects funded from the Multilateral Fund for the Implementation of the Montreal Protocol.

HC BASED HEAT PUMP & WATER CHILLERS

- Triple Aqua's efficient **heat pump using hydrocarbons** is running in two offices and a supermarket in the Netherlands

- can **save up to 50% in heating and cooling costs** in commercial buildings compared to traditional heat pumps, with a COP (coefficient of performance) between 4 to10

- The system employs propaene (R443A), a mixture of the hydrocarbons propane (R290) and propene (R1270), with a global warming potential (GWP) of 3 and a **charge of < 5 kg**

HC BASED HEAT PUMP & WATER CHILLERS

- HC based water chillers introduced by several companies targeting **commercial air-conditioning** and **process cooling applications**
- RSA Cooling - water chiller for outdoor installations, and are available with **cooling capacity from 3,0 to 15,0 kW**
- HC water chillers in Australia, **reliable performance at 45C** days this summer

HEAT PUMPS

JAPAN: RESIDENTIAL CO_2 HEAT PUMPS

Eco Cute (CO_2 heat pump) in Japan: big success story, with strong government support initially.

6+ million CO_2 HP water heaters in total

98% of all new residential HP water heaters in Japan

400-500k new units per year

CHINA: CO_2 COMMERCIAL HEAT PUMPS - WATER HEATERS (SEPT 2017)

CO_2 is being supported and will find inroads to the Chinese market - it already is happening

Currently **800 commercial CO_2 HP water heaters** in total

CONCLUDING REMARKS

- **Competition between natural refrigerants** => Innovation to increase performance, and reduce costs?

- **Air conditioning:** Cost and energy efficiency as main drivers. Who will take the lead?

- **Heat Pumps** with Natural Refrigerants show huge potential: towards integrated solutions?

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