MAKING MODERN LIVING POSSIBLE

Components for Clima Friendly Refrigeration

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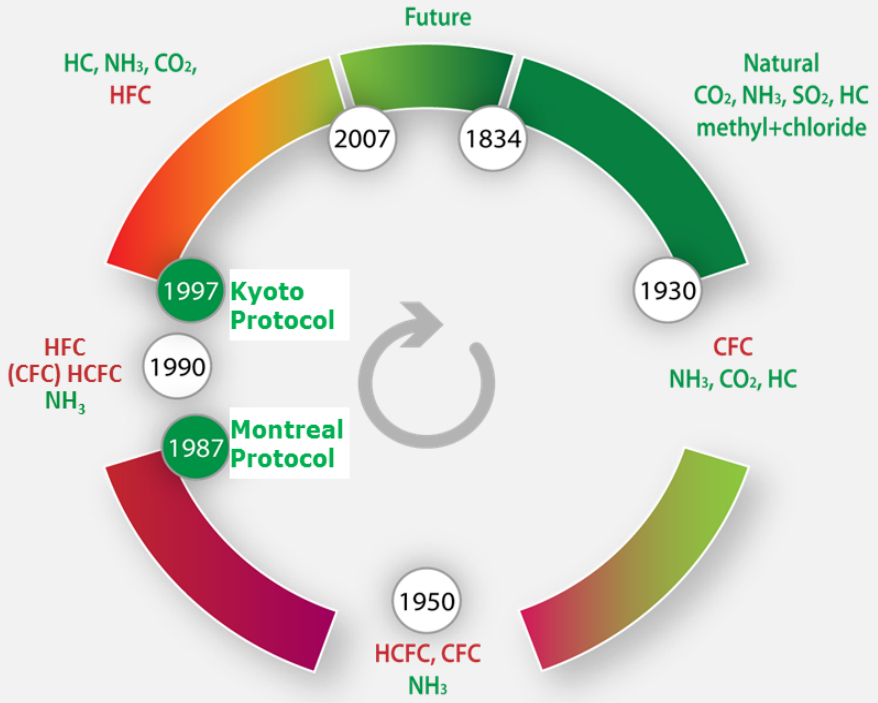


Content

- Clima friendly - what is that ?
- Applications & Refrigerants
- Components for natural refrigerants
- Obstacles
- Developing versus developed countries
- Conclusion

Climate friendly….

Everyone wants

- Low Emission
- High Efficiency

But is it

Technically possible ?

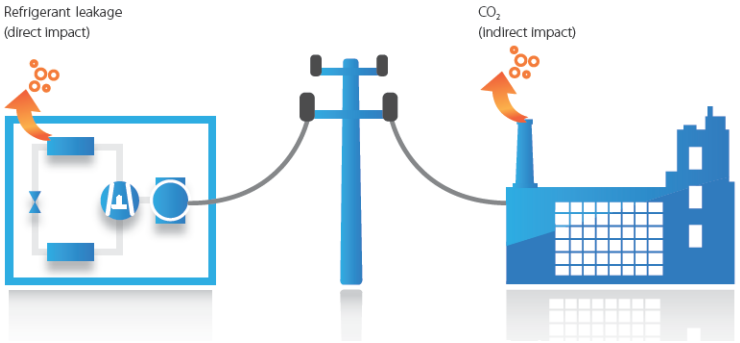
Economically feasible ?

Practically feasible ?

Safety wise responsible ?

Yes ! – but conditoned

The refrigerant has to fit to the given application to obtain best possible performance



Direct Emissions
= Refrigerant Bill

Indirect Emissions
= Electricity Bill

Cost Coincides with TEWI

- The cost of a product is important

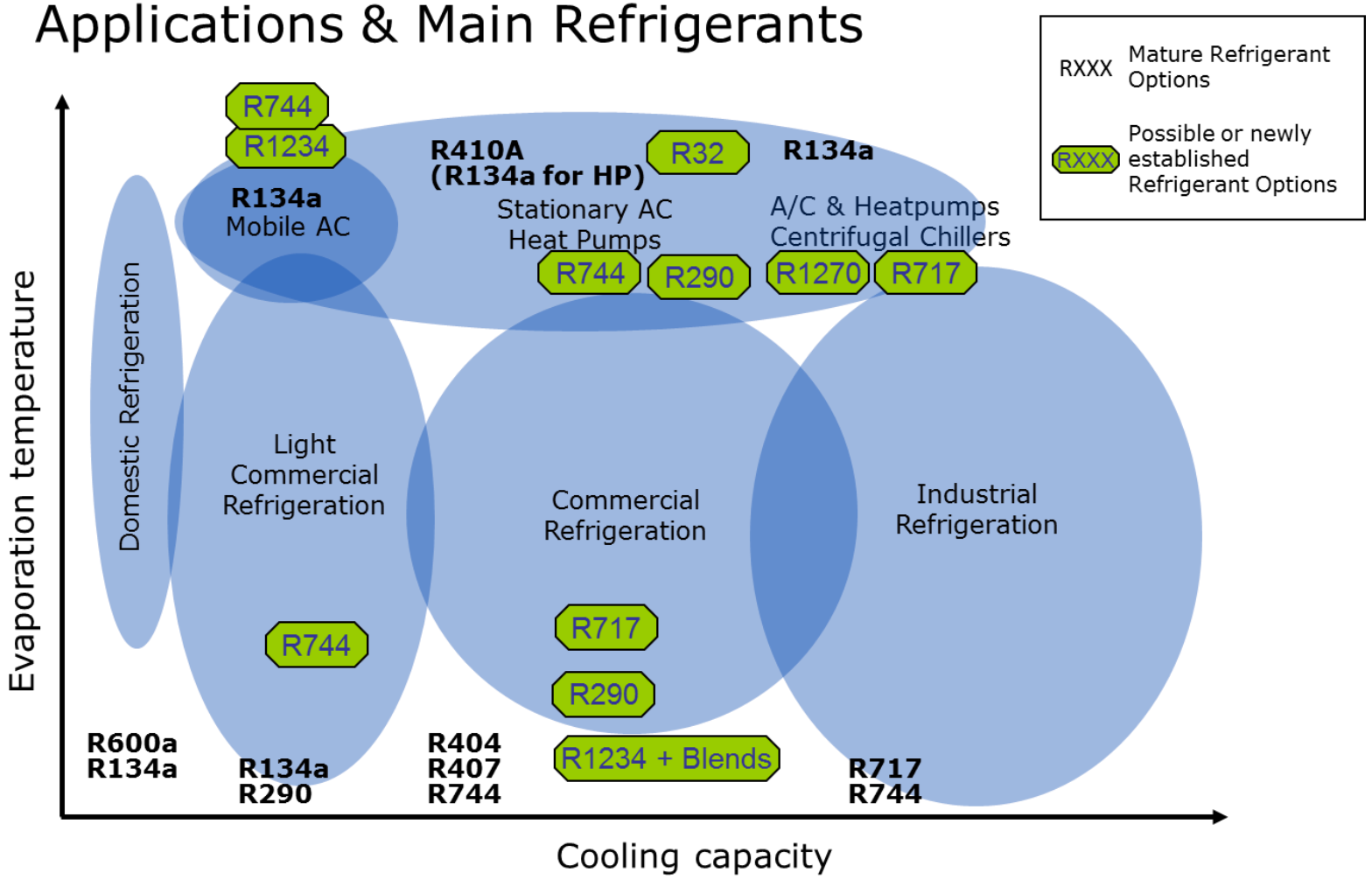
but

- The cost of operation is increasingly more important

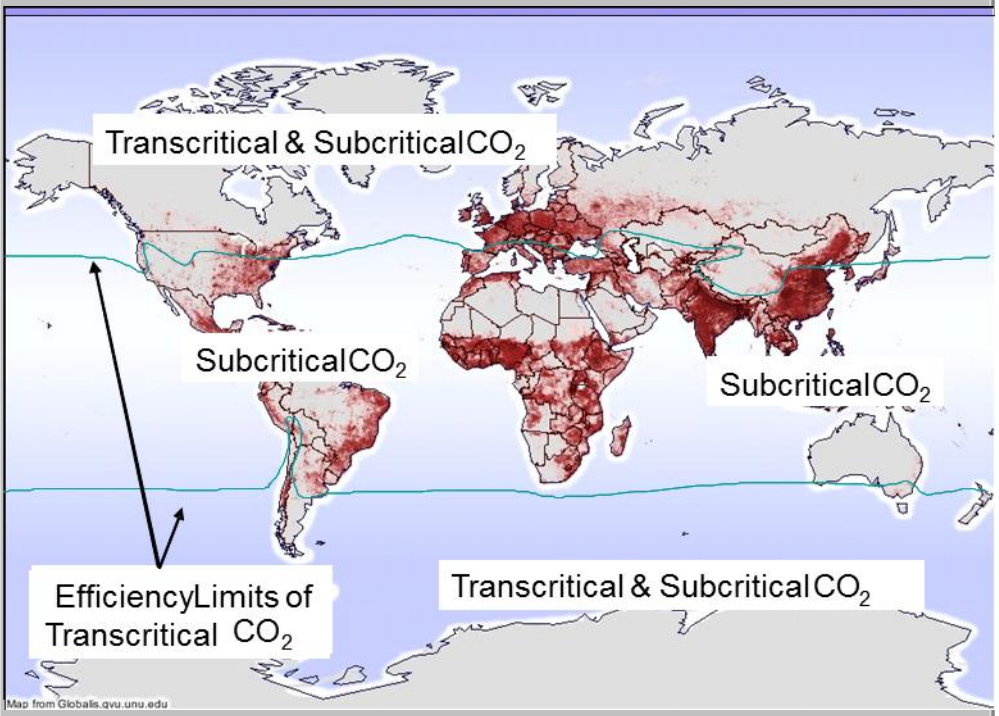
- What matters is the technology giving the minimum total cost of ownership

The Key is Sustainable Technology

Applications & Main Refrigerants



Geographical considerations

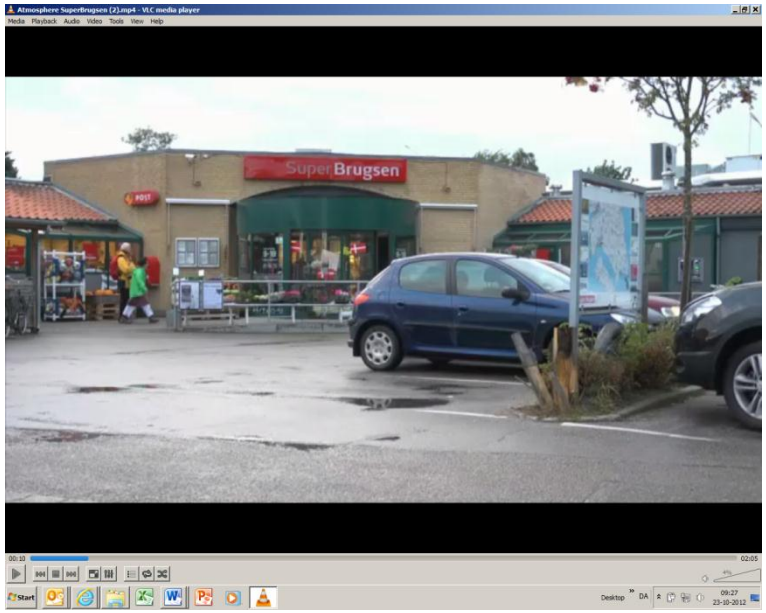


- CO_2 as stand alone refrigerant has its limitations to regions with relatively low average temperatures
- The north/south limits moves in favor of CO_2
- In warm regions CO_2 should be considered in combination with NH_3 or Hydro Carbons and **low GWP** HFC solutions

Controls for HC, CO_2 and NH_3 are developed

- TXV
- Solenoid valves
- Sight Glass and other line components
- Heat exchangers
  - Braze plate
  - Micro Channel
- Filter Driers
- Switches
- Electronic controllers

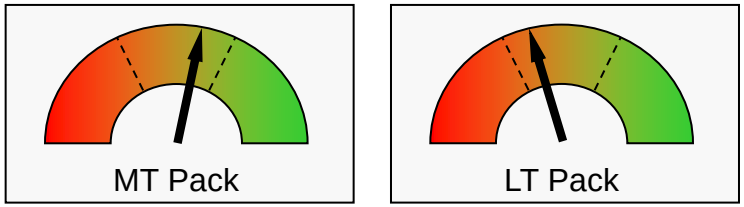
Heat Reclaim Case

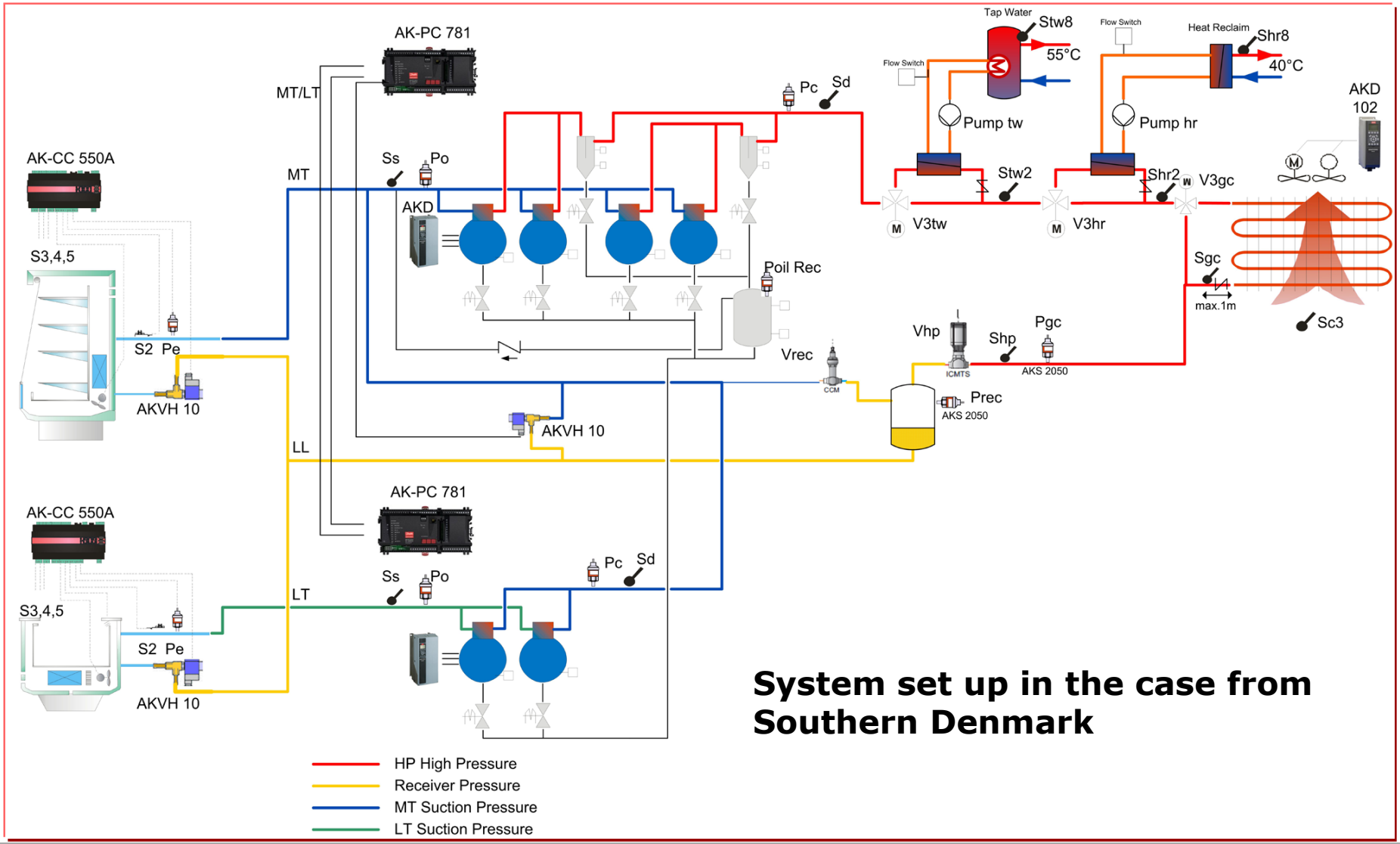


- Høruphav, Southern Denmark
- Area: 1000 m^2 from 2010
- Compressors: 5 MT (1 VS), 4 LT
- Cooling Capacity: 160/ kW MT/LT
- Online COP calculation

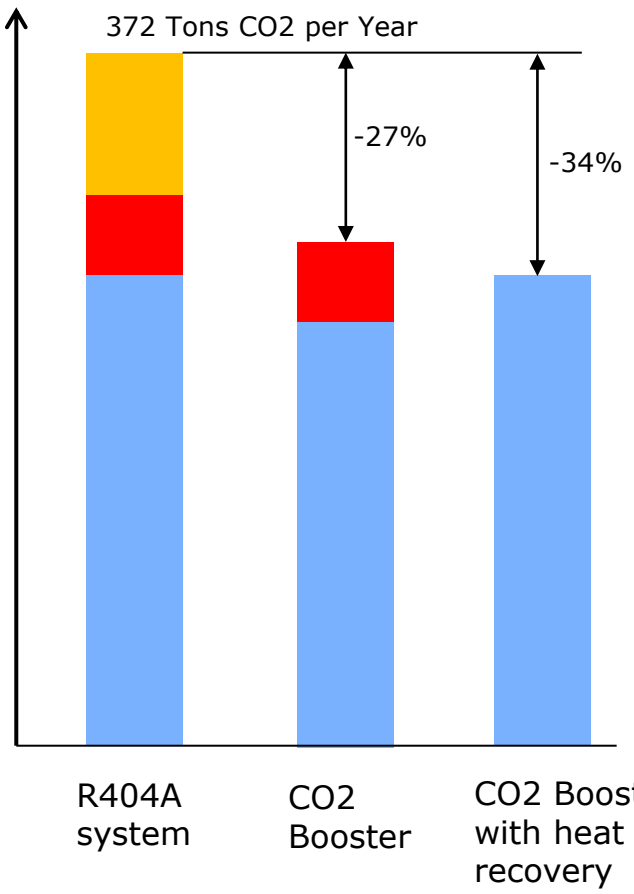
- Heating :
  - Sanitary water (1800 l tank ($T_{reference}$ = 65 ^oC)
  - Floor heating and low temp coils - ($T_{reference}$ = 45 ^oC)
  - Heating investments (add on) is less than 7000 €

Performance of refrigeration system (COP)





System set up in the case from Southern Denmark

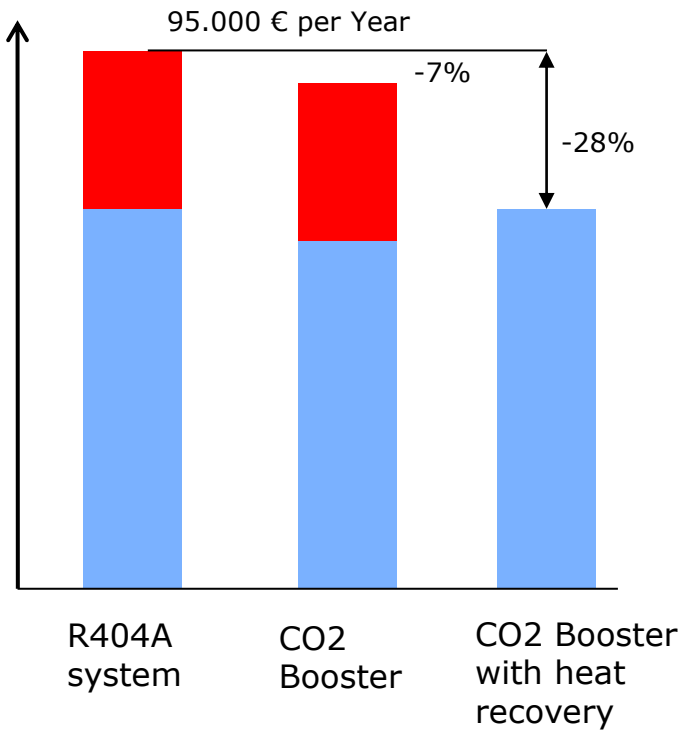


Electricity : ½ kg CO_2/kWH
Gas: 2 kg CO_2 / M3
Leakage rate 10%
Charge: 200kg R404A (GWP =3922)

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

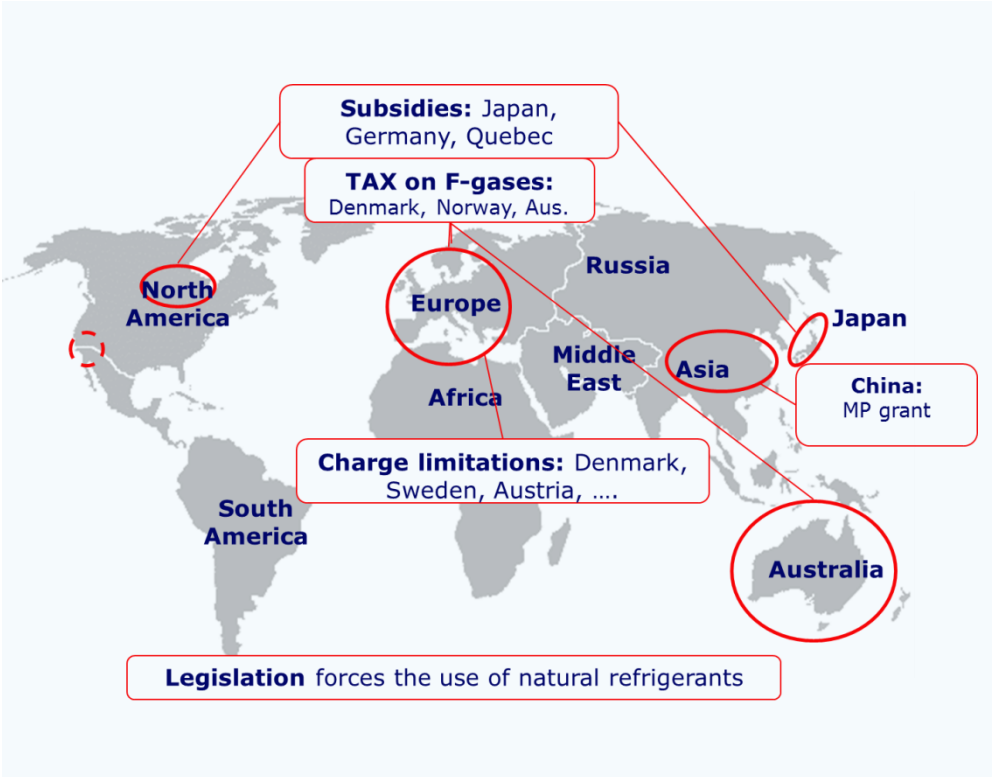
- The CO_2 booster system with heat recovery decreases *overall* energy cost with more than 20 %
- Savings in running costs for topping up on refrigerants leaks are not considered
- The CO_2 system with Heat recovery increases Electricity cost up to 10% compared to systems without heat recovery.

Standard and Legislation (S&L)

A patchwork of standards and legislation is a barrier.

- The global regimes
- The regional measures
- The country measures

S&L are not synchronised in time and content



Safety Standards

Safe hydrocarbon systems can be built by ensuring that systems design and service follow international standards:

- EN 378
- IEC 60335 + UL related translations
-
- Others
- *(ISO 5149:2012 FDIS* ***(final draft ISO standard)***

Beyond standards

Danfoss decided to move beyond standards. Eventually release limitations will be less stringent as market readiness develops:

- Charges below 150g are regarded as having a very low risk for accidents. Danfoss components for charges below 150g applications world wide.

- EU has well defined standards for system safety with flammable refrigerants.

  Danfoss (with exceptions) limit sales for charges larger than 150g to EU and require that our customers follow EN378 or get an notified body approval.

We assure that our components comply in every aspect :

- All components sold for flammable refrigerants comply with ATEX zone 2. Even a leak should occur by error, our components will never be ignition source !

Most critical barriers for low GWP Refrigerants

	Top Barrier Force	To Do
CO2	• Market readiness	• Education / Training
NH3	• Technical ability • Market readiness	• Components to be developed • Pilot systems to be installed • Education / Training
HC	• Standard & Legislation	• Implement ISO 5149 in developing countries
HFO	• Standard & Legislation • Cost / Get on market	• Implement ISO 5149 in developing countries • Get on market

Conclusion

- Technically (efficiency / reliability) ? - YES
- Economically (invest./run.cost) ? – Depends on the region
- Practically ? (training etc.) – Depends on the region
- Safety ? (standards - training) – depends on the region

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