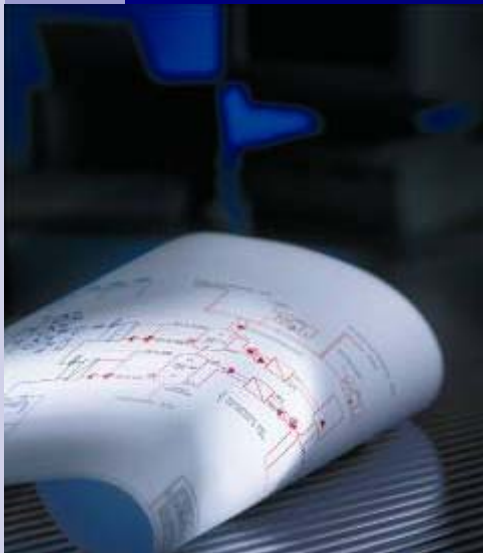


CO₂ as a refrigerant

Innovations in Commercial Refrigeration

27th September 2010



Frigo-Consulting AG



Engineering



Consulting
Specifications



Support



Optimization

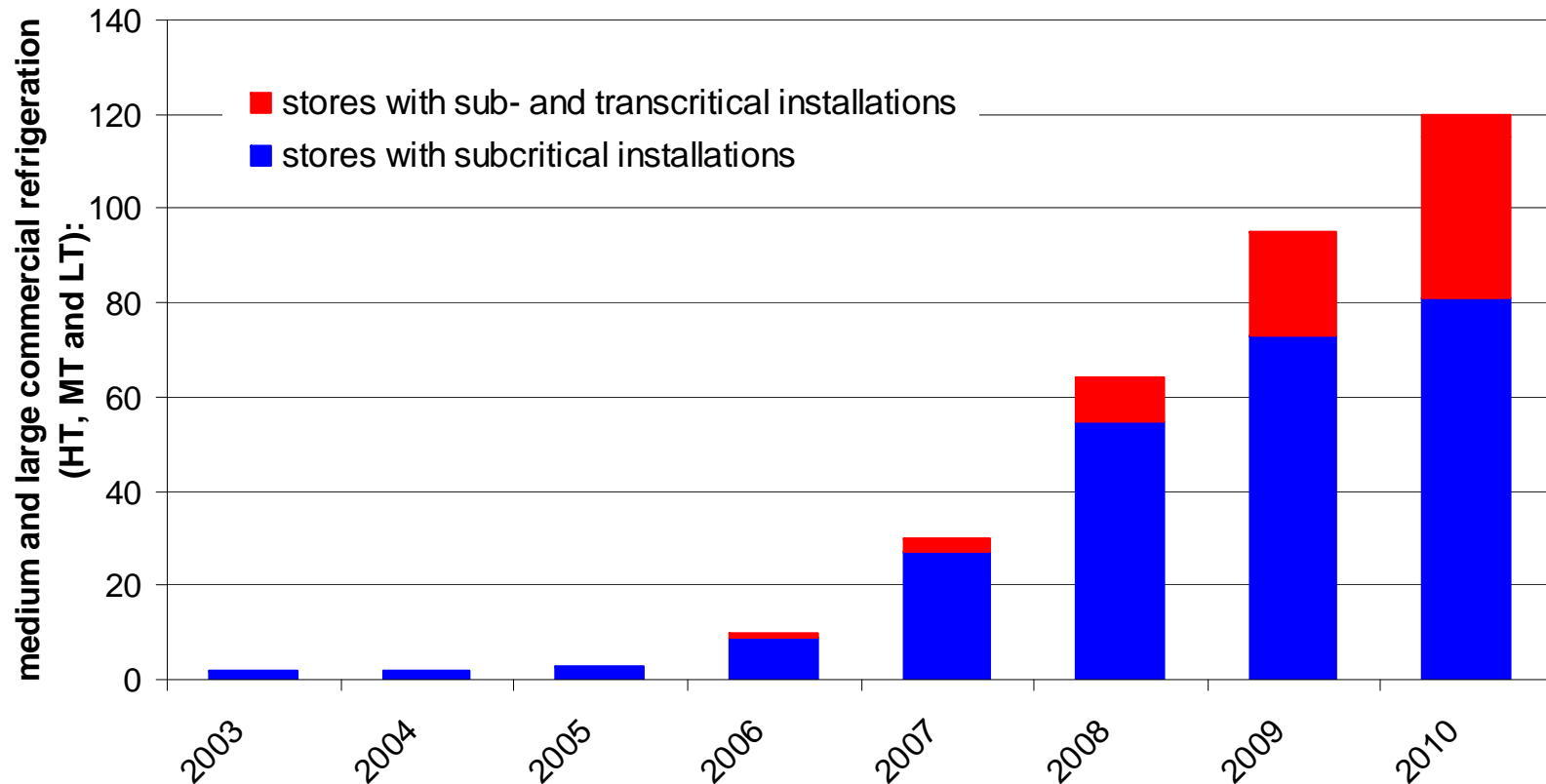
- ✓ CO₂
- ✓ Commercial
- ✓ Industrial
- ✓ Vacuum-Systems
- ✓ Ice slurries

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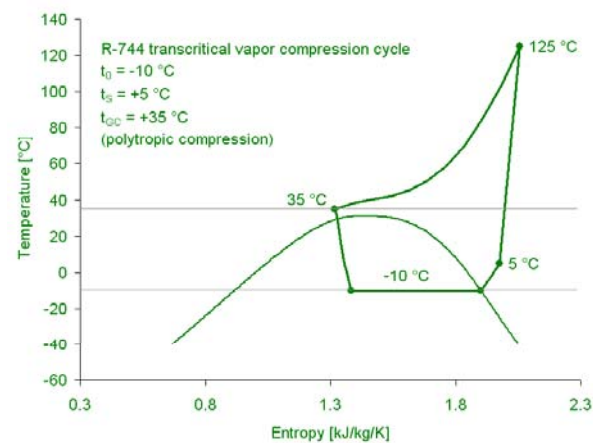
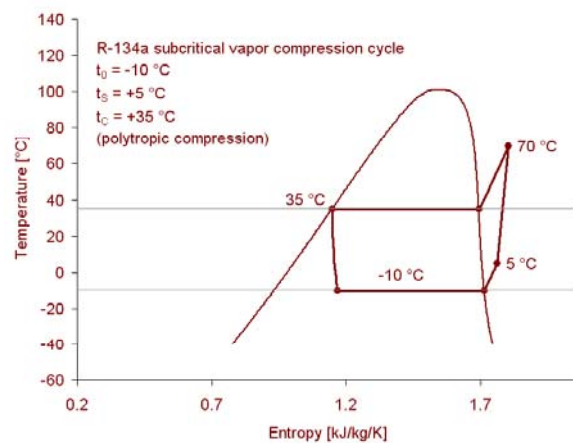
CO₂ commercial references

Running CO₂ installations, Switzerland (engineered by Frigo-Consulting AG)

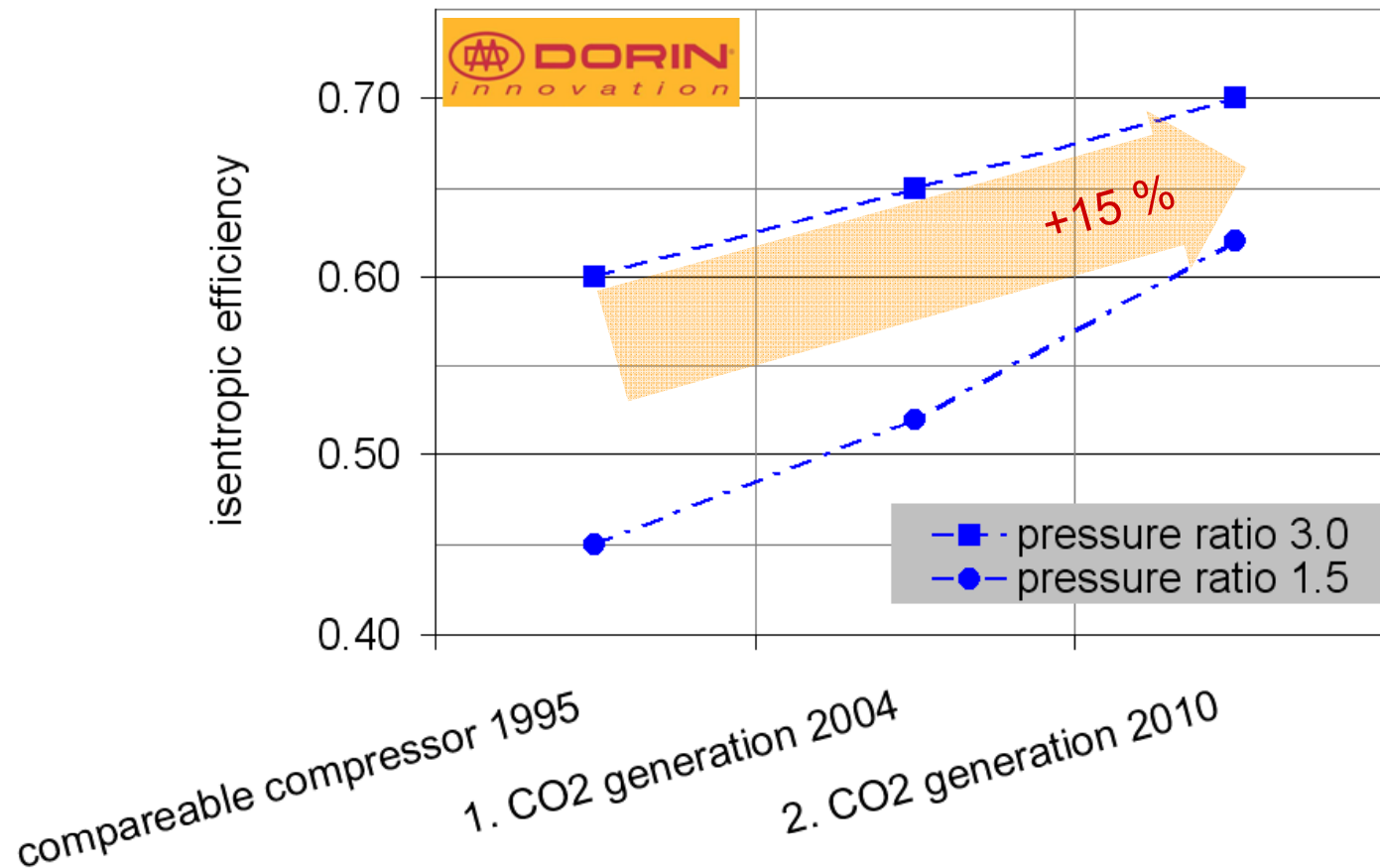


the potential of CO₂

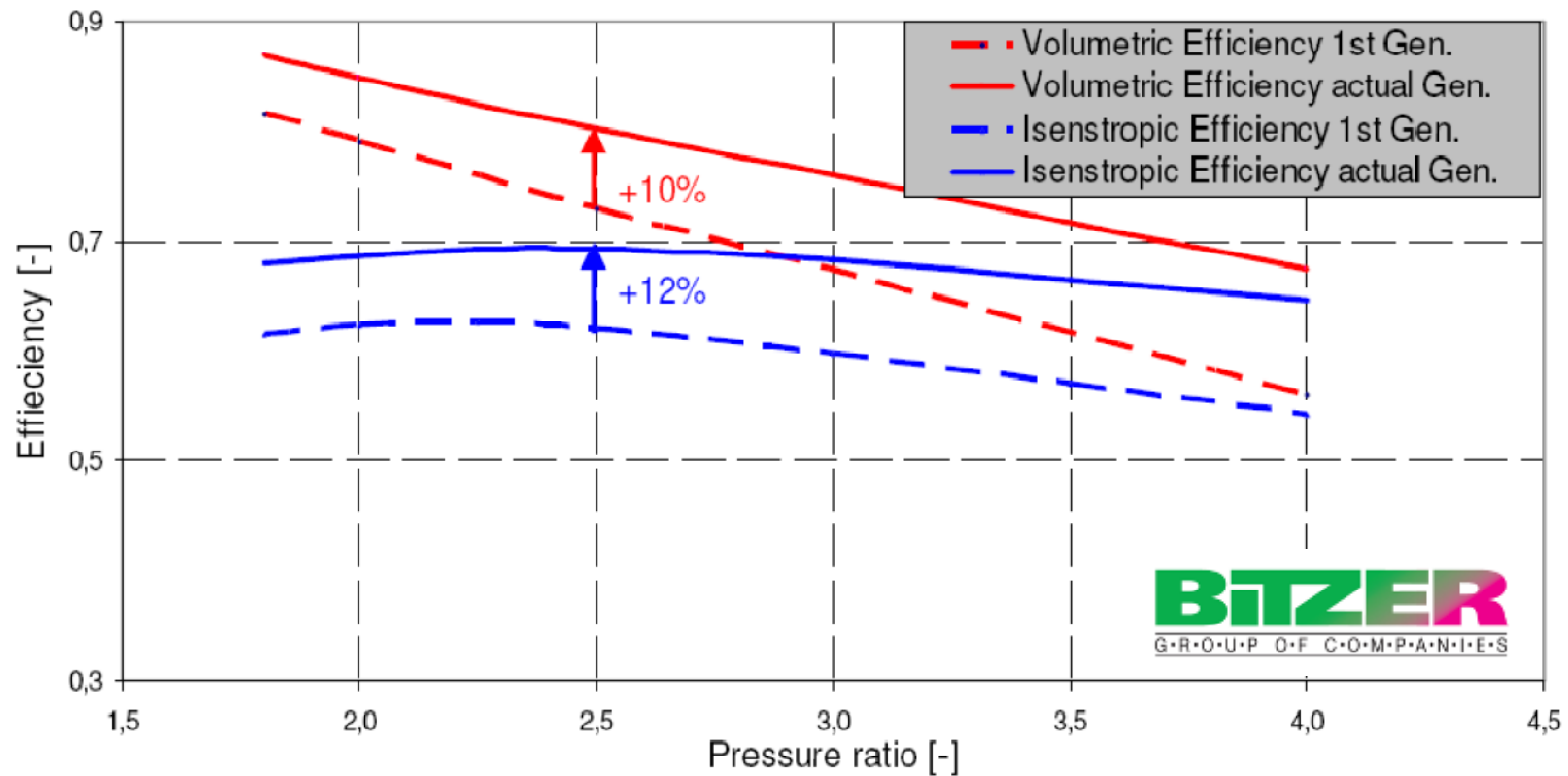
- components are available and are being optimized
- ecological and economical advantages are pushing
- thermodynamic potential is promising



compressors: efficiency trend



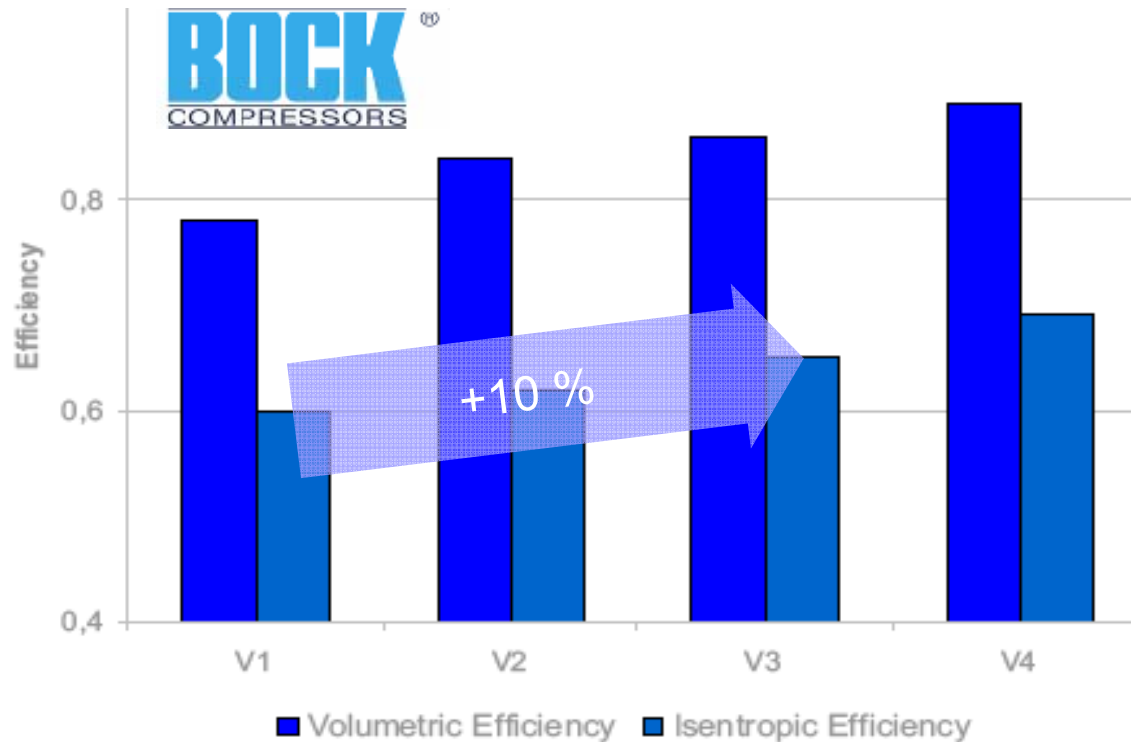
compressors: efficiency trend



BITZER
G·R·O·U·P O·F C·O·M·P·A·N·I·E·S

Reference: Javerschek, O.; Dittrich, G.: Advanced compressor design and various systems for commercial applications with CO₂. IIR International Conference on Compressors and Coolants, Papiernicka 2009

compressors: efficiency trend



Operating point:

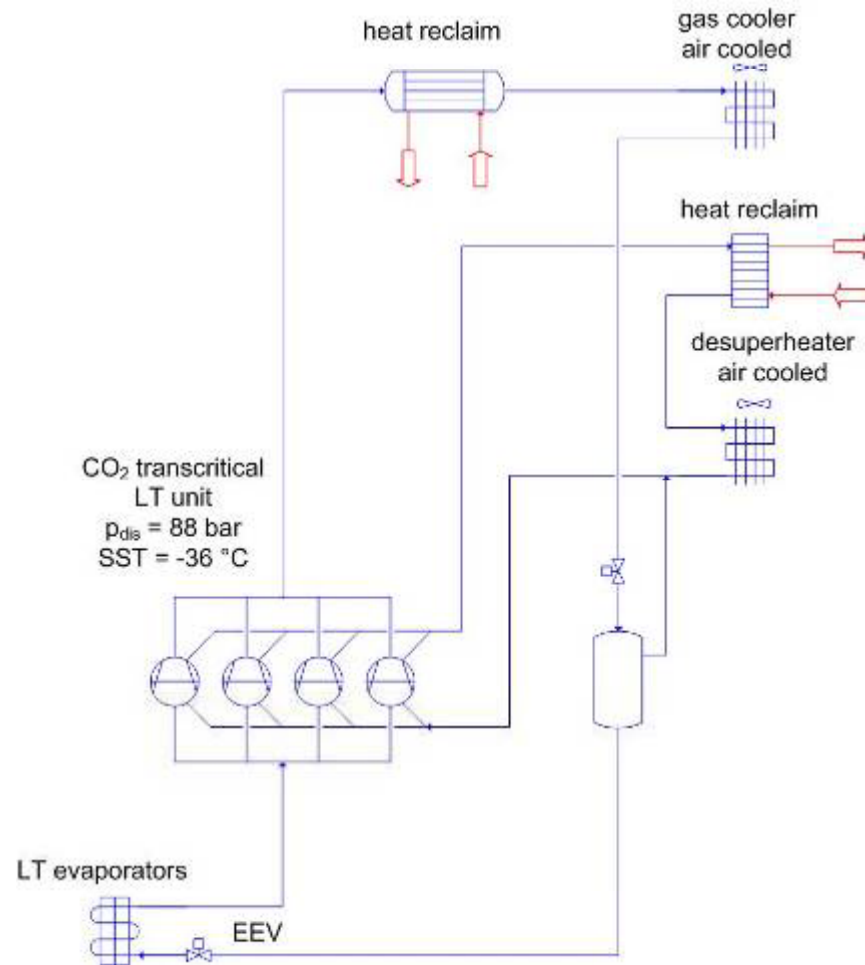
$t_o = -10 \text{ }^\circ\text{C}$
 $p_c = 60 \text{ bar}$
 $t_c = 22 \text{ }^\circ\text{C}$
 $\pi = 2,5$

- | | | |
|----|---|----------------------|
| V1 | Suction gas-cooled compressor HGX2 CO ₂ T | (First generation) |
| V2 | Suction gas-cooled compressor HGX2 CO ₂ T | (Current generation) |
| V3 | Suction gas-cooled compressor HGX34 CO ₂ T | (New generation) |
| V4 | Air-cooled compressor HAX34 CO ₂ T | (New generation) |

examples to improve the efficiency

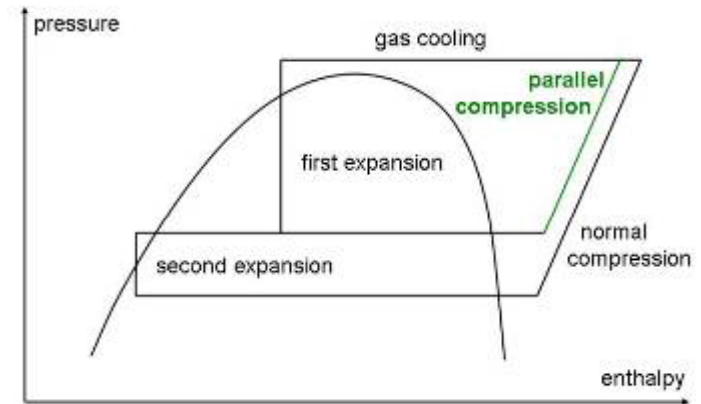
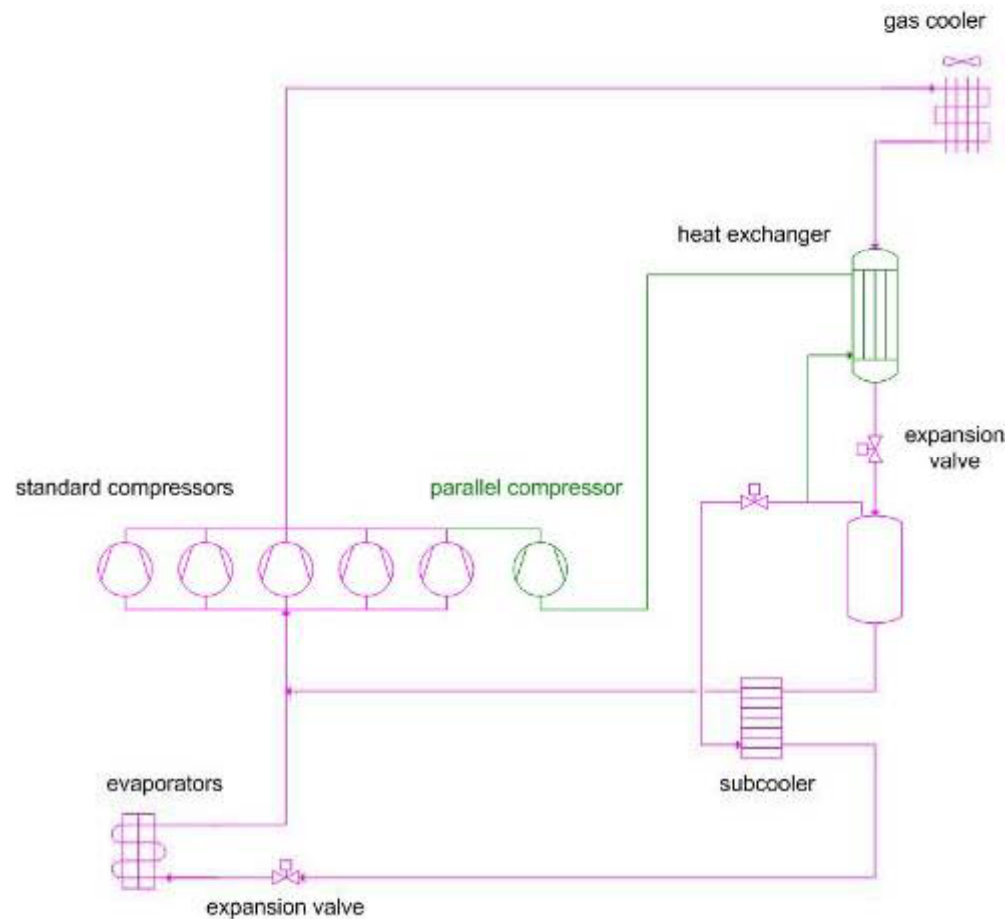
- adiabatic or wet heat rejection (water spray)
- multiple expansion and compression (flash-tank, parallel compression)
- work extracting expansion (ejector, expander)
- subcooling the liquid CO₂
- clever controls
- heat transfer (microchannels)

open flash-tank systems



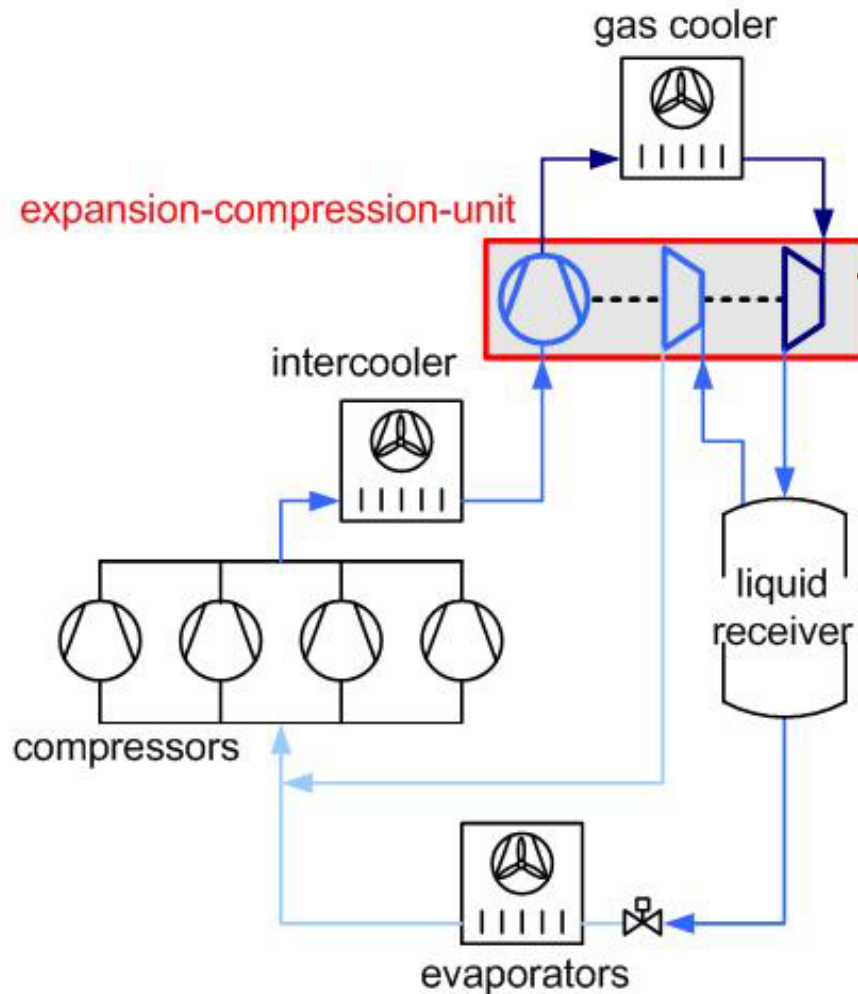
Growa Bern, Switzerland, low temperature installation, $Q'_0 = 50 \text{ kW}$

Parallel compression



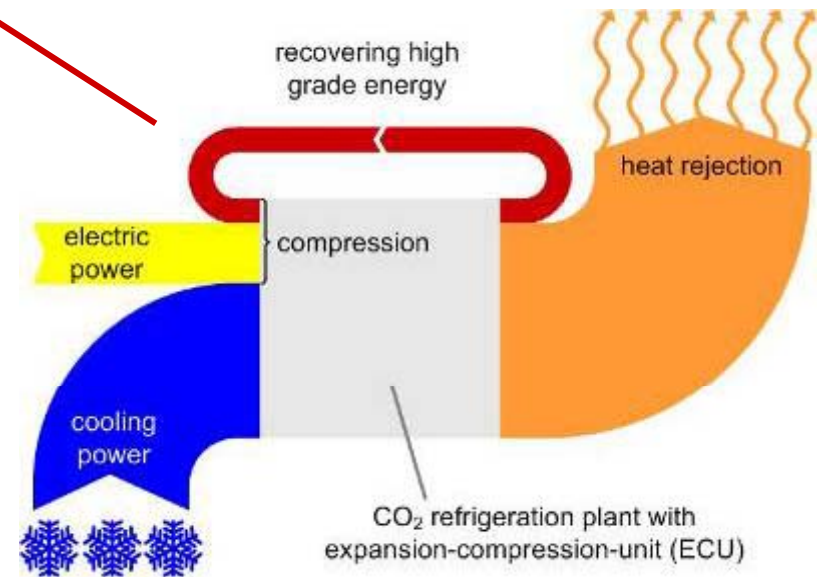
Prodega Givisiez, Switzerland, medium temperature installation, $Q'_0 = 150 \text{ kW}$

recovering high grade energy

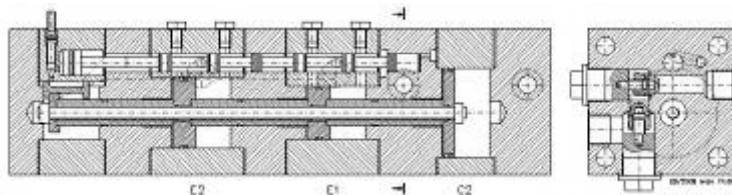


expected energy savings:

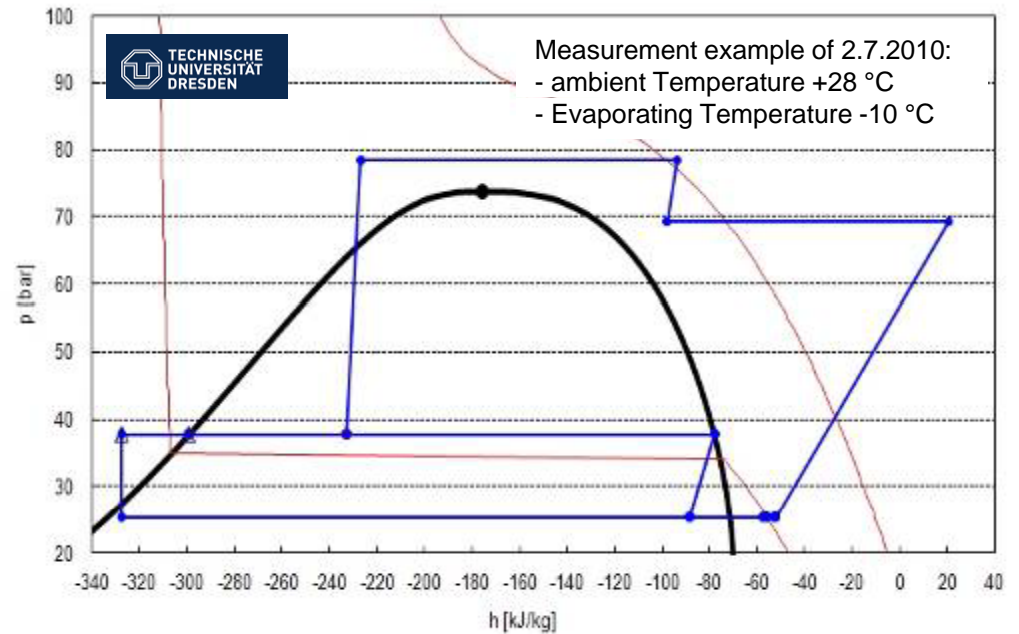
- 10-15% in average
- up to 30% at high ambient temperatures



expansion-compression-unit (ECU)



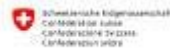
Source: Wenzel, M; CO₂-Expander-Kompressoreinheit: Weiterentwicklung, Einbindung in Kälteanlagen und Regelung, DKV Berlin, 2009



expansion-compression-unit (ECU)



Prodega Basel, Switzerland
 medium temperature installation, $Q'_0 = 80 \text{ kW}$



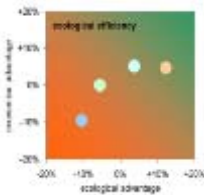
HOW to Bring Natural Refrigerants Faster to Market through Innovations...

think long term...
- prove energy efficiency
- show pay back
- consider rising energy cost



find partners...

benefit from the
technical potential of
the refrigerant CO₂



go green...
- show ecological
efficiency

don't underestimate...
- technical solutions

show advantages...
-no cost risk (purchase price,
taxes)
- green image

thank you.

