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Heat recovery from data centres with optimised heat pumps

- using natural refrigerants

M. +45 6110 7769
E. khj@fenagy.dk

Bio:

- Klaus H. Jensen
- Sales Director at Fenagy
- Degree in mechanical engineering
- 14 years experience in refrigeration and heating

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Manufacturer of heat pumps and chillers with natural refrigerants only

- Part of Beijer Ref
- Founded 2020
- 4,400 m^2 office and production in Aarhus
- +100 dedicated employees
- 114 projects sold

- 75 projects handed over
- 400 MW sold
- 231 heat pumps
- Revenue:
  2023: 30 M €, 2024: 41 M €, 2025: 47M €, 2026: 65M €

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Considerations for location of data centres

Power

- Availability
- Stability
- Prices
- Access to renewable power sources

Land

- Space available
- Low prices
- Possibility to expand in the future

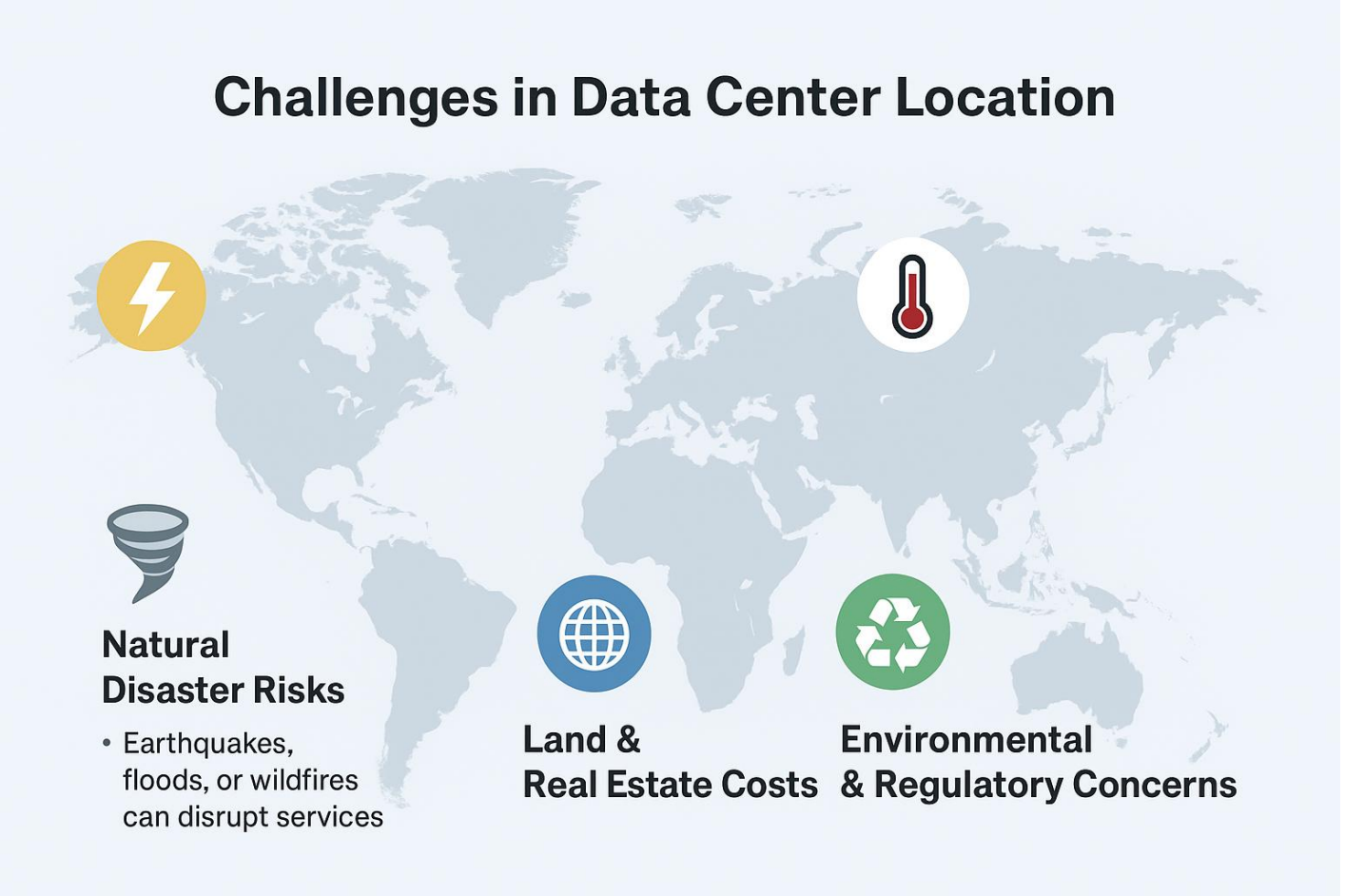
IT Infrastructure

Climatic considerations

- Colder climate = Less energy required
- Risk of natural disasters

Heat recovery

- Location near larger cities



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Efficiency of a data centre

PUE (Power Usage Effectiveness)

- A metric indicating how much of a data centre's total power consumption is used by IT equipment

$$\text{PUE} = \frac{\text{Total facility power}}{\text{IT equipment power}}$$

ERE (Energy Reuse Effectiveness) – Increased focus

- A metric that evaluates a data centre's energy efficiency by accounting for energy recovered and reused

$$\text{ERE} = \frac{\text{Total facility power} - \text{reused energy}}{\text{IT equipment power}}$$

- A heat pump will improve the ERE value for a data centre

- Ownership of the heat pump affects both PUE and ERE.

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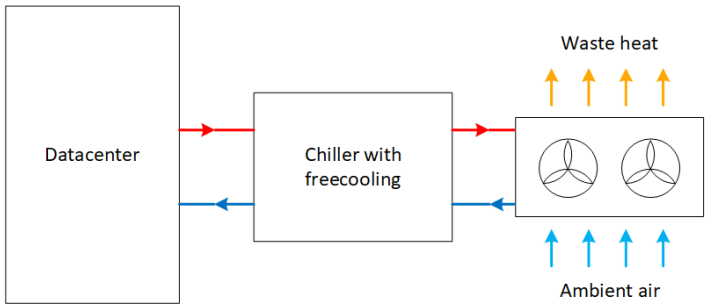
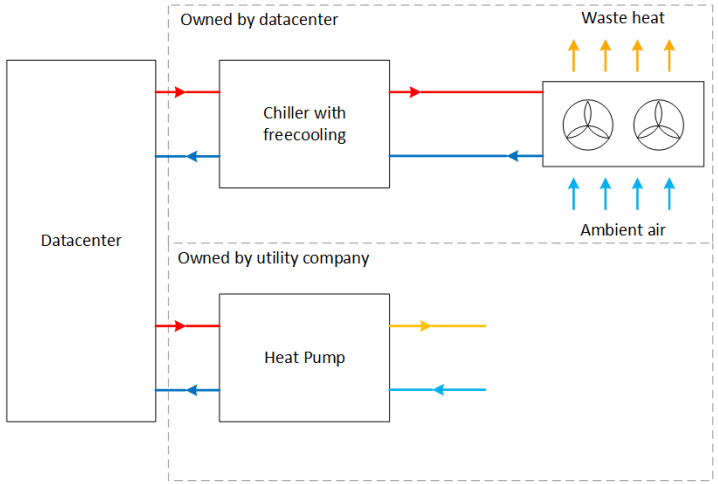
Traditional and future cooling solutions



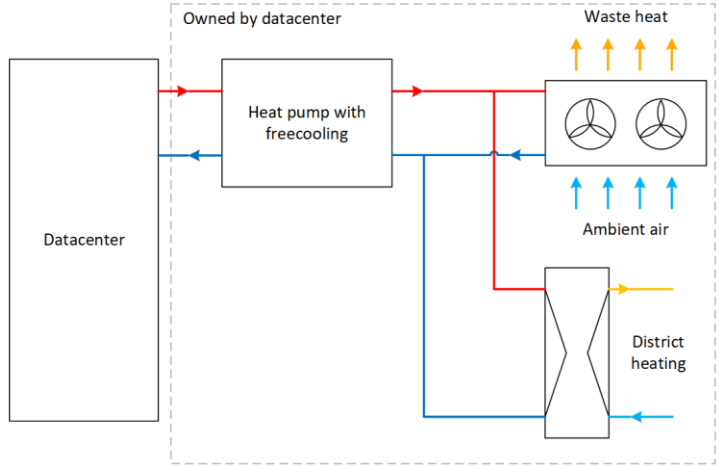
Chiller with free cooling

- Cheap cooling in low ambient temperature
- All heat is wasted
- Data centre owns all equipment
- Possibility of redundancy
- Climate conditions are important



Chiller with free cooling combined with a heat pump, owned and operated by the utility

- All heat produced in the data centre can be used for district heating networks
- Agreement on cooling water must be reached
- Possible redundancy



All cooling comes from a heat pump

- Heat recovery when possible (heat demand)
- Less equipment (avoid investment in chillers)
- Agreement with district heating company
- Same level of redundancy
- Improved PUE/ERE makes heat recovery more attractive

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Fenagy solution: HCI-1000/2000

- Natural refrigerant: Isobutane (R600a)
- Capacity per cabinet: up to 2 MW
- Flow temperatures up to 95°C
- Source temperatures up to 40°C
- Modular design for optimized efficiency and capacity
- Easily scalable during start-up and future expansion
- Flexible operation
  - Large operation envelope
  - Quick start/stop

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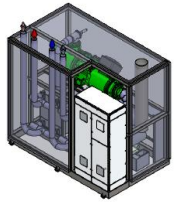
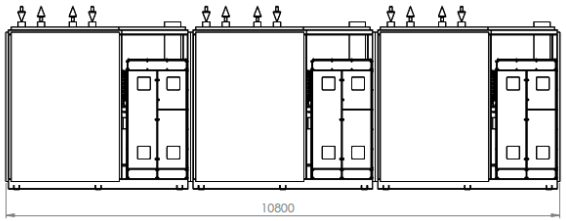
Modular design solution in series

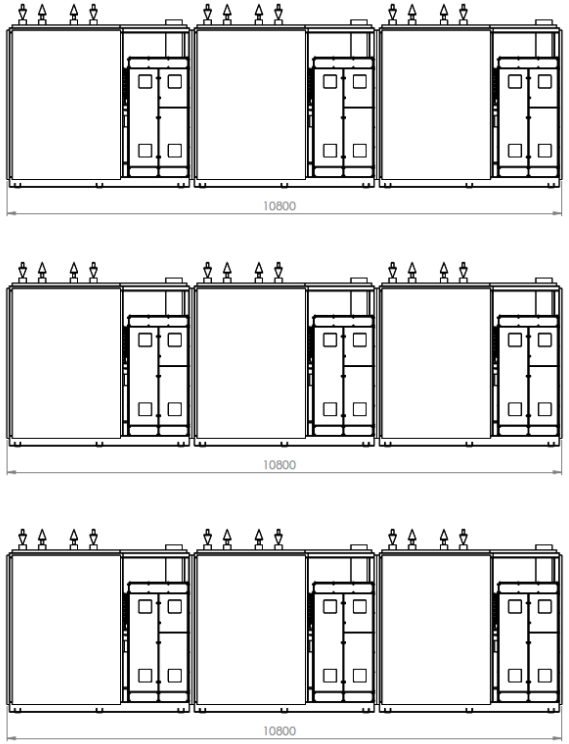
HCI/P modules = perfect match for many applications



HCI-1000/2000



HCI-3000/6000 (3 x HCI)



Modular design benefits:

- Easily scalable for large capacities
- Low part load important (especially co-location)
- Water side configuration can be optimized based on the project

Low operational cost

Data centre temperatures are well suited to isobutane

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Fenagy case story – Finnish data centre

Considerations for the data centre solution

- Only natural refrigerants – future-proof solution
- Solution with propane and isobutane selected because of extra capacity and no price impact

Equipment for Finnish data centre project, 1st phase

- 6 x HCI-3000
- Capacity cooling/heating: 10.3/13.4 MW
- COP system including auxiliary: 4.1
- Unit factory acceptance tested (FAT) at the Danish Technological Institute (Aarhus)

Equipment for 2nd phase

- 9 x HCI-3000 (total 15 x HCI-3000)
- New total capacity cooling/heating: 25.8/33.5 MW

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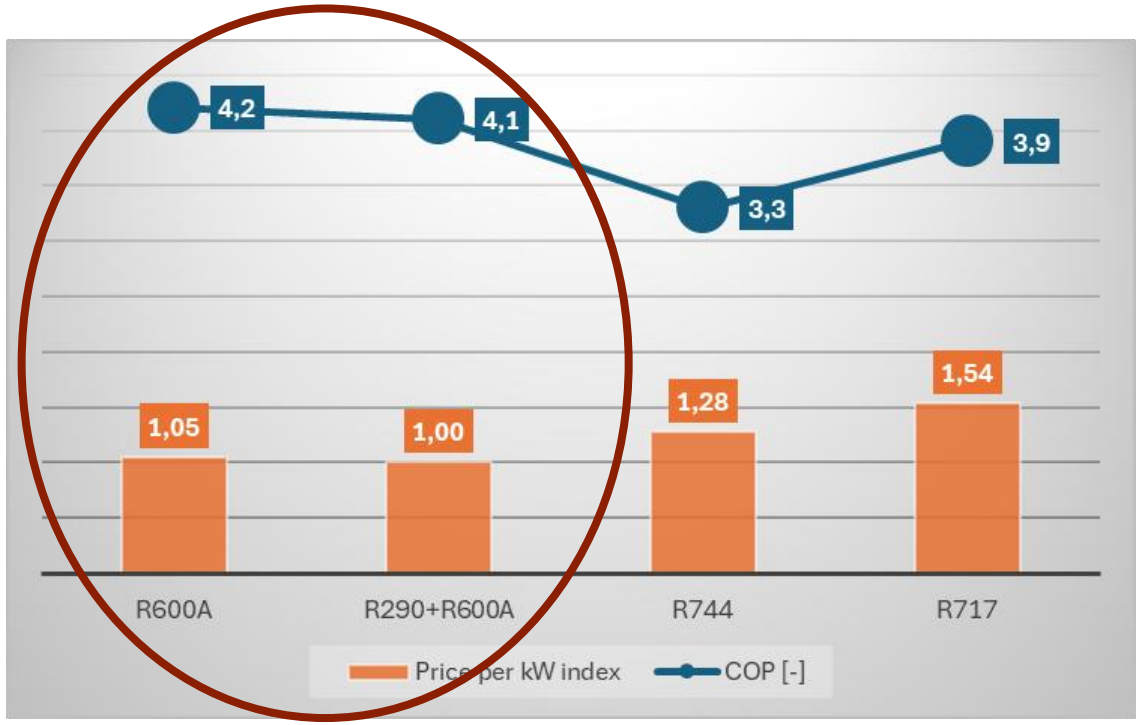
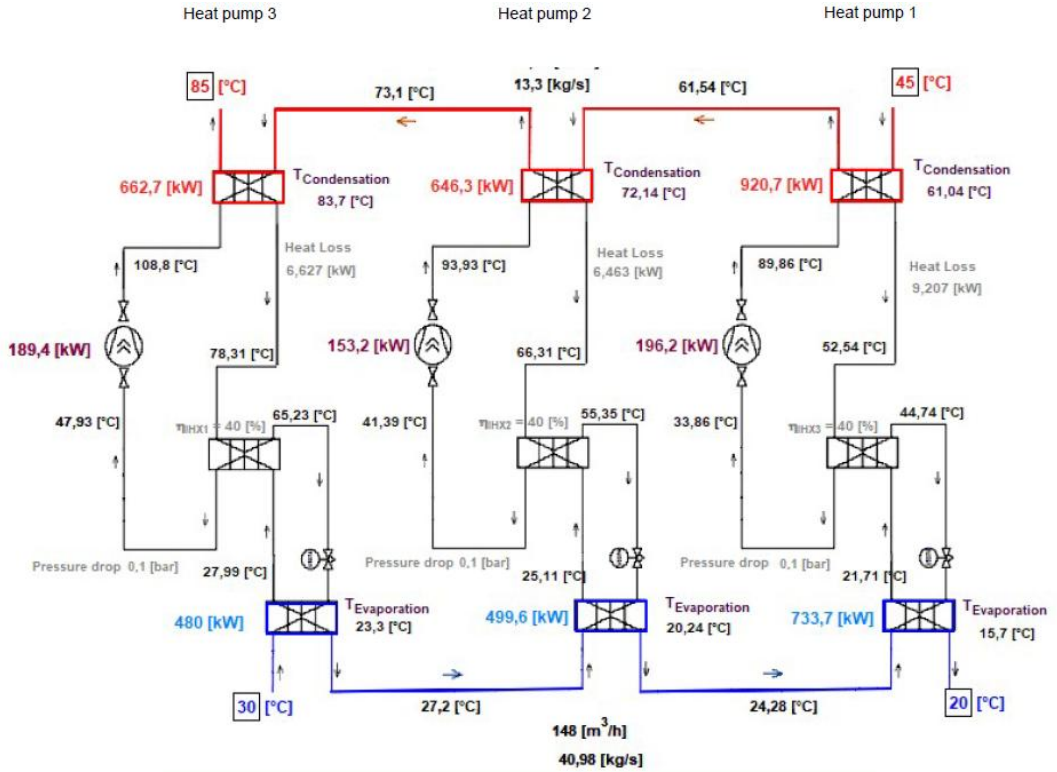
Refrigerant comparison

Design point

- Heat source: 30/20°C
- Heat sink: 45/85°C





$Q_{SafeHeating}$	0 [%]	*Total Heating Capacity*	2230 [kW]
$Q_{SafeCooling}$	0 [%]	*Total Cooling Capacity*	1713 [kW]
W_{Safe}	0 [%]	*Total Compressor Power*	538,8 [kW]
		Total COP heating	4,138
		Total COP (Cooling+Heating)	7,318

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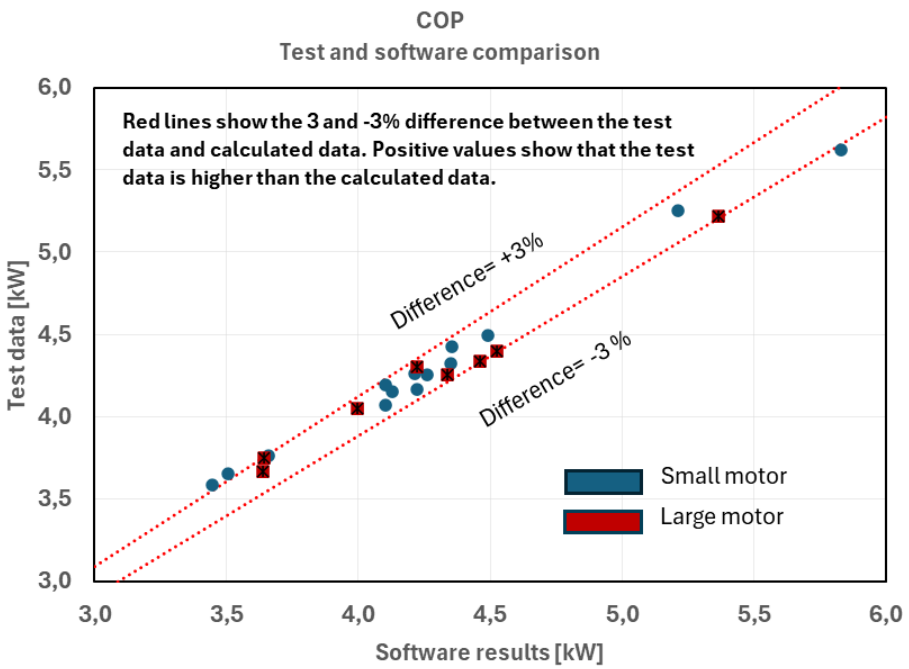
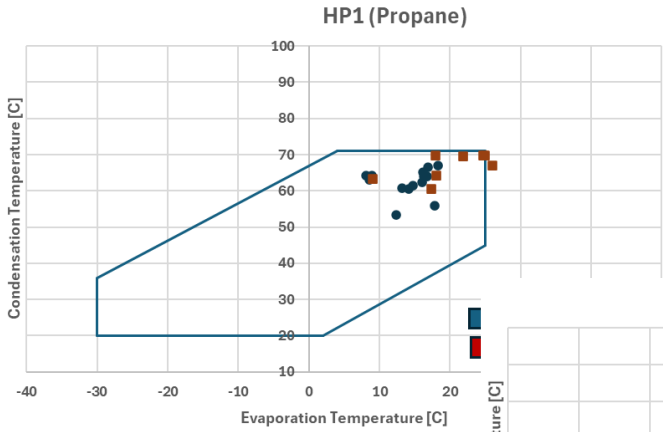
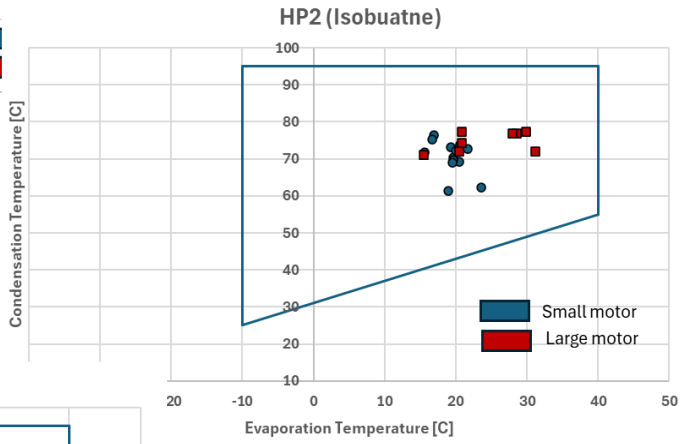
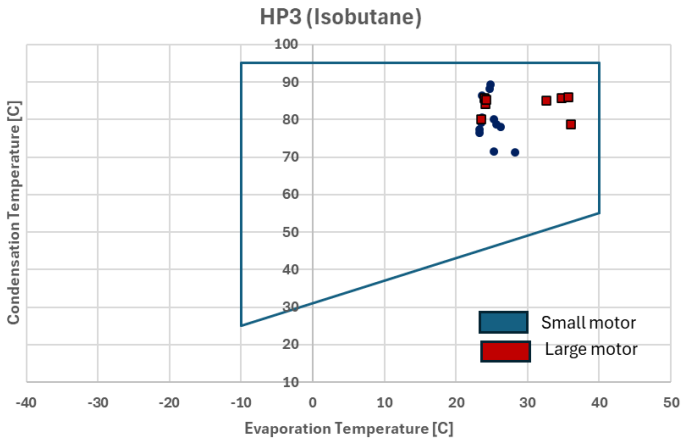
FAT - Factory Acceptance Test

- Hot water inlet temperature: 41 - 60 °C
- Hot water outlet temperature: 70.6 - 90.6 °C
- Cold water inlet temperature: 30 - 45.4 °C
- Cold water outlet temperature: 9.7 - 29.8 °C









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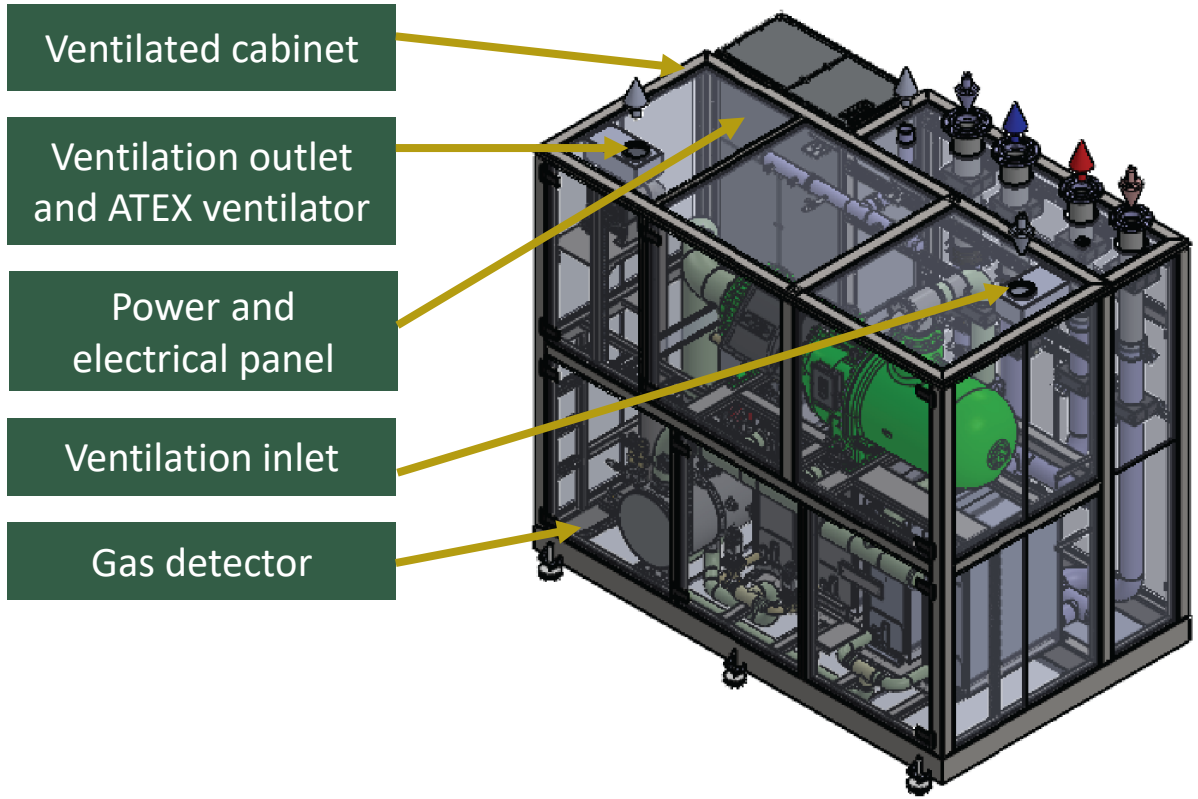
Safety considerations

- Ventilated cabinet
  - ATEX fan and gas detector
    - Isobutane heavier than air, therefore suction from the bottom
    - Differential pressure measurement between machinery room and ventilated cabinet, to ensure ventilator is active
    - If leakage or no differential pressure, power will be cut from the unit
- Enhanced tightness
- Separated electrical panel
- Risk assessment made with leading experts
- Ventilation CFD simulation
  - Ensures no dead zones near ignition sources
  - Sufficient ventilation speed



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Heat pump perspectives

- We are experienced in district heating
- We are experts in large-scale air-source heat pumps
- We are becoming experts in heat pumps for data centres

What's next?

Potential applications for waste heat:

- **Data centres**
- Sewage water
- Greenhouses
- Biogas
- Carbon capture
- Industrial waste heat

The potential is virtually unlimited …

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Thanks for listening

Klaus H. Jensen
M. +45 6110 7769
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Meet me in the audience today and tomorrow.