

CO₂ HEAT PUMPS – AND WHY HEATING TEMPERATURES MATTERS



FENAGY
FUTURE ENERGY SOLUTIONS

FENAGY

Manufacturer of heat pumps and refrigeration systems in Aarhus

- + 3000 m² office and production in Lystrup (just outside Aarhus, Denmark)
 - + 60 dedicated employees
 - + 40 projects sold and getting close to 100 MW installed capacity
 - + 80 heat pumps (2020:1/2021:13/2022:28/2023:38)
 - + 30 M€ revenue (2023)
-
- + We do – Refrigeration | Heat Pumps | Combined Heating and Cooling
 - + We focus on CO₂ as refrigerant, but also HC's (isobutane and propane)
 - + We are industrially focused on the MW capacity range (0,5– 10 MW range)

Heat pumps
District heating and
industry

**Refrigeration
systems**
Chillere, DX racks,
Freezing

CHC
Combined Heating
and Cooling



The way we work

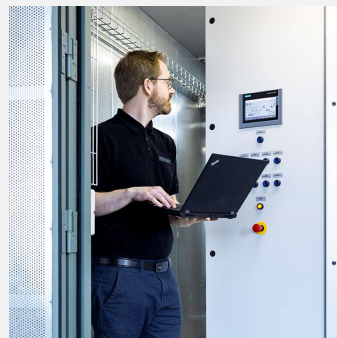
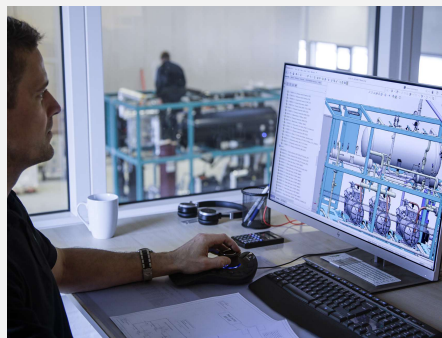
ADVICE

PROJECT
MANAGEMENT
& DESIGN

START UP &
COMMISSIONING

REMOTE
MONITORING

SUPPORT



PRODUCT
DESIGN
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PRODUCTION
+++

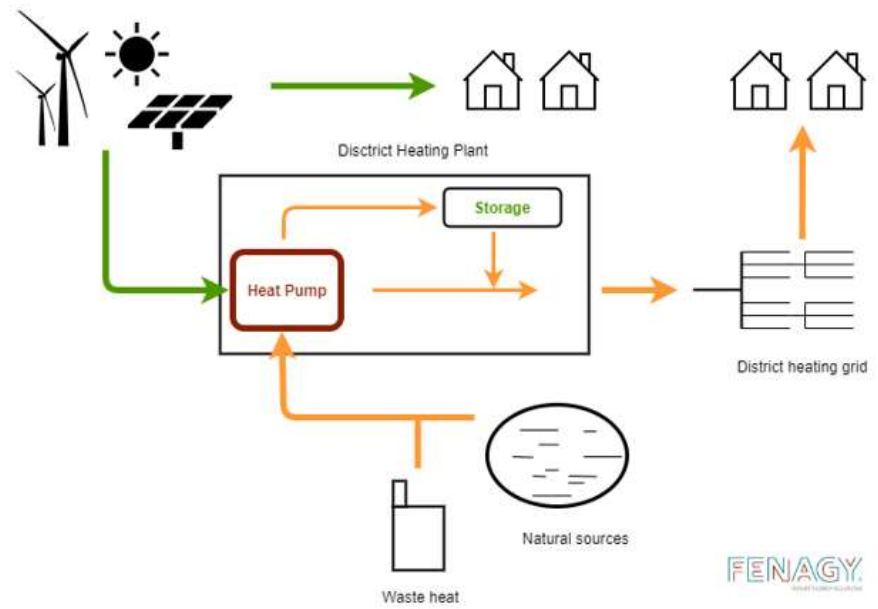
INSTALLATION
-

COMMISSIONING
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SERVICE
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Heat pumps and CHC - district heating and industry



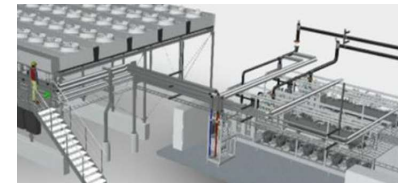
Storage

Evaporators

Controls and
SCADA



Machine room




Heat pump rack



Defrost module



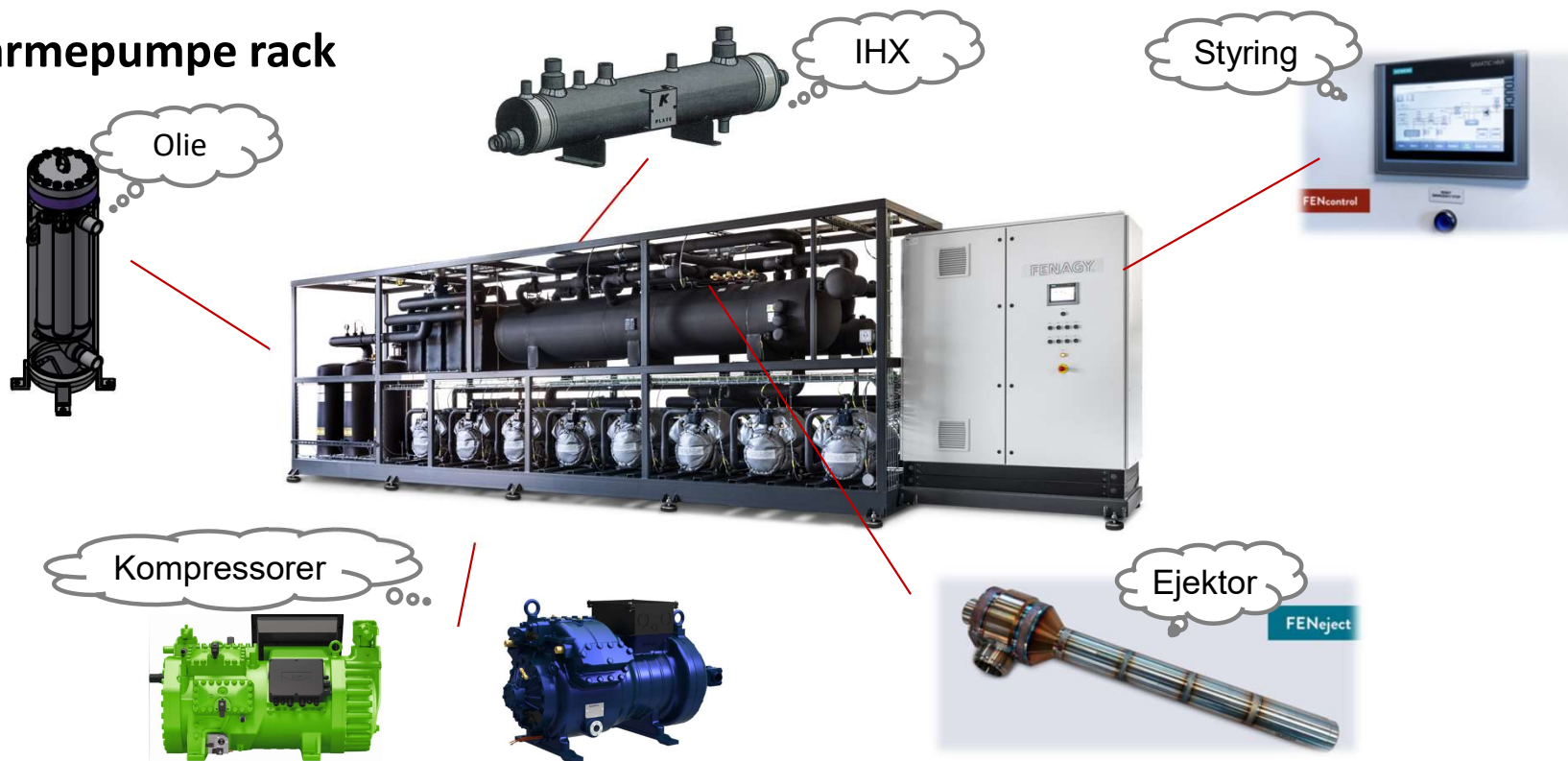


Aalborg utility have installed
a district cooling plant at IKEA Aalborg

YEAR: 2022
MODEL: H1200-AW / WW - 4+4B
APPLICATION: Air-to-Water og Water-to-Water heat pump
CAPACITY (HEAT): 1200 kW (5 °C Evaporation, 72/40 °C Hot water)
CAPACITY (cool): 8/13 °C Hot water
HEAT SOURCE: Air
COP: 3
AFRIMNINGSMETODE: Glycol



Varmepumpe rack



Products (Heat pumps and chillers)

H300 AW - WW



CAPACITY: 300 kW
DIMENSIONS: 2.5/4.8/1.3

H600 AW - WW



CAPACITY: 600 kW
DIMENSIONS: 2.5/4.8/1.3

H1200 AW - WW



CAPACITY: 1200 kW
DIMENSIONS: 2.5/8.0/1.3

H1800 AW - WW



CAPACITY: 1800 kW
DIMENSIONS: 2.5/10.0/1.3

H2600 AW - WW



CAPACITY: 2600 kW
DIMENSIONS: 2.8/12.0/1.5

Difference between WW and AW



Water source heat pumps do have a chiller module for cooling of water, where as air source include remote air to refrigerant evaporators

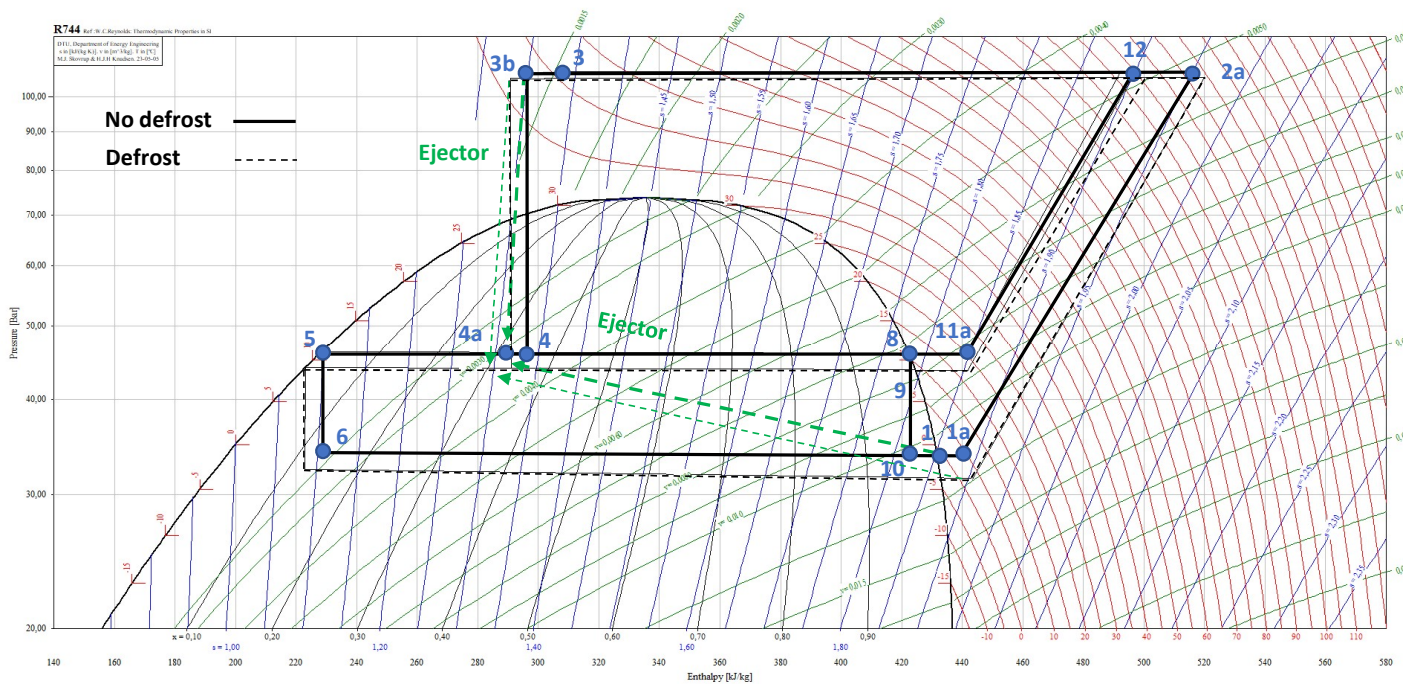


Technology facts for Fenagy CO2 HP's

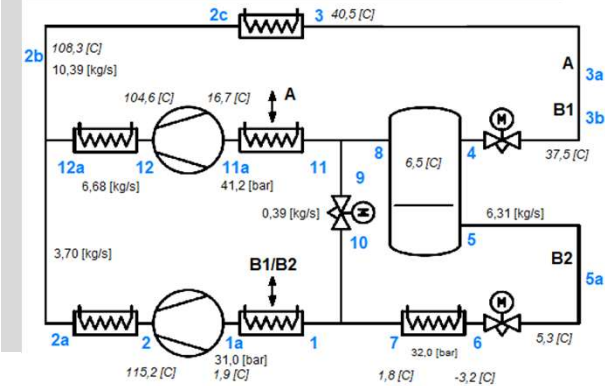
- ❖ CO2 is a natural refrigerant with GWP = 1 and not flammable – refrigerant of the future
- ❖ Unique technology and design and for optimization of COP and operational safety
- ❖ Robust operation in large range of temperatures both on heat source (-20->+20°C) and heat sink (40-85°C)
- ❖ Factory built with a service friendly and compact design
- ❖ Unique Fenagy components - FENEject
- ❖ Unique PLC control system
- ❖ Fenagy own algorithms based on PLC – FENcontrol and FENcloud
- ❖ Unique defrosting capabilities and winter functions
- ❖ Startup and shutdown very fast (5-10 minutes)
- ❖ Monitoring 24/7 and cloud solution with benchmark and “digital twin”



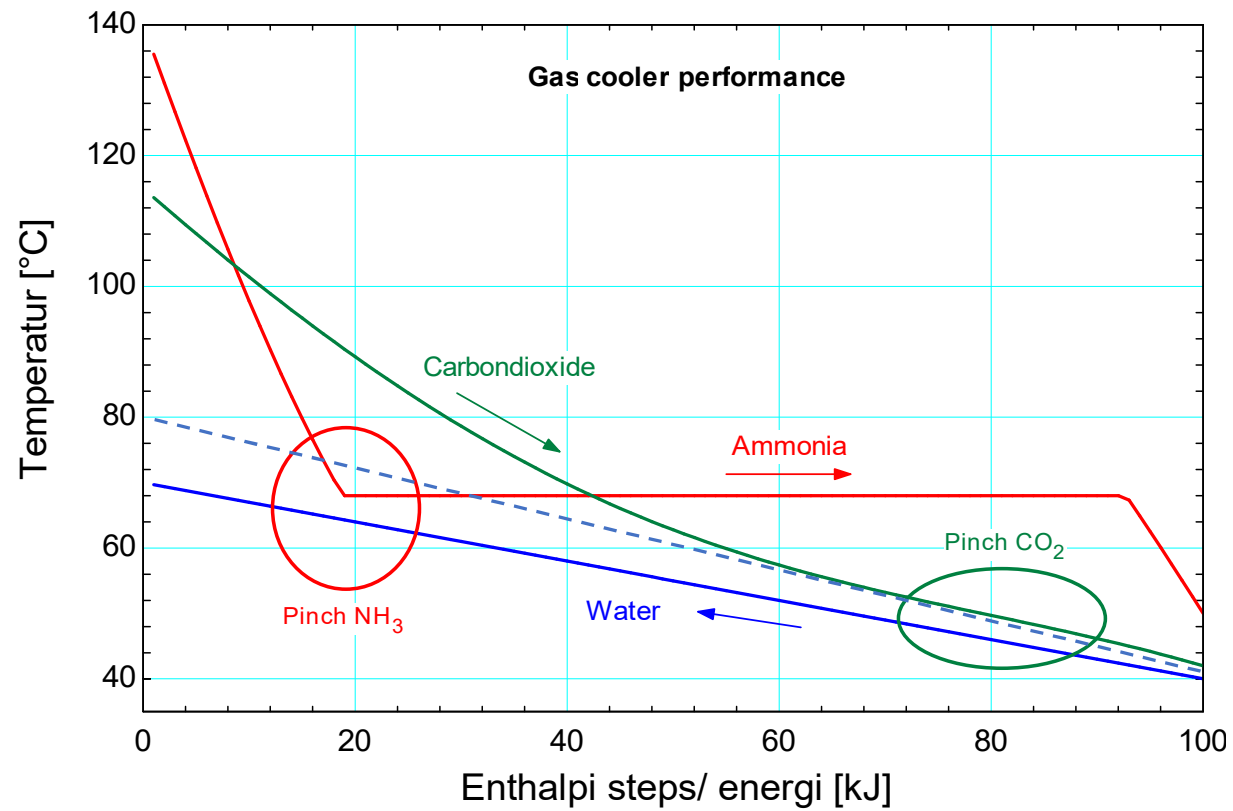
Performance of systems



Simpelt diagram fra beregningsprogram med interne veksler og uden ejektor

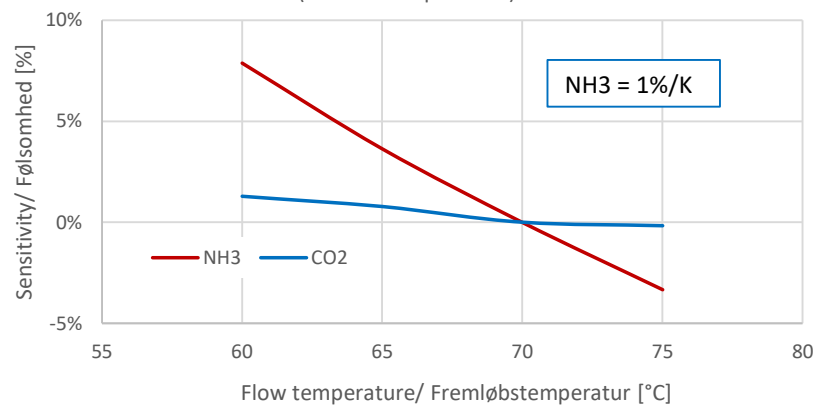


Supply and return temperature

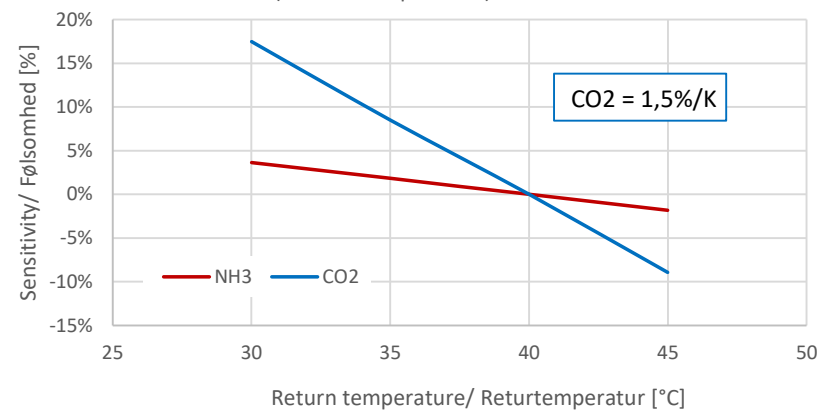


Sensitivity for return- and flow temperature

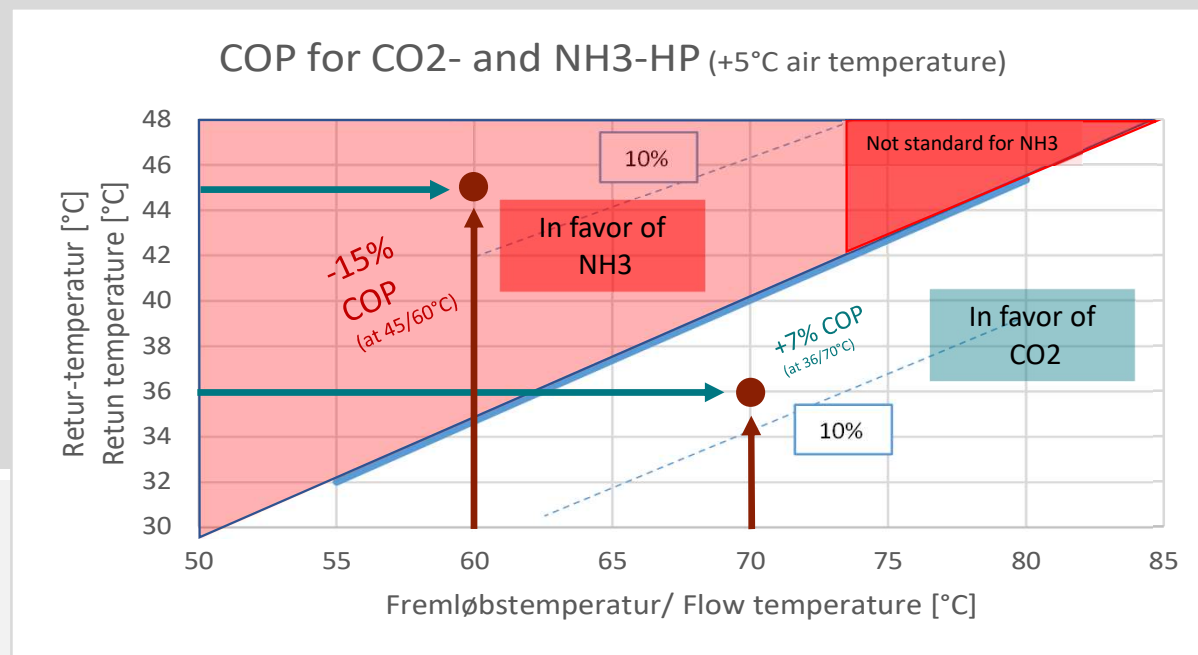
COP sensitivity of flow/ supply temperature
(+5°C air temperature)



COP sensitivity of return temperature
(+5°C air temperature)



Comparison between CO₂ and NH₃ heat pumps



Economical dependance on return temperature

- Modern DHN uses lower temperatures

Modern DHN = 35/75°C

Older DHN = 60/80°C

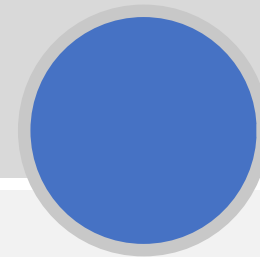
- Heat loss reduced by **30%** bring the loss in DHN below 15%

-30%



- Reduced piping diameter by **25%**

-25%



- Reducing pump work for the DHN by **50%**

-50%



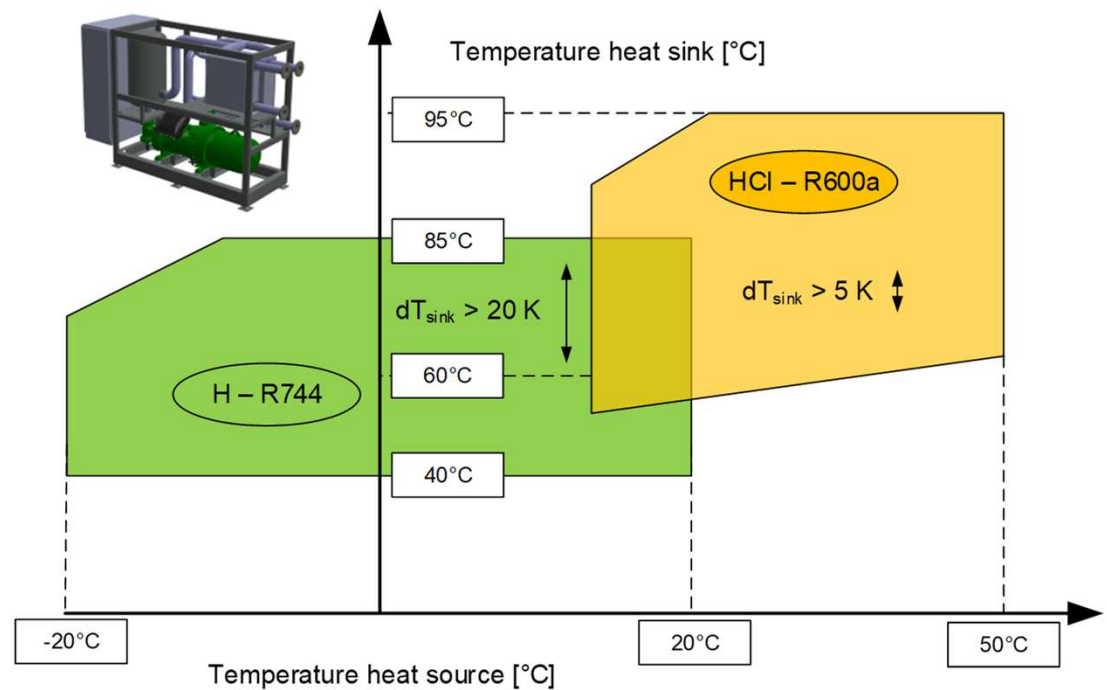
HCI – units with isobutane (reach for new applications)

Where is HCI beneficial:

- ❖ High temperature level of the heat source
- ❖ High temperature demand on heat sink
 - but little dT of sink 😊

What applications:

- ❖ Industrial application with food industry
- ❖ Applications with the energy sector
 - Biogas
 - PtX
 - Geothermal
- ❖ As “sub-cooler” for our CO₂-HP’s
15% COP gain ...



BALANCING ELECTRICAL GRID - TOMORROW

- ❖ Analysis together with Danish TSO and customer (Energinet)
- ❖ aFRR requirements are start and stop within 5 minutes
- ❖ Remove upstart recirculation and change PI settings
- ❖ Conclusion: The machine is the first HP to be approved for aFRR

					
FFR	FCR-D	FCR	FCR-N	aFRR	mFRR
Aktiveringstid					
~ 1 s	5 - 30 s	2,5 min	30 s – 15 min	15 min	

