ATMOsphereネットワーク東京

最新のグローバル市場・政策動向

東京, 2016年05月30日

ヤン・ドゥシェック

ビジネス・ディベロップメント・マネージャー

shecco Japan株式会社

sheccoとは

ミッション：

環境負荷の低い技術市場の活性化

分野：

冷凍冷蔵・空調業界における自然冷媒（CO2、炭化水素、アンモニア、水、空気）

拠点：

ベルギー、ニューヨーク、東京、ベルリン

クライアント：

世界中で150社以上

事業：

①メディア

②イベント　③市場開発

shecco - 活動概要

shecco Media

ACCELERATE

744R.com

hydrocarbons21 everything natural

ammonia21 everything natural

R718

Webinars

shecco Events

ATMOsphere faster to market natural refrigerants

ATMOsphere network natural refrigerants

shecco MarketDevelopment

guide shecco publications

THE NATURAL VOICE

THE CIRCLE

RegulatoryAffairs

MarketResearch & Consulting

Projects United Nations, Europe & Global

ATMOsphere イベント（2009年~2015年）

ATMOsphere イベント 2016

ATMOsphere Asia	ATMOsphere Europe	ATMOsphere Australia	ATMOsphere America
第３回	第７回	初回	第５回
2016年2月 9-10日	**2016年4月19-20日**	**16 May 2016**	**2016年6月16-17日**
東京	**バルセロナ**	**メルボルン**	**シカゴ**

ATMOsphere ネットワーク 東京 2016

TOKYO ATMOsphere network natural refrigerants

第1回：5月30日 @東京 新丸の内ビルディング

第2回： 7月13日

第3回：9月

第4回：12月

ATMOsphere Japan 2017

2017 年 2 月 in 東京

概要：

食品小売、メーカーなどのリーディングカンパニー、政府関係者、団体代表などを含めた120〜150人ほどが集い自然冷媒市場の今後を話し合う場を構築

業界誌 アクセレレート・ジャパン

web: http://acceleratejapan.com/

shecco Media

本日の流れ

18:00：開会の辞

18:10：講演１
株式会社ローソン 開発本部長補佐　宇都慎一郎氏

18:20：講演２
環境省 地球環境局 フロン対策室 室長　馬場康弘氏

18:30：講演３
東京都環境局 環境改善部環境保安課 課長 高橋輝行氏

18:40：講演４
日本チェーンストア協会 政策第三部 課長　渡辺正治氏

18:50：講演５
shecco Japan株式会社 ビジネス・ディベロップメント・マネージャー
ヤン・ドゥシェック

19:30：ビジネス・ネットワーキング（懇親会）

ATMOsphere Europe & Australia 2016

プログラム EU：http://www.atmo.org/events.programme.php?eventid=35

プログラム AUS：http://www.atmo.org/events.programme.php?eventid=43

取材 EU：https://storify.com/sheccomedia/atmosphere-europe-conference-on-natural-refrigeran

取材 AUS：https://storify.com/sheccomedia/follow-the-first-ever-atmosphere-australia

エンドユーザー

EUROPE ATMOsphere
solutions for europe
natural refrigerants
19 & 20 April, 2016 – Barcelona

Transcritical CO_2

Carrefour
SPAIN

エンドユーザー

Actual situation

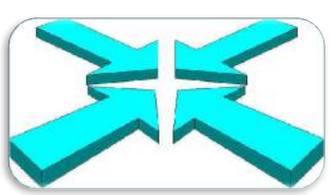
The use of HFC refrigerants is being penalized by Spanish (Law 16/2013, Art. 5) and European (f-gas UE 517/2014) laws.

- 20 €/ Tn equivalent CO_2.
- Reductions of production, - 80% in 2030.
- HFC installations with direct expansion to be forbidden.

Carrefour response

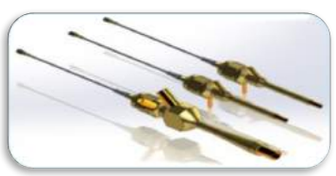
We reduce the refrigeration needs, use natural refrigerants, implement elements and regulations that minimize the COP plus consumption and leakage control for minimizing the carbon footprint.

Efficient refrigerated displays
(Doors, Led, EC Fans,
Electronic expansion valve…).



Improve refrigerated surface
(Reductions to 50%)

Natural refrigerants. CO_2



Innovation investment
(Parallel compresor, Ejector…)

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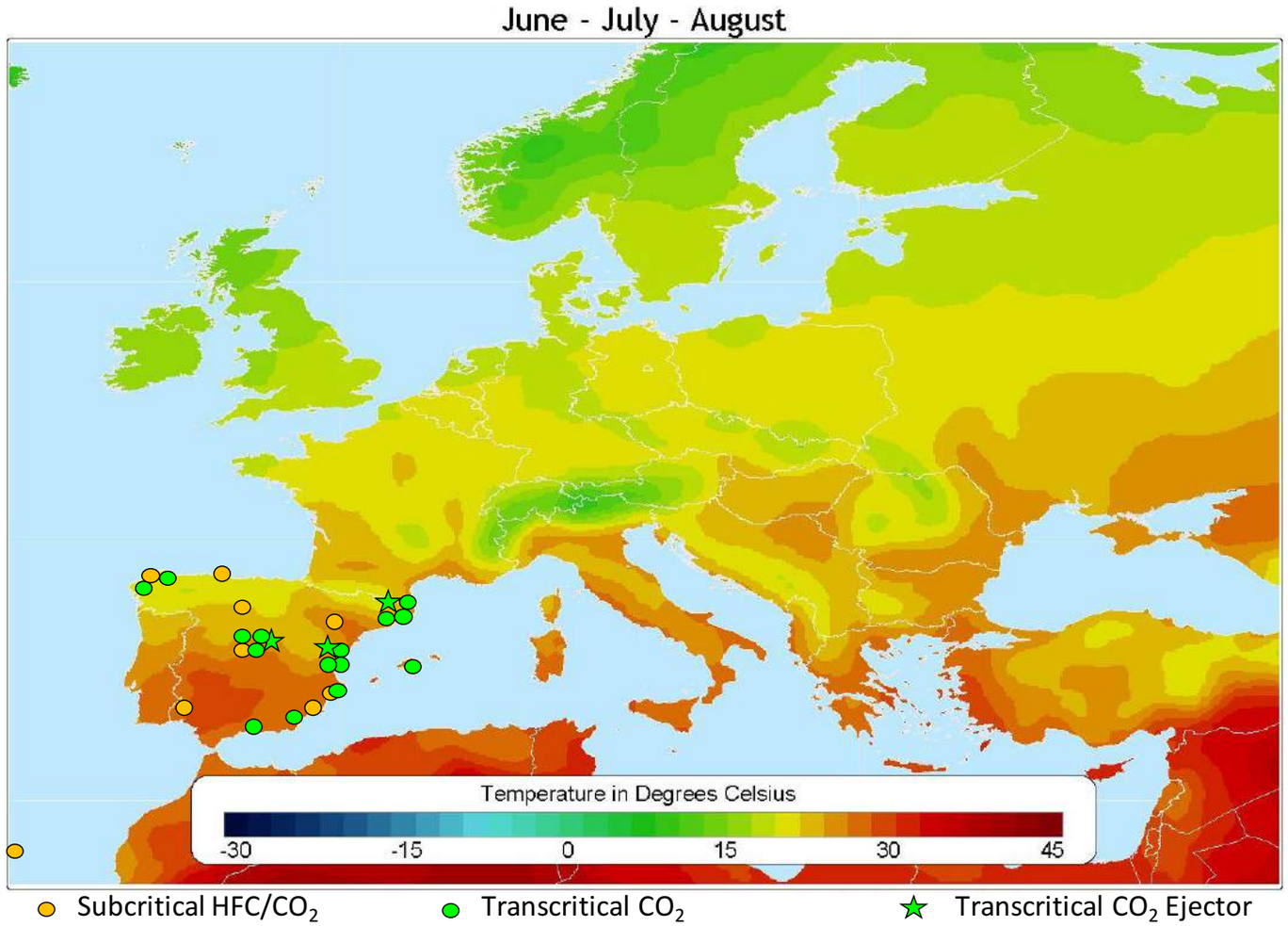
ATMO EUROPE sphere solutions for europe natural refrigerants

Carrefour

CO_2 Refrigeration in Carrefour Spain

2012	**Santiago.** First transcritical hipermarket in Spain.
2013	**Ferrol & Alzira**. Parallel compresor Installations. 7 Subcritical installations.
2014	**Castellón.** First installation with controllable ejector in Europe. 2 Subcritical and 5 transcritical installations.
2015	6 Transcrítical installations.
2016	4 Transcritical installations to develop.



19 Transcriticals and 9 Subcriticals.

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Carrefour

Pictures Castellón. Transcritical installation

Positive Rack

Negative Rack

GasCooler

Cool rooms

Electric board

Evaporator

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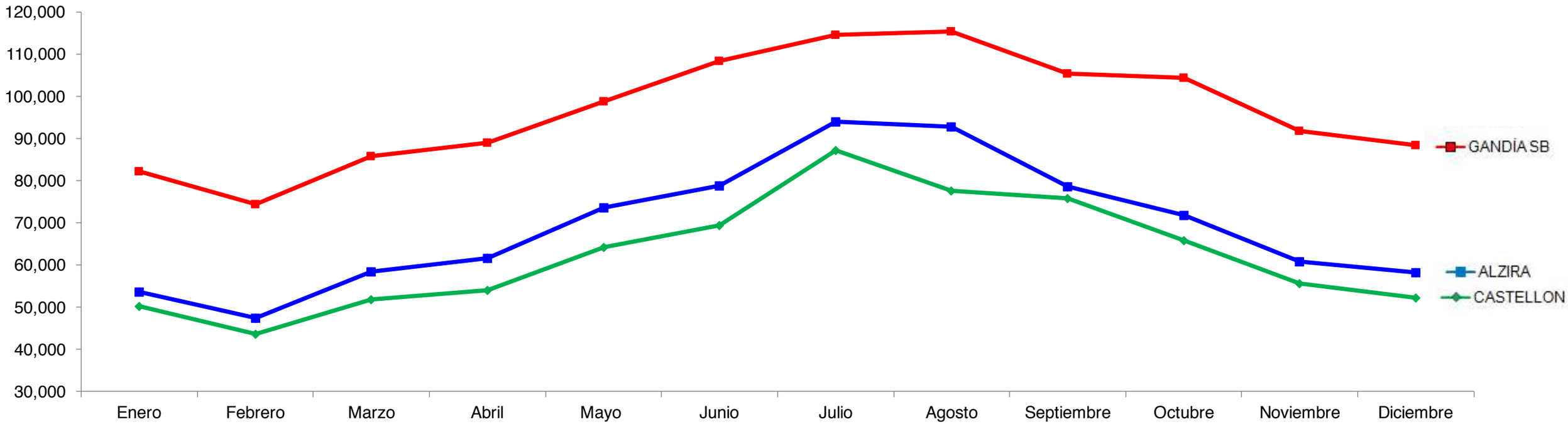
Comparative consumption Transcritical VS Subcritical



Hypermarket	Tecnology	Surface	Need (+)	Need (-)	Jan.	Feb.	Mar.	April	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total [kWh]
GANDÍA SB	Subcrítica	9.229 m2	257 kW	71 kW	82.107	74.315	85.756	88.930	98.706	108.309	114.534	115.277	105.290	104.288	91.732	88.379	1.157.623
ALZIRA	Transc. Comp Eco	10.734 m2	177 kW	66 kW	53.715	47.355	58.417	61.648	73.543	78.782	94.019	92.728	78.649	71.723	60.712	58.279	829.570
CASTELLON	Eyector	9.641 m2	224 kW	57 kW	50.286	43.693	51.897	54.103	64.171	69.462	87.228	77.662	75.841	65.866	55.648	52.194	748.051

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COLRUYT GROUP

ATMOsphere EUROPE solutions for europe natural refrigerants

19 & 20 April 2016 in Barcelona

Compact cooling using R290

ATMOsphere Europe Food Retail Panel

Collin Bootsveld, 20 April 2016

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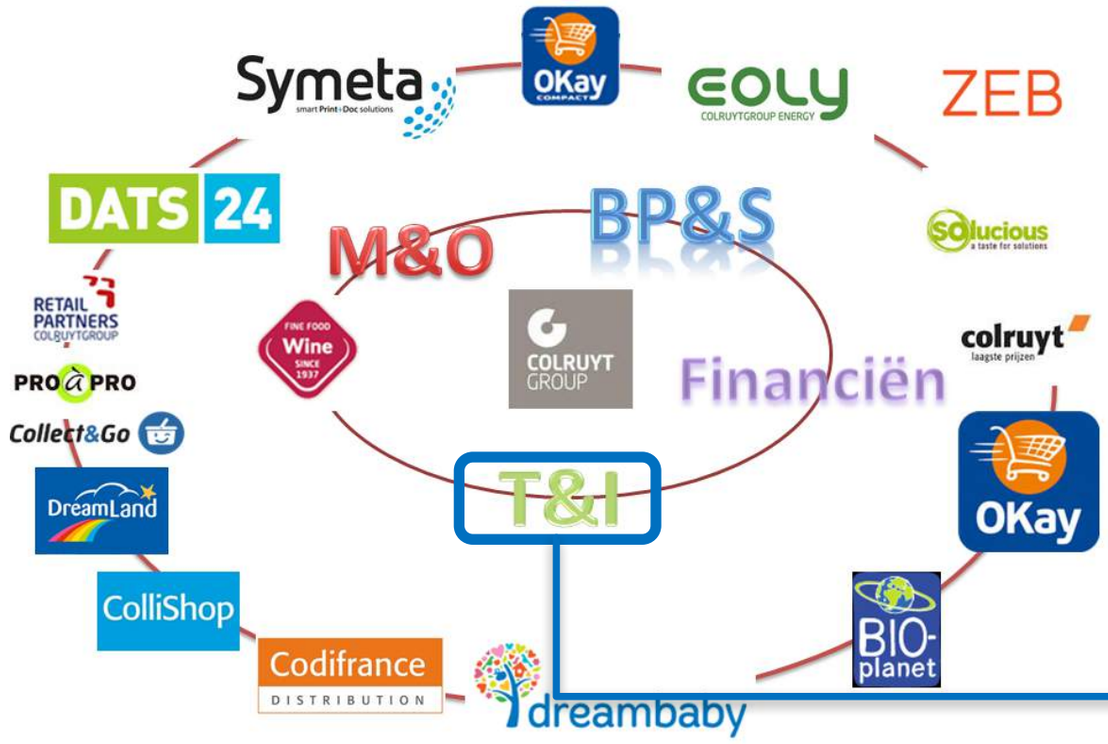
Colruyt Group, a family of companies



- T&I = Internal technical service department for Belgium, France and Luxembourg
- 1300 employees
- Design & study

↓

Realization

↓

Maintenance

"Creating sustainable added value together through value-driven craftsmanship in retail"

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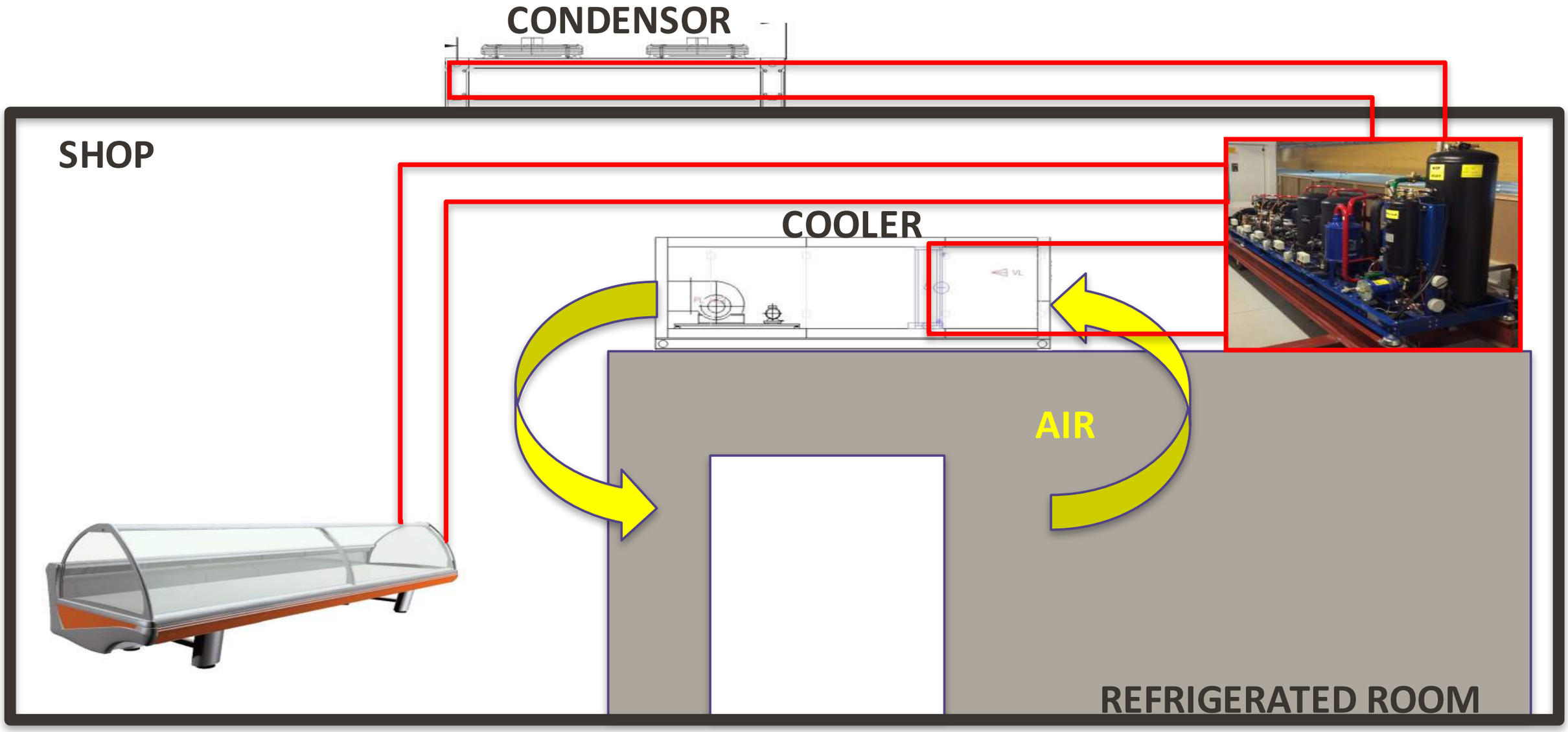
Current refrigeration with R507



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Timeline natural refrigeration

Regulation 517/2014: 'F-gas'

1999
Ammonia cooling of distribution center

2012
Study natural refrigerant

2013
Propane Cooling OKay Roeselare

Jan. 2015
Quota-system R507: price increase

Nov. 2015
Propane Compact Chillers BIO-Planet Mons

2020
Prohibition new installations with R507

2030
Prohibition R507

Optimization and rollout

エンドユーザー

Propane cooling OKay Roeselare 2013

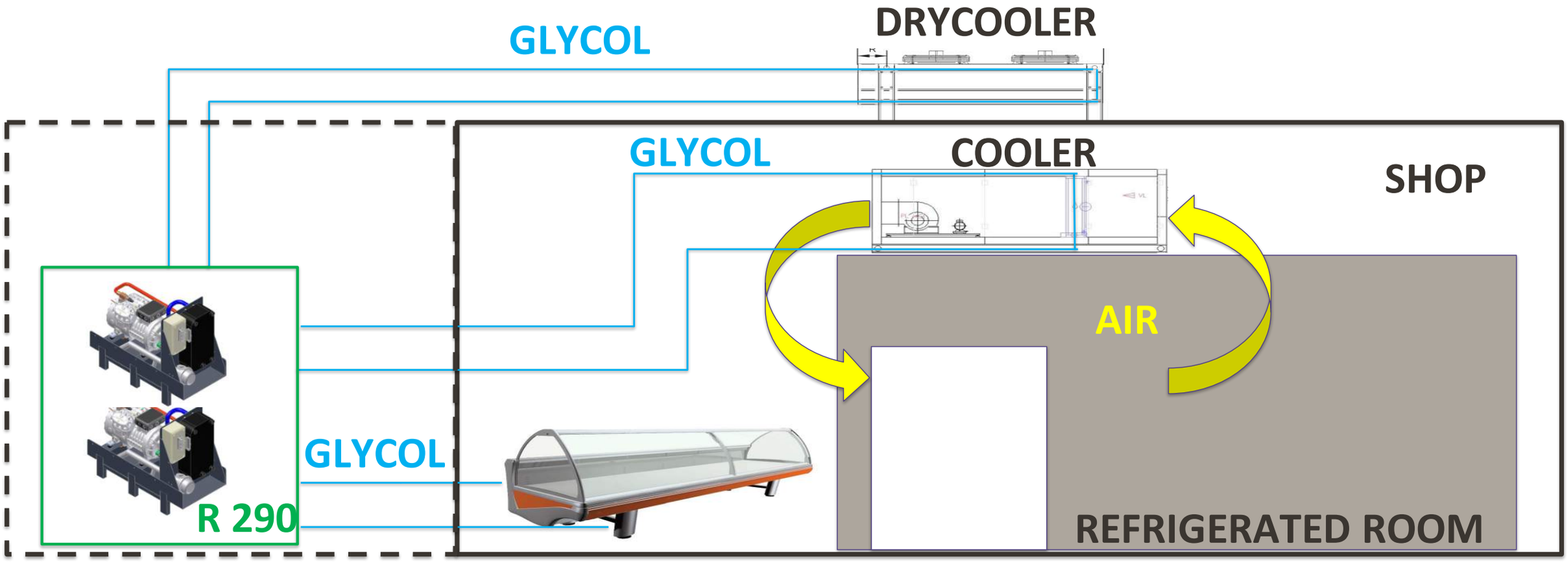
Works well BUT NO:

- Practical training for technicians
- Redundancy
- Placement inside
- Practical refrigerant recovery

Integral approach:

Technician must feel safe	Technical performance & safety
Sustainable & good for the people	Integration in shop & surrounding

Configuration with propane units (R290)

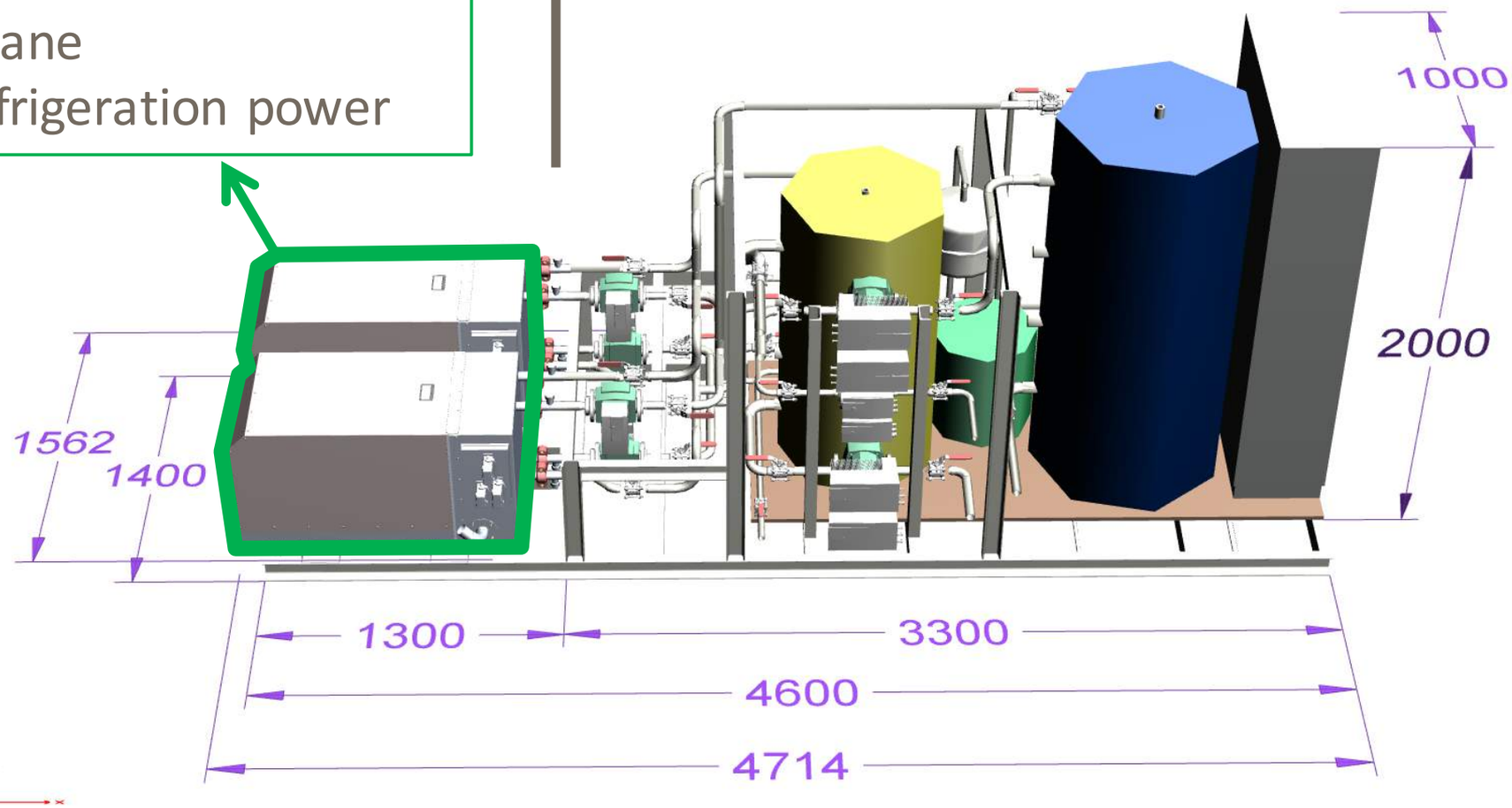


Configuration with propane units (R290)

Propane (R290)

2 x 1,7 kg propane
2 x 31,5 kW refrigeration power

Glycol



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BIO-Planet november 2016

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Realisations and rollout

- Immediate rollout for BIO-Planet
  - Mons
  - Hasselt
  - Jambes
- First OKay and Colruyt with propane refrigeration in 2016
- Applicability in France and Luxembourg

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Natural 4 Neutral in Convenience
Sainsbury's
live well for less

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200th CO_2 Refrigeration Store
Abbey Wood

Sainsbury's
live well for less

200 Sainsbury's STORES

CO_2E SAVINGS

330,000
TONNES CO_2E SAVING

EQUIVALENT TO
2.53 SQ MI
OF DEFORESTATION

EQUIVALENT TO LIGHTING
1.7 MILLION
DOMESTIC BUILDINGS FOR A YEAR

£/HFC £/CO_2

COST NEUTRAL

132
ENGINEERS TRAINED WITH SSL FUNDING

HEAT RECLAIM OPPORTUNITY FROM CO_2 REFRIGERATION IS GREATER THAN HFC DUE TO HIGH GRADE OF HEAT AVAILABLE

CO_2 REFRIGERATION STORE INVESTMENTS

NUMBER OF SYSTEM VARIATIONS EVALUATED

VARIANTS IN NATURAL SOLUTIONS:

York CO_2/HFC pumped HT, DX LT cascade	Clapham
Linde CO_2 Cascade	Greenwich
Booster Mk1	Pepper Hill
Booster Mk2	Crayford
Booster Mk3 2 tier	Current
Booster 60Bar	On Trial

CO_2 SYSTEM INCORPORATION INTO OTHER BUILDING SERVICES HR/GSHP

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Olympic Way, Wembley solution

- 2712 sqft [252m^2]
- Refrigeration 52.0kW @ -8^{o}C & 3.9kW @ -32^{o}C R744 Booster pack – 80/60 bar IP & LP
- Internal gas cooler
- Hot water point of use
- Sales floor - heat reclaim to water; 4 Nr 8.5kW cassettes & 10kW over door heater (0.36kg/s – 50oC flow / 30oC return)
- De stratification fans
- Cash office cooling 3.0kW – IT system + LPHW radiator

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Sainsbury's live well for less

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Energy performance data

Refrigeration average weekly usage (ex Wembley) kWh	2309.3
Wembley average weekly refrigeration usage kWh	1436.2 -37.8%
Total average weekly usage (ex Wembley) kWh	5036.1
Wembley average weekly total kWh	2170.9 -56.8%

Pay back period - 14.15 months

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Sainsbury's live well for less

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Refrigerants and Refrigeration Plant Design
The Path Forward

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Coles Overview

- Full Line Supermarket Retailer
- Operating Since 1914
- Australia Wide Footprint
- 780 Supermarkets
- 110,000 plus Team members
- Wesfarmers Owned (November 2007)
- FY15 38.2b Revenue
- One of Australia's Largest Refrigeration Plant Operators

coles
A little better every day

エンドユーザー

Current Standard R134a/Co2 Hybrid

COMBINED COOLING PLANT (LARA)

R134a/Co2 Hybrid CCP Plant
Integration of Mechanical /Refrigeration plant simplifies installation and maintenance

- Store Count 120 plus
- Plant Designed to Retrofit HFC to low GWP Refrigerant once tested & approved
- Plant Refrigerants
  - Low Temperature Sub-Critical Co2
  - Medium/High Temperature & A/C R134a
- Number of Racks Three
  - 2 off Med/High Temperature
  - 1 off Low Temperature
- Store Load Diversification per Rack
  - High-Medium Temperature Plants
  - 50% Low Temperature Condensing
  - 50% Med/High Temperature Loads
  - 50% Air-Conditioning

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Trial Transcritical Parallel Compression System

COMBINED COOLING PLANT

COBURG NORTH

Brief: Replicate current standard with a Natural Solution

Transcritical Plant Specifics

- Store Count One
- Plant Refrigerant Co2
- Number of Racks Two
- Store Load diversification, 50% per Plant
  - 50% Medium/High Temperature Refrigeration
  - 50% Low Temperature Refrigeration
  - 50% Air-Conditioning
- 620kWr Total Store Refrigeration Duty
  - 250kWr Chilled Water A/C Duty
  - 40kWr Low Temperature Refrigeration Duty
  - 330kWr Medium Temperature Refrigeration Duty

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Coles Refrigeration

TRANSCRITICAL TRIAL

RESULTS

Coburg North V's Lara "First 6 Months"

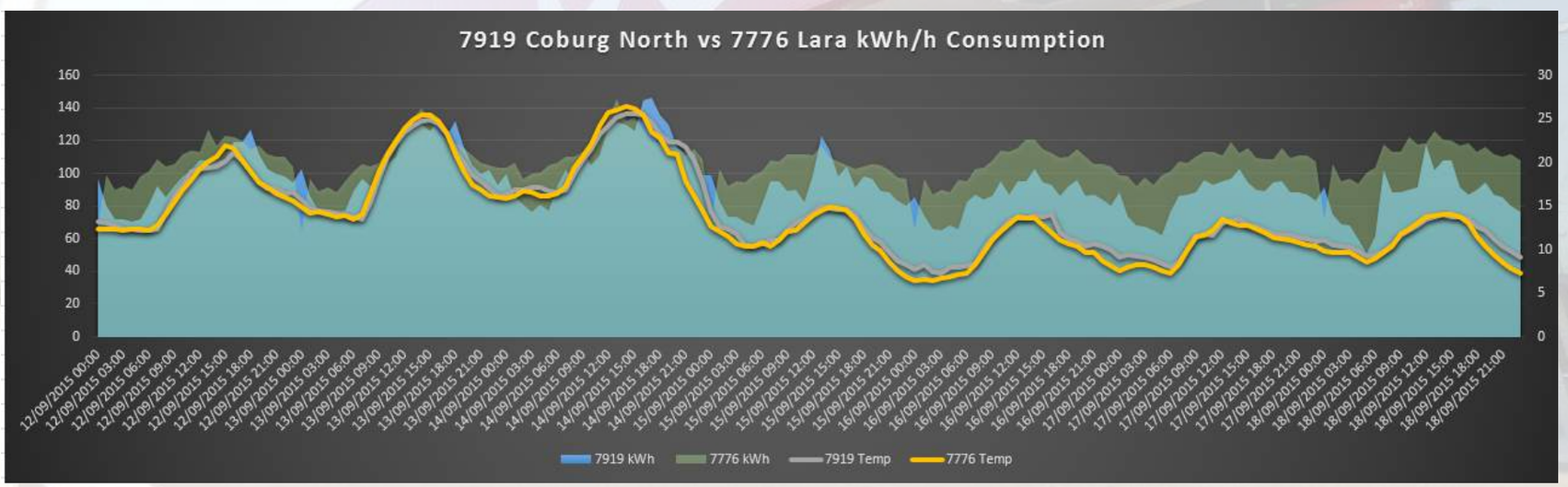
Parameter	Coburg North 7919S	Lara 7776S	% Diff
Climate Zone	6	6	
Age (months)	7	15	
SLA (m2)	2995	2151	28%
Total kWh	421700	485496	-15%
Avg Temperature	18.3	17.7	3%
Avg kWh Open	118.80	135.11	-14%
Avg kWh Close	89.92	109.49	-22%
Avg kW Demand	112.78	129.77	-15%
Refrig Design Load (kW)	621	629	-1%
Theoretical COP	5.51	4.85	12%

Co2

- Coburg North Transcritical plant delivered a **15% energy reduction** over Lara
- Combined Cooling Plant an average consumes 67% of total store power

Hydrocarbon Water loop

- Proof of concept in Liquor Format
- Results being validated
- Next step Cost Modelling for larger application



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Our Journey to Natural Refrigerants

Woolworths Engineering

Michael Englebright
Greg Lewis

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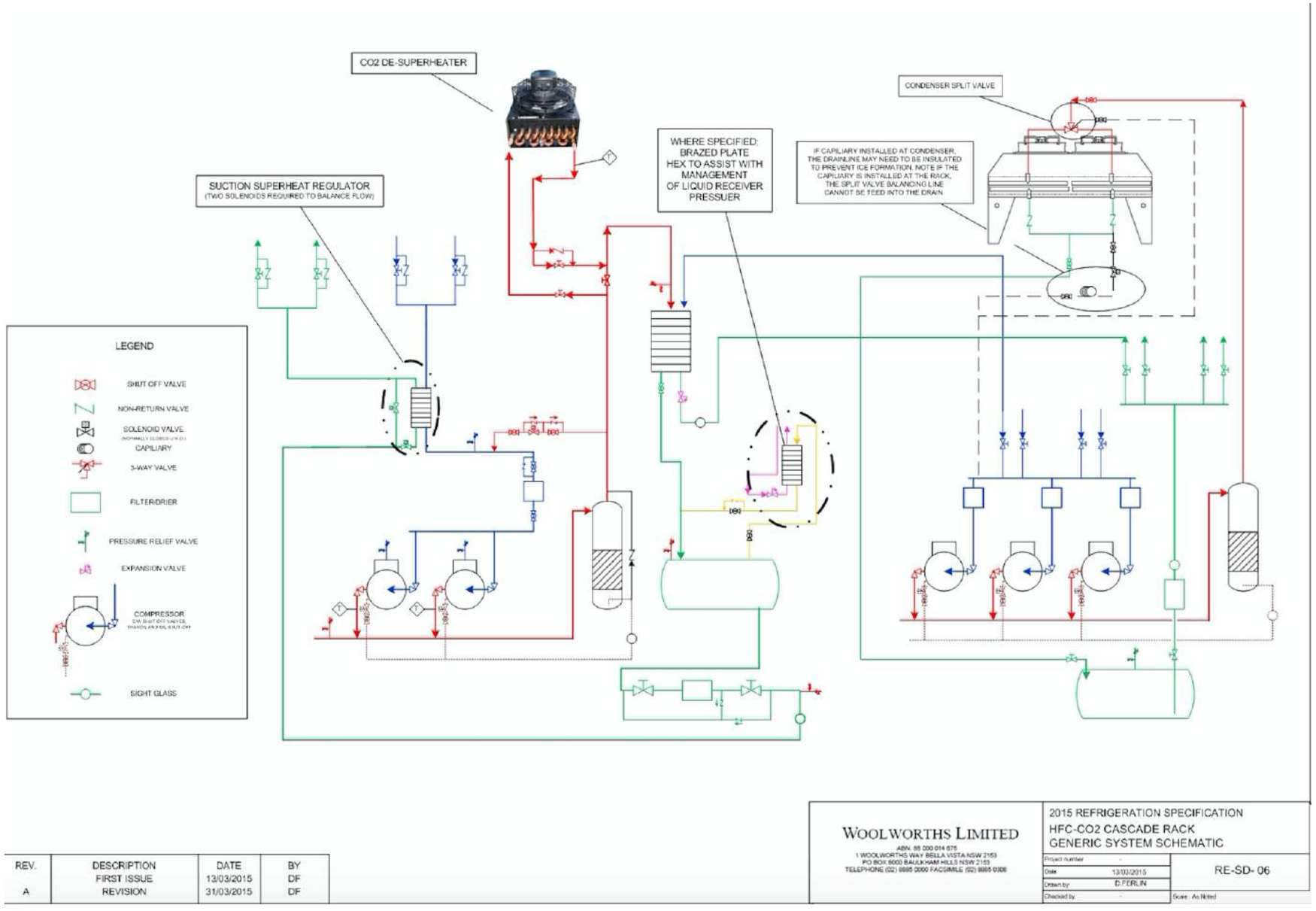
Business As Usual - Model R134a / R744



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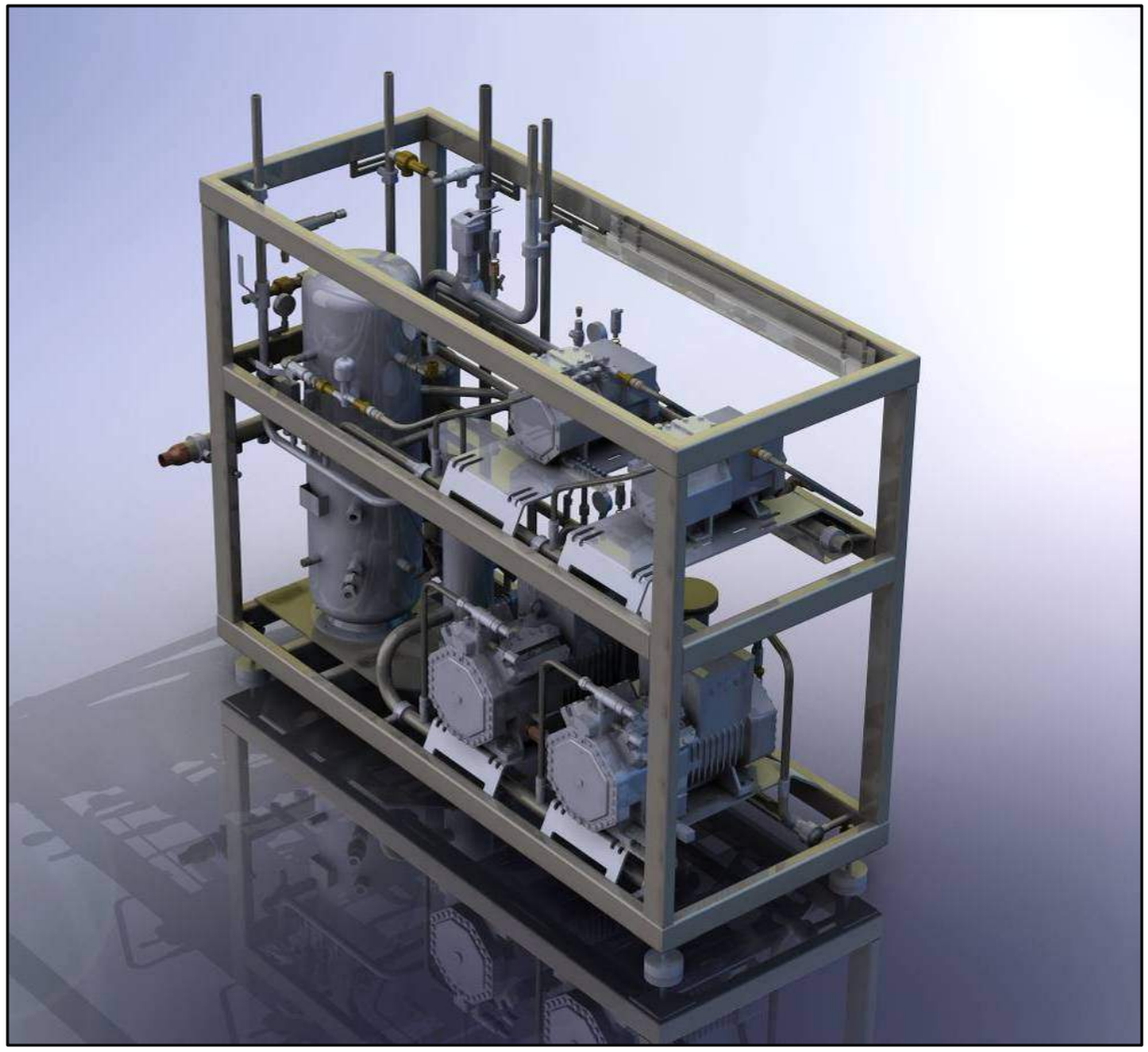
Moving Forward - Australia



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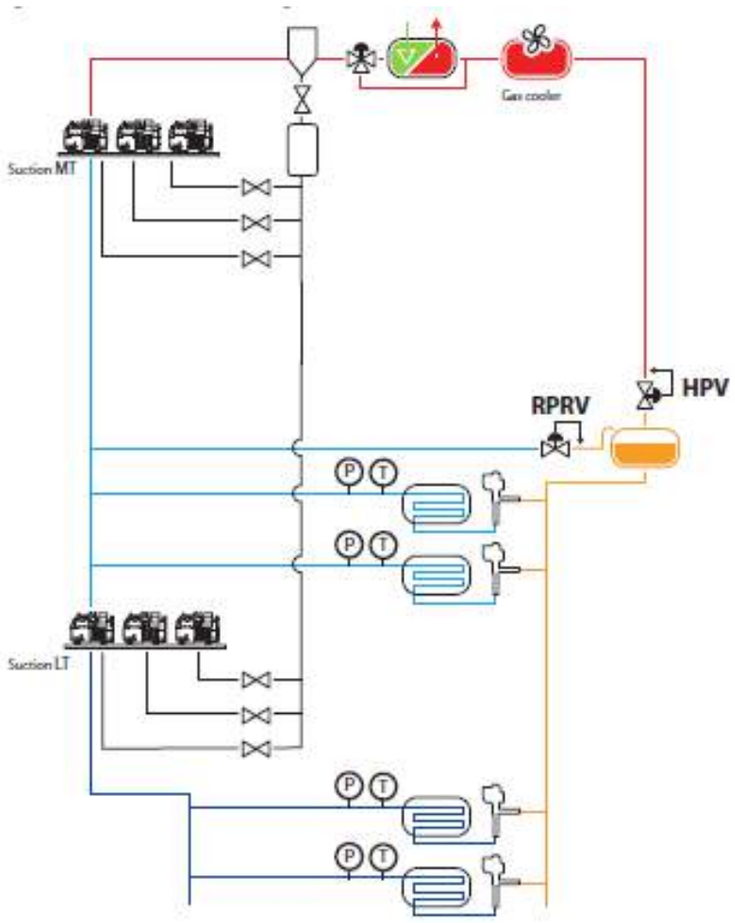

エンドユーザー

Moving Forward - New Zealand

- Countdown have committed to the installation of a further 4 x Transcritical systems

  – Countdown Ashburton: Green and Cool
  – Countdown Mosgiel: Green and Cool
  – Countdown Reddings: Yet to be tendered
  – FC Alexandra Park: Green and Cool

- Ashburton and Mosgiel will utilise the low grade heat for the HVAC and the high grade heat for the Hot water

- Reddings will utilise the parallel compression to provide cooling for the Dual Path HVAC system.

- Transcritical will be the way forward for stores in Main centres where there is strong technical support . Co2/134a Hybrid systems will still be an option for regions that are remote and are not supported well, These areas are few and with time the skill level will catch up.

- The solutions have been opened up to: Green and Cool, SCM, Advancer, Bitzer, Heatcraft

市場動向セッション

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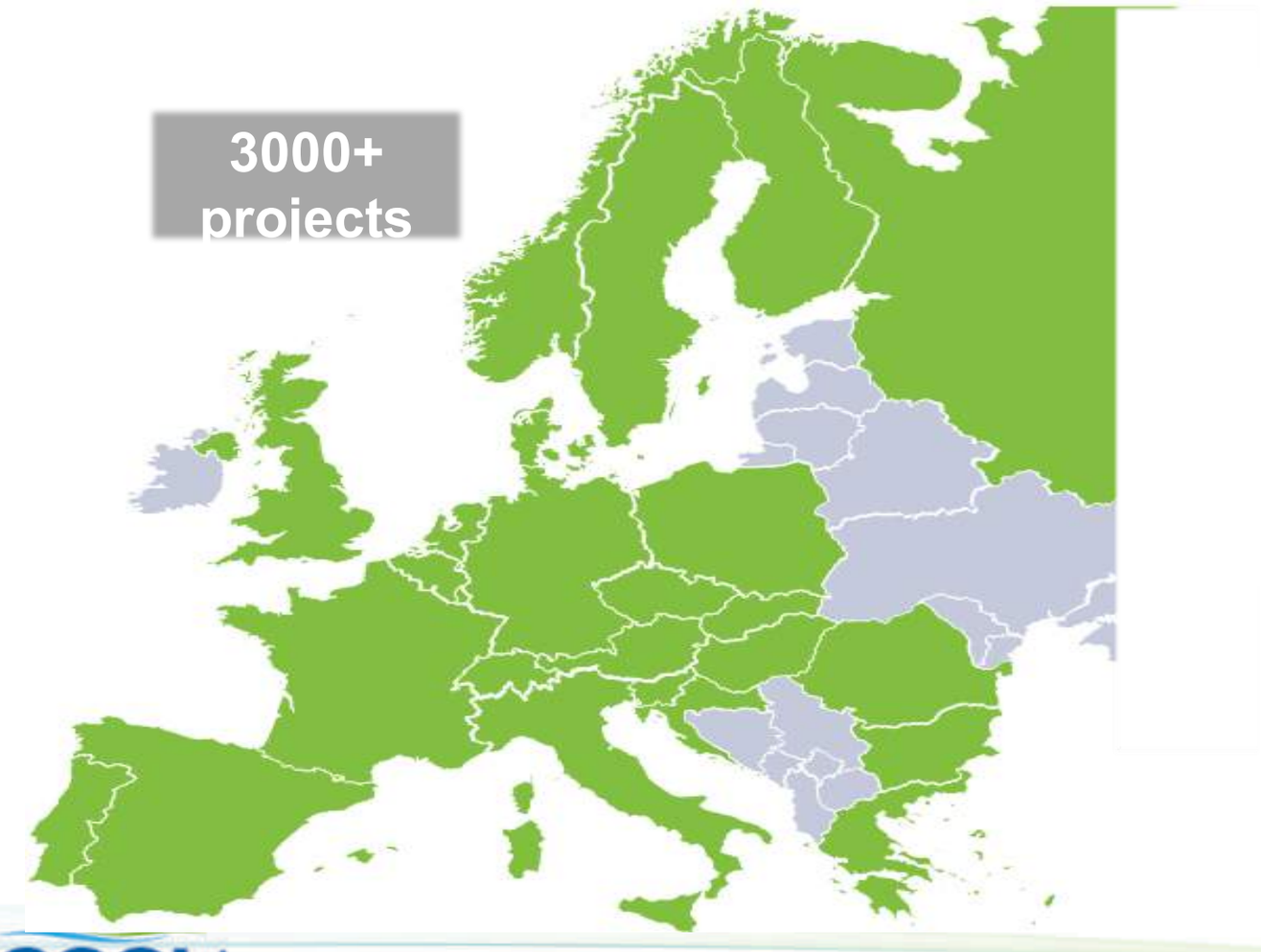
Carrier
United Technologies

Segment Trends -
CO_2 Systems in Europe

Guillaume Burvingt, Director Product Management
Carrier Commercial Refrigeration Europe

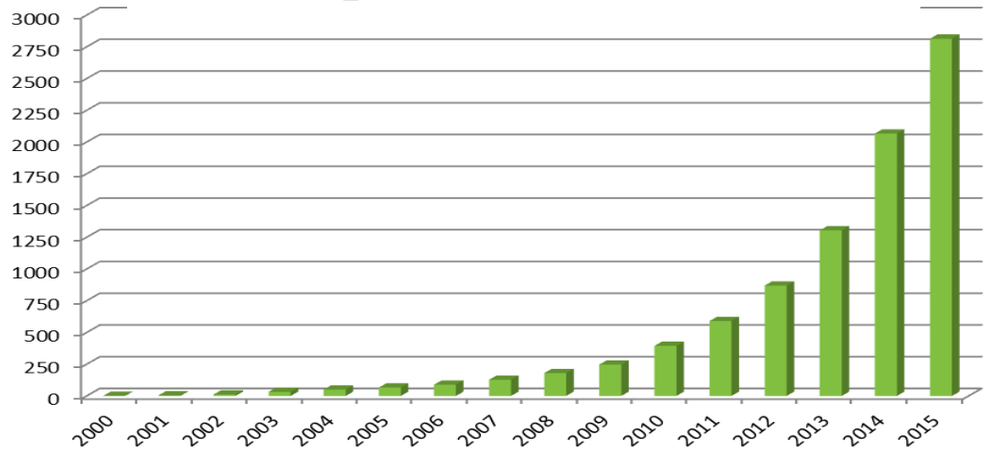
SEGMENT EVOLUTION & CURRENT STATUS

Carrier™ CO_2 projects in Europe



Project uptake trend

CO_2 Project Evolution



CO2OLtec HybridCO2OL

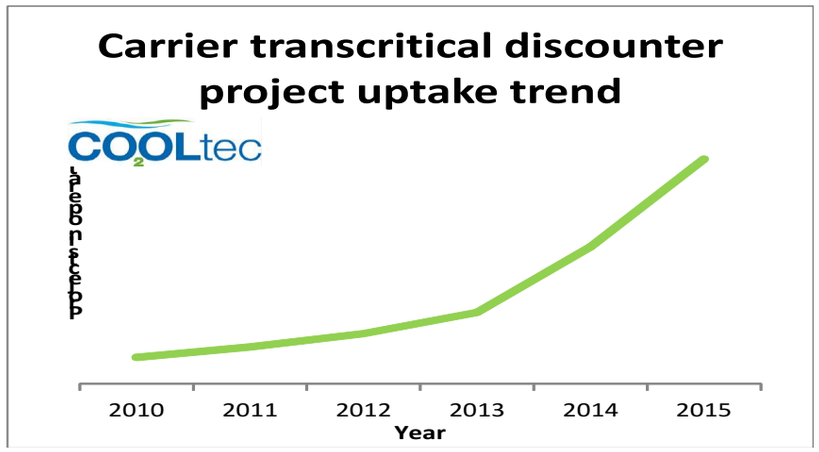
Number of CO_2 projects in operation
> tripled in last 3 years

Source: Carrier Commercial Refrigeration Europe

CO_2 SEGMENT TRENDS

Discounters and small stores

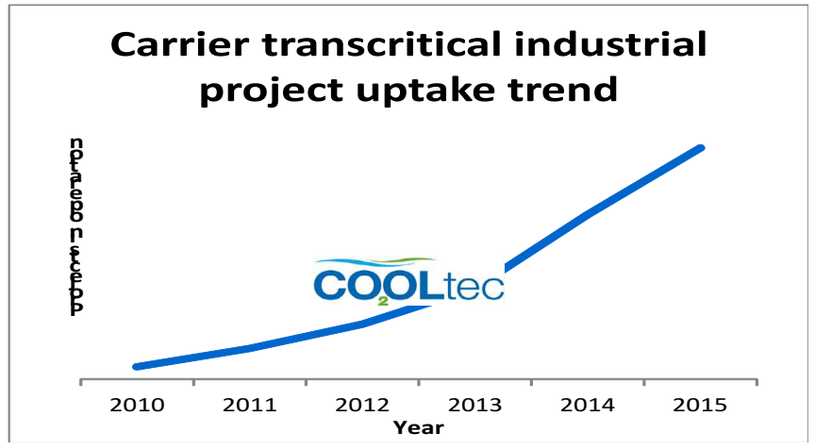
- Transcritical CO_2 a standard solution for supermarkets and hypermarkets
- Continued uptake by discounter segment
- Development of small store CO_2 solutions
- Attractive life cycle costs
- CO_2 not affected by F-Gas Regulation



CO_2 SEGMENT TRENDS

Refrigerated warehouses

- Momentum in transcritical warehouse segment
- Larger rack cooling capacity available
- Improving energy efficiency
- A1 safety classification
- Copper pipe work can be used
- Excellent refrigerant for heat recovery
- Trusted and well established technology

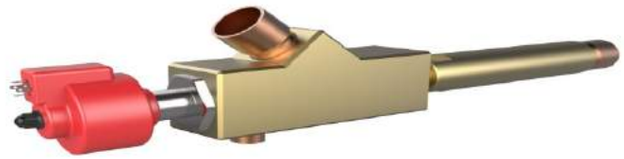


COOLtec MaxiCOOL COOLheat

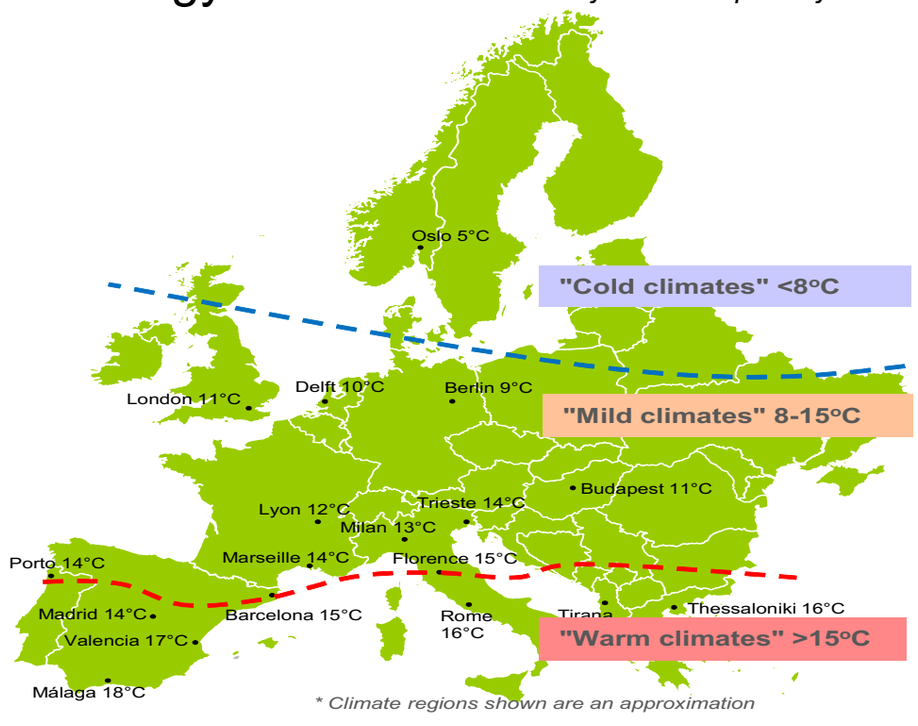
ADJUSTABLE EJECTOR

High efficiency solutions for all of Europe

- Proven efficiency of transcritical DX CO_2 systems in cold to mild climates
- Carrier adjustable ejector developed, contributing to attractive energy performance also in **warm climates**
- Variable flow to ensure optimal part load performance
- May be combined with economiser cycle, liquid pump…
- >20% energy savings possible in warm climates[1]
- Also offers energy savings:
  - In **mild climates**
  - In **cold climates**, during heat recovery mode



Carrier adjustable vapour ejector



** Climate regions shown are an approximation*

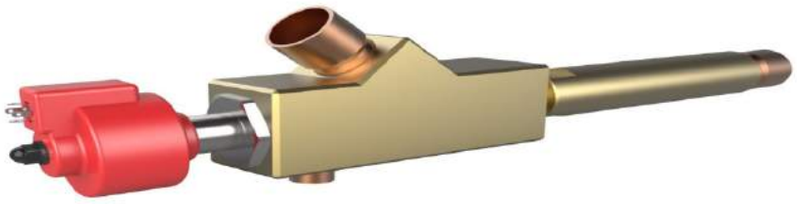
High efficiency transcritical CO_2 solutions now available for all European climates

[1] *'High Efficiency' rack configuration including ejector, vs standard CO2OLtec transcritical booster system. Rack only.*

ADJUSTABLE EJECTOR

Field trial status

- Measuring operational performance, efficiency and reliability
- Field trials in operation since October 2014
- >20 ejectors delivered to date
- Projects in Spain, France, Netherlands, Switzerland



市場動向セッション

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Market trends 2016

Advansor

ADVANSOR by Hill PHOENIX

About ADVANSOR

- Danish OEM
- Only TC CO2 (100% focused)
- 750 systems in 2016
- ∞15 systems per week

- Reference list: 2102 systems operating in 20 countries

市場動向セッション

Products

compSUPER

ValuePack

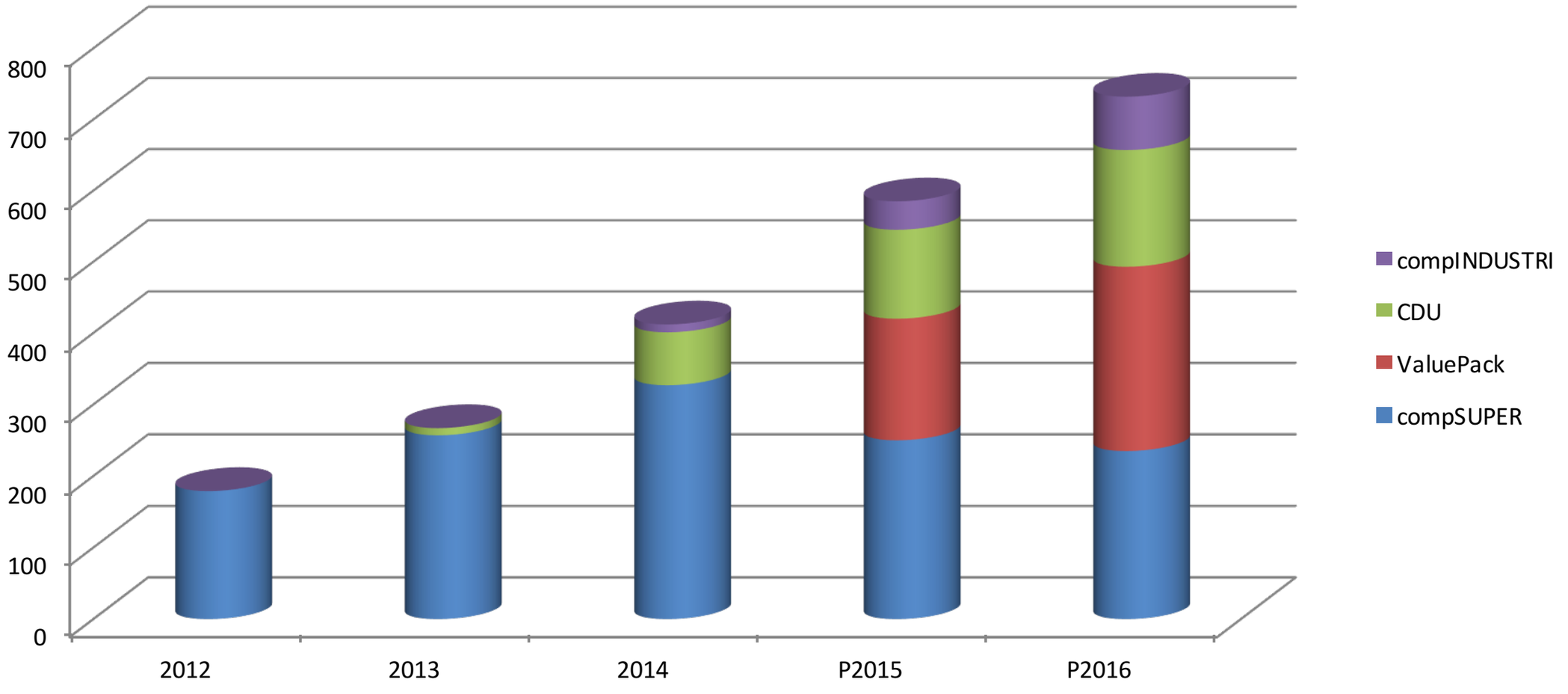
CDU

Industrial

Sigma

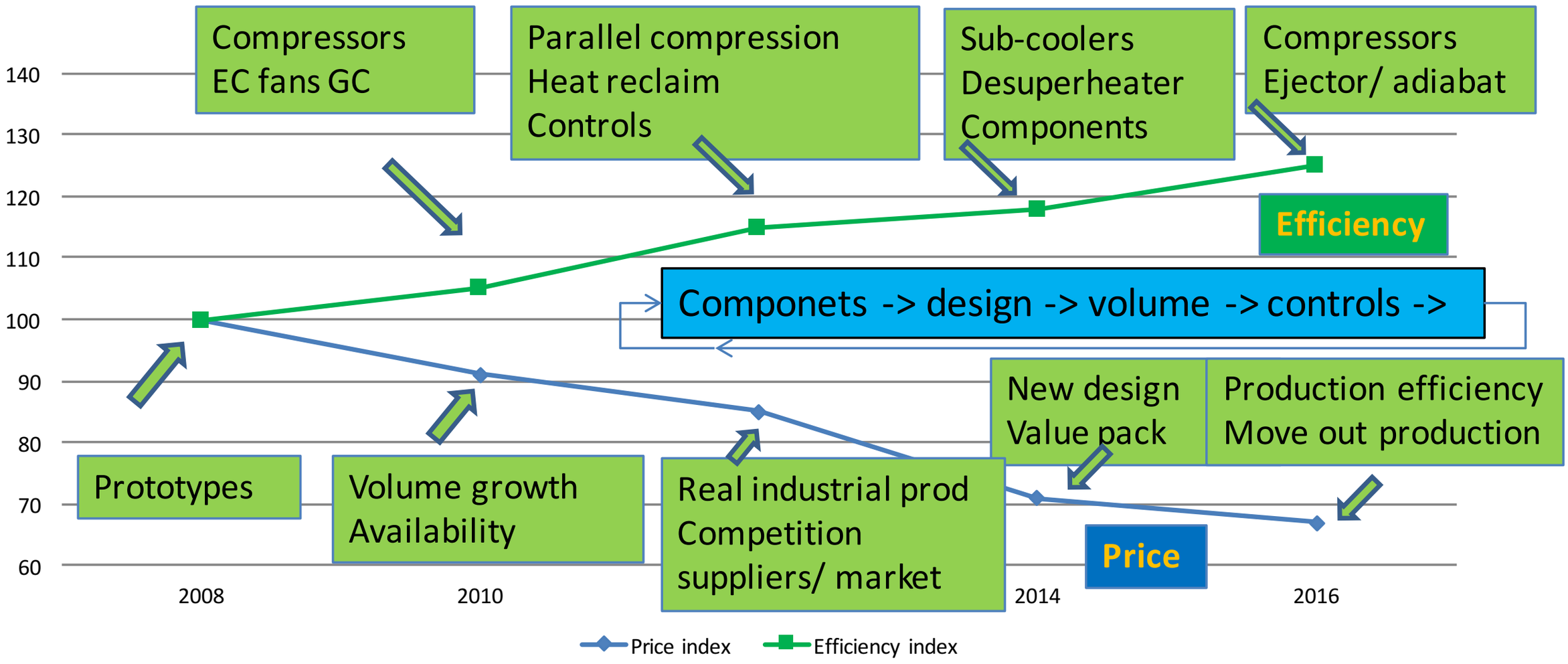
市場動向セッション

Market growth – TC CO2 (units)



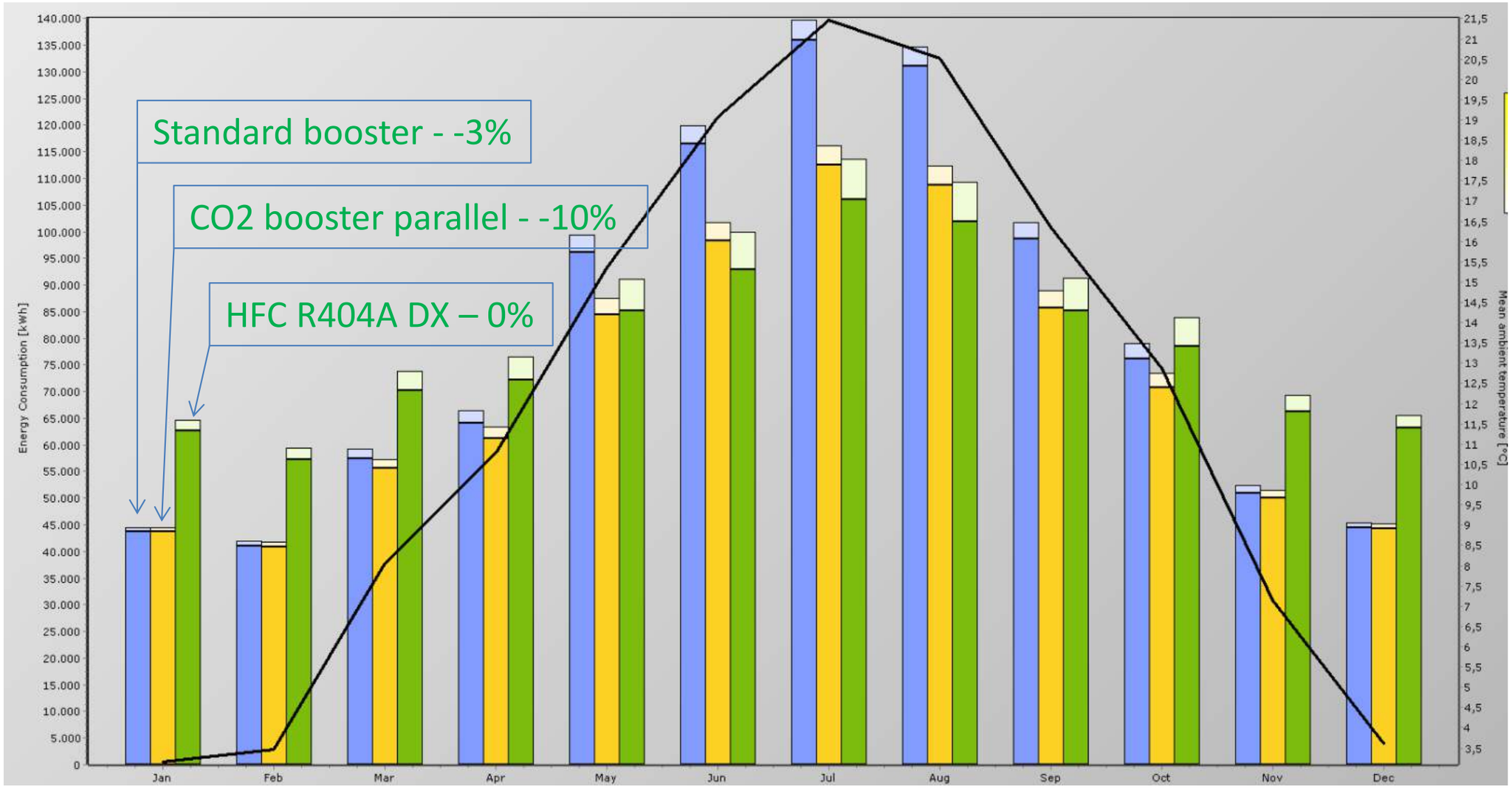
市場動向セッション

Efficiency and price



市場動向セッション

Energy consumption (Barcelona)



市場動向セッション

AUSTRALIA

ATMO sphere

business case

natural refrigerants

16 May, 2016 — Melbourne

HEATCRAFT™ Worldwide Refrigeration

An Industry in Change

市場動向セッション

ATMO AUSTRALIA sphere business case natural refrigerants

16 May, 2016 — Melbourne

Company Overview

- Operations in North America, South America, Europe, Asia, and Australia / New Zealand

- Natural refrigerant system applications
  - 249 HFC/CO_2 hybrid systems and counting
  - 11 transcritical CO_2 systems (additional in process)
  - 2 ultra-low-charge ammonia-CO_2 cascade installed in the U.S.

HEATCRAFT™ Worldwide Refrigeration

Heatcraft Global Footprint

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Latest NR Projects

NH_3/CO_2 Supermarket

- Ammonia (NH_3) top cycle (24 kg / 35 L)
- CO_2 low temperature direct expansion
- CO_2 medium temperature liquid overfeed

Benefits

Optimized LCCP

- HFC-free system
- Low NH_3 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

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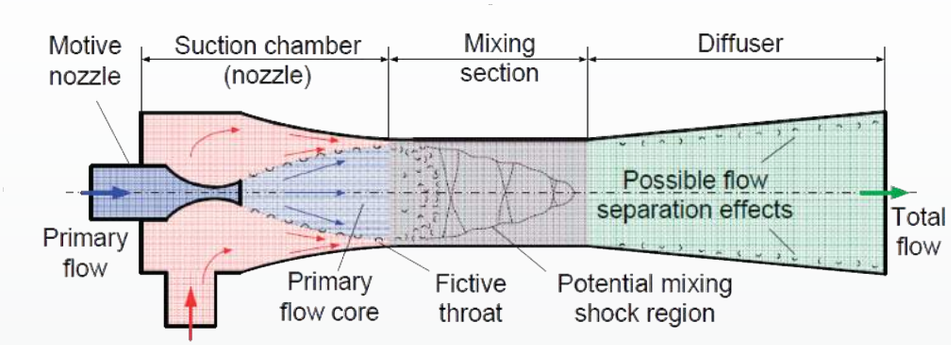
Tomorrow's Technology Today

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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MARKET TRENDS
EPTA 2016

Francesco Mastrapasqua
Refrigeration Systems Marketing Manager

市場動向セッション

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CO_2 Product range, Refrigeration Systems

Epta

EPTABLUE 2.0

ECO2 Small

EPTACLIMA

ECO2 Large

E+E Epta Educational

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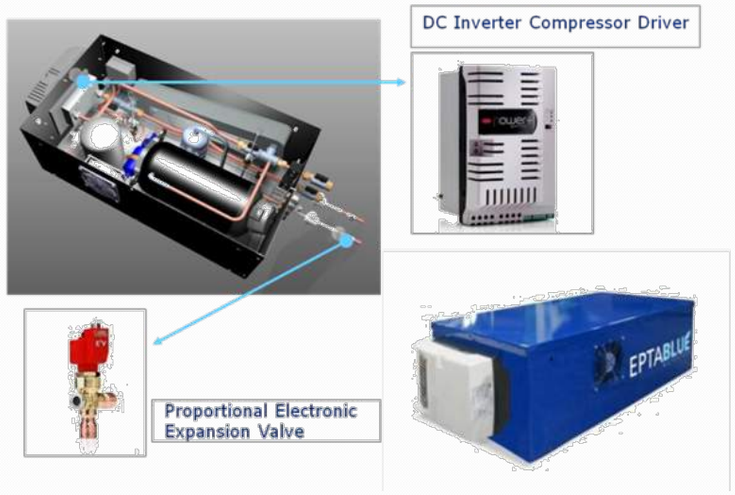
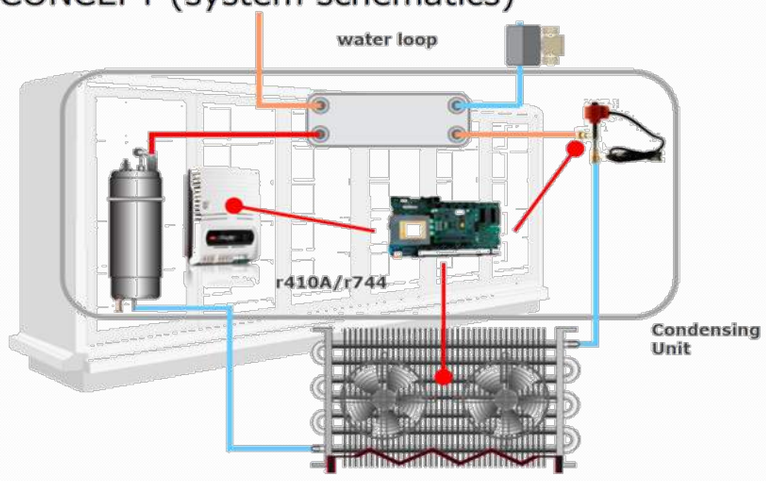
Convenience store: waterloop system



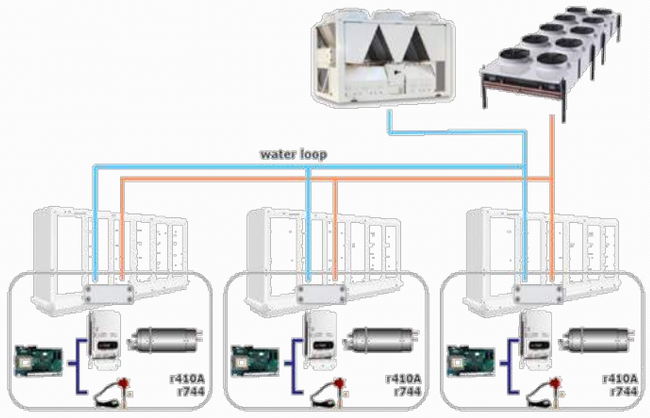
STORE LAYOUT
Simple, economical and practical

- ✓ Single loop for MT/LT
- ✓ No subcooling chiller
- ✓ No technical room nor installation work
- ✓ No perceptible noise
- ✓ No equipment outdoor
- ✓ Warm climate version and new extended limits
- ✓ Freezing protected up to -25°C (glycol)

CONCEPT (system schematics)



CONCEPT (system schematics)



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SANDEN
Delivering Excellence

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Compact & down-sized CO_2 cooling solutions

Sylvain GILLAUX – Sales & Marketing Manager

SANDEN CO_2 Technology

市場動向セッション

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① Air plug-in solutions

SANDEN CO_2 Technology

Key feature	1st CO_2 inverter-type plug-in in Europe
Challenges	Horizontal mounting of scroll compressor
	Allow intelligent communication between cabinet control and CDU control
	Adapt CO_2 loop layout
1st installation in Europe	October 2015 (France / Paris)
Initial cost	~+15% vs HFC (cabinet + CDU)
Energy efficiency	-21% (to be confirmed by field data over 12 months)
ROI	Depending on cabinet quality / pricing
N°1 end user's comment	Extremely silent

PROJET LABELLISÉ PARIS2015 COP21-CMP11

biocoop 21

SANDEN Delivering Excellence

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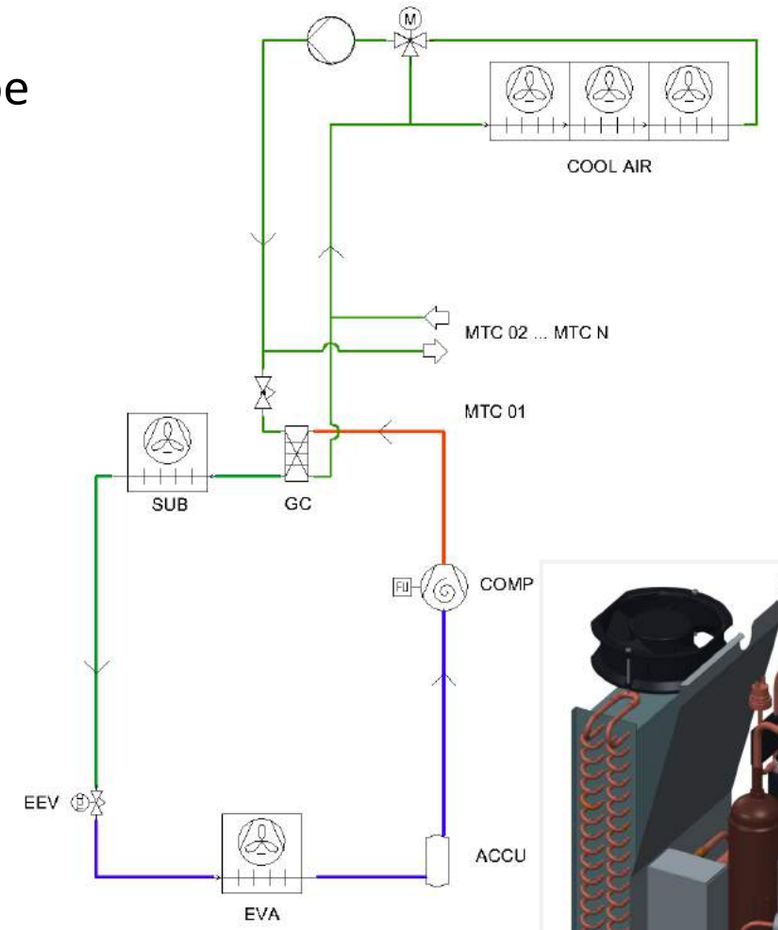
② Semi plug-in solutions

SANDEN CO_2 Technology

Key feature	1st CO_2 inverter-type semi plug-in in Europe
Challenges	Allow intelligent communication between cabinet control and CDU control
	Adapt CO_2 loop layout to cabinets
1st installation in Europe	January 2016 (Switzerland)
Initial cost (total store)	Lower vs CO_2 rack // equivalent to HC
Energy efficiency	Equivalent to best-in-class water-loop (to be confirmed by field data over 12 months)
ROI	Depending on cabinet quality / pricing
N°1 end user's comment	Extremely silent



SANDEN Delivering Excellence

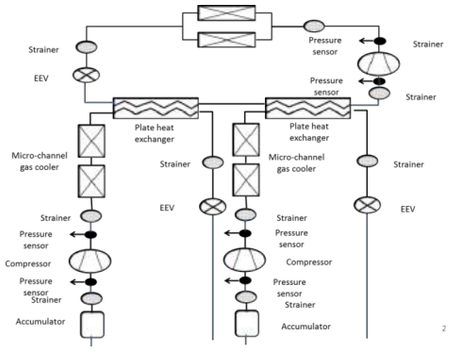
市場動向セッション

ATMO EUROPE sphere solutions for europe 3 4 natural refrigerants

Remote CDUs for cabinets & cold rooms

SANDEN CO_2 Technology

Key feature	1st CO_2 inverter-type CDU range 2~10kW
Challenges	Communication with store monitoring sys.
	Adapt to European power input
	Adapt CO_2 loop layout
	Get “acceptance” from installers
1st installation in Europe	*December 2015 (France)*
Initial cost	~+8~17% vs HFC (including installation)
Energy efficiency	See next slide (to be confirmed by field data over 12 months)
ROI	Depending on cooling capacity installed
N°1 end user’s comment	Installation easiness / silent / compact



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市場動向セッション

Focus on energy efficiency

SANDEN has optimized its CDUs for temperature conditions with highest occurrence.

Data were measured on the field in Asia, then extrapolated to European typical climates

Conditions: evaporating temperature = -5°C // Same cooling capacities for R404a and CO_2 systems

Calculation is weighted on: > temperature occurrences of each climate area

> hourly cooling demand function of the outside temperature

CDU-S unit	Annual consumption [kWh]
Strasbourg	3 353
Helsinki	2 990
Athens	4 492

CDU-L unit	Annual consumption [kWh]
Strasbourg	13 556
Helsinki	11 383
Athens	20 151

SANDEN CO_2 CDU	Annual savings
Strasbourg	**37%**
Helsinki	**39%**
Athens	**30%**

業務用冷凍ケーススタディ

High Efficiency Solutions.

CAREL

High efficiency CO_2 transcritical systems for all formats in warm climates

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Diego Malimpensa

April 19th 2016

業務用冷凍ケーススタディ

Electronic Modulating Ejectors (EmJ)

Carrier CO_2 refrigeration expertize met Carel controls expertize to jointly deliver a full **RANGE** of **MODULATING EJECTORS**

- Continuos stepper modulation
- Easy adaptation to all working condition and part load
- Replacement of existing high pressure valve (HPV)
- Different sizes to match different compressor rack capacities
- Vapour ejectors design for full mass flow

- Full advanced control system (rack, cabinets, monitoring)

業務用冷凍ケーススタディ

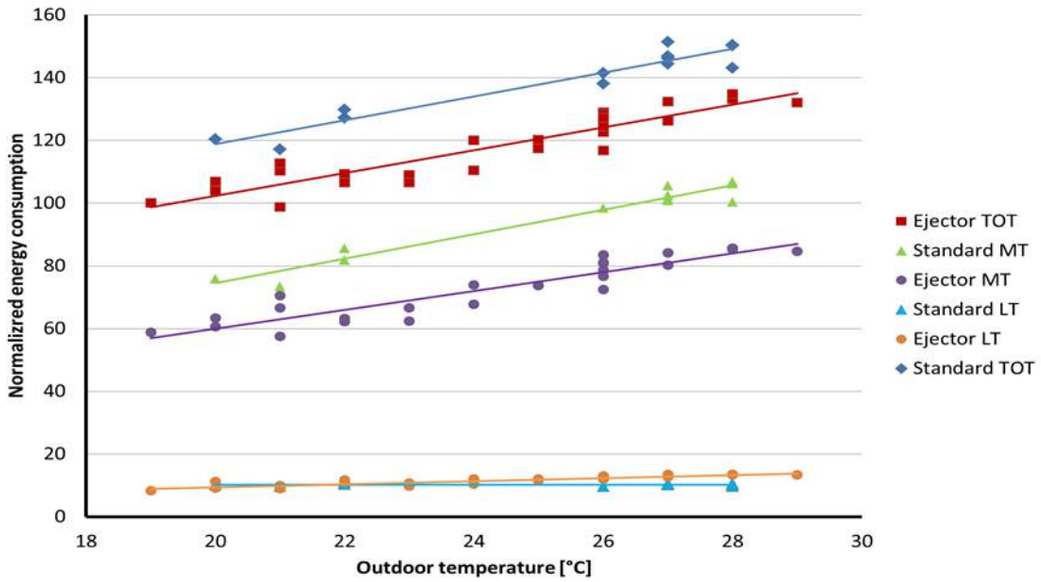
Real store installation

Ejector field trials (from Carrier)

- Spain, France, Netherlands, Switzerland
- Daily energy consumption during summer operation @28°C outside temp
- -25% MT compressor rack
- -13% total refrigeration system

Full system installation: Switzerland

- 3x MT compressor
- 3x LT compressor
- 1x Parallel comp
- 35kW ejector
- HR



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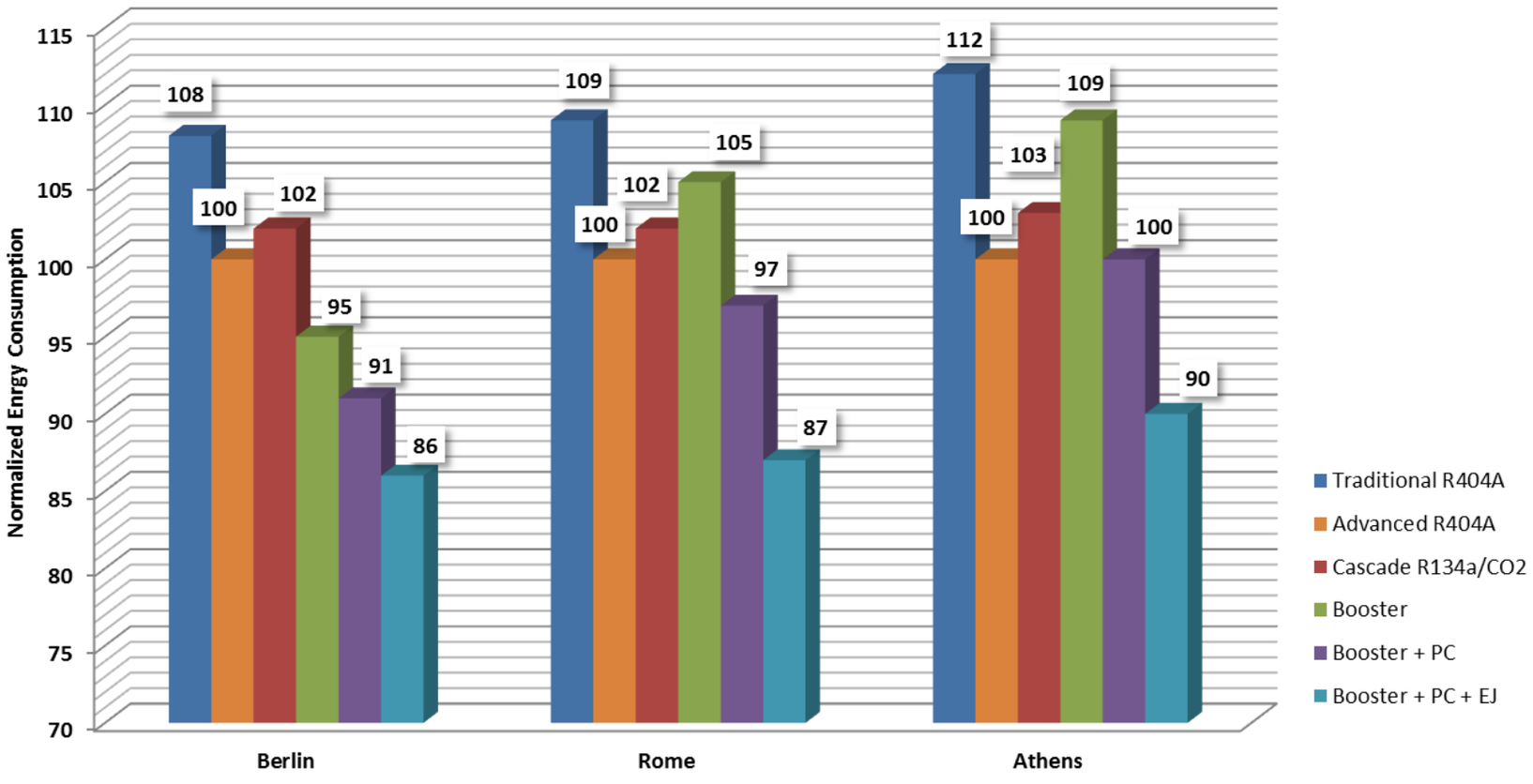
Efficiency in warm climate

Performance analysis



Normalized Energy Consumption (Advanced R404A)

		Abs	%
Berlin	Traditional R404A	108	8%
	Advanced R404A	100	
	Cascade R134a/CO2	102	2%
	Booster	95	-5%
	Booster + PC	91	-9%
	Booster + PC + EJ	86	-14%
Rome	Traditional R404A	109	9%
	Advanced R404A	100	
	Cascade R134a/CO2	102	2%
	Booster	105	5%
	Booster + PC	97	-3%
	Booster + PC + EJ	87	-13%
Athens	Traditional R404A	112	12%
	Advanced R404A	100	
	Cascade R134a/CO2	103	3%
	Booster	109	9%
	Booster + PC	100	0%
	Booster + PC + EJ	90	-10%

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Energy saving effect of ejector technology

Applications in heating and cooling

DENSO Europe
Masataka Imazu
Pim Vernooij
Jennifer Yun

Contact:
m.imazu@denso.nl
p.vernooij@denso.nl
j.yun@denso.nl

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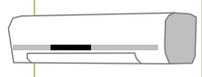
DENSO ejector product development

	‘03	’04	’05	’06	’07	’08	’09	’10	’11	’12	’13	’14	’15	→
Refrigerated truck (R404A)	● World first Ejector 					● EJECS® Ⅱ 2 temperature evaporator								
Stationary products (CO_2)	● World first CO_2 Ejector (EcoCute)  						● EJECS® Ⅱ 2 temperature evaporator (EcoCute)					● Vending machine Collaboration with Fuji Electric 		Display cabinet  Stationary AC 
						● CO_2 heat pump with ejector cycle (Stiebel Eltron WPL5N) 								
Car air conditioner (R134a)						● Cool box	● EJECS® Ⅱ (Car air conditioner)					● EJECS® Ⅱ (STEP2)		

World first mass production type ejector was released in 2003

m.imazu@denso.nl
p.vernooij@denso.nl
j.yun@denso.nl

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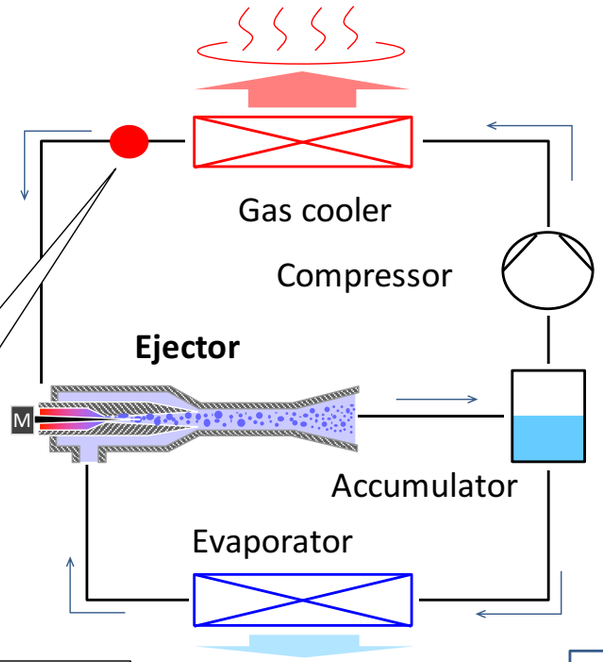
New control scheme

Conventional

■EcoCute



Control high pressure for heating

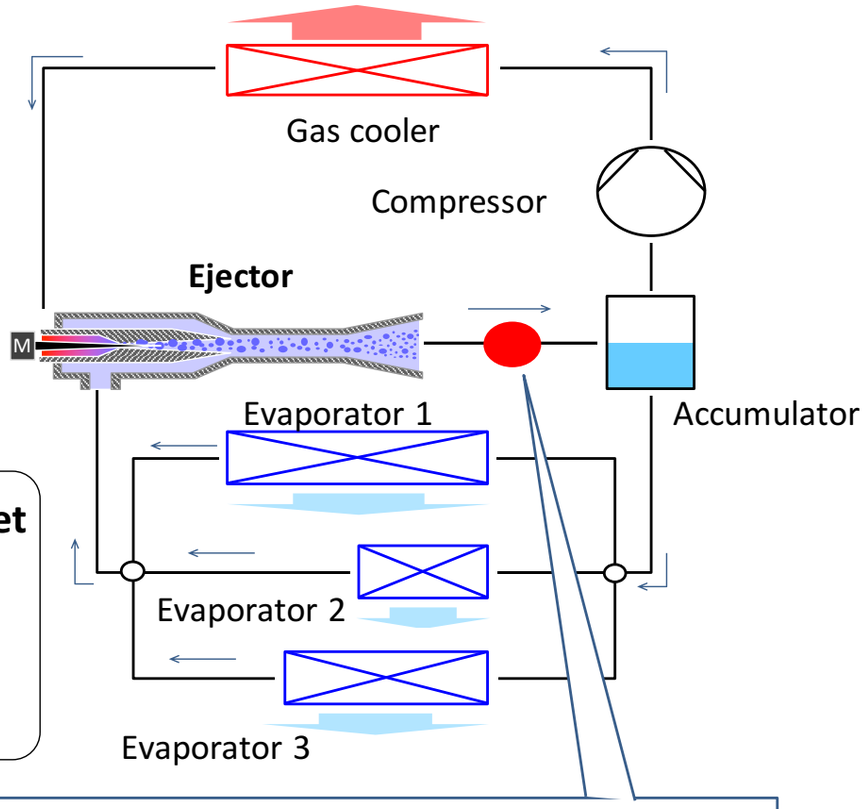
Developed

■Vending machine

Issue

Each evaporator outlet temperature are different

Poor response



Control low pressure by monitoring ejector outlet temp.

Stable refrigerant cycle control and COP improved was achieved

p.vernooij@denso.nl
j.yun@denso.nl

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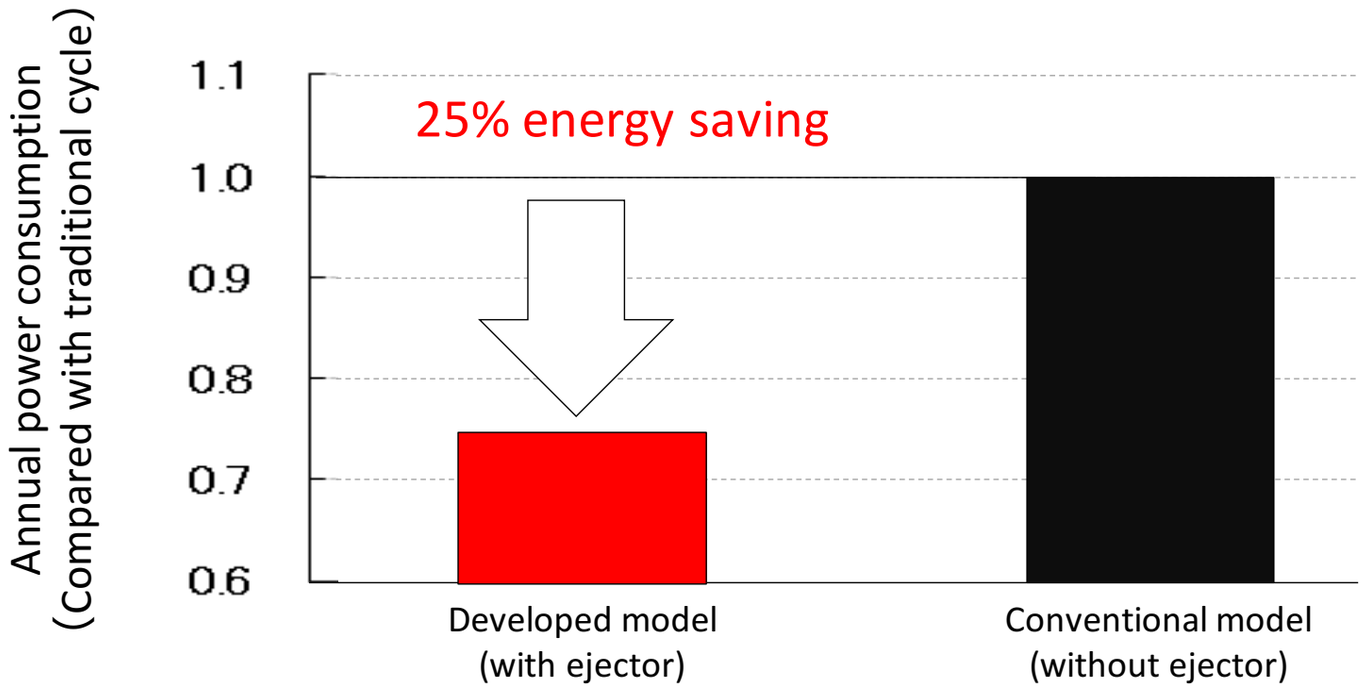
Energy saving effect



Measuring condition :
JIS B 8561 : 2007

25% energy saving was achieved by ejector
→Top class energy saving comparable to HFO machine !

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j.yun@denso.nl

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Frigo-Consulting

CO_2-Refrigerating Systems for southern climate

Jonas Schoenenberger

19. April 2016

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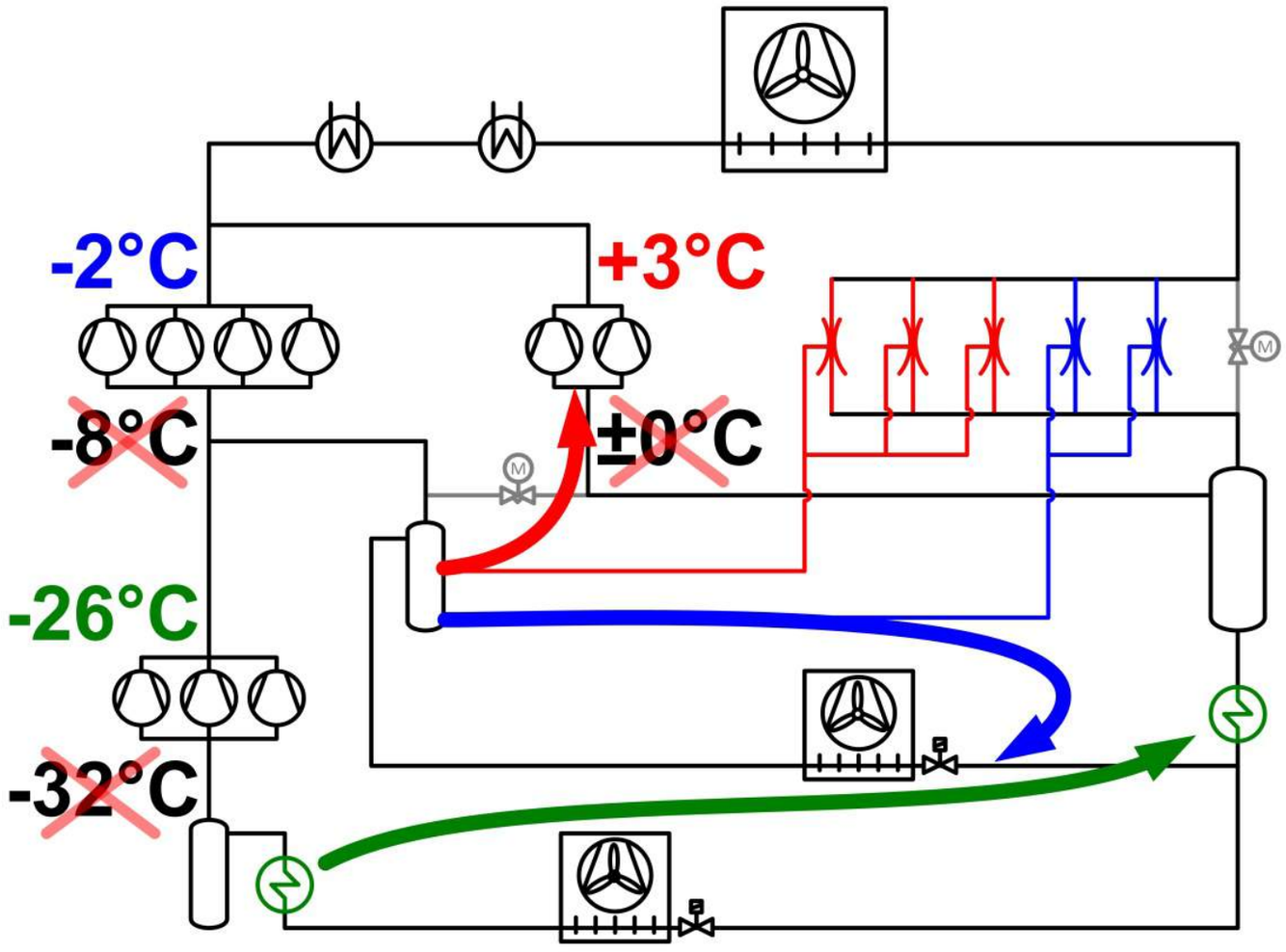
Migros Mythencenter, Switzerland

- Total sales area: 5’250 m^2
- Total length of cabinets: 135 m
- Medium temperature cabinets without glass doors
- Walk-in-cooler/freezer: 9
- Medium temperature capacity: 2 x 100 kW
- Low temperature capacity: 2 x 30 kW
- 2 identical racks
  - Unique possibility for energy benchmarking
  - Supported by Swiss federals for energy research

Source: Genossenschaft Migros Luzern

Efficiency increase



Benchmark power consumption:
rack with parallel compression

Liquid ejector	6-10%
Vapour ejector	5-8%
Heat exchanger	4-7%
Efficiency increase	**15-25%**

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ENGINEERING TOMORROW

A case study on Ejector Efficiency based on 4 Test sites

Torben Funder-Kristensen: TFK@DANFOSS.COM

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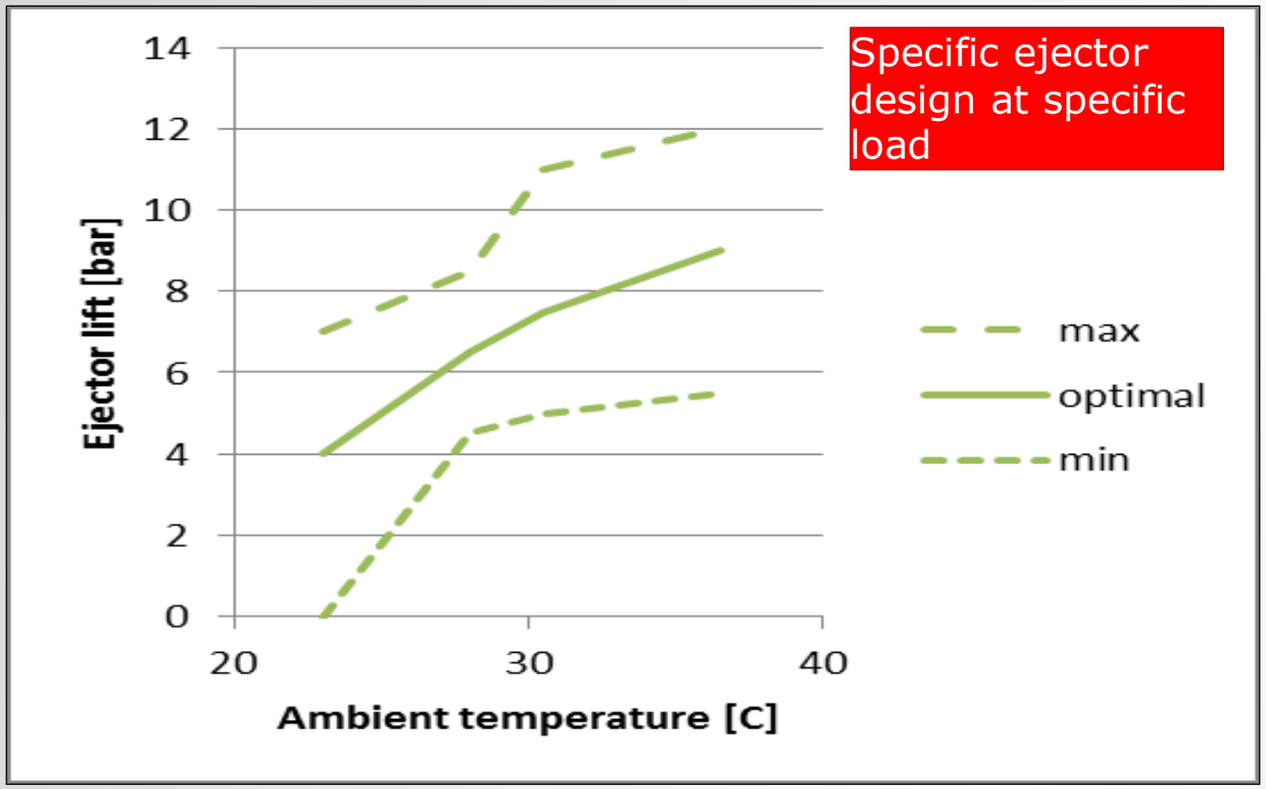
The test of Ejectors – how to evaluate



- Variable capacity Ejector is a new component
- System design needs to adopt to the Ejector nature
- Ejector performance* is linked to design, ambient condition and pressure lift

$$\eta_{ej} = \frac{(\dot{W}_{actual})}{(\dot{W}_{is-exp})}$$

$$\varepsilon = \frac{\dot{m}_{suction}}{\dot{m}_{motive}} = \eta_{ej} \frac{(w_{is-exp})}{(w_{is-comp})}$$

*Definitions according to Ebele (2008)

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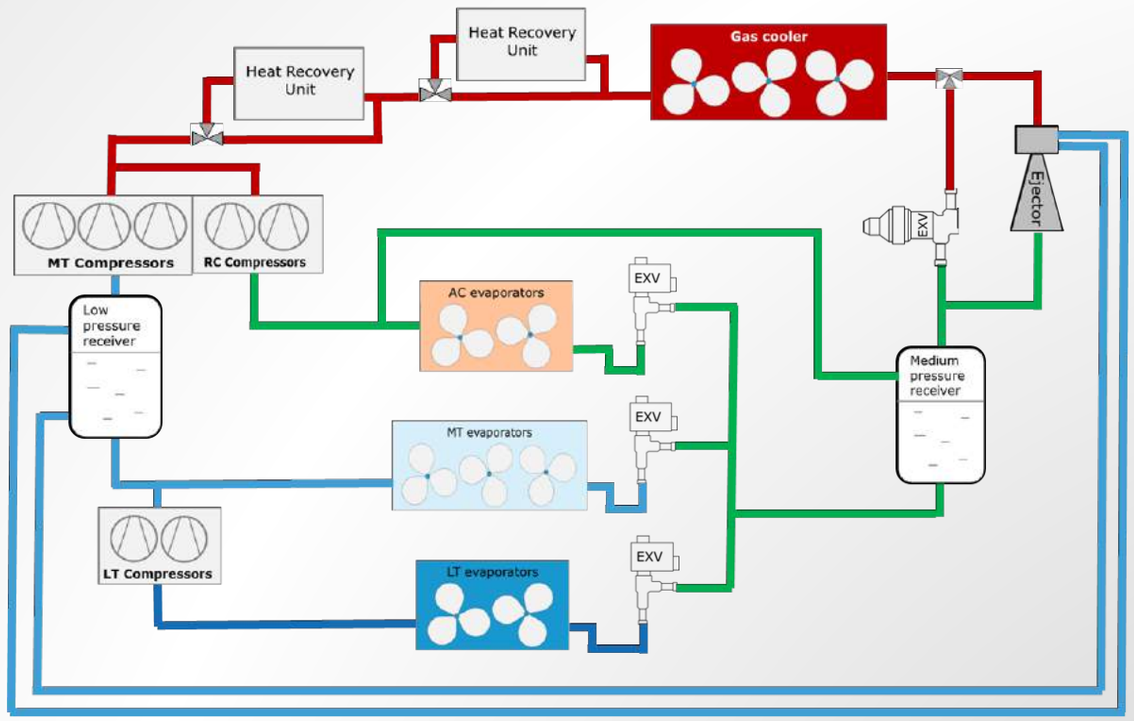
4 Test Installations

Full system description



Plant	Location	Out door temperature	Evaporators	AC [%mt]	Size [MT kW]	Heat recovery
1	SE-EU	12	Flooded*	No	163	Y
2	W-EU	20	DX	No	225	N
3	S-EU	30	Flooded*	350%	70	N
4	Africa	27	DX	No	120	N

* Only the gas ejector part is evaluated

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Conclusion

- 4 test sites show that the ejectors are working as expected under varying real life conditions in different set-ups.
- Ejector efficiencies up to 30 % over several hours has been achieved in real supermarkets
- Plant design must account for ejector performance characteristics.
  - Compressor capacity to allow for ejector usage
  - Pressure difference to receiver to be lowered to optimise the ejector
  - Oil return design must be evaluated carefully
- Calculations on energy consumption (only vapour ejector part) show:
  - 4% Energy Efficiency improvements for refrigeration systems at 27 °C ambient
  - 10-15 % Energy Efficiency improvements for the refrigeration part of the system benefiting from AC at ambient temperature of 30 °C

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ENEX – CO_2 REFRIGERATION IN SOUTHERN EUROPE

ENEX – Innovation using "only CO_2" – since 2004
First on the market with:

- Auxiliary compressors - 2008
- Liquid ejector - 2012
- Vapor ejectors - 2013

After extensive development and testing now available refrigeration systems suited for Italy, Spain, Portugal, Greece

- Longest experience in CO_2 refrigeration
- Wide range of heat pumps and refrigeration units

Already present in Spain with heat pumps in partnership with Eurofred. Also in commercial refrigeration market with Drava & Neva, refrigeration units with enjector®

EUROFRED
being efficient

enex
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CO_2 AS NATURAL REFRIGERANT – DIRECT USE FOR SPACE HEATING AND COOLING

Water is a safe secondary fluid but it entail:

- Loss of efficiency
- Risk of corrosion
- Significant cost

The use of CO_2 as refrigerant allows:

- Direct heating/cooling
- Space saving – no need of space for water reservoirs & pumps
- Cost reduction
- Efficiency increase
- Reduction of time for installation
- No risk of corrosion in high pressure heat exchanger

The solution can be used for any capacity but it is the optimal solution for small plant.

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CASE STUDY

Place of installation: Trento province (I)
Max temp in summer: 35C°
Min temp in winter: -15C°
Refrigeration capacity: 95 kW
Air Conditioning: 200 kW
Heating duty: 150 kW
Sanitary hot water : 40 kW

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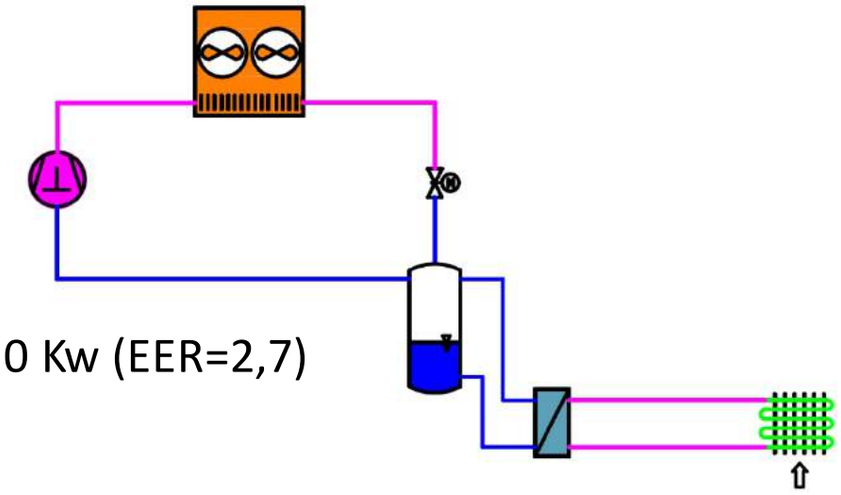
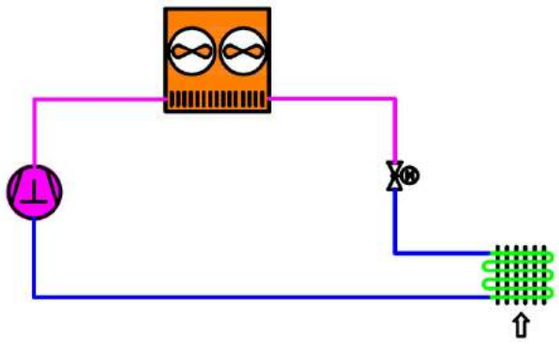
EFFICIENCY COMPARISON - SUMMER

External temperature: +32°C; AC duty: 100 kW



El. Power in$_{AC}$: 37,0 Kw (EER=2,7)



El Power in$_{AC}$: 28,6 kW (EER=3,5)

~ -20%

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Panasonic BUSINESS

MORE THAN 20% ENERGY SAVINGS COMPARED TO R404A

CO_2 GWP: 1

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Introduction of Panasonic CO_2 refrigeration system

Apr. 20th 2016

Panasonic Corporation Appliances Company
Refrigeration and Air-Conditioning Devices Business Division
Hidekazu Tachibana

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Field Test performed in Denmark

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Field Test performed in Denmark

Installation

Freezer

Size room	4.0m x 4.5m x 2.4m

Freezer for low temperature.
Capacity need 2 x 2HP units.

Cold Room

Size room	4.0m x 4.5m x 2.4m

Cold room for medium temperature.
Capacity needed 1 x 2HP unit.

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Field Test performed in Denmark

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Compressor Technology Options Supporting R744 System Design for Diverse End-User Needs

Venugopal Kandi
Product Manager Refrigeration Marketing
Emerson Climate Technologies GmbH
52076 Aachen
Germany

venugopal.kandi@emerson.com
+49 172 3959 437

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Different R744 System Architecture Types Serving Diverse End User Needs

Cascade System (Scroll / Scroll)

1

RIVACOLD MASTERING COLD

- Fully Natural R290/R744
- Cold & Warm Climates
- Compact Design

Investment & Operational Cost
Cold Room
Convenience Stores

Booster System (Semi / Scroll)

2

EDEKA

- Booster Semi / Scroll
- Digital Modulation
- System Efficiency

Residential Areas
Small & Big Stores
Investment & Operational Cost

Booster System (Semi / Semi)

3

alepa

- Booster Semi / Semi
- High Design Pressure
- CoreSense Technology

Resilience
Preventive Maintenance
Faster Concept to Production

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Natural Refrigerant Cascade System for a Cold Room Application in a Supermarket

End User Need:

- Natural solution for low-temperature cold rooms
- Centralized booster system is not an option, as Integrals are used for medium-temperature cases
- Installation accross Europe - both in cold and warmer regions
- Solution needs to be cost effective, compact & efficient

Potential Solutions:

- R744 transcritical condensing unit with 2-stage compressors OR
- R290 / R744 cascade system

EMERSON Climate Technologies ⟺ RIVACOLD MASTERING COLD ⟺ Supermarkets

業務用冷凍ケーススタディ

R290/R744 Cascade System – Innovative System Design for Cold Rooms

System Design

- The application demands a compact system and natural refrigerant for both high / low side
- R290 on high side condenses R744 on low side
- Split system design concept to isolate R290 module
- Auxiliary unit integrated in the R290 main refrigerant circuit
- New system concept for the cold room application (patent pending)



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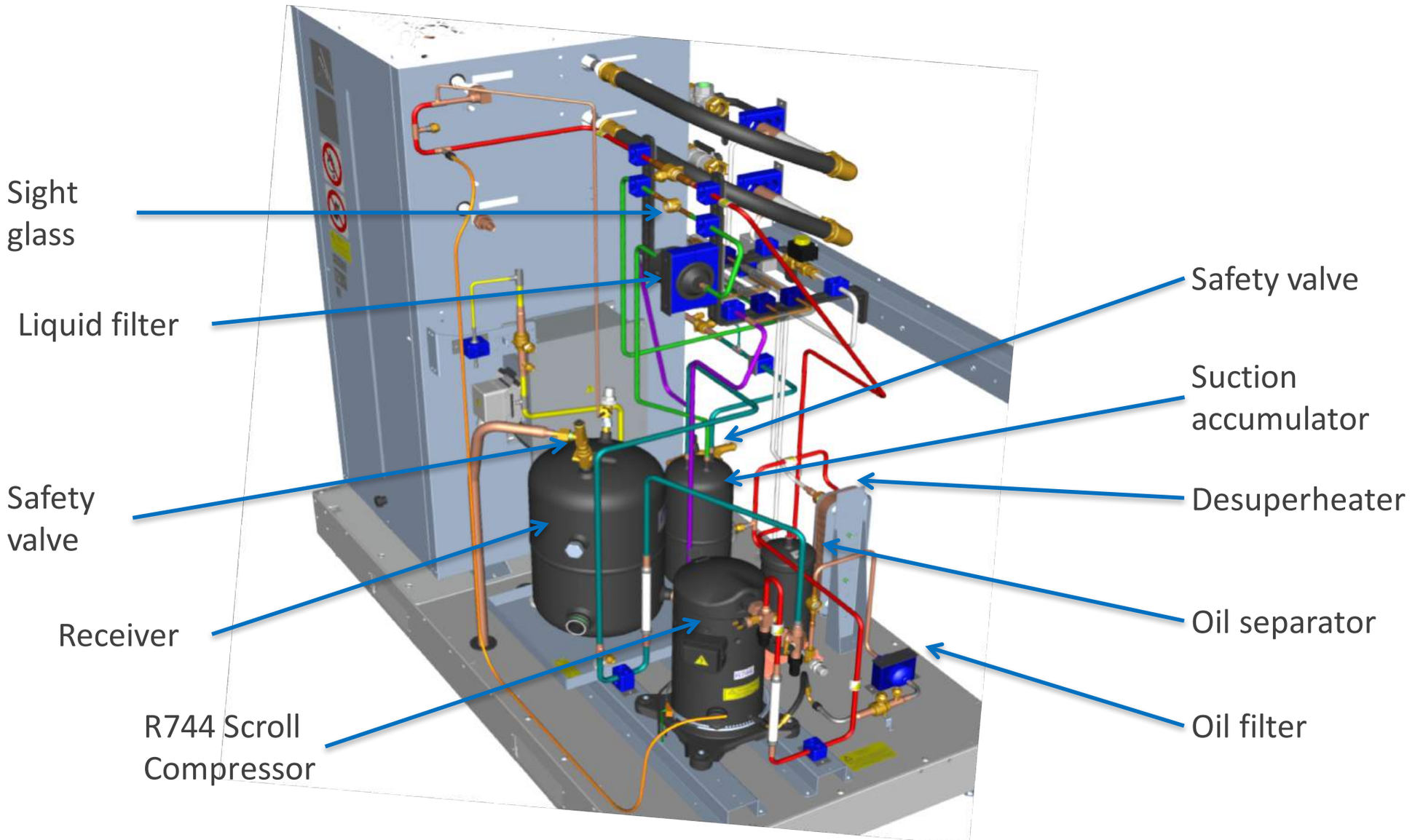
RIVACOLD MASTERING COLD

R744 Module Design In The Cascade System



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Installation, Benefits & Next Steps

Installation

- Installations in countries such as Germany and Switzerland
- First installation in June 2015
- R290 refrigerant stays outside cold room

Benefits

- Reduced investement costs in comparison to transcritical R744 condensing unit
- The system can be used in both cold and warmer regions
- Improved performance even in warmer regions as the R744 circuit always runs in subcritical mode

Next Steps

- Realize a system for medium-temperature cold room (evaluation phase)

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green . freshness . worldwide AHT

PROPANE
Solutions for the Supermarkets and Discounters

AHT Cooling Systems

Reinhold Resch

Head of R&D

Barcelona, 20. April 2016

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green.freshness.worldwide AHT

Supermarket installations worldwide

R290 is the **best** **alternative** **refrigerant**

France

Denmark

KOREA

Sweden

Plug in solutions

We already did it !

AHT's cabinets in the market with R290

730.000 worldwide

3.500 Thailand (hot country)

700.000 in Europe's supermarkets

aht.at

業務用冷凍ケーススタディ

ATMO sphere EUROPE solutions for europe natural refrigerants

green . freshness . worldwide AHT

AHT CASE STUDY

VENTO GREEN

- Multi deck for Supermarkets and Discounters
- Plug in solution with PROPANE
- Refrigeration quantity > 150g
- Risk assessment
  - for all steps all over the life time
- TÜV Süd, KISC, VDE

GOAL for 2015

- First installation of VENTO GREEN in the market

業務用冷凍ケーススタディ

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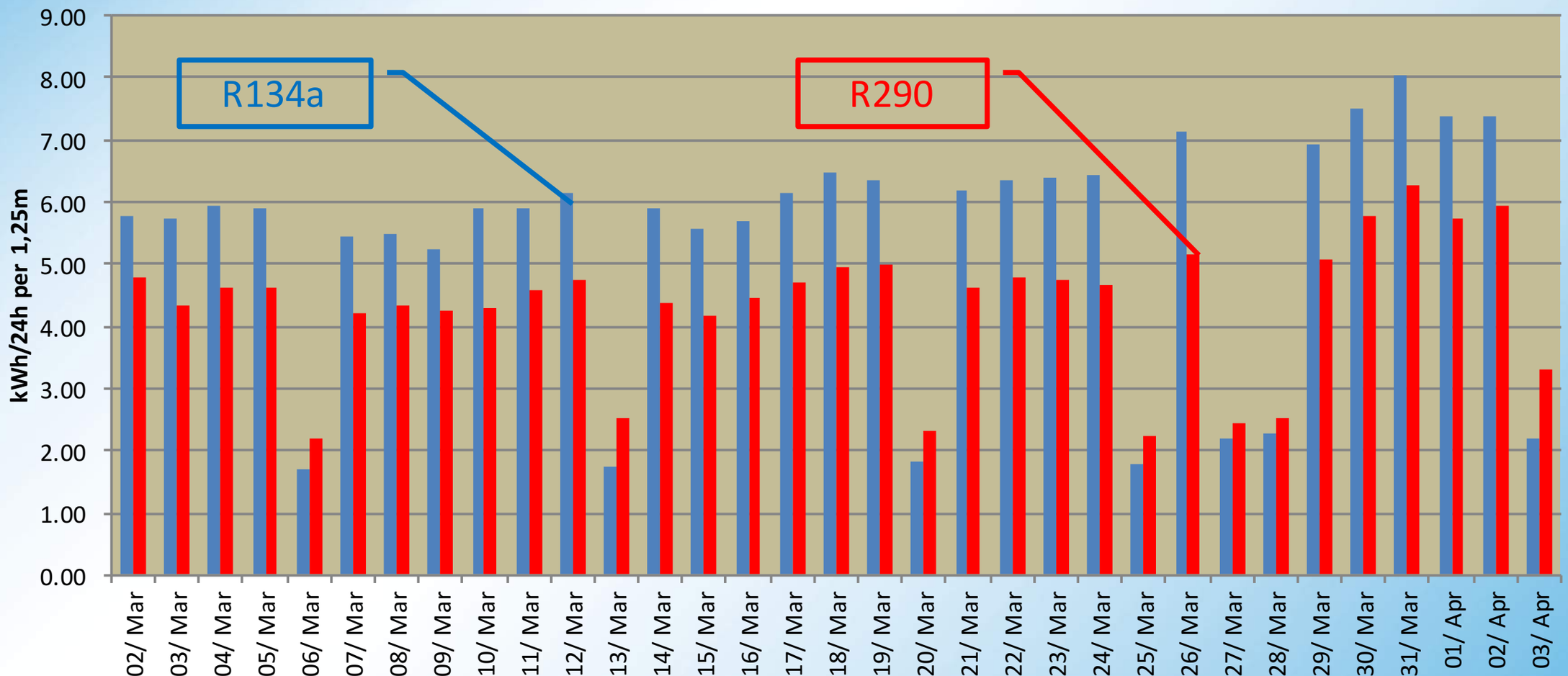
green.freshness.worldwide AHT

Energy consumption VENTO R134a – VENTO GREEN



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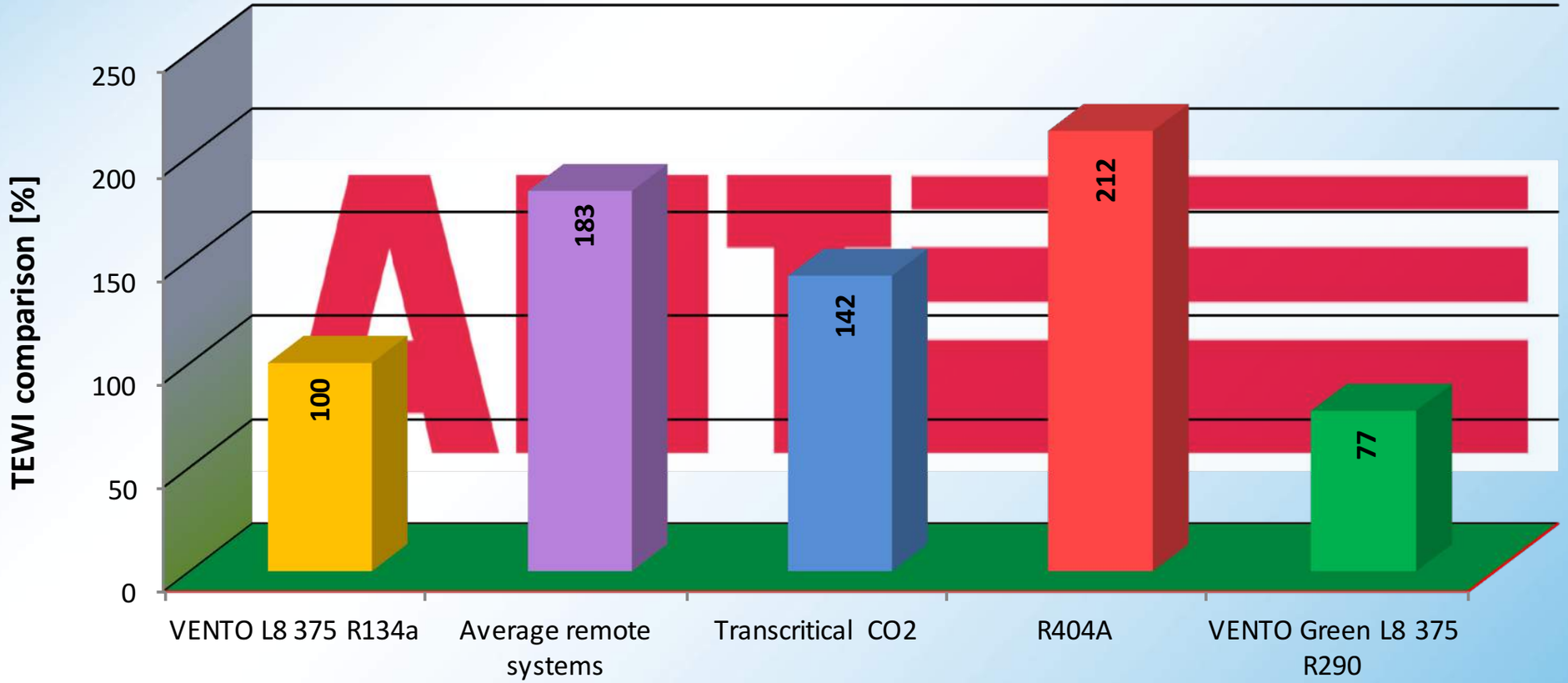
TEWI comparison

Market installation



業務用冷凍ケーススタディ

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CO_2 Plug-in cabinets for supermarket

The ISA experience

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HFC phase out

ISA your visible value

60% Isa cabinet range is now operating natural refrigerant

15% of it using CO_2

HydroCarbon

CO_2

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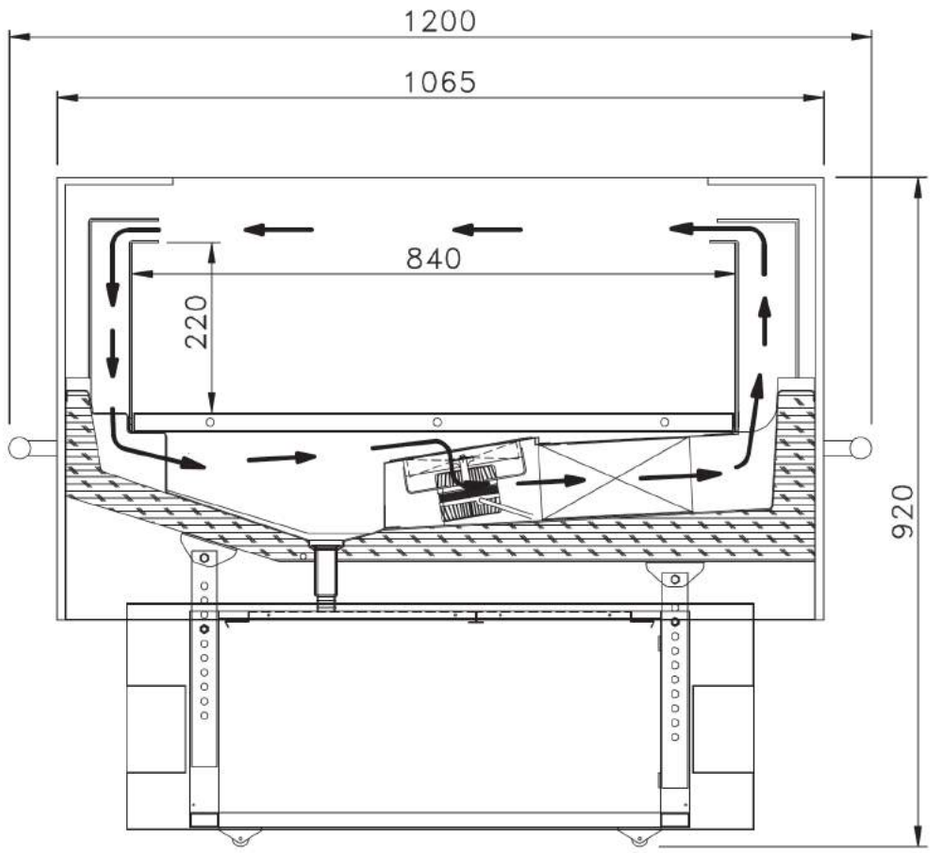
Case Study #2

ISA your visible value

spot merchandiser cabinet: comparative test



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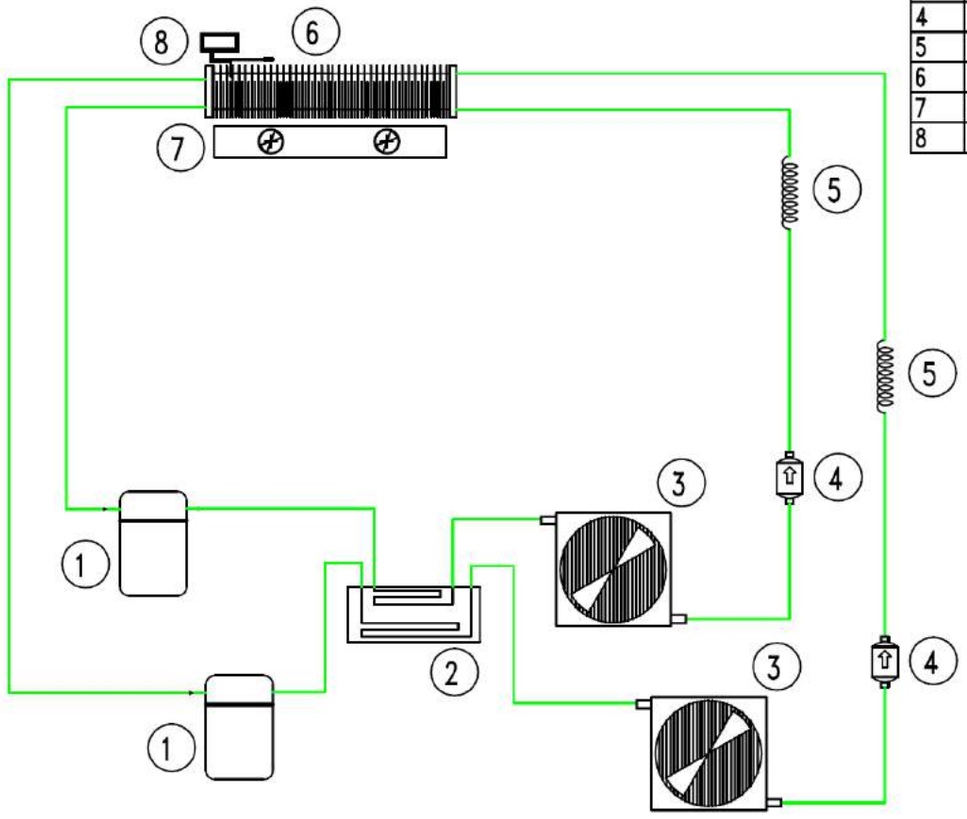
Case Study #2

ISA your visible value

spot merchandiser cabinet: R290



1	COMPRESSORE \ COMPRESSOR
2	VASCHETTA ASCIUGA CONDENSA \ DRY PAN
3	CONDENSATORE \ CONDENSER
4	FILTRO \ FILTER DRYER
5	CAPILLARE \ CAPILLARY
6	EVAPORATORE \ EVAPORATOR
7	VENTILATORI \ FANS
8	CENTRALINA ELETTRONICA \ ELECTRONIC BOARD

cabinet class 3M0 EN 23953

spot merchandiser R290			
component	quantity	type	technical details
Compressor	**2**	Hermetic	2 x 10 cc
Evaporator	1	Tubes and fins	
Evaporator fan	2	EC	low energy consumption
Condenser	**2**	Tubes and fins	
Condenser fan	2	EC	low energy consumption
SLHEx	2	Suction/cap. tube	
Driptray heater	2	hot pipe	
Refrigerant Charge	2 x 135	R290	
Energy consumption		14% less of R404A	

業務用冷凍ケーススタディ

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Case Study #2

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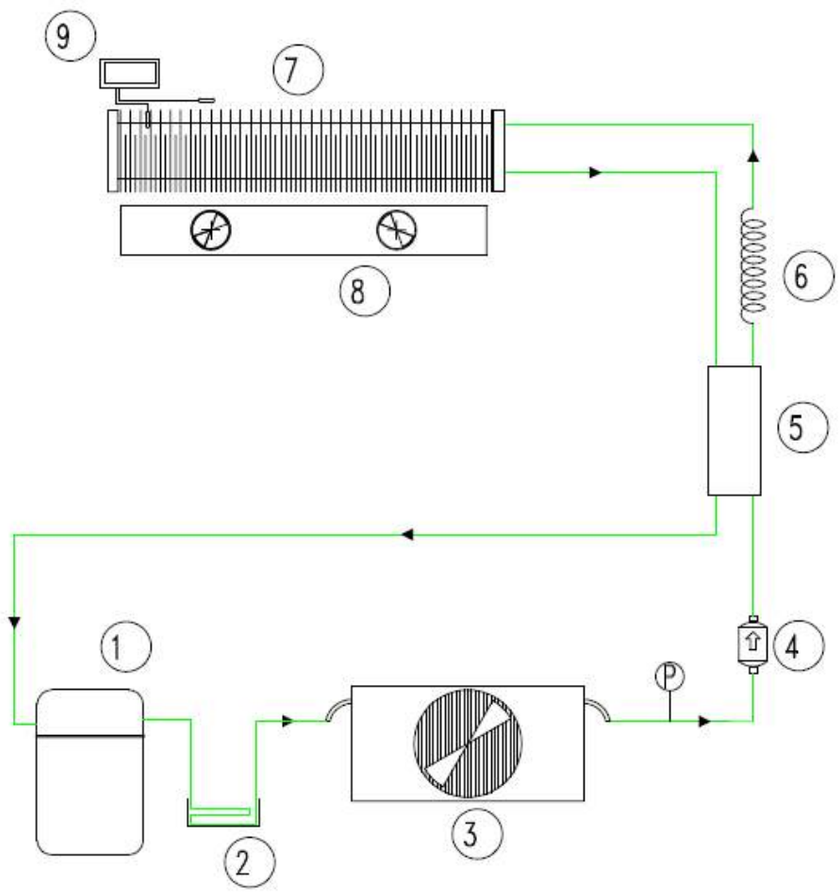
spot merchandiser cabinet: R744 (CO_2)



1	COMPRESSOR
2	DRIP TRY
3	GASCOOLER
4	DRYER FILTER
5	SLHEX
6	CAPILLARY PIPE
7	EVAPORATOR
8	FANS
9	ELECTRONIC DEVICE
P	PRESSURE SWITCH

cabinet class 3M0 EN 23953

spot merchandiser R744 (CO_2)			
component	quantity	type	technical details
Compressor	**1**	Hermetic	2,5 cc
Evaporator	1	Tubes and fins	
Evaporator fan	2	EC	low energy consumption
Condenser	**1**	Tubes and fins	
Condenser fan	**1**	EC	low energy consumption
SLHEx	1	Suction/cap. tube	
Driptray heater	1	hot pipe	
Refrigerant Charge	650 gr	R744	
Energy consumption		16% less of R404A	

業務用冷凍ケーススタディ

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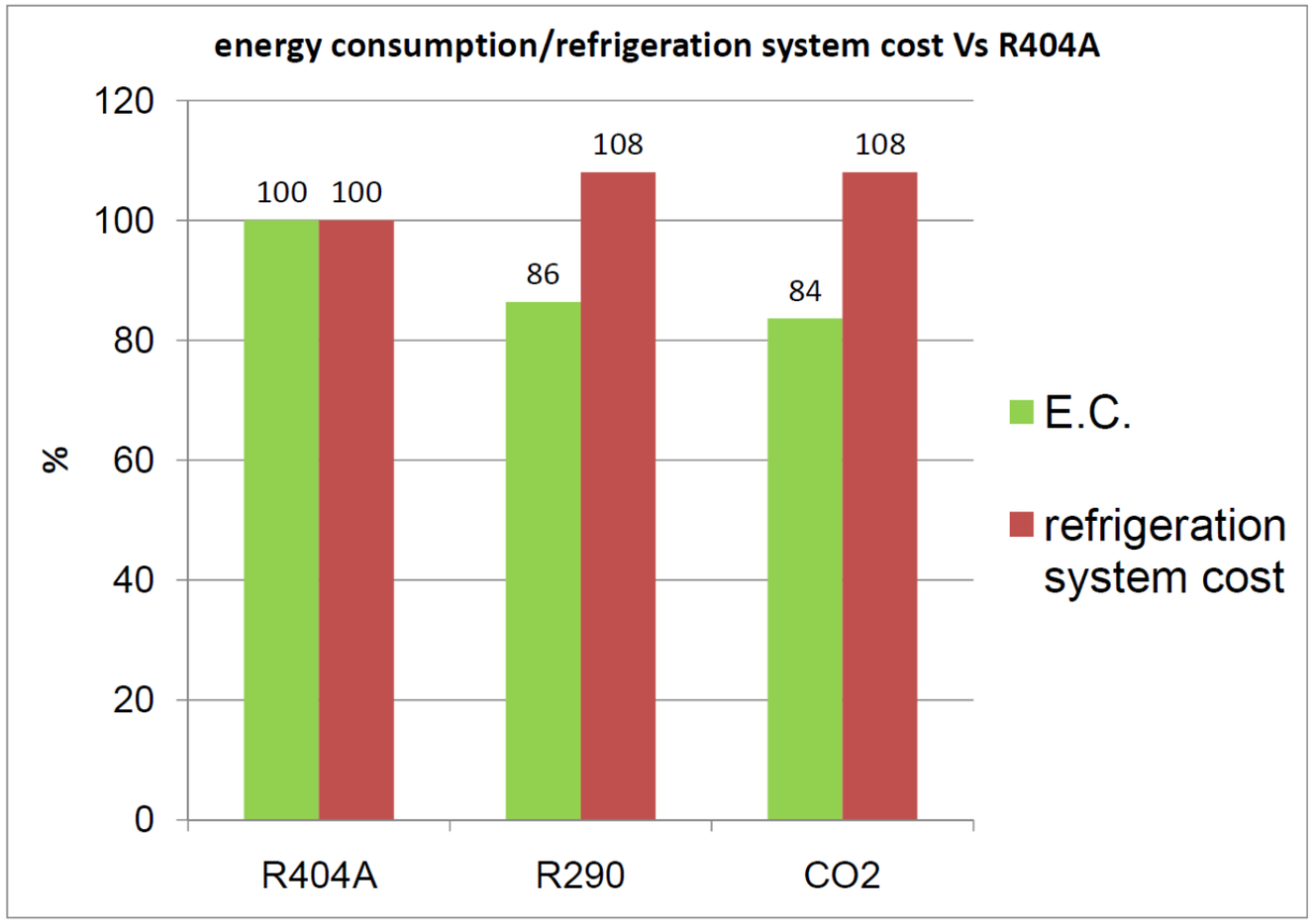
Case Study #2

ISA your visible value

spot merchandiser cabinet: the final selection



Why different cost compare to R404A?

R290 → Because of the double compressor

CO_2 → Because of the heat exchanger

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Use of transcritical CO_2 in industrial applications

ADVANSOR by Hill PHOENIX

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Advansor solution

- Advansor L4x3-2R
  4 Bitzer MT compressors, 120 kW @ -10°C
  3 Bitzer LT compressors, 58 kW @ -35°C
  2 x 130 litre receivers
- + Heat recovery for space heating
- + Separate chiller module (glycol/seawater +2/-2°C)

"We found it attractive to be able to utilize also the waste heat for heating purposes and were even granted with a subsidy from the local energy provider by choosing this solution" S. Wittrup

産業用冷凍ケーススタディ

Conclusions

- **6% lower energy consumption than HFC (expected)**
- **Lower running costs**
- **Typically HFC is no longer wanted**
- **Alternatives to NH3 for small medium sized needed**

- **Our industrial team working on (examples)**
  - **3.2 MW vegetable factory**
  - **200, 500, 950 kW warehouse**
  - **200 kW ice rink**
  - **600 kW professional kitchen**
  - **1.2 MW food factory**

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MYCOM

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faster to market
natural refrigerants

Interactive workshops bringing together decision makers from industry and government to change the future of natural refrigerants.

VII Congress

IMPROVING ENERGY EFFICIENCY & REFRIGERATION LATEST TECHNOLOGIES WITH NATURAL REFRIGERANTS

FIELD CASE OF "NATURAL 5 REFRIGERANTS" TECHNOLOGY

MAYEKAWA´S HIGH PRESSURE NH3 HEAT PUMP FOR HOT WATER PRODUCTION.

19 – 20 . IV 2016. Barcelona, Spain

MAYEKAWA

Presented by Pedro Nogal, MAYEKAWA S.L.

産業用冷凍ケーススタディ

NATURAL 5 REFRIGERANTS

NH3 HIGH PRESSURE APPLICATION
TO HEAT RECOVERY FOR
HIGH TEMPERATURE HOT WATER

INTRODUCTION

REQUEST	**333 m3/day of hot water +65ºC**	**Hot water for production and cleaning process.**
HOT WATER	~ +14ºC	Reduce boiler gas consumption NH3 heat pump (ODP & GWP=0) Tc=+68ºC (31,6 bar) Use 'waste heat' <> condensor load
NH3 FLOW AVAILABLE	0,915 kg/s	
SELECTION	NH3	+29/+68ºC NH3 : flooded system with HS compressor unit.

産業用冷凍ケーススタディ

OPERATION SAVINGS

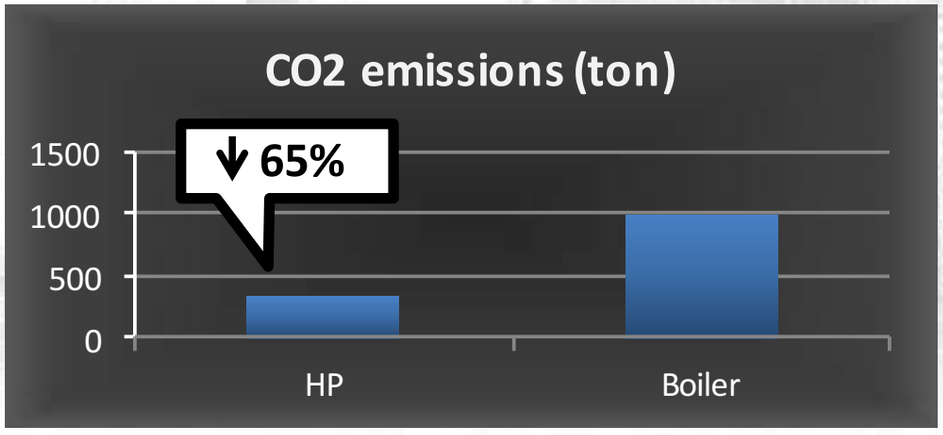
HOT WATER HEAT PUMP

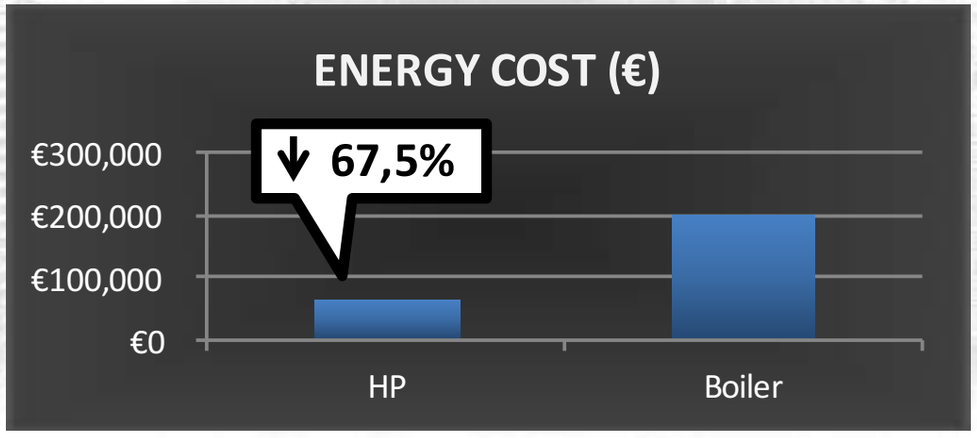
333 m3/day from +14ºC to +65ºC = 19.747 kWh/day

NATURAL 5 REFRIGERANTS

NH3 HIGH PRESSURE APPLICATION
TO HEAT RECOVERY FOR
HIGH TEMPERATURE HOT WATER

	HEAT PUMP	BOILER
COP (Coefficient of Performance)	6,02	0,90
Energy consumption (kWh/day)	3.328,5 KWh/day	21.942 Kwh/day
Annual energy consumption (KWh/260days)	865.410 kWh/year	5.704.920 kWh/year 490.535 m3 Natural Gas
Energy prices	0,075 €/kWh	0,035 €/kWh
Energy costs	64.906 €	199.672 €
CO2 emissions	346 ton	1.006 ton





産業用冷凍ケーススタディ

ZANOTTI S.p.A

Experience in compact system with R290

Monoblocks units for coldstores

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Models available with R290:

Semihermetic compressor – Water cooled condenser

Model	Cool. Cap. Watt	Charge grams	V min m3
MSB135N--Y	2420	300	37,5
MSB135T--Y	3550	300	37,5
BSB135T--Y	2600	250	31,3
MAS135N--Y	2420	350	43,8
MAS135T--Y	3550	350	43,8
BAS135T--Y	2600	300	37,5

SB

AS

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Reference installation

Waitrose

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AS wall mounted
R290 / R1270

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Second case: Vietnam case hystory: UNIDO project

With this second project, under UNIDO and Vietnam government agreement, our company has verified the possibilities to use the natural refrigerants in fishery storage in different places :

For this we have developed a special wall mounted units (with R290), for various cold-rooms for frozen fish storage installed in Hanoi and Ho Chi Minh.

This projects started in October 2014, in September 2015, 25 units were installed in 4 different companies and these were the first results:

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Second case: Vietnam case hystory: UNIDO project

Report of three months of normal functionning from September to December 2015

The comparison is between the old plants (multicompressor system) made with R22 and new one (independent system) with R290. I summarize some paragraph from our internal report:

“All the 9 cold rooms now have much better room temperature, temperature of -20°C is easy to maintain even though the installed power of HC290 refrigeration equipment is only from 45% to 60% of installed power of previous R22 refrigeration equipment that had been replaced.

All the 25 HC290 refrigeration units had been succesfully installed in the four selected companies”

ヒートポンプケーススタディ

NxtHPG project

"Next Generation of Heat Pumps working with Natural fluids"

José M. Corberán

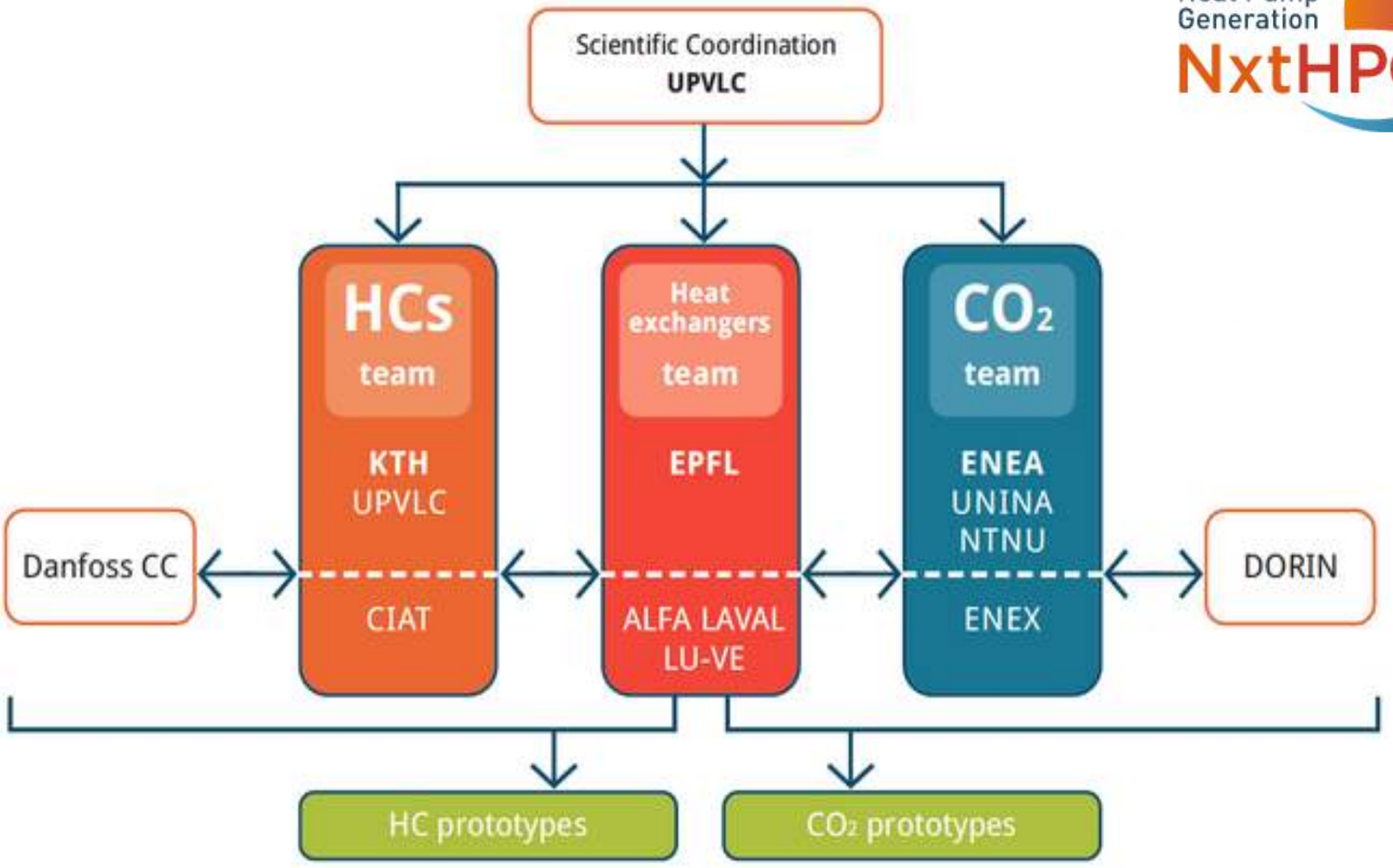
INSTITUTE FOR ENERGY ENGINEERING

Universitat Politècnica de València

ヒートポンプケーススタディ

Project Organization

Next Heat Pump Generation NxtHPG

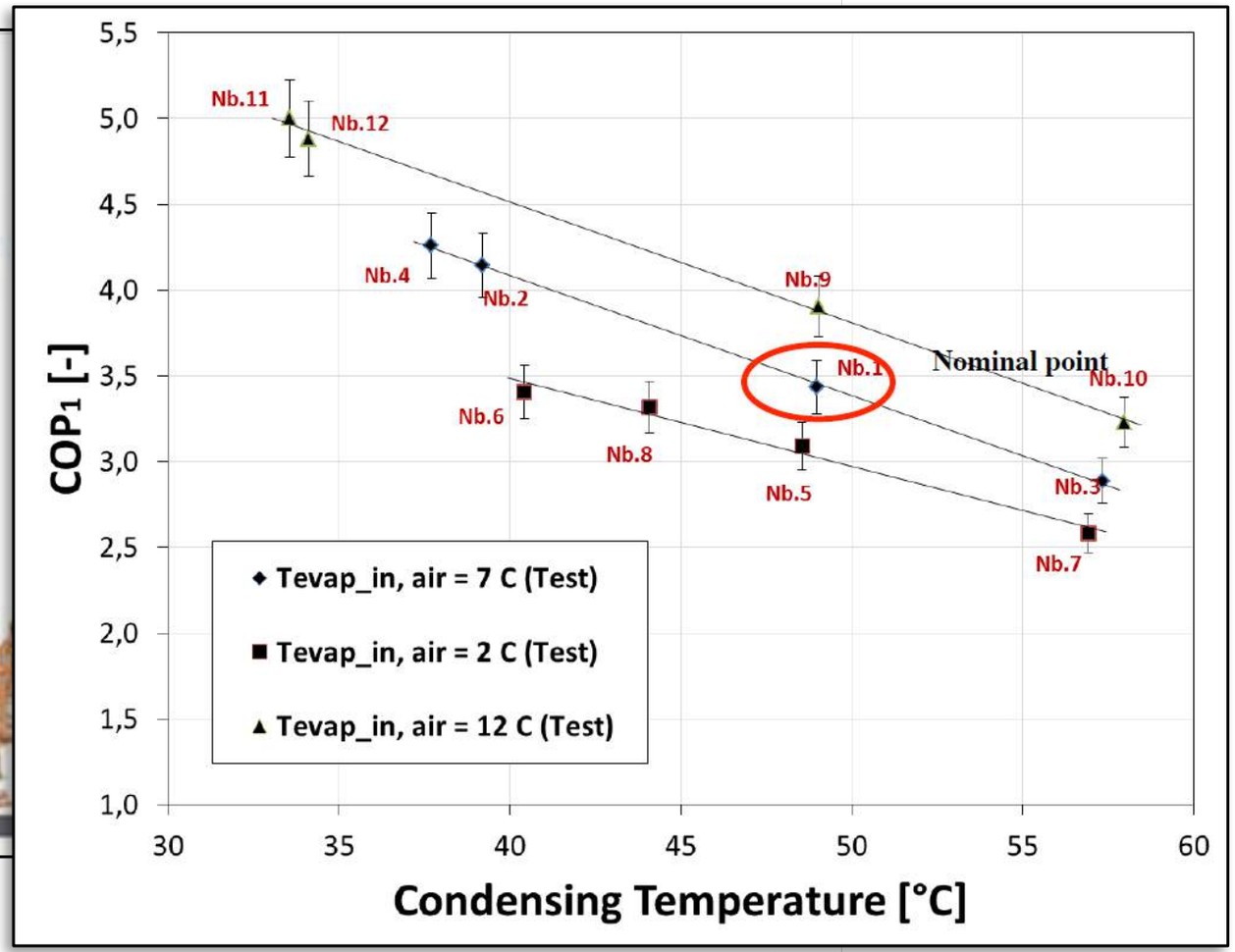


ヒートポンプケーススタディ

Prototype 1: Propane

Air to Water HP (reversible) — Tested at KTH

Case	Fluid	Source	T(°C)	Sink	T(°C)	Application	(kW)
1	HC (Propane)	Air	-10 to 35 (outdoor air)	Water	40 to 50	Heating Water production	40
					60	Low demand of Domestic hot water	

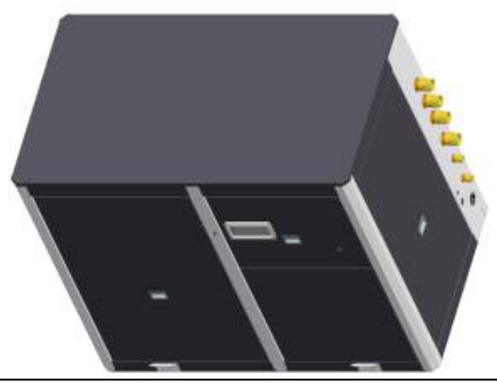


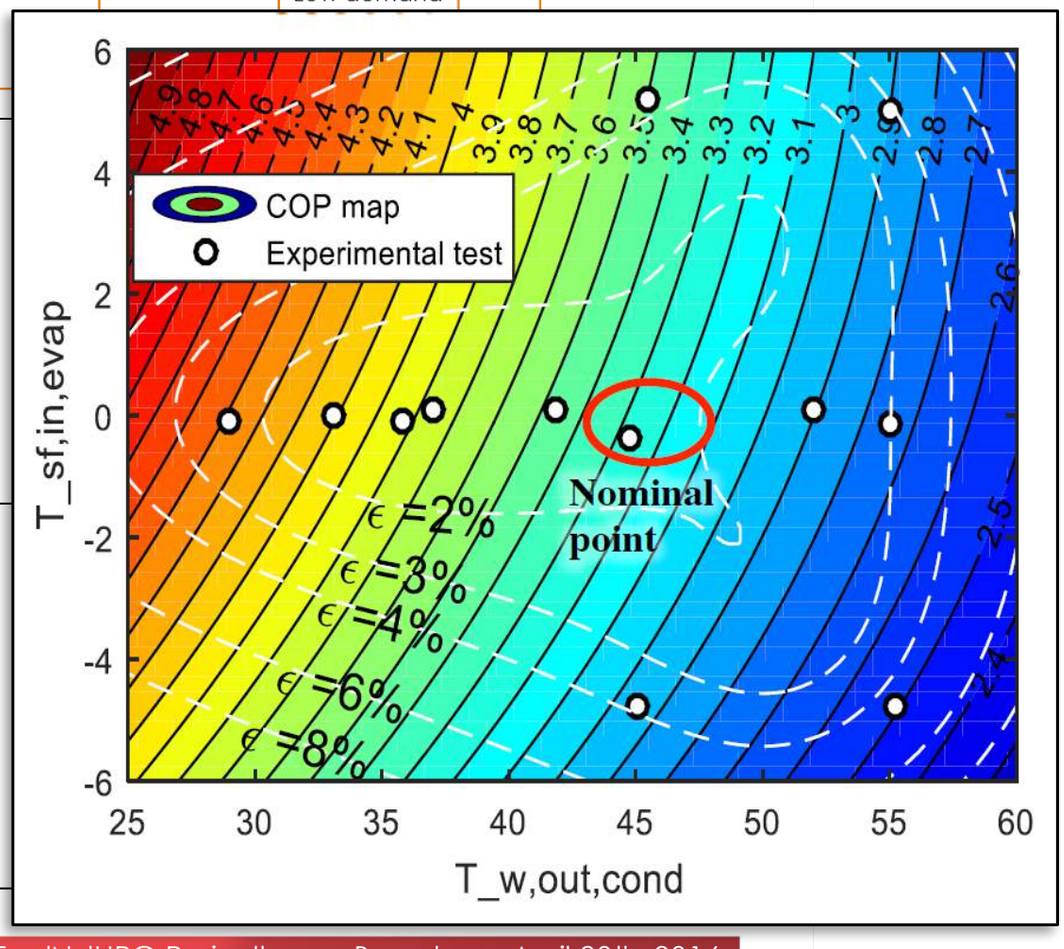
ヒートポンプケーススタディ

Prototype 2: Propane

Ground to Water HP (reversible) Tested at KTH

Case	Fluid	Source	T(ºC)	Sink	T(ºC)	Application	(kW)
2	HC (Propane)	Water (brine) from a ground coupled heat exchanger	-5 to15	Water	40 to 50	Heating water production	60
						Low demand	





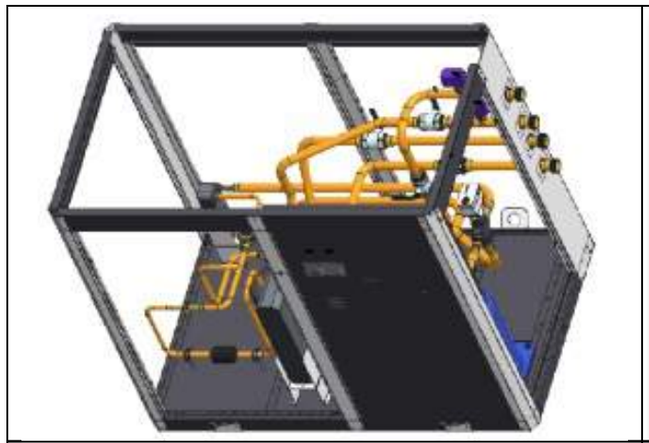
ヒートポンプケーススタディ

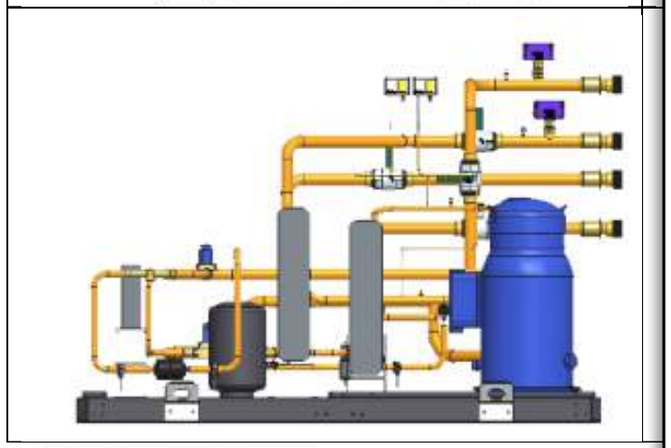
Prototype 3: Propane

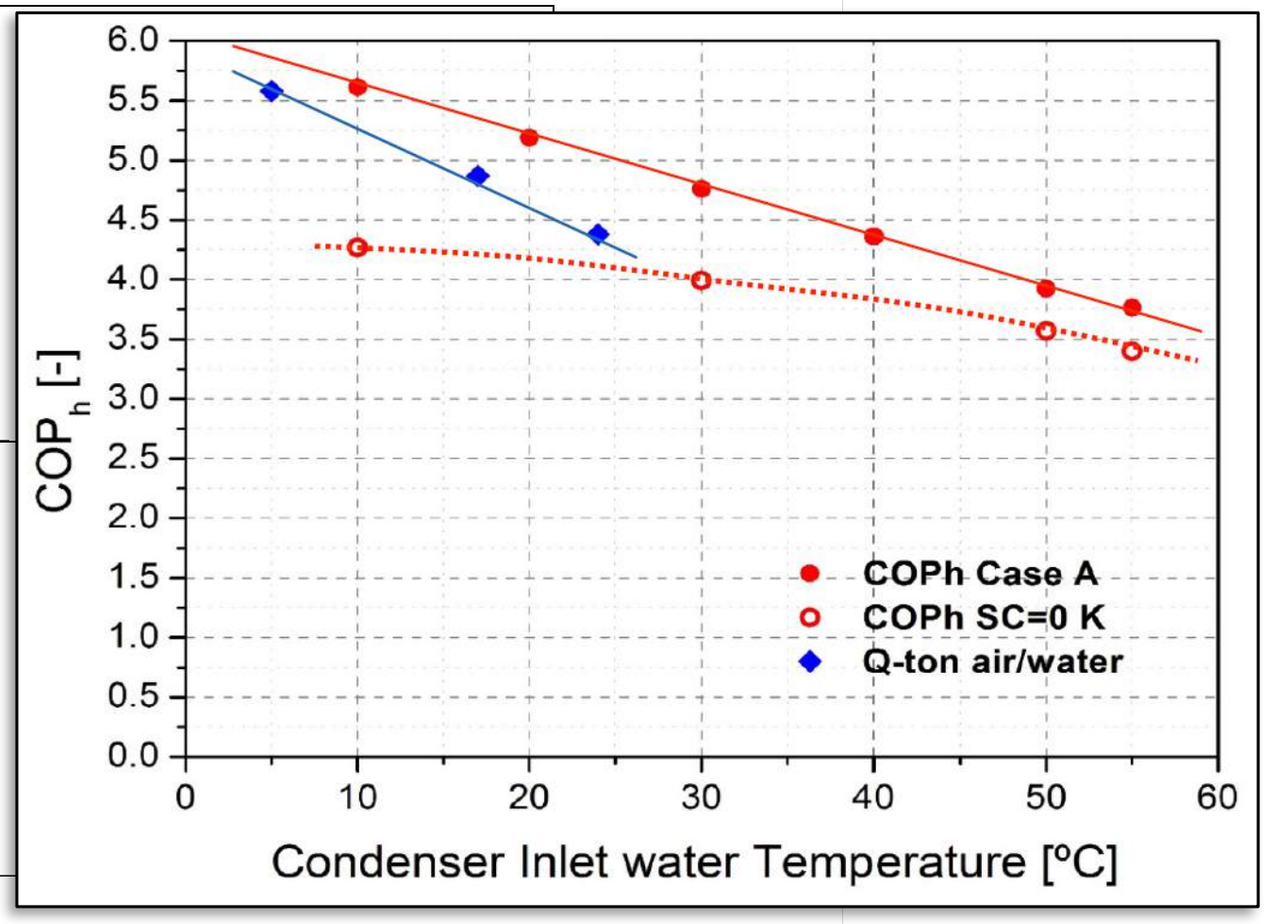
UNIVERSITAT POLITÈCNICA DE VALÈNCIA

HEAT PUMP BOOSTER – SHW Tested at UPVLC

Case	Fluid	Source	T(ºC)	Sink	T(ºC)	Application	(kW)
3	HC (Propane)	Water (Neutral loop)	10 to 15 (Sewage water) or 25 to 30 (Condensation loop)	Water	60	Domestic hot water production	50





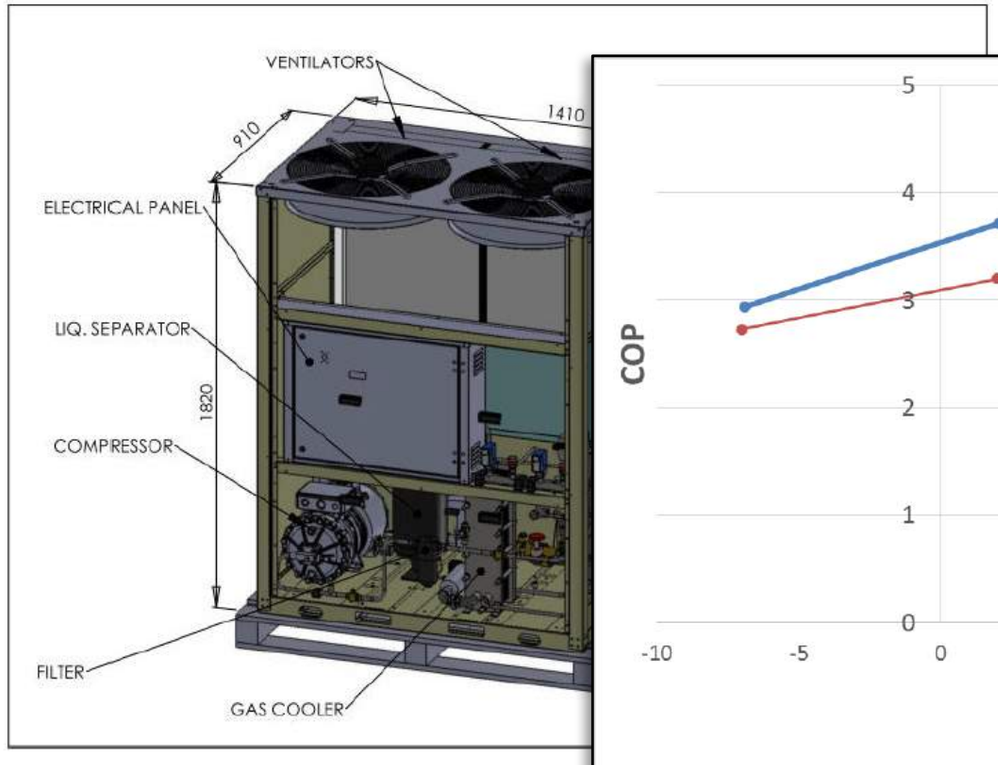


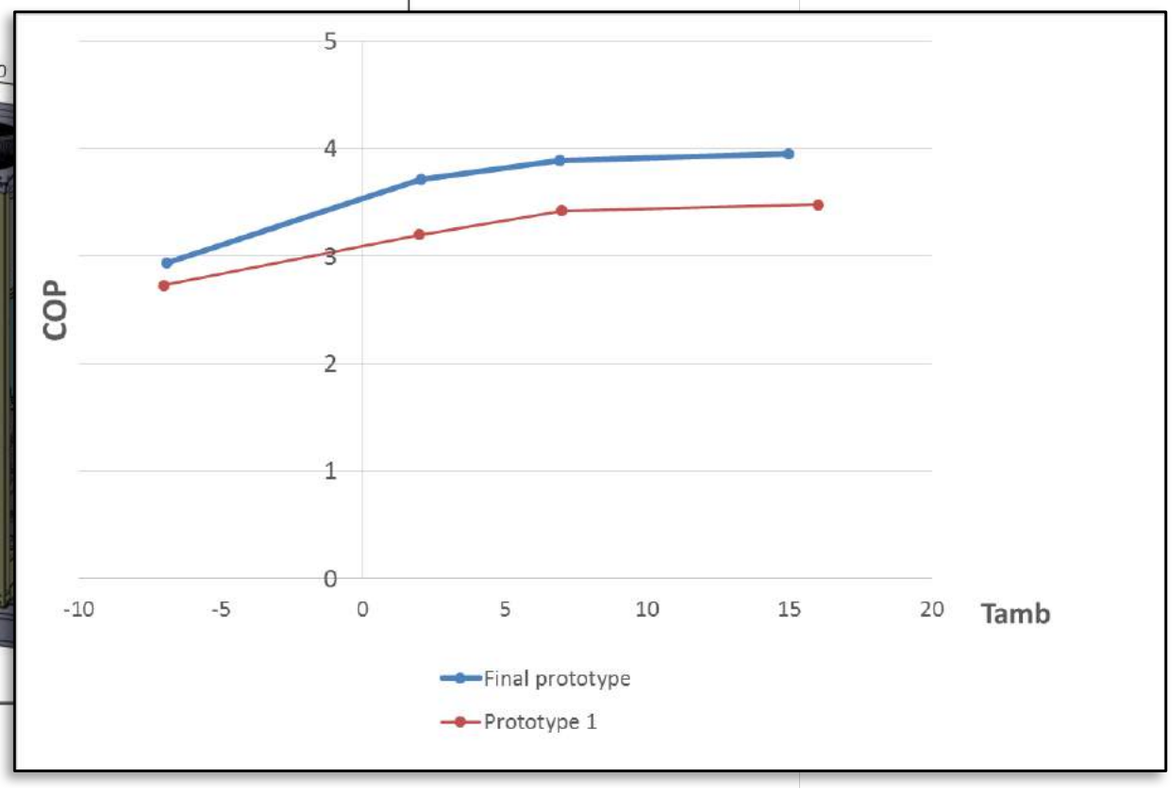
ヒートポンプケーススタディ

Prototype 4: CO2

AIR - DHW PRODUCTION Tested at ENEA

Case	Fluid	Source	T(ºC)	Sink	T(ºC)	Application	(kW)
4	CO2	Air	-10 to 10 (winter) 20-35 (summer)	Water	60 (up to 80)	Domestic hot water production	30





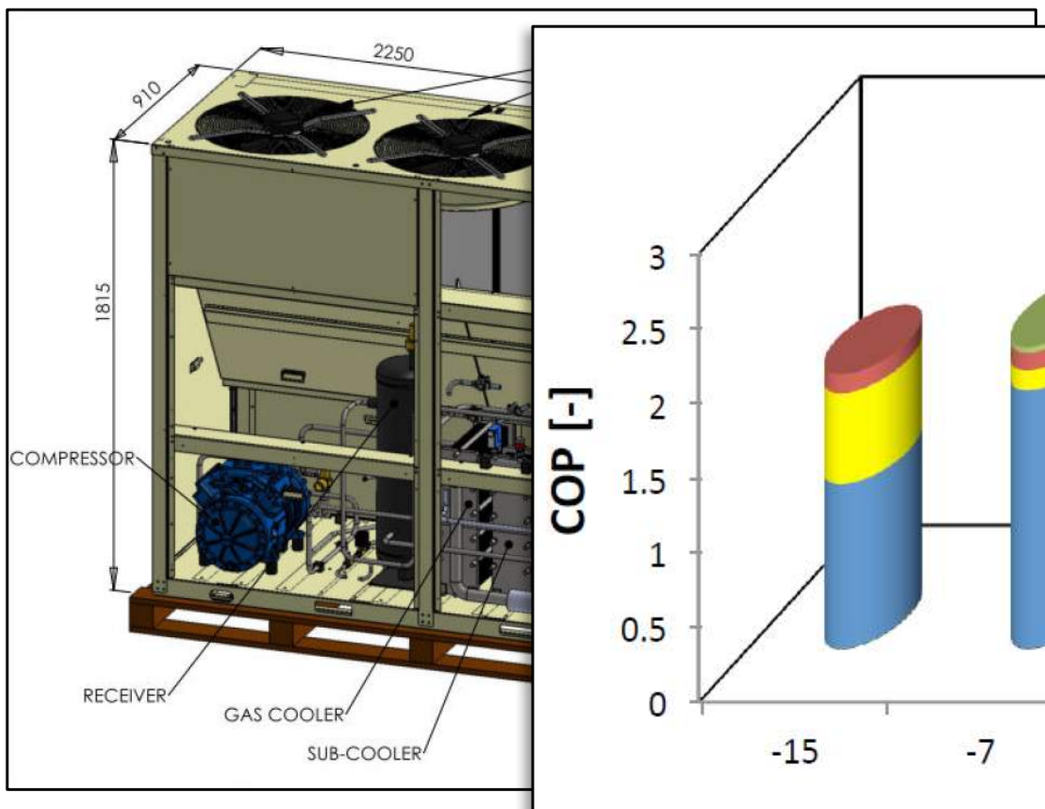
ヒートポンプケーススタディ

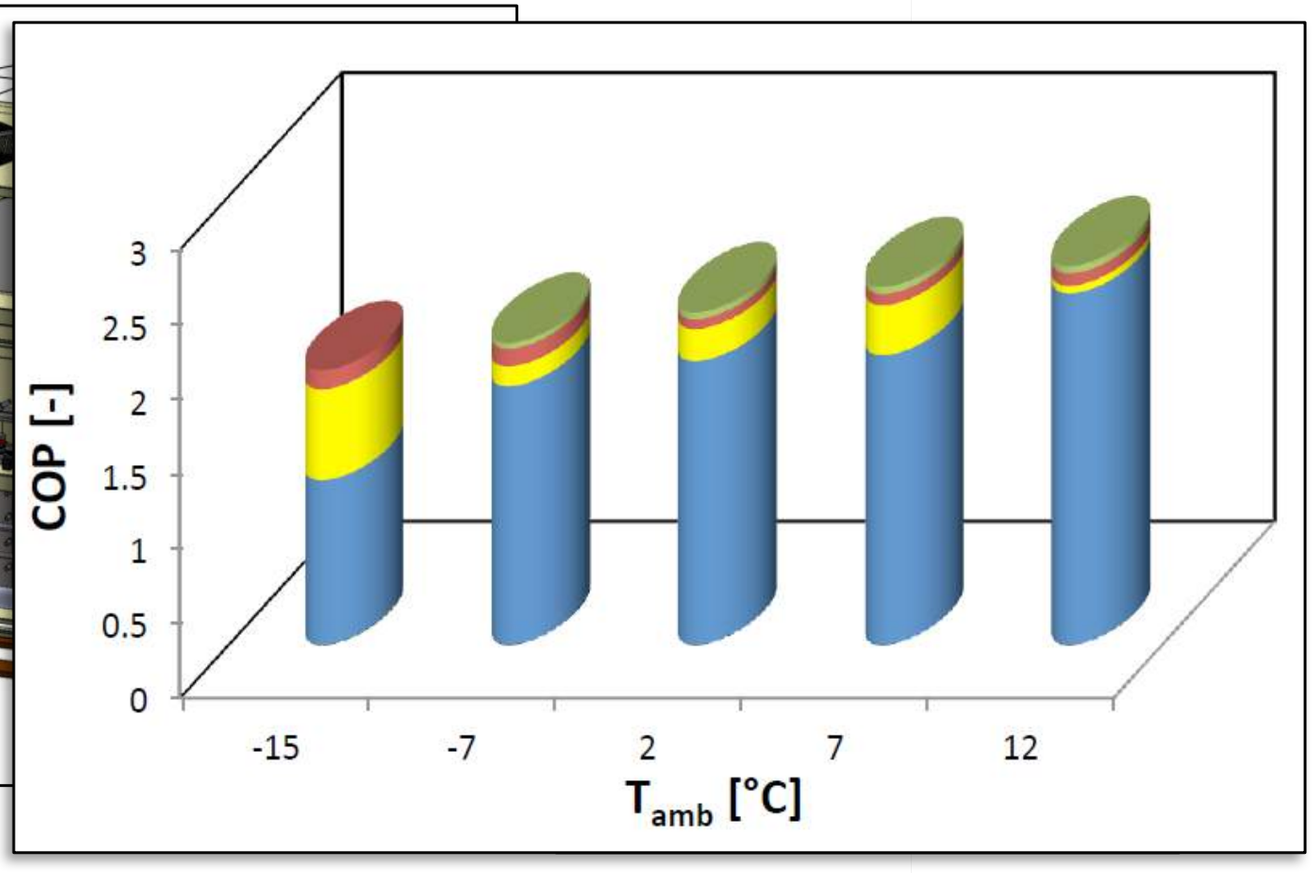
Prototype 5: CO2

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

AIR – High T HEATING WATER Tested at ENEA

Case	Fluid	Source	T(°C)	Sink	T(°C)	Application	(kW)
5	CO2	Air	-10 to 35	Water	80 (return water 40)	Heating & DH water production (DHW in summer)	50





ヒートポンプケーススタディ

Conclusions

- **The project have involved a large group of OEMs of both components and heat pumps** who have provided their best technology to reach the project objectives.
- **5 cases have been selected because** they offer both an **interesting market** and because a solution with a **natural fluid fits well with the application**.
- A completely dedicated prototype has been manufactured for each application: **3 employing propane and 2 employing CO2**.
- **Each prototype has been especially designed** taking into account the specific characteristic of **the application**.
- The prototypes have been fully tested along two testing campaigns and **interesting innovations and improvements have been found** along the project duration
- Final results prove considerable **high performance and reliable and safe operation**

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http://www.ammonia21.com

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お問い合わせ：

ヤン・ドゥシェック

jan.dusek@shecco.com
Mobile: +81-80-3558-6464

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