Geothermal heat pumps with ammonia high efficient

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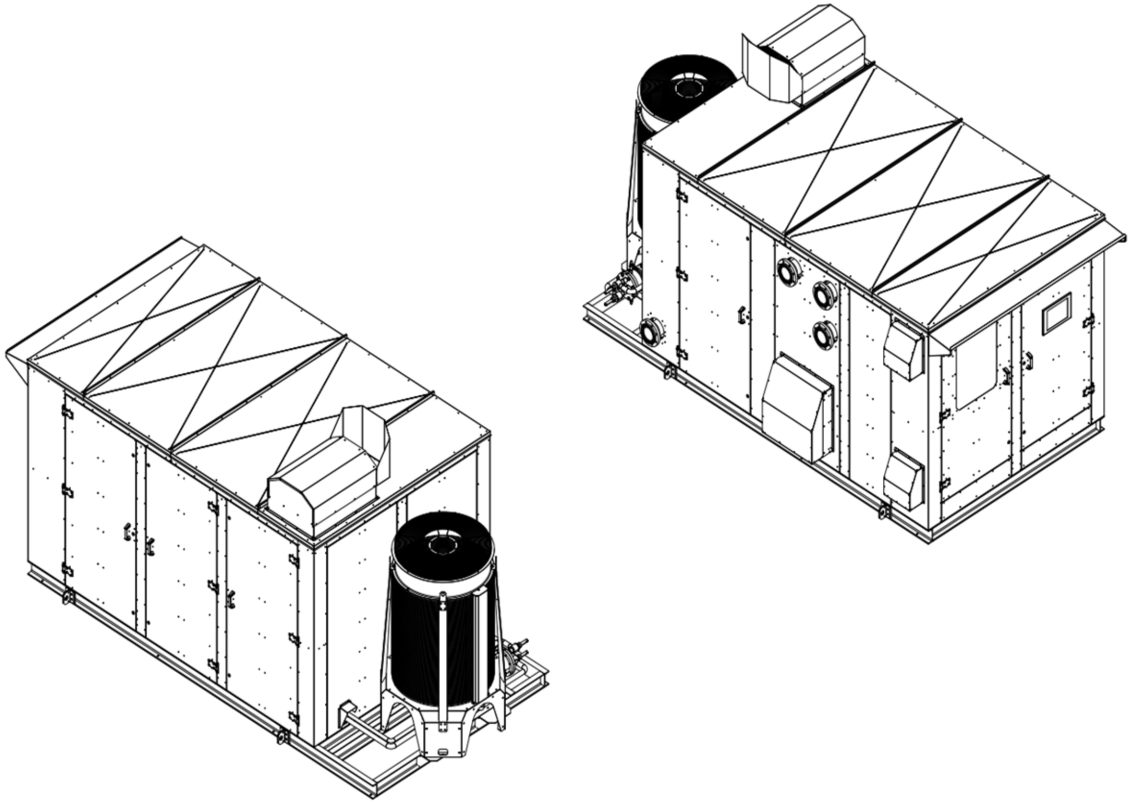
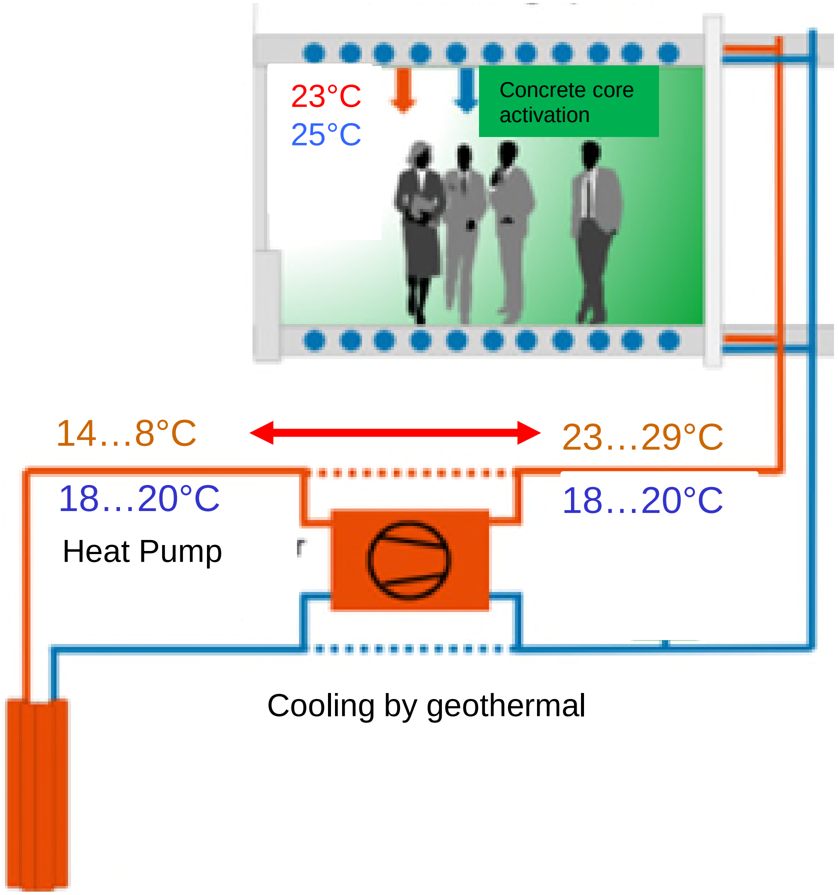
Geothermal heat pumps with ammonia highly efficient for concrete core heating and concrete core cooling (Seasonal Coefficient of Performance 7...9)



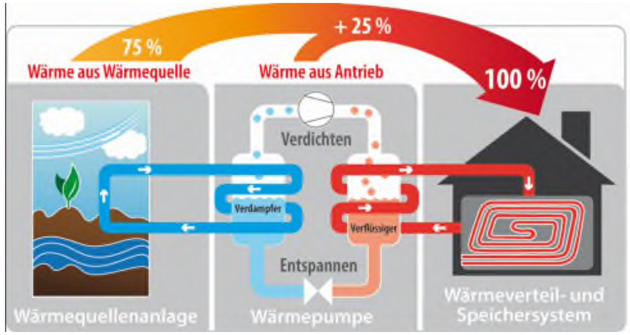


Why use heat pumps……… to archive decarbonization

- A heat pump is a heating system that uses the thermal energy stored in the environment or in waste heat

- This is an important aspect compared to usual heat generation plants (combustion of oil, gas, wood, etc.) to achieve decarbonization

- Possible heat sources from the environment



- Possible sources of waste heat

Basically, heat pumps with high efficiency are needed to be economically

Comparison of specific costs of electrical energy and specific costs of natural gas

Specific costs of electrical engergie in Germany 2022/2023

0,40 EUR/kWh

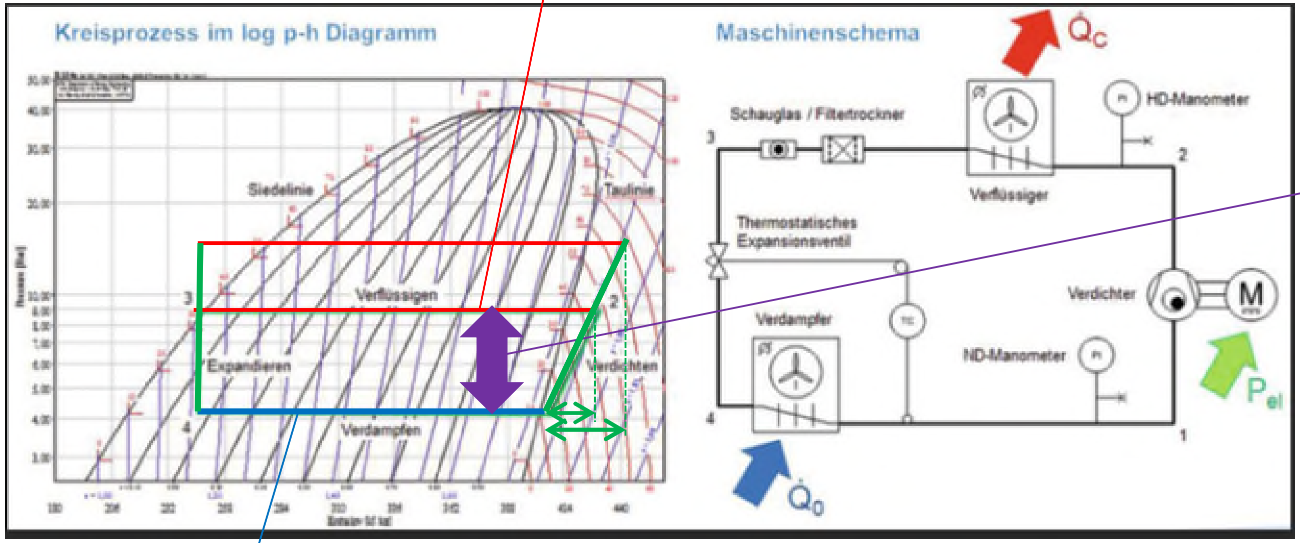
Specific costs of natural gas in Germany 2022/2023

0,12 EUR/kWh

Result: to be financial economical the efficiency of the heat pump has to be > 0,40/0,12 = 3,33

The main goal is to design heat pumps with a high level of efficiency

- Heat pump efficiency: $\mathbf{COP} = \frac{\textbf{heating energy}}{\textbf{electrical energy}}$
- Mean:
  - ➢ **Low** heat sink temperature (process temperatures)



  - ➢ **High** heat source temperature (Geothermal)

Carnot factor

$$COP = Gütegrad \times \frac{T_{Senke}}{T_{Senke} - T_{Quelle}}$$

$$Carnot = \frac{(273{,}15+29°C)}{(273{,}15+29°C)-(273{,}15+10°C)} = 15{,}9$$

Carnot: Max possible efficiency

The main goal is to construct heat pumps with a high level of efficiency

heat source temperature geothermal range 8…14°C

heat sink temperature concrete core heating range 23…29°C

Usual heat pumps: SCOP: 4,1

Friotherm SCOP: 7

JAZ = Jahresarbeitszahl

SCOP = Seasonal Coefficient of Performance

Maximum measured electrical power
4,2 kW at 14.12.2022
-8°C Ambient temperature
for 2.100m²
Max installed: 9,2 kW
Min installed: 3,6 kW

Heat pump

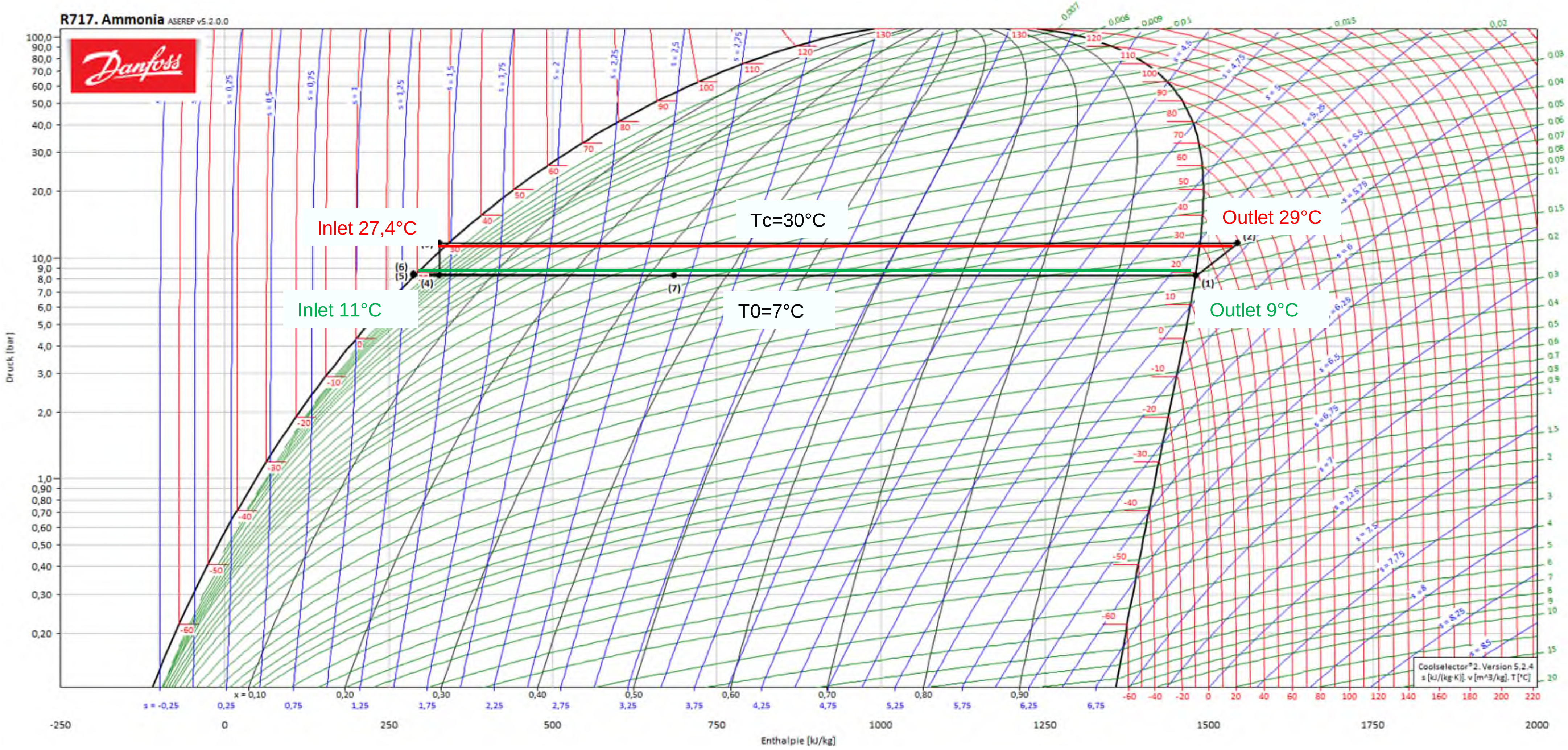
Heating Energy 7kWh

Electric Energy
1 KWh

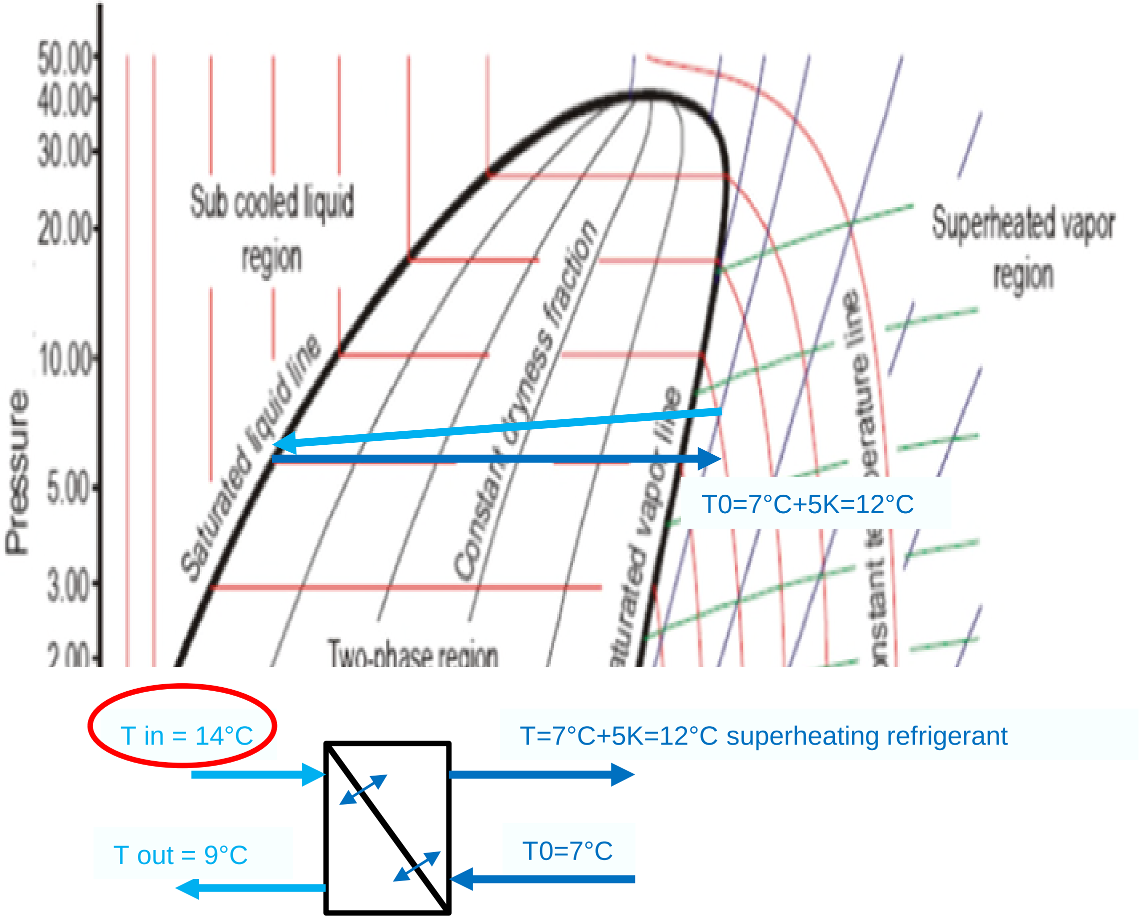
Heating season 2022/23
Electric power consumption 11.535 kWh / 2.100 m²
spec. el. power consumption.: 5,49 kWh/m²*a

Geothermal Energy
6 kWh

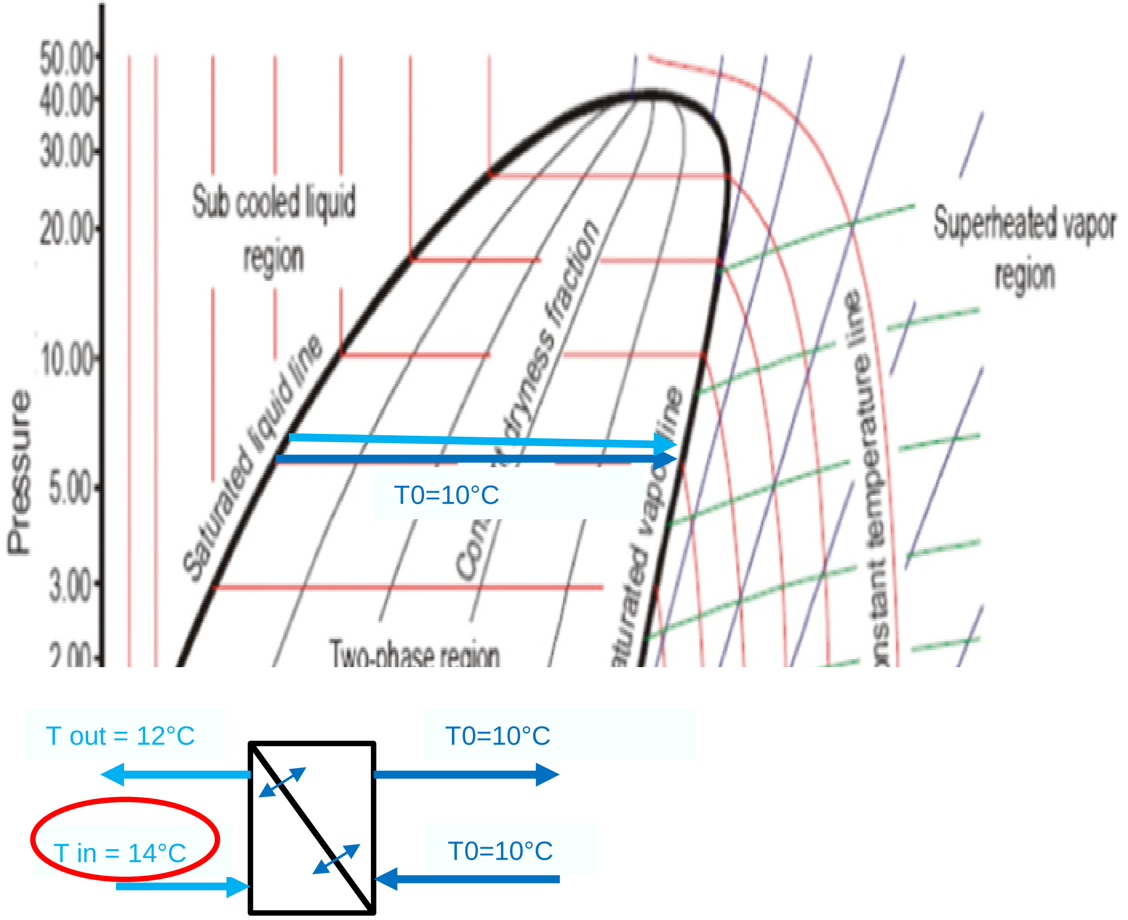
Why Friotherm can archive the high level of efficiency



Why Friotherm can archive the high level of efficiency



DX – Evaporator (counter flow)



Flooded – Evaporator (parallel flow)

Why Friotherm can archive the high level of efficiency

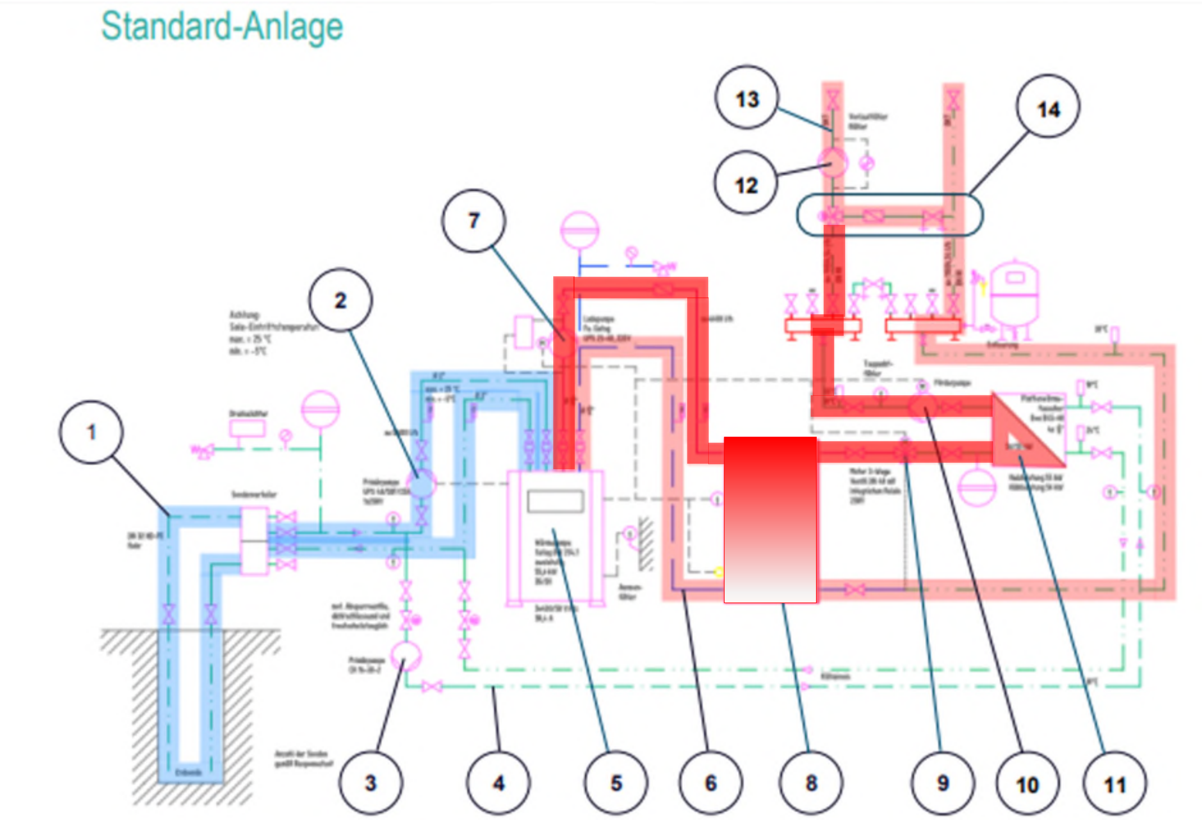


Bild 3 Standard Geothermie-Wärmepumpen-System

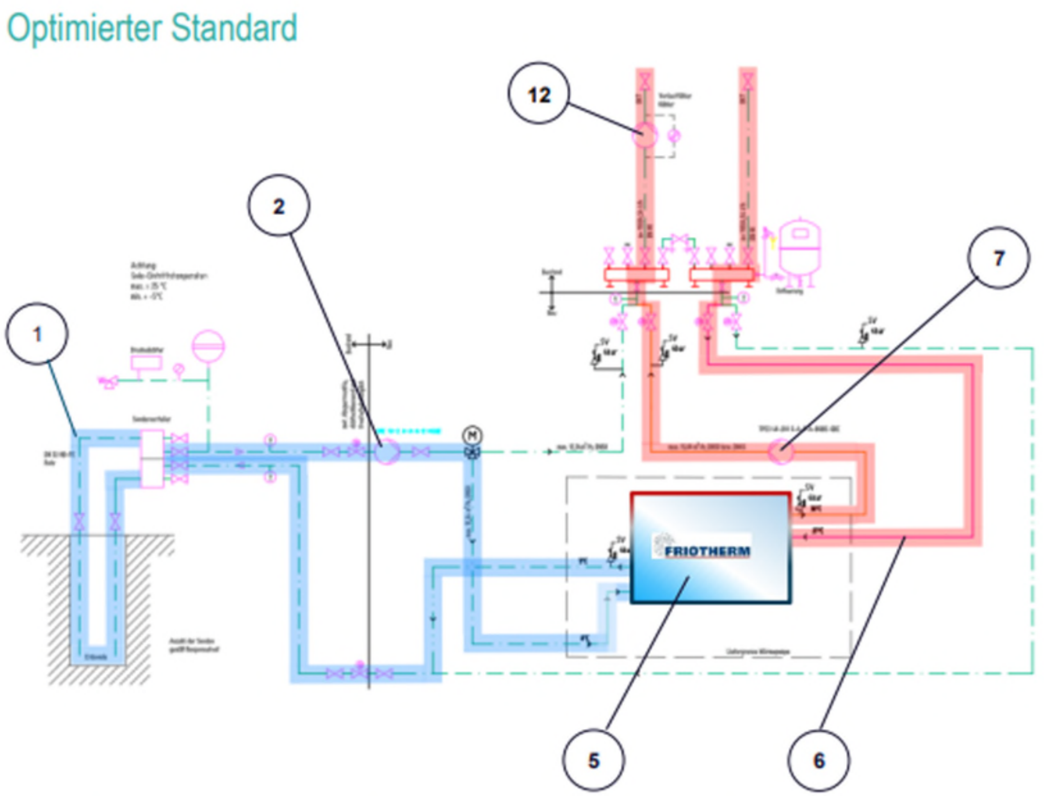


Bild 4 optimiertes Friotherm Geothermie-Wärmepumpen-System

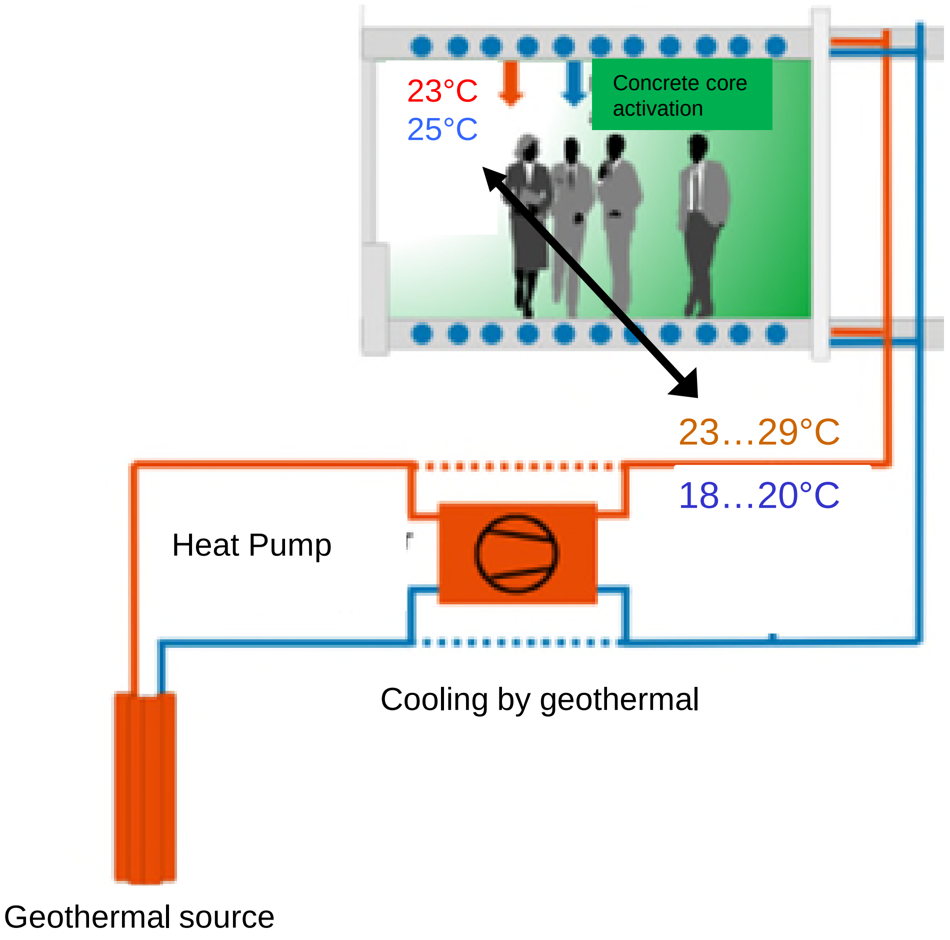
Comparison: Heat Pump flooded evaporator / DX- evaporator



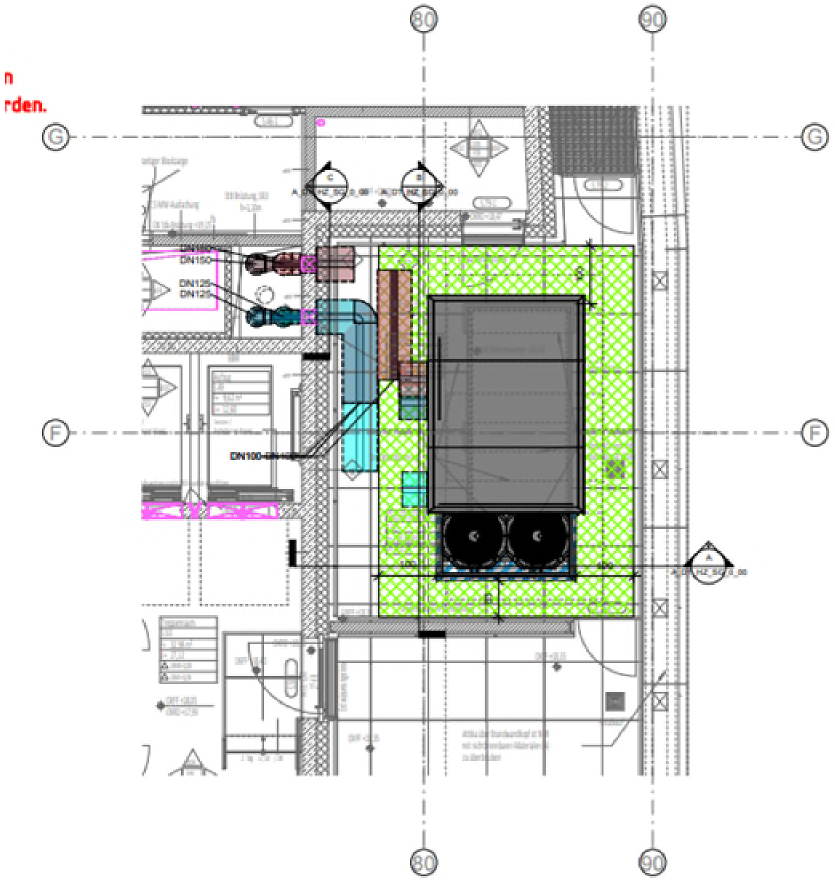


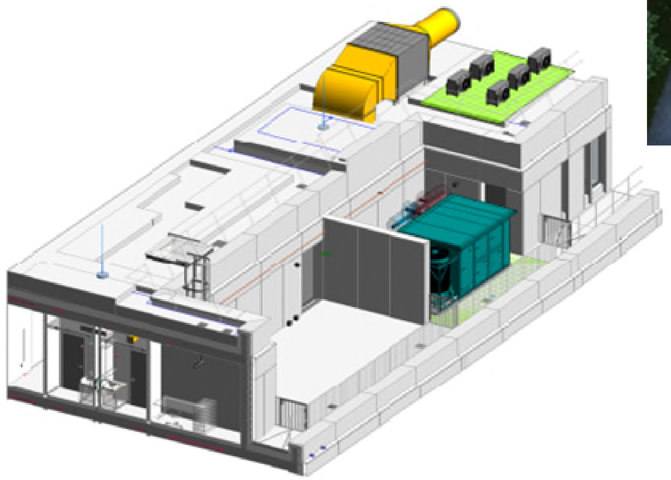

Summary aspects for high efficent heat pump operation

- Minimum difference between <u>source</u> and <u>sink</u> temperature
- Optimum refrigerant circuit
- High efficient part load mode (means more compressor and speed controlled)
- Frequency controlled compressor, source pump, sink pump
- special in part load the heating temperature has not to be not higher than required

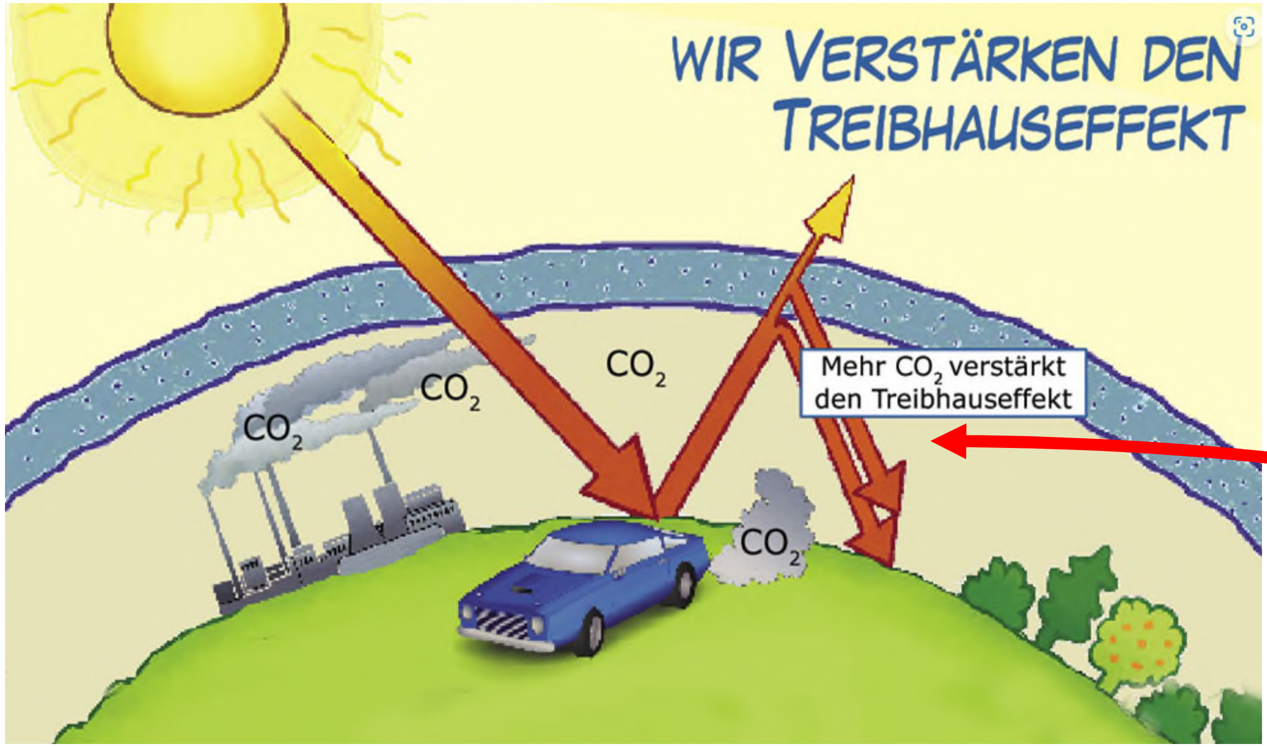


Optimum integration of the heat pump in the office building system





CO_2- equivalent because of refrigerant



harmful greenhouse gases

<u>Theoretical example</u>

CO_2- equivalent of **2,1kg R410A**

Means combustion of **1.648 ltr.** Fuel oil

	Anzahl Wärmepumpen	Kältemittel-füllmenge	Kältemittel	GWP	Annahme bei 100% Kältemittelverlust: CO_2-Äquivalent bei **100%** Verlust	Annahme bei 100% Kältemittelverlust: Äquivalente Heizölmenge (2,66 kg CO2/ltr.)	Annahme bei 1% Kältemittelverlust: CO_2-Äquivalent bei **1%** Verlust	Annahme bei 1% Kältemittelverlust: Äquivalente Heizölmenge (2,66 kg CO2/ltr.)	Annahme bei 1% Kältemittelverlust: Äquivalente Wärmemenge
	Stück	**kg**			**Tonnen**	**ltr.**	**Tonnen**	**ltr.**	**kWh**
10 Mio Einfamilienhaus-Wärmepumpen	10.000.000	2,1	R410A	2.088	43.848.000	16.484.210.526	438.480	164.842.105	1.648.421.053
je Einfamiliehaus-Wärmepumpe	1	2,1	R410A	2.088	4,385	1.648	0,044	16,48	165
je Einfamiliehaus-Wärmepumpe !!! GWP>150 !!	1	2,1	R32	675	1,418	532,9	0,014	5,33	53,3
je Einfamiliehaus-Wärmepumpe !!! PFAS !!!	1	2,1	R1234ze	7	0,015	5,5	0,000	0,06	0,6
je Einfamiliehaus-Wärmepumpe	1	2,1	R600a	3	0,006	2,4	0,000	0,02	0,2
je Einfamiliehaus-Wärmepumpe	1	10,0	NH_3	0	0,000	0,0	0,000	0,00	0,0

Ammonia: GWP = 0 means zero CO_2 - equivalent

eurammon e. V. is always available as a sparring partner for questions on refrigeration with natural refrigerants.

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