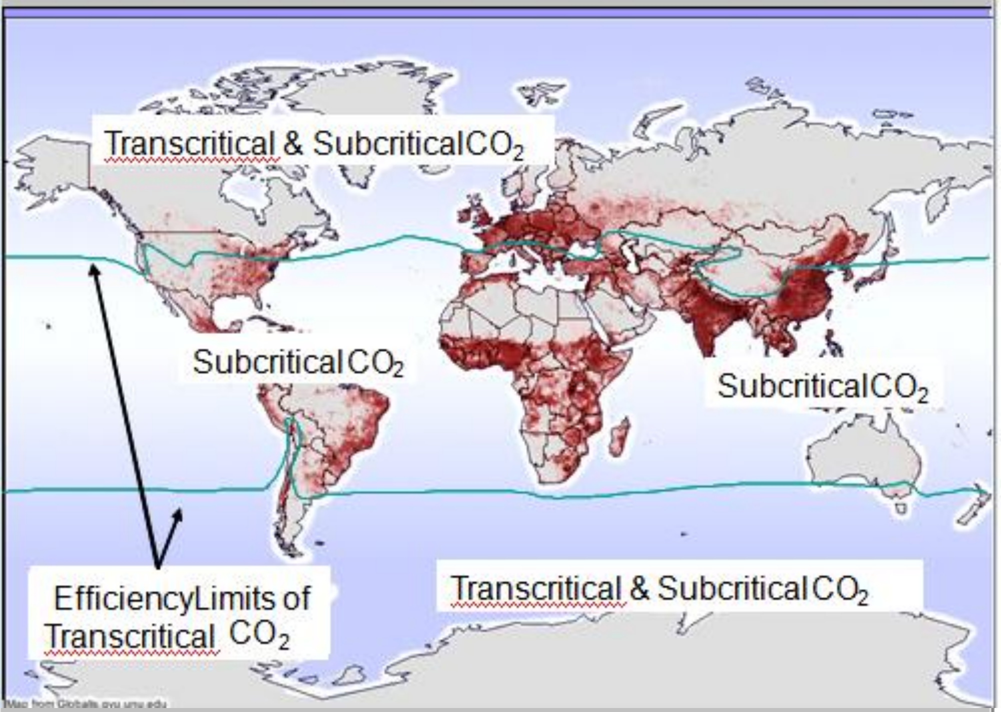
MAKING MODERN LIVING POSSIBLE

Refrigeration and Heat Recovery with CO2 in Food Retail stores

Torben Funder-Kristensen, VP Public Industry Affairs
TFK@danfoss.com



Agenda

- What about Green
- Basic needs
- Heat Recovery Concept
- Why CO_2 is the best
- Case – Heat Recovery
  - COSP and COP
  - TEWI
  - COST
- Conclusion

What about Green

Everyone wants

- Low Emission
- High Efficiency

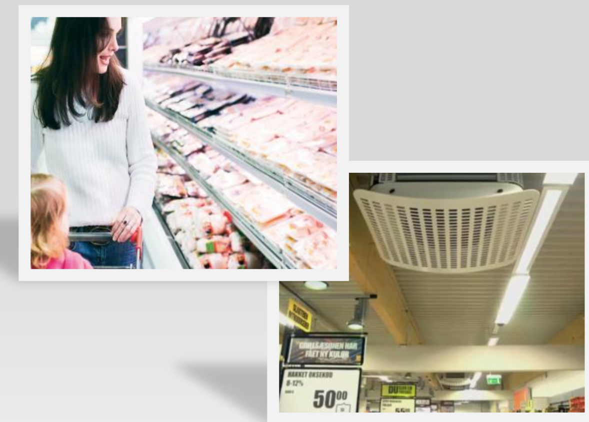
But a good business case is needed!

The good thing is that it is possible with CO2 as refrigerant !

Food Retail Basic Needs

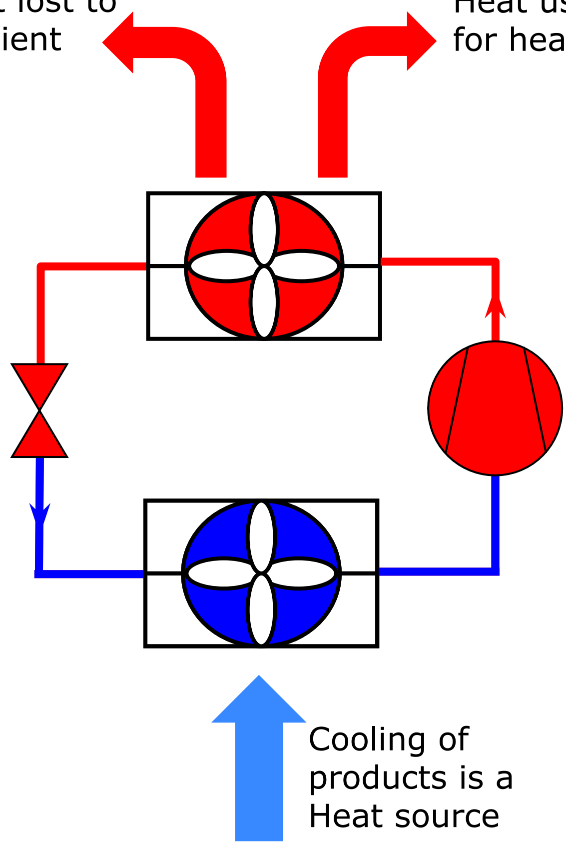
Hot water for sanitary purposes

Cooling for conservation of perishable foods



Heating for comfort

All above needs to be addresed in Economical and Environmental benign solutions.



Heat Recovery Concept

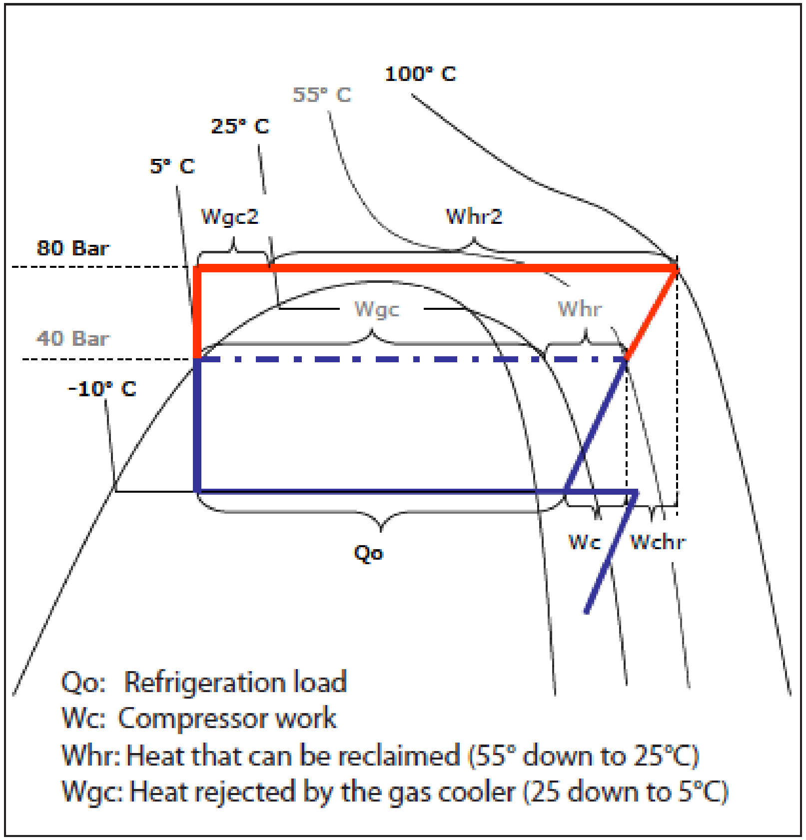
- Utilise the fact that cooling creates heat!

$$COSP = \frac{Q_{Cool} + \sum Q_{Heat}}{W_{Compr}}$$

COSP : Coefficient of System Performance

- Design a system where the discharge gas is utilised to serve heating needs
  - Select the most suitable refrigerant
  - Ensure Cooling obligations
  - Optimise COSP

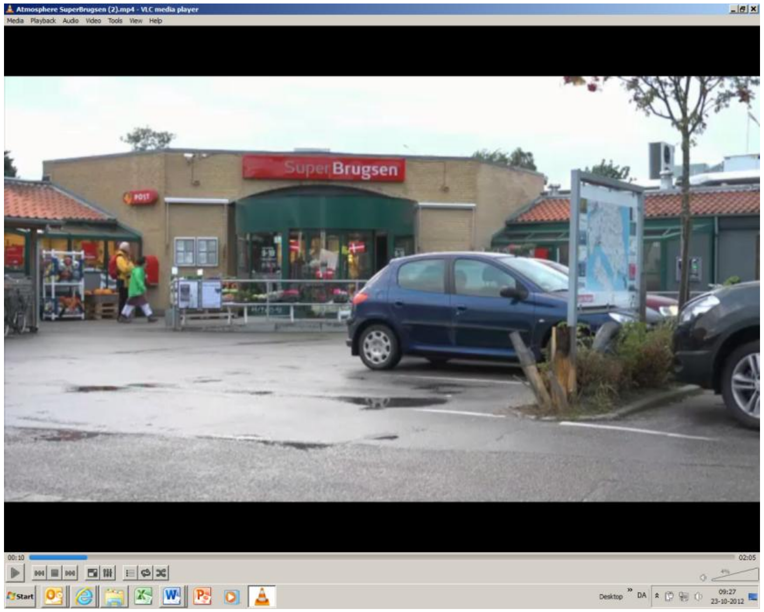
Why CO_2?



The high pressure has been increased to 80 bar (trans-critical condition).

- Mature status as refrigerant for refrigeration – more than 2000 systems running in the EU
- Temperature regulation within large temperature band of discharge gas
- Efficiency less dependent on discharge temperature
- Efficiency most dependent on return water temperature
- Transcritical phase invites for high efficient counter flow heat exchangers

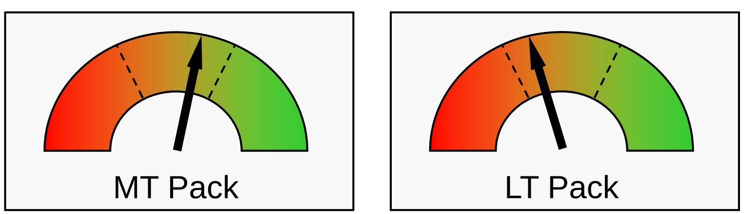
Heat Reclaim Case

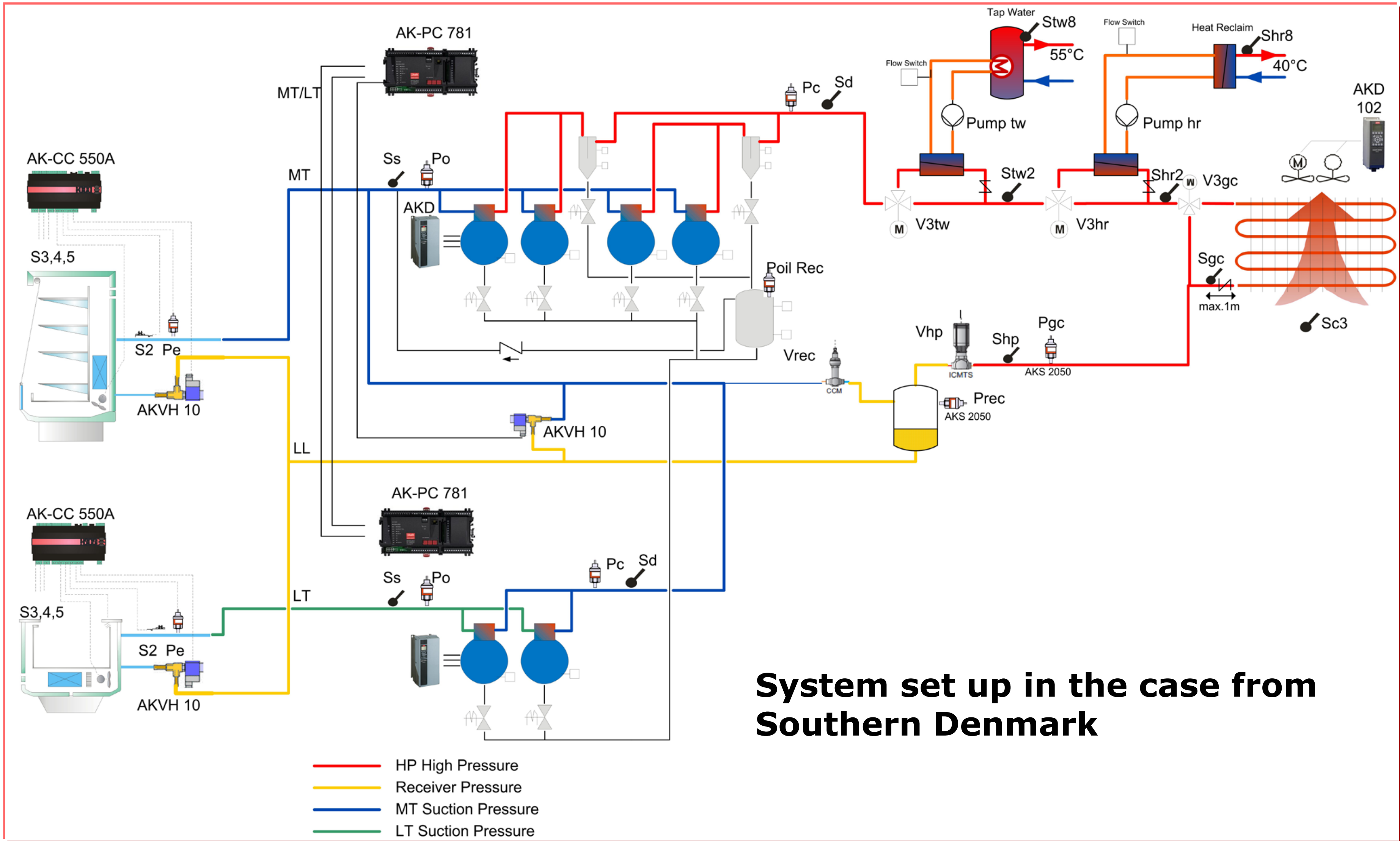


- Høruphav, Southern Denmark
- Area: 1000 m² from 2010
- Compressors: 5 MT (1 VS), 4 LT
- Cooling Capacity: 160 kW
- Online COP calculation

- Heating :
  - Sanitary water (1800 l tank (65 ºC)
  - Floor heating/low temp coils (45 ºC)
  - Heating investments (add on) is less than 7000 €

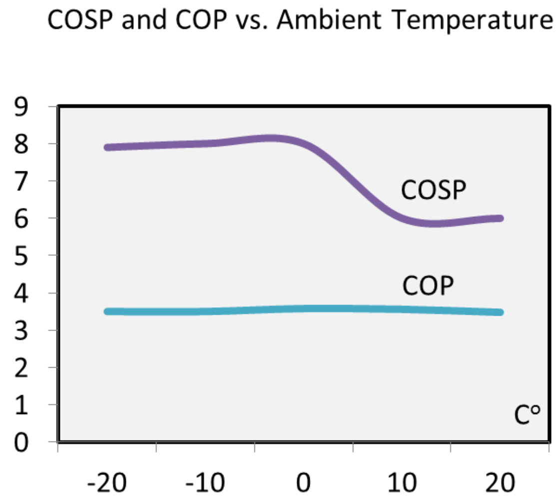
Performance of
refrigeration system (COP)

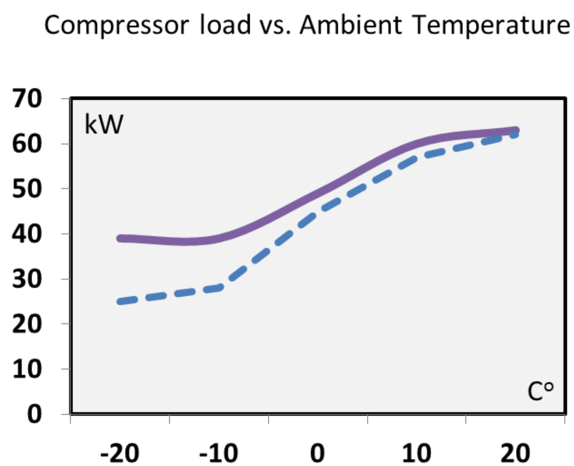




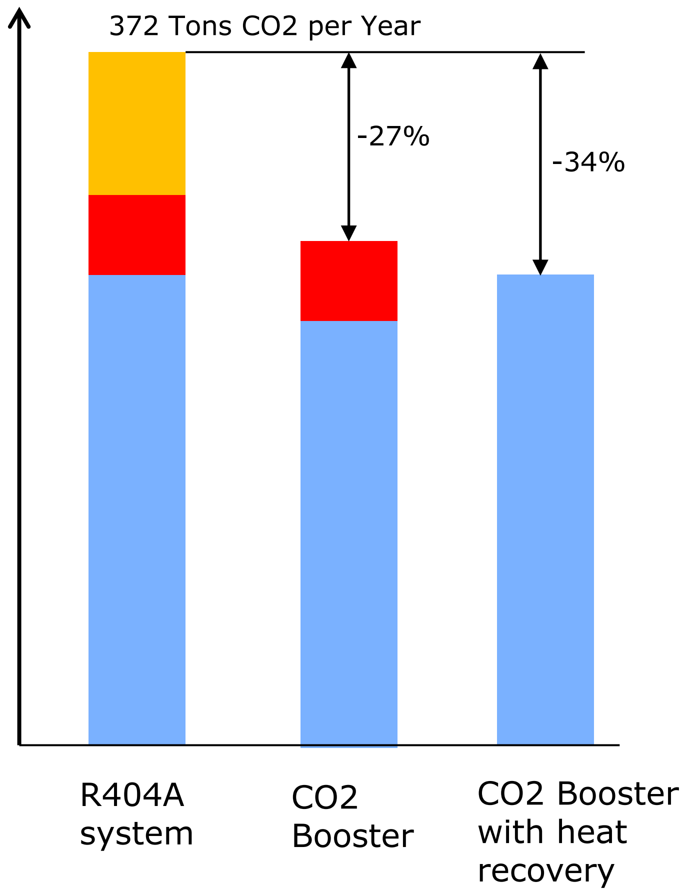
System set up in the case from Southern Denmark

Case results





- COP is nearly constant
- COSP can get as high as 8 during the cold periods
- Former natural gas heating has been 100 % substituted without loosing comfort
- Pay back on heat recovery has shown to be less than 5 months

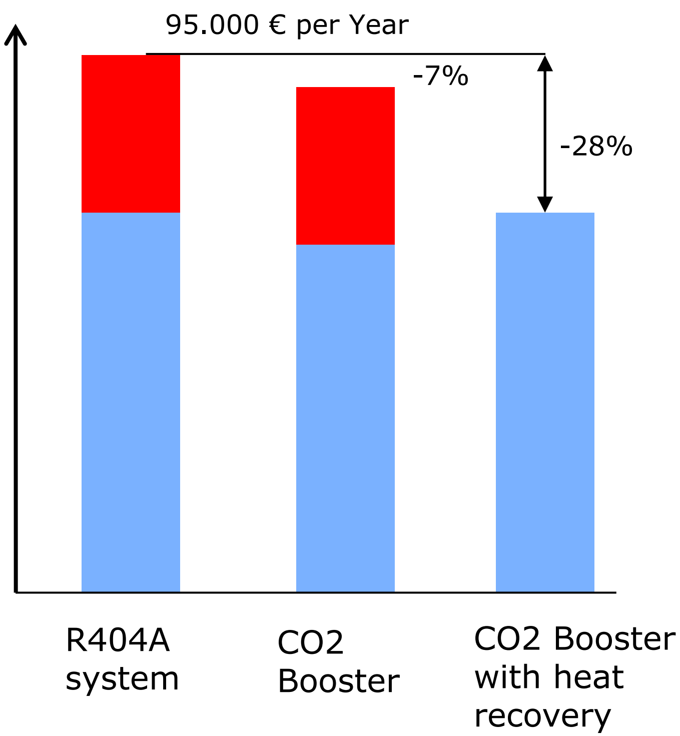


Electricity : ½ kg CO_2/kWH
Gas: 2 kg CO_2 / M3
Leakage rate 10%
Charge: 200kg R404A (GWP =3922)

Case : TEWI comparison between systems

- CO_2 is an excellent Heating server. Obtainable temperature levels can eliminate heating sources like gas
- Heat recovery will increase compressor power consumption by cose to 10 % due to temporary peak heating tasks
- TEWI decreases significantly using CO2 and heat recovery. More than 30 % improvements was achieved compared to a conventional system with high direct emission
- Minor TEWI decrease based on heat recovery alone

Case : Energy running cost comparison between systems



Electricity : 0,14 € / kWh
Gas : 1,40 € / m^3

- The CO_2 booster system with heat recovery decreases *overall* energy cost with more than 20 %
- Savings in running costs for topping up on refrigerants leaks are not considered
- The CO_2 system with Heat recovery increases Electricity cost up to 10% compared to systems without heat recovery.

Conclusion

- Supermarket applications are very suitable for improving overall system performance of CO_2 systems using heat recovery
- The traditional CO_2 weaknesses as high temperatures and pressures is turned into advantages using heat recovery
- TEWI can be reduced by 5-10 % using heat recovery
- Running cost can be reduced by more than 20% by introducing heat recovery and removing conventional heating sources
- Pay back has been proven to be very short on excess investments

MAKING MODERN LIVING POSSIBLE