EUROPE

ATMOsphere

Business Case for Natural Refrigerants

19-21/11/2018 – Lago di Garda

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Carrier

United Technologies

High efficiency CO_2 systems

Sascha Hellmann,
Engineering Project Manager Mechanical Systems

NATURAL EVOLUTION

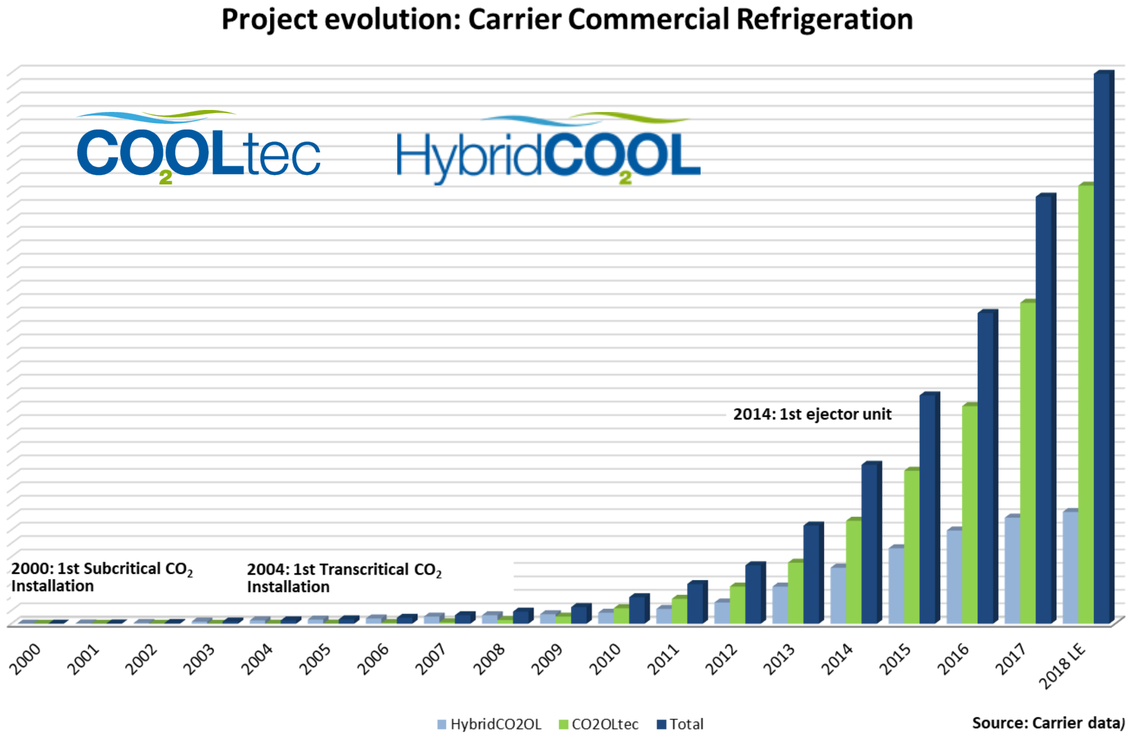
Carrier CO_2 technology status

More than 18 years of CO_2 projects

10 000+ CO_2 delivered[1]

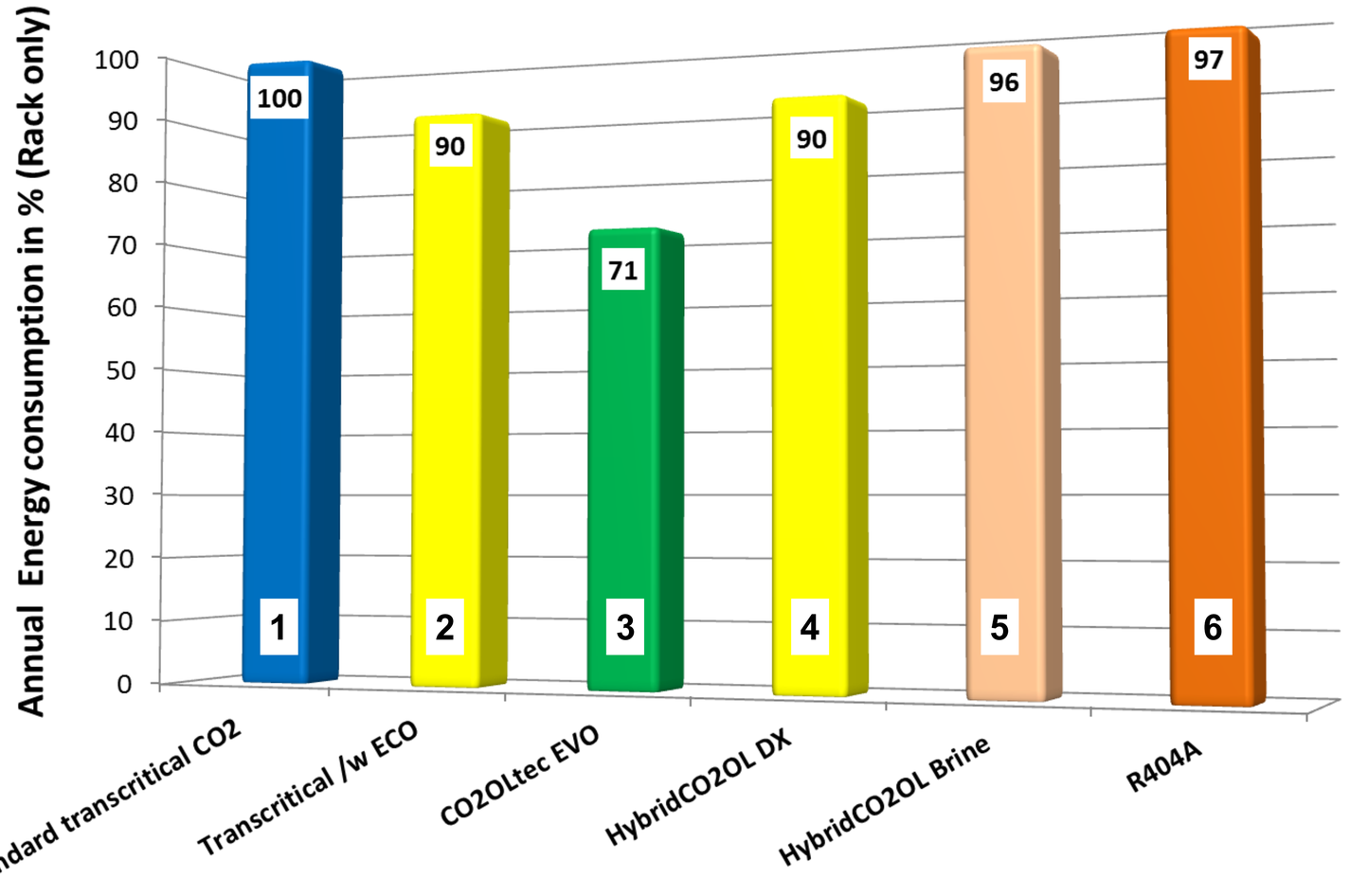
Evolution of…

- **Technology**: HFC/CO_2 cascade → **full CO_2**
- **Applications**: Supermarkets → **all formats**
- **Climates**: Mild / cold → **all climates**



[1]*Status as of Nov 2018. Transcritical & subcritical, all brands*

TECHNOLOGY COMPARISON



1 Standard transcritical

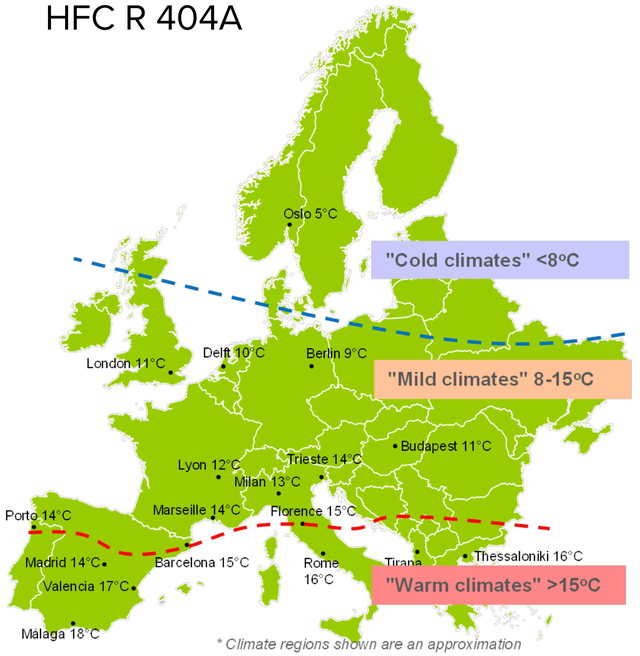
2 Transcritical incl. ECO

3 **CO2OLtec EVO**

4 Hybrid (CO_2 + R134a DX)

5 Hybrid (CO_2 + R134a Brine)

6 HFC R 404A



Annual energy consumption (AEC) reduction vs. standard transcritical system for **warm climates**

- *Projection based on 94m MT cabinets, 38m LT cabinets, 228m³ MT coldroom, 55m³ LT coldroom. MT cabinets /w glass doors, EC fans, LED lighting.. (Carrier e*cube).*
- *Temperature profiles: warm Climate = Average of Seville, Athens, Barcelona & Madrid*
- *CO_2OLtec EVO with all efficiency components*
- *HybridCO_2OL = CO_2 LT + R134a MT.*

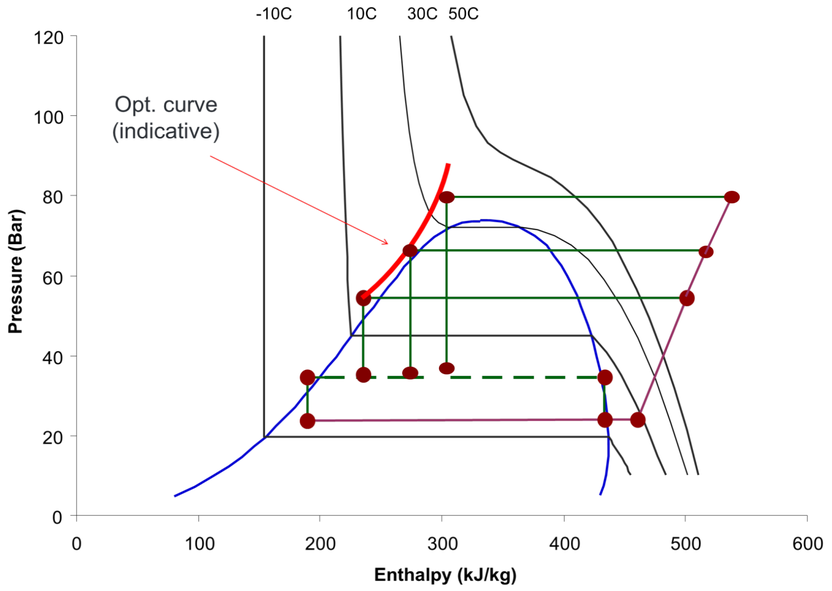
NEED FOR CO_2 CYCLE ENHANCEMENTS

What is the reason?

Higher external temperature

Increase ambient conditions =
Increase significantly flashgas.
(Vapor cannot be used for cooling)

Solutions :
Efficient use of flash vapor (Parallel Compr.)
Reduce of flash vapor (Subcooler, Adiabatic)

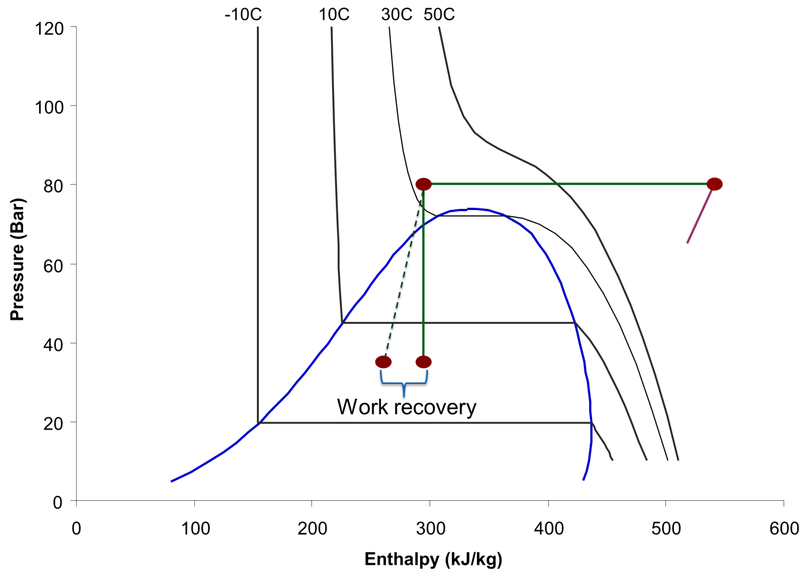


High absolute pressure difference

High potential energy on high pressure side.

Throttled and lost during the 1st Expansion.

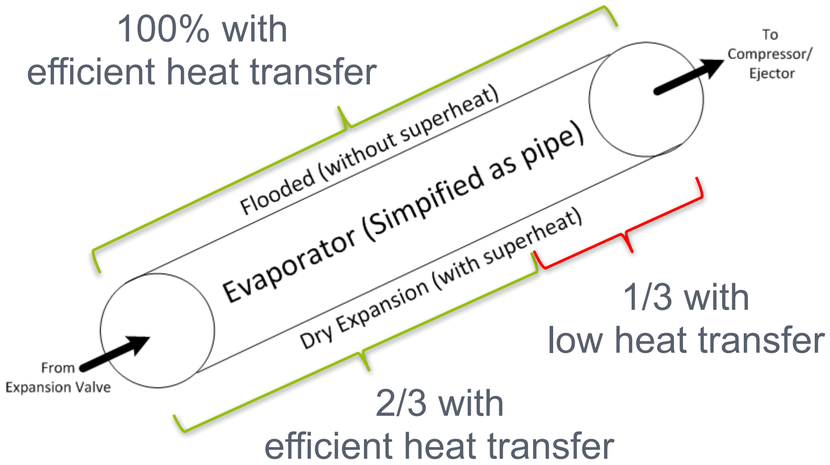
Solutions :
Work recovery by Expander or Ejector



Reduce superheat on Evaporator

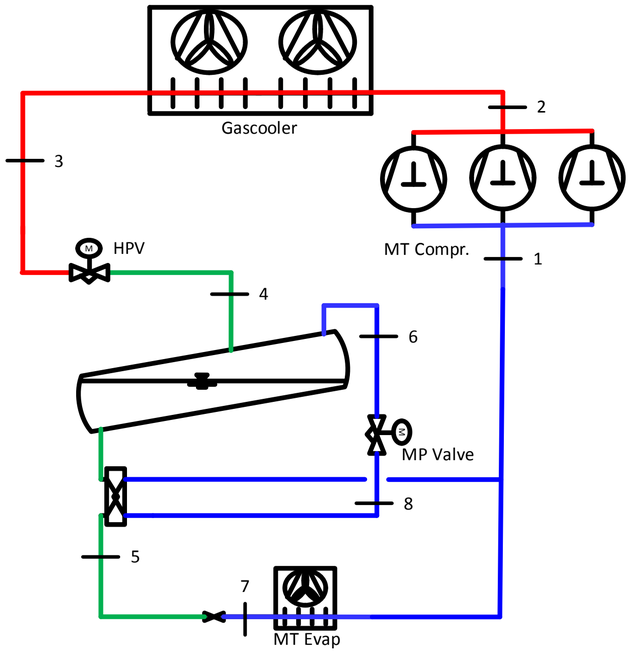
Heat transfer during Evaporation = High
Heat transfer during Superheating = Low

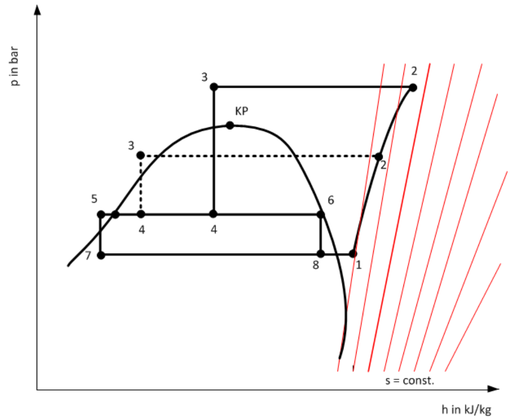
Solutions :
Flooded Evaporator

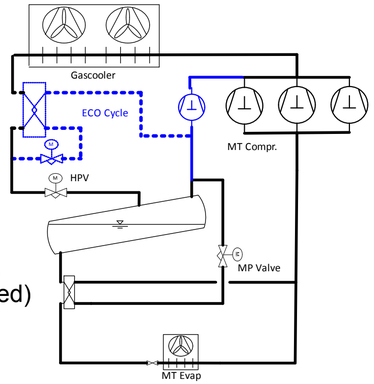


NEED FOR CO_2 CYCLE ENHANCEMENTS

What is the aim?



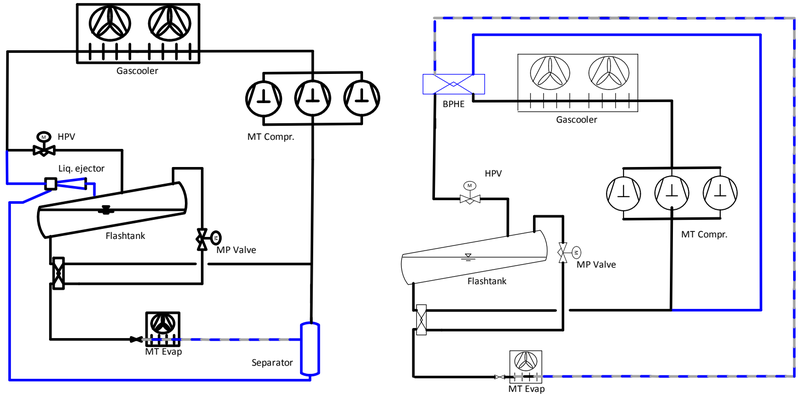




Via Flashtank
Via 2nd HX (dotted)

Parallel Compressor (ECO)

installations in Germany, Switzerland, Italy, Netherlands, Spain, …



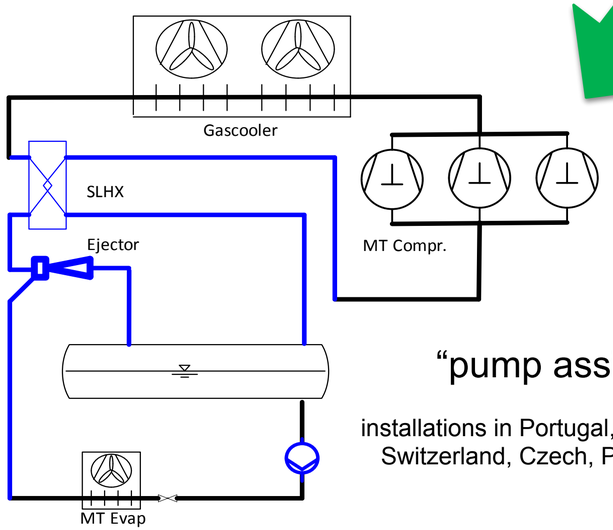
Flooded
Liquid Ejector or via Plate HX

Installations in Spain, Switzerland, Russia, Germany, …

CO_2OLtecEvo

combines all enhancements

- efficient flashgas use
- work recovery
- flooded operation

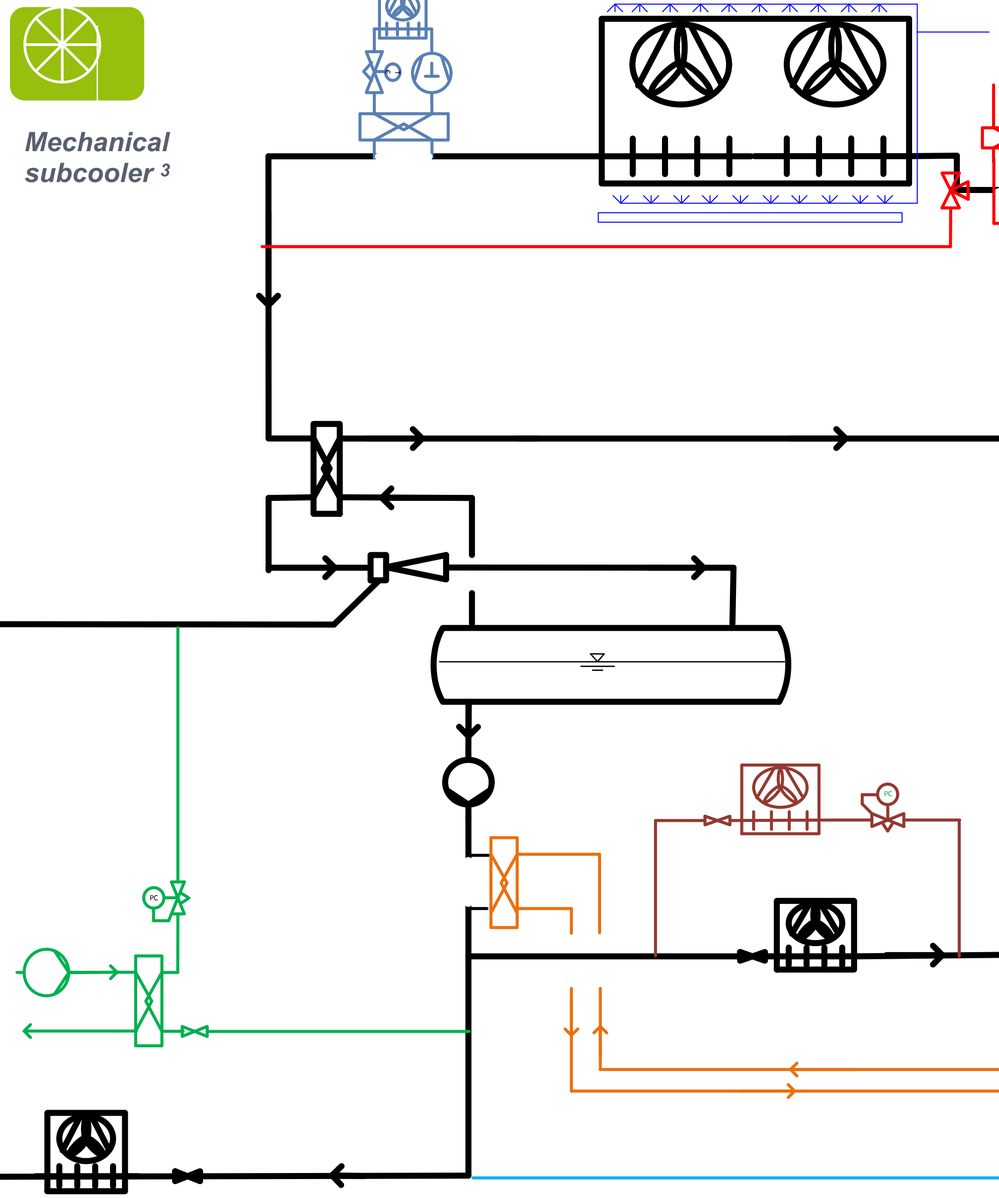


“pump assisted“ Ejector system

installations in Portugal, Spain, France, Netherlands, Germany, Switzerland, Czech, Poland, Bulgaria, Hungary, Sweden, …

= Simple cycle, easy to understand, easy to maintain

SOLUTIONS PORTFOLIO TO SUIT YOUR NEEDS



Mechanical subcooler [3]

Adiabatic gas cooler [3]

Modulating ejector [1]

CO2 pump (flooded MT) [1]

AC cooling capacity [2]

Heat pump [2]

Heat recovery [1]

High efficiency compressor motors [1]

De-superheater [1]

Flooded LT [1]

Special duty counter [1]

[1] available
[2] field trial status
[3] under evaluation

CASE STUDY

EDEKA MIOS Soltau

Location: Soltau, Germany
Application: Cash & Carry
Commissioned: Q1, 2016

Highlights :

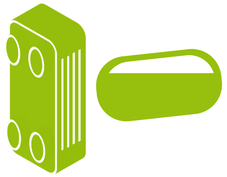
Winner of the EHI[1] Energy award 2017

Including low temperature flooded operation, for added efficiency + CO_2OLheat (100% heat recovery /w GC bypass)

Solution:

Modulating ejector

CO_2 pump (flooded MT)



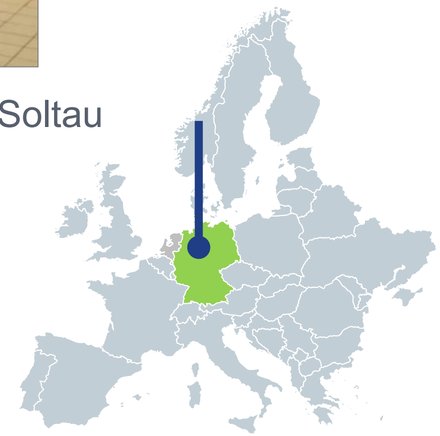
Flooded LT

Heat Recovery

208 kW MT

74 kW LT

Soltau



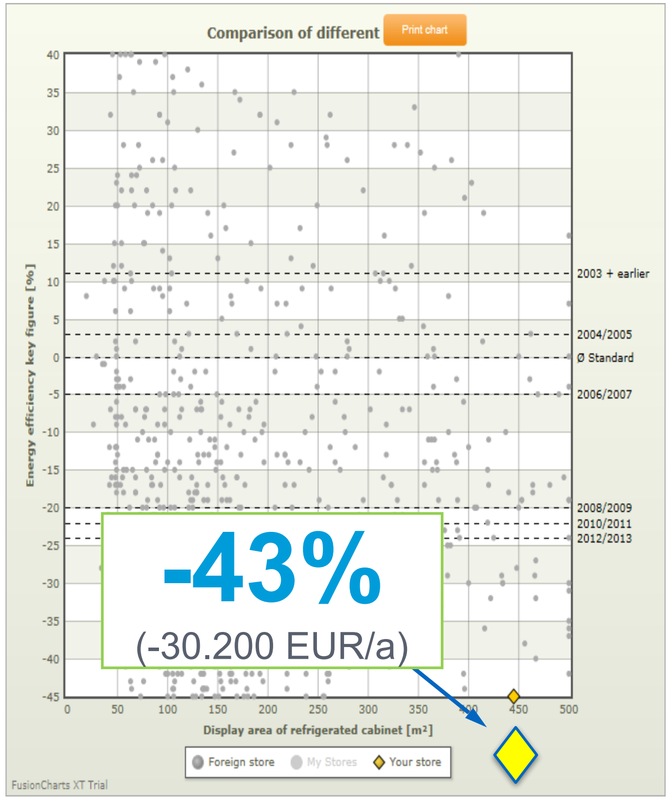
[1]www.ehi.org

PROVEN ENERGY SAVINGS

EDEKA MIOS Soltau complete store with ejector and CO_2 pump

Jahresenergiebedarf		Energieeffizienz-Kennzahl [%]	
gemessen per Displayfläche [kWh/a m²]	945	Prozentualer Mehr/Minder-Energiebedarf im Vergleich zum durchschnittlichen Standard aller in 2009 betriebenen Märkte.	-57 %
		Effizienz-Vergleichswert [kWh/a m²]	2.188
gemessen per Laufmeter [kWh/a m]	1.596		
JEB-Vergleichswert [kWh/a]	920.907	Energie Mehr/Minder-Kosten [EUR/a]	-52.290,68 €/a

(0,10 EUR/ kWh)



2012 / 13 average of stores

Our 2017 store

Energy measured for **complete store**[1]

Benchmarking via the independent VDMA "Quickcheck" tool, vs. average stores, per year[2]

CO_2OLtecEvo total store savings:

- -57% AEC[3] vs. average 2009 store
- **-43% AEC[3] vs. average 2012 / 2013 store**

[1] Complete store w/ CO_2OLtec®Evo plant (ejector / flooded MT / flooded LT), cabinets, cold rooms

[2] www.effizienz-quickcheck.org

[3] AEC = Annual Energy Consumption

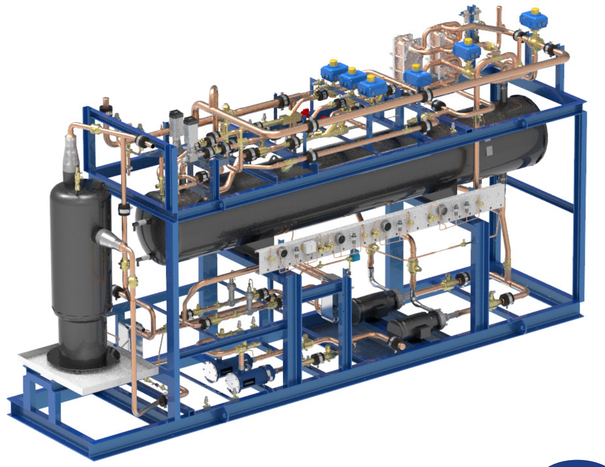
NEW HIGH-EFFICIENCY STEP

Latest developments in Carrier CO_2 technology

COOLtecEvo®

Key drivers for a new generation of CO_2 systems:

- Further improvement in energy efficiency
- Suitable for all climates
- Suitable for multiple applications
- Reduced complexity
- Tailored to specific customer needs & priorities
- Optimal energy gains via a configurable approach for different formats



30%

annual rack energy savings[1], vs. initial transcritical CO_2

A range of tailored, high-efficiency solutions

- **Suitable no matter the application or climate**
- **No 'one size fits all' approach to avoid performance compromise**

[1] annual energy saving, for rack only. Based on model store in warm climate, compared to 1st generation transcritical system.

Thank you for your attention!

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