Challenges when selecting future proof working fluids for high temperature heat pumps

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The EU-Commissions green new deal

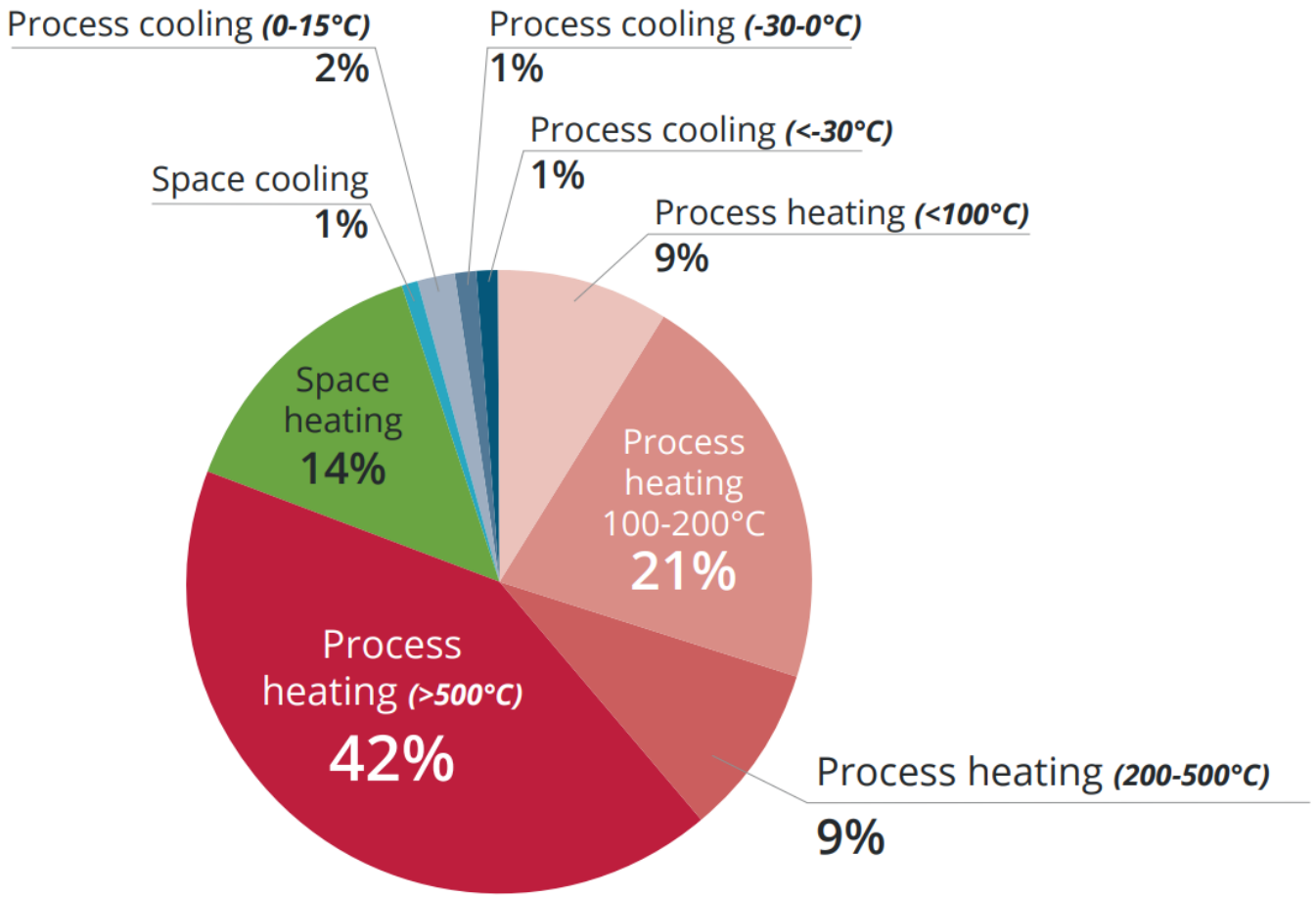
- Our most pressing challenge is keeping our planet healthy. This is the greatest responsibility and opportunity of our times. **I want Europe to become the first climate-neutral continent in the world by 2050.** To make this happen, we must take bold steps together. Our **current goal of reducing our emissions by 40% by 2030 is not enough.**

  Ursula von der Leyen

- In the mean time the 40% has increased to 55%
- 2030 - that is not so far away
- Some technologies required are still not born or in their infancy
- For heat pumps there is still many challenges to be solved

Process heating and cooling

- Space heating and cooling accounts for about 40% to 50% of all energy produced
- Space heating and many processes can be supplied by heat pumps
- New developments will provide heat pumps for up to about 180°C – 250°C
- With more development water vapor heat pumps can produce heat up to 350°C or higher producing dry superheated steam
- This cover the main heating needs below 500°C



Decarbonisation – what does it mean

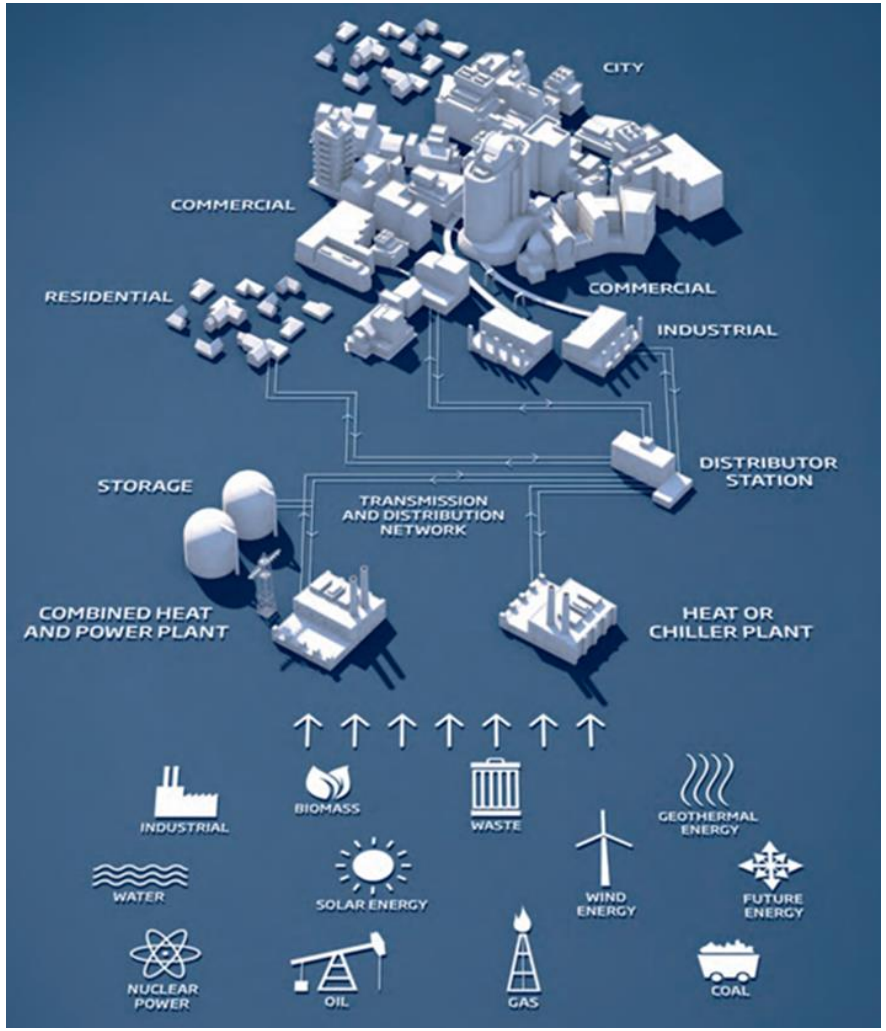
- Stop of using fossil fuels
- Be careful with white washing of fuels
- All fuels containing carbon will produce CO_2
- Hydrogen and ammonia do not develop CO_2

- For district heating and cooling systems it is essential with reliable systems
- In many cases heat pumps and electrical heaters are used to balance the electric grid

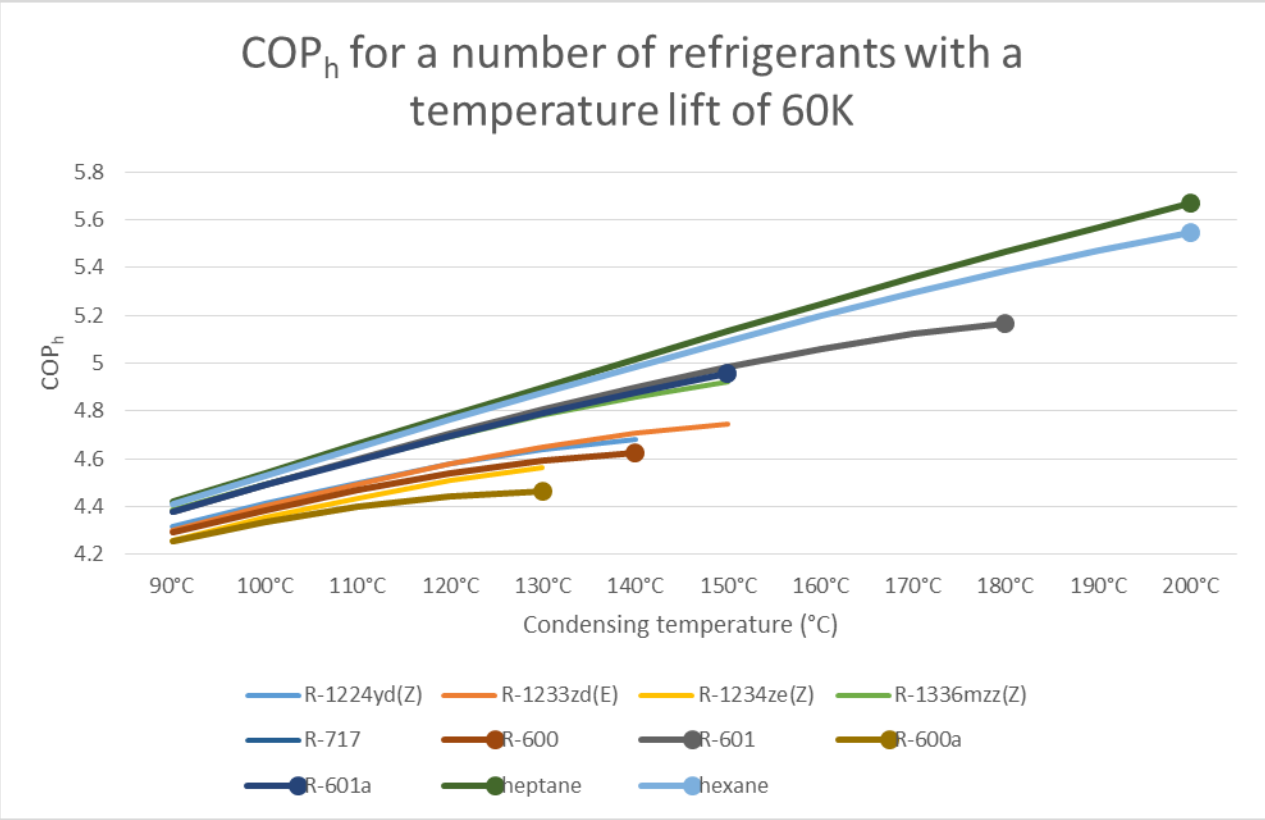
Fuel	Emissions in $kgCO_2$ / kWh	Emissions in $kgCO_2$ / GJ
Wood *)	0.39	109,6
Peat	0,38	106,0
Lignite	0,36	101,2
... Lusatia	0,41	113,0
... Central Germany	0,37	104,0
... Rhineland	0,41	114,0
Hard coal	0,34	94,6
Fuel oil	0,28	77,4
Diesel	0,27	74,1
Crude oil	0,26	73,3
Kerosene	0,26	71,5
Gasoline	0,25	69,3
Refinery gas	0,24	66,7
Liquid petroleum gas	0,23	63,1
Natural gas	0,20	56,1
*) not sustainable used without reforestation		
Source: Fachbuch Regenerative Energiesysteme and UBA		

The future – the part of the future we think we know

- The future energy net will be made with different technologies
- Heat pumps will play an important role producing both cold and hot water
- In production facilities heat pumps can produce both heat and cooling – perhaps in cascade system using two different fluids in order to reach the optimal efficiency

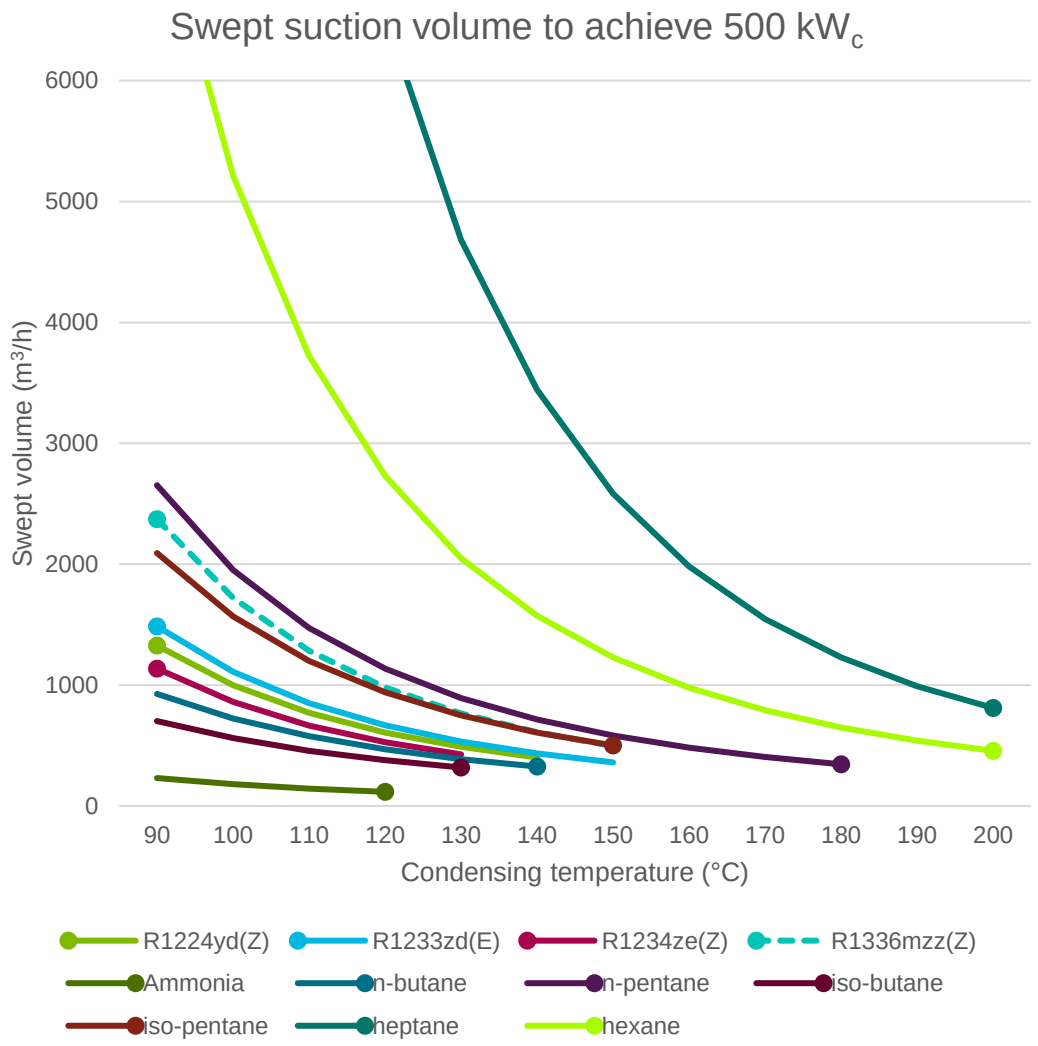


About Coefficient of Performance (COP)



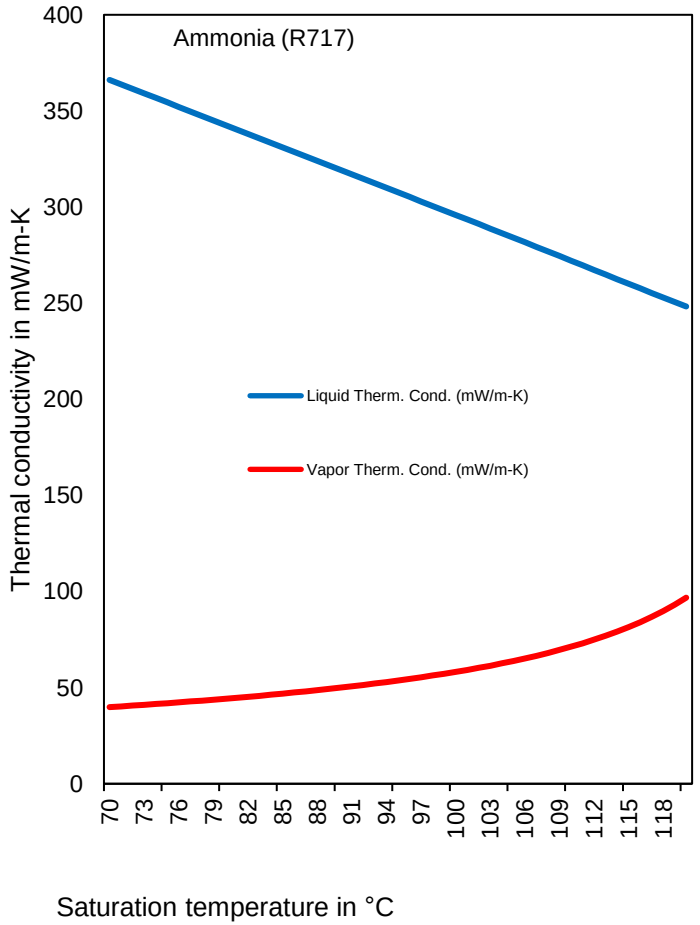
- If you only consider COP the obvious choice would be Heptane (R603)
- But …..
- What about swept volume if I need e.g. 120°C water for the local DH system?

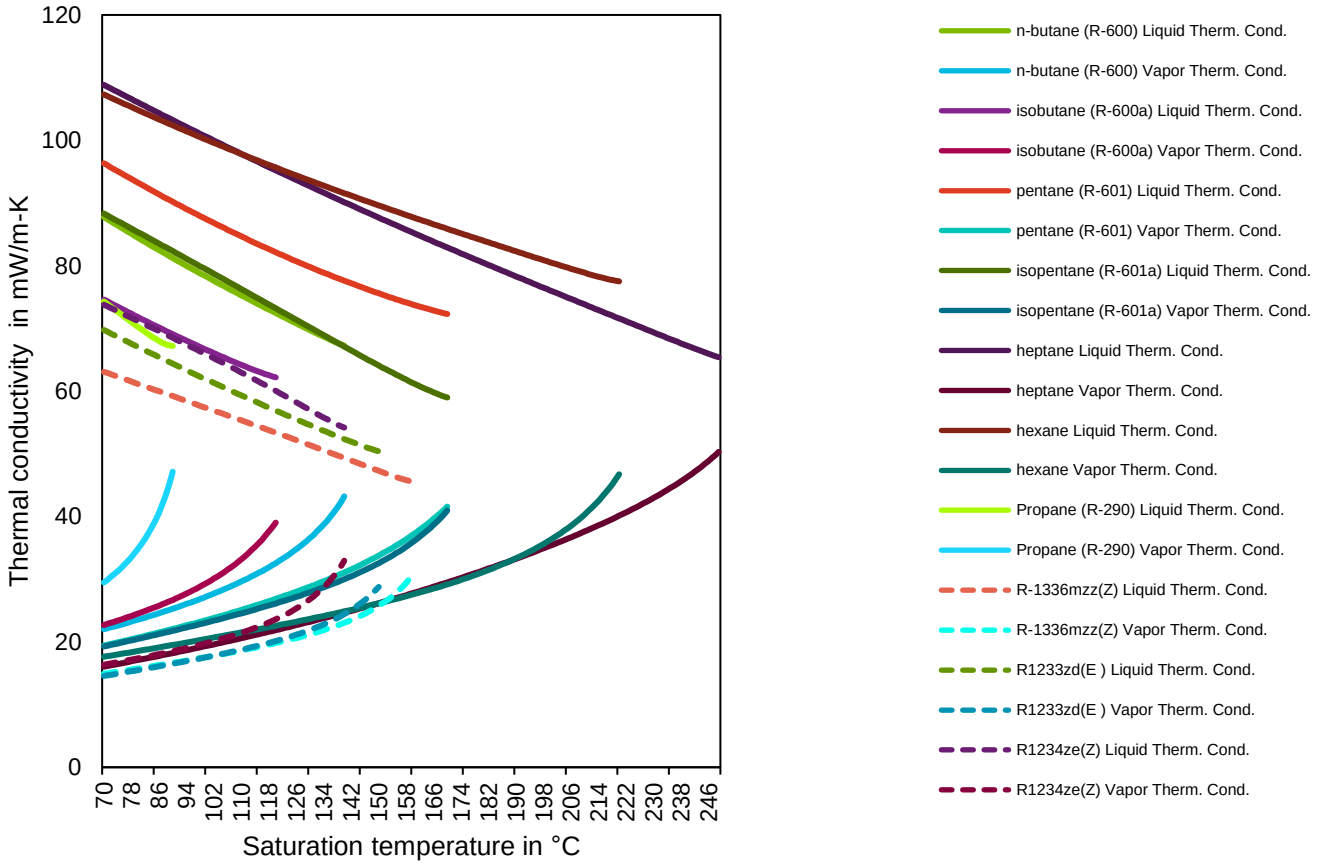
Swept Volume

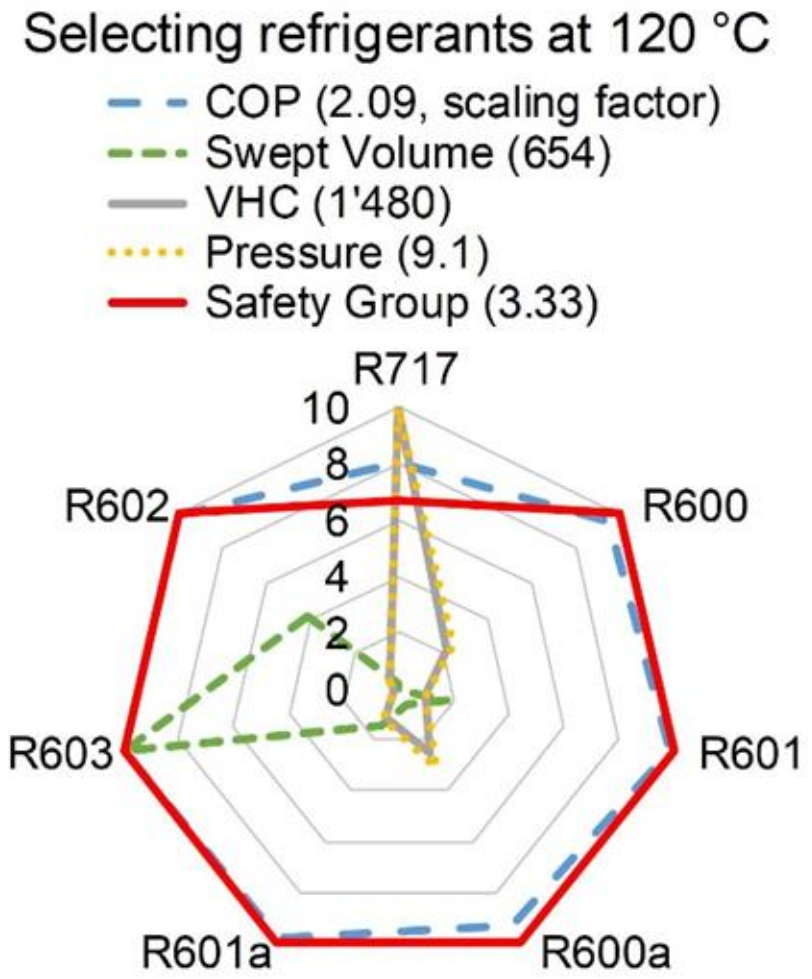


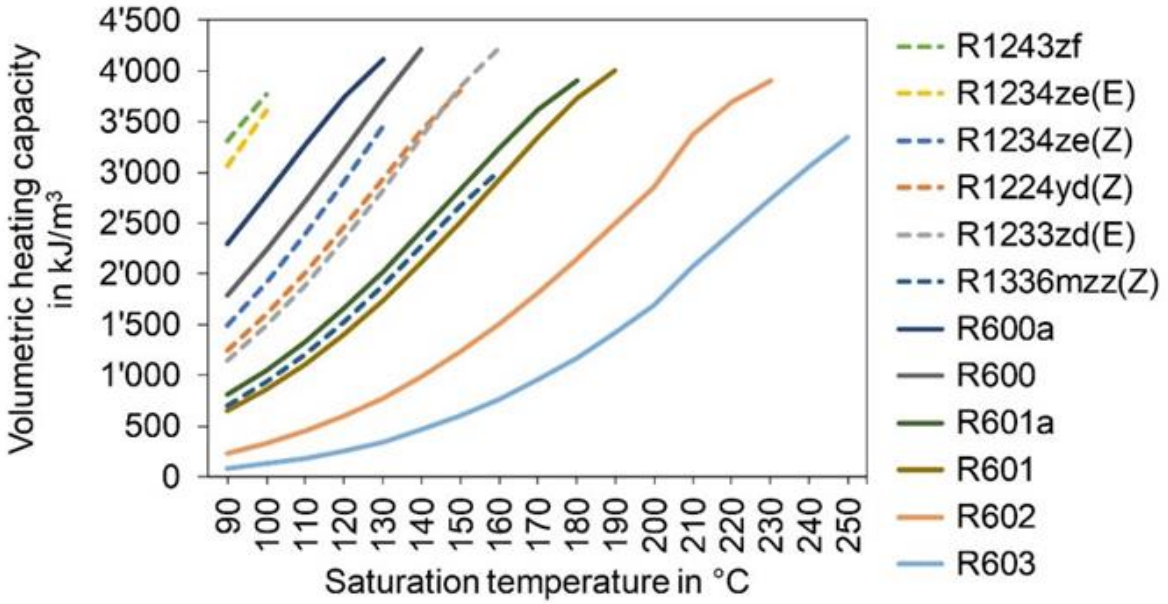
- The swept volume is also about the cost of the system
- COP and cost of the system are the two main parameters for the purchaser of the system
- In this case an ammonia heat pump at 120°C would be the best choice
- Or …?

Thermal condutivity

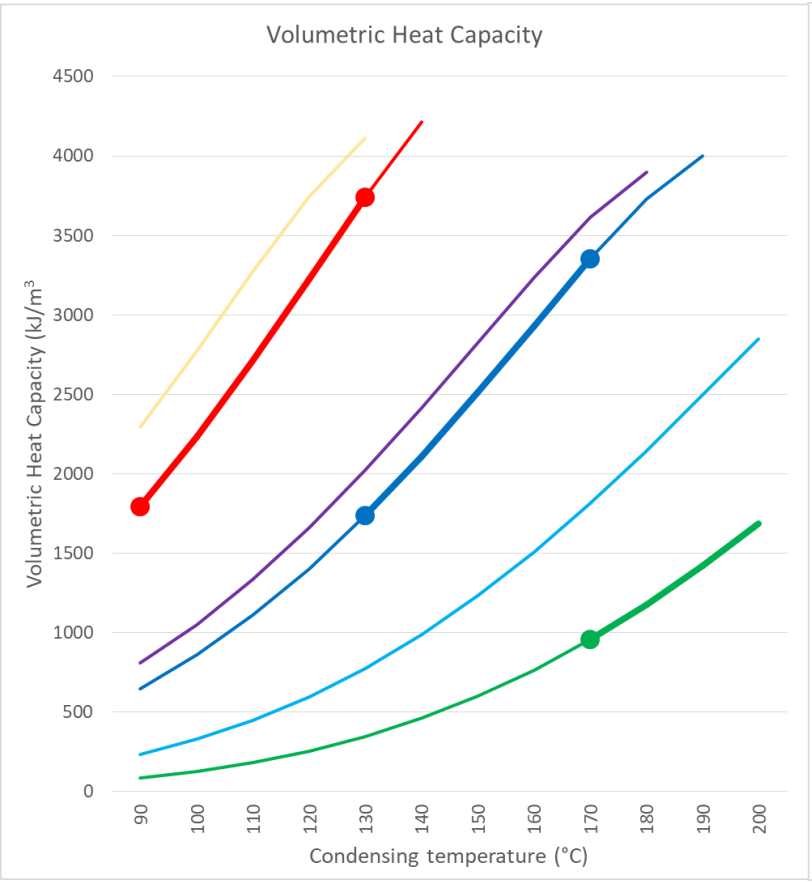


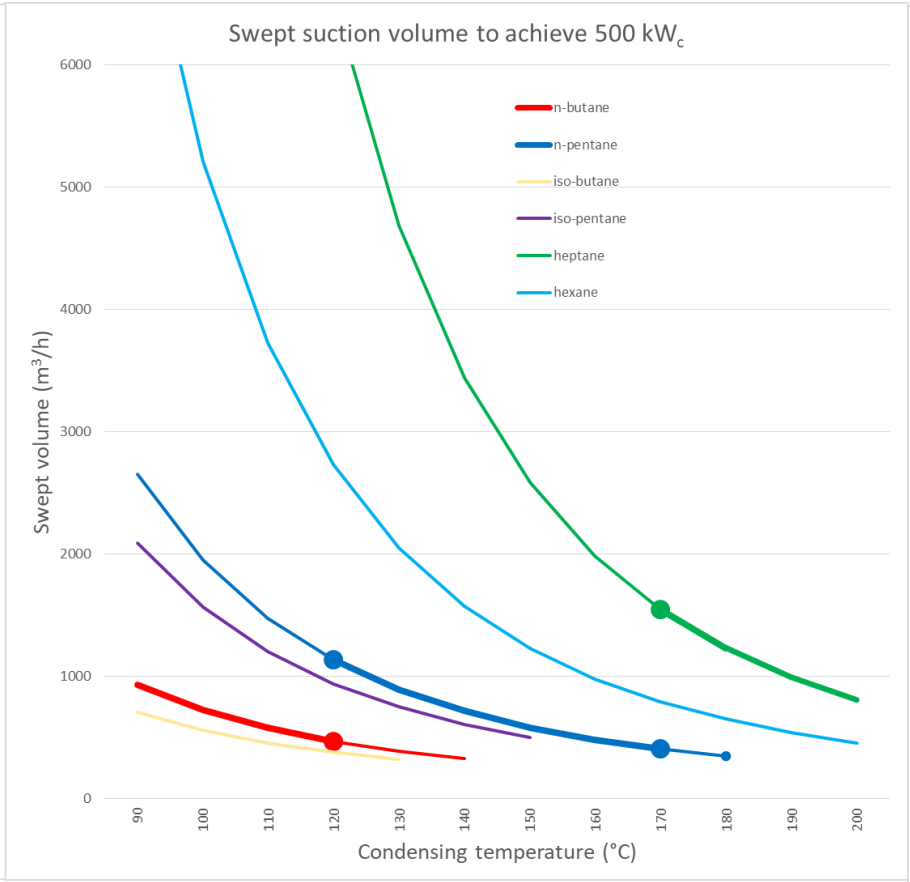


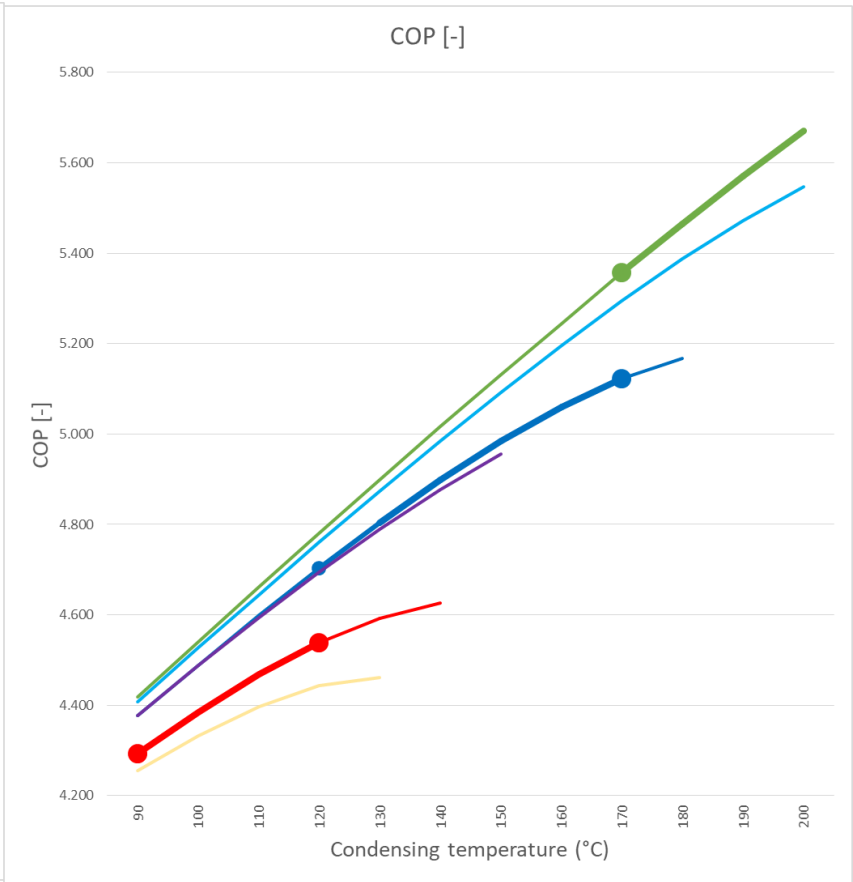




Getting closer to the target

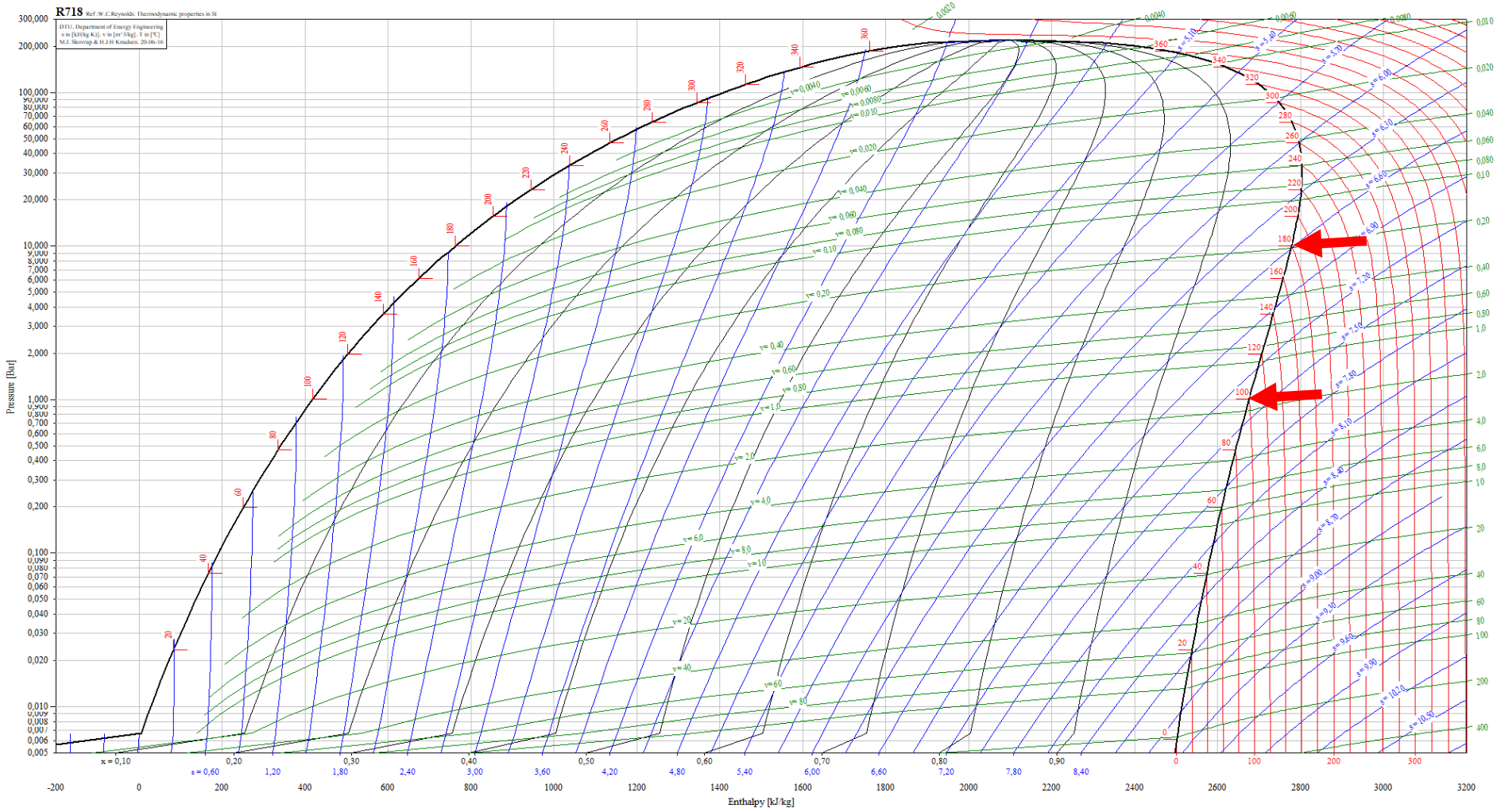






Water as a working fluid – mainly for high temperatures

- High pressures for high temperatures



There are many other things

- Cables – heat will damage the insulation
- Sensors and solenoid valves can be sensitive to heat
- Some valves are still not approved for higher temperatures
- Oil can start to break down about 180 to 200°C
- Refrigerants can have temperature limitations
- Compatibility
- PED approvals
- ATEX??
- Price and availability

- These parameters is something that is not calculated but better dealt with in a traffic light sheet

Components	Availability	Comments
Compressors		Not all brands
Refrigerants		Not all suppliers
Lubricants		Not all temperatures
Valves		Limits about 150°C
Pipes		
Vessels		Low pressures, temp?
Filter driers		Not evaluated
Heat exchangers		Not all evaluated

At the end

- When you have been around all the topics
  - You know more about your new refrigerant
  - You know where the pitfalls are
  - You know the limitations and properties of all details in the system
  - You know how to realise the product and the cost implications
- Then comes the testing!

- More relevant is that you know if your project will be relevant for the future

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- In the mean time 40% has been increased to 55%
- 2030 - that is not that far away and neither is 2050 if we are to make this happen
- Some technologies required urgent investments - NOW
- For heat pumps there is still many challenges to be solved but it can be done!

- Lets do it!!

Good luck and thank you very much for your attention