Air-source heat pumps with natural refrigerants

Franz Sperl, Güntner GmbH & Co. KG

eurammon Symposium, 29 June 2023

Güntner

eurammon

refrigerants delivered by mother nature

AGENDA

- Güntner GmbH & Co. KG
- Market & Trends
- Best Practice Examples
- Multiple Heat Source Concept
- Technical Air-Side Considerations
- Conclusion

Güntner GmbH & Co. KG

The Power of Progress

- 90 YEARS OF PROGRESS

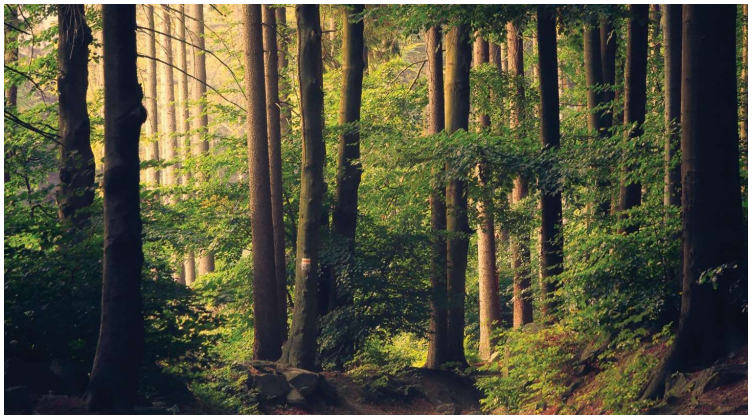
  Founded in 1931 in Munich as a refrigeration equipment manufacturer for SO_2, CO_2, NH_3 and water

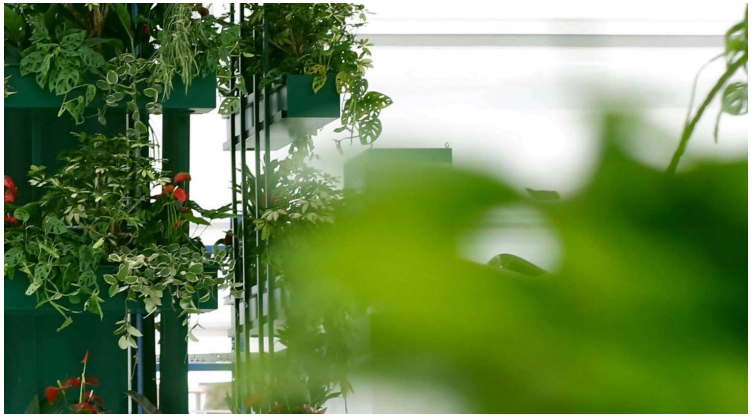
- We operate across more than 50 office locations and 6 manufacturing plants in Europe, Asia and the Americas.

- We are critical to a wide variety of industries: We power everything from
  - keeping food fresh to
  - providing comfortable indoor temperatures in office buildings,
  - enabling renewable energy production and
  - efficiently empowering heat pumps.

Güntner GmbH & Co. KG

Sustainability – At Our Heart





We are united in the desire to find ways to progress as a society – unified in our search for well-being, prosperity for future generations, and the protection and preservation of our shared home. And we believe it's part of our role to make our industry better – step by step.

WE ALWAYS KEEP THIS COMMITMENT IN MIND

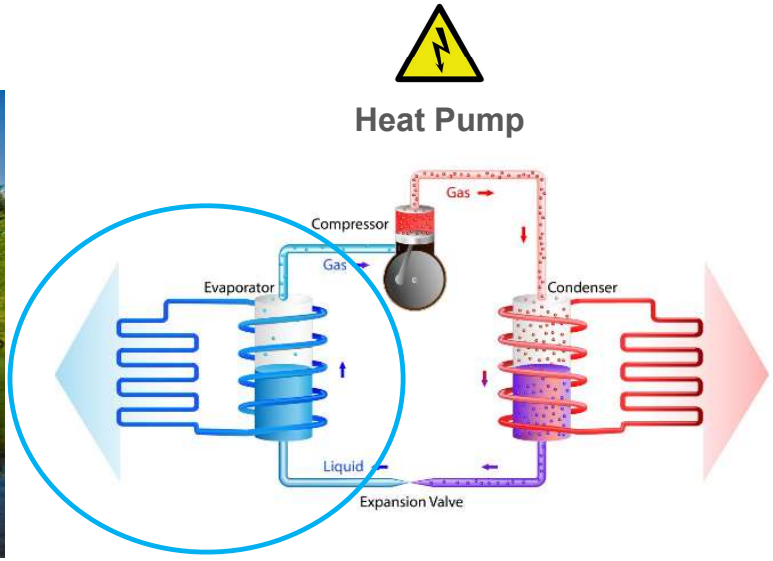
Our manufacturing plants are designed with respect for our nature:

- We use green energy
- We have implemented sustainable water treatments
- Our unique 'planted plant' concept in Sibiu (Romania) is a breakthrough in healthy work environments

Also, all our units operate with the lowest water and energy consumption possible, protecting the world's valuable resources.

Market & Trends

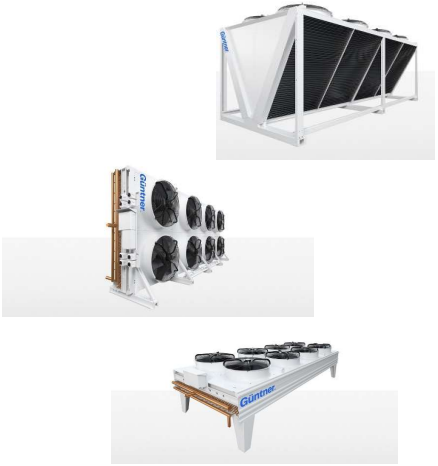
Heat Pump

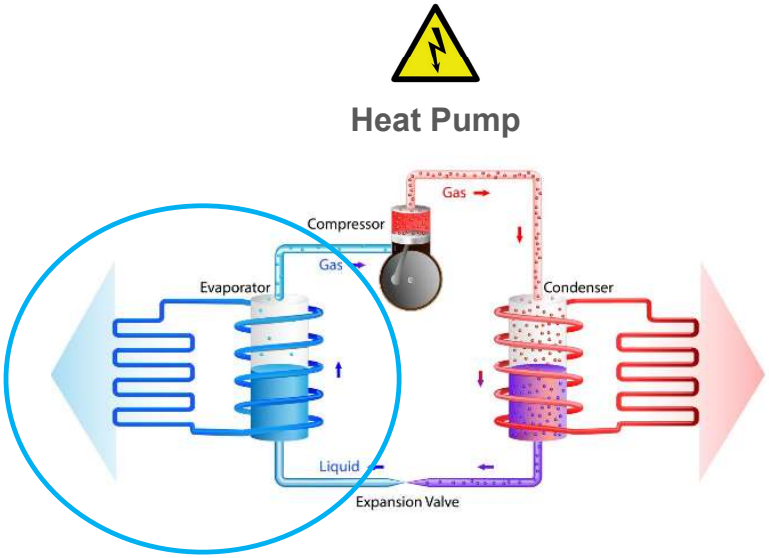


Market & Trends

Heat Pump

Heat Collectors





Market & Trends

Influence Factors

Decarbonization

Supply chain

Independence

Efficiency

Energy Transition

Commissione europea

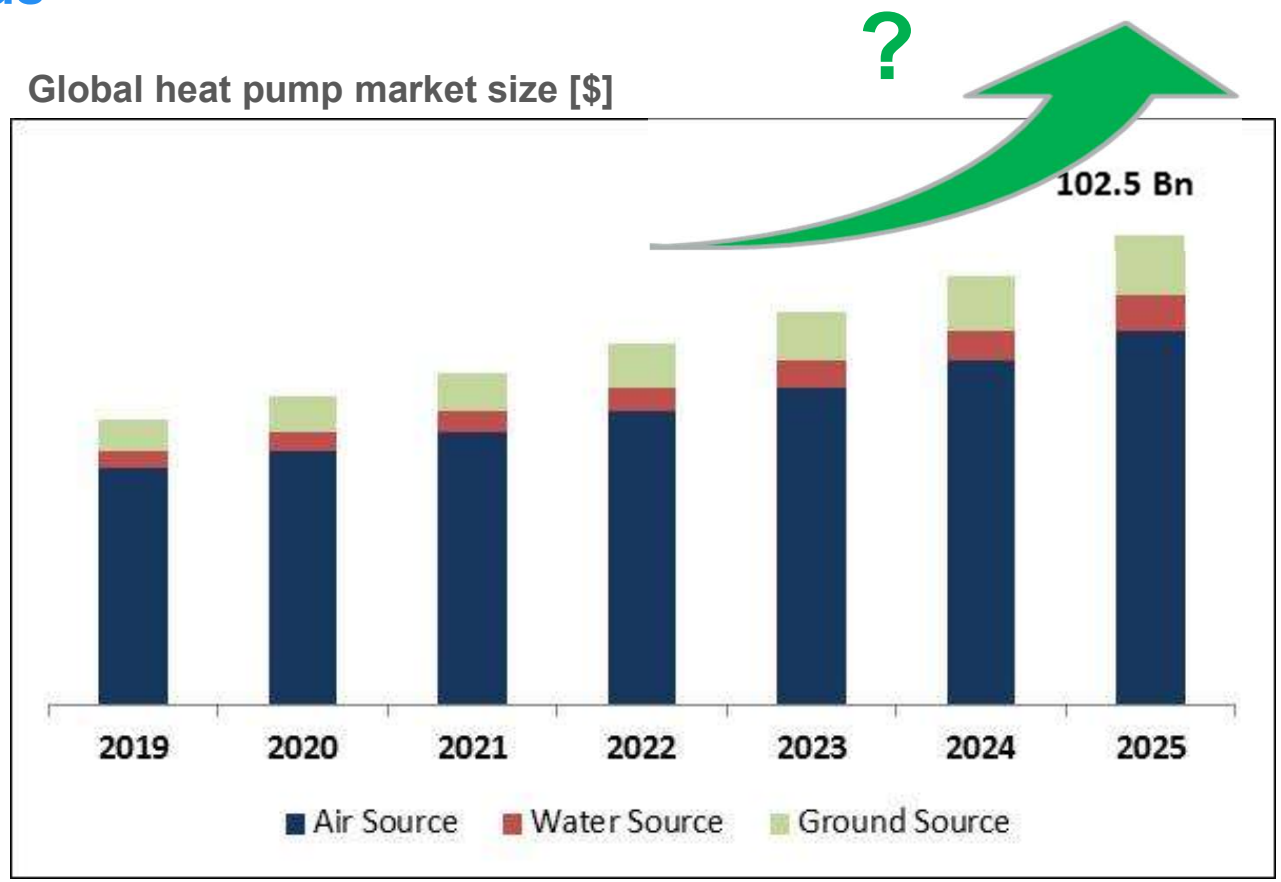
REPowerEU

Legislation

CO2 Prize

Market & Trends

Trend



https://www.kbvresearch.com/heat-pump-market/ ; Year 2019

Market & Trends

Trend

Global: IEA “Net Zero by 2050”

	2020	2030	2050
Worldwide stock – million units	180	600	1,800
Heat pumps (electr.) covering heat supply	7%	20%	55%

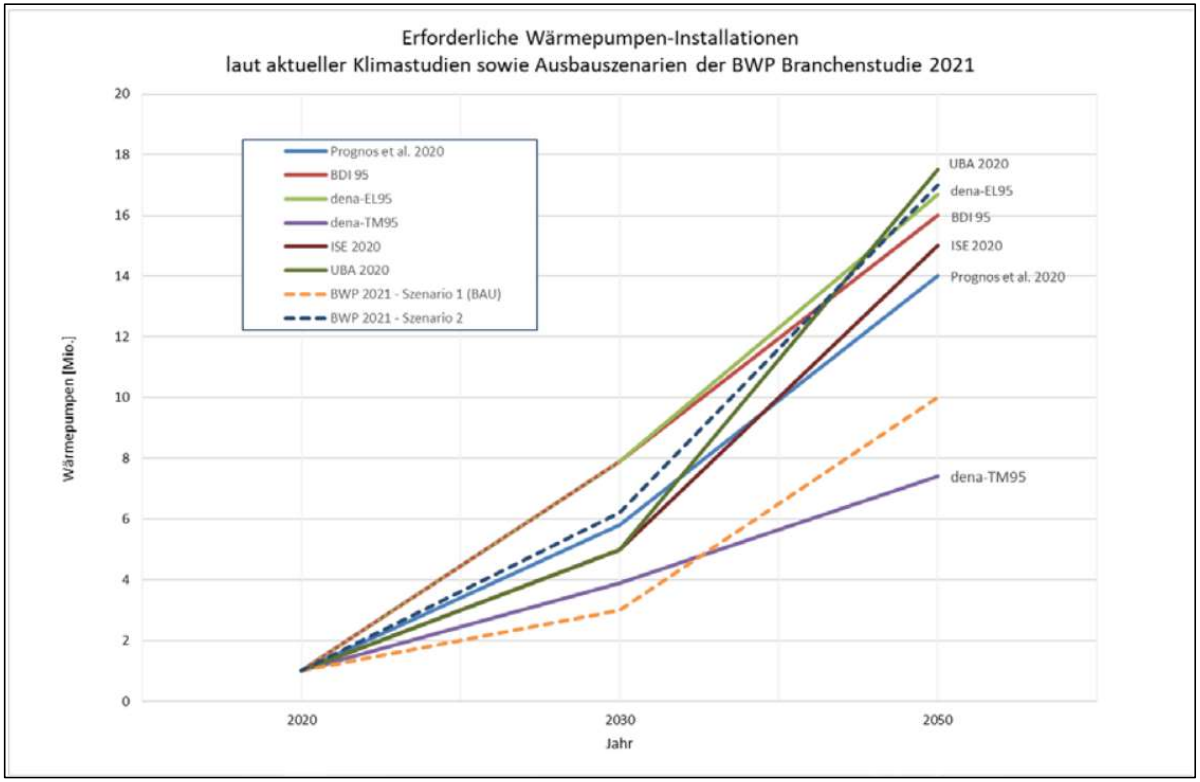
EU: REPowerEU proposal (2021):

Cumulative sum until 2026:

10 million units

Update May 2022:

30 million units until 2030



Germany: Industry survey BWP 2021

https://www.waermepumpe.de/fileadmin/user_upload/waermepumpe/07_Publikationen/Sonstige/2021-04-29_BWP_Roadmap_final.pdf; Year 2021

Market & Trends

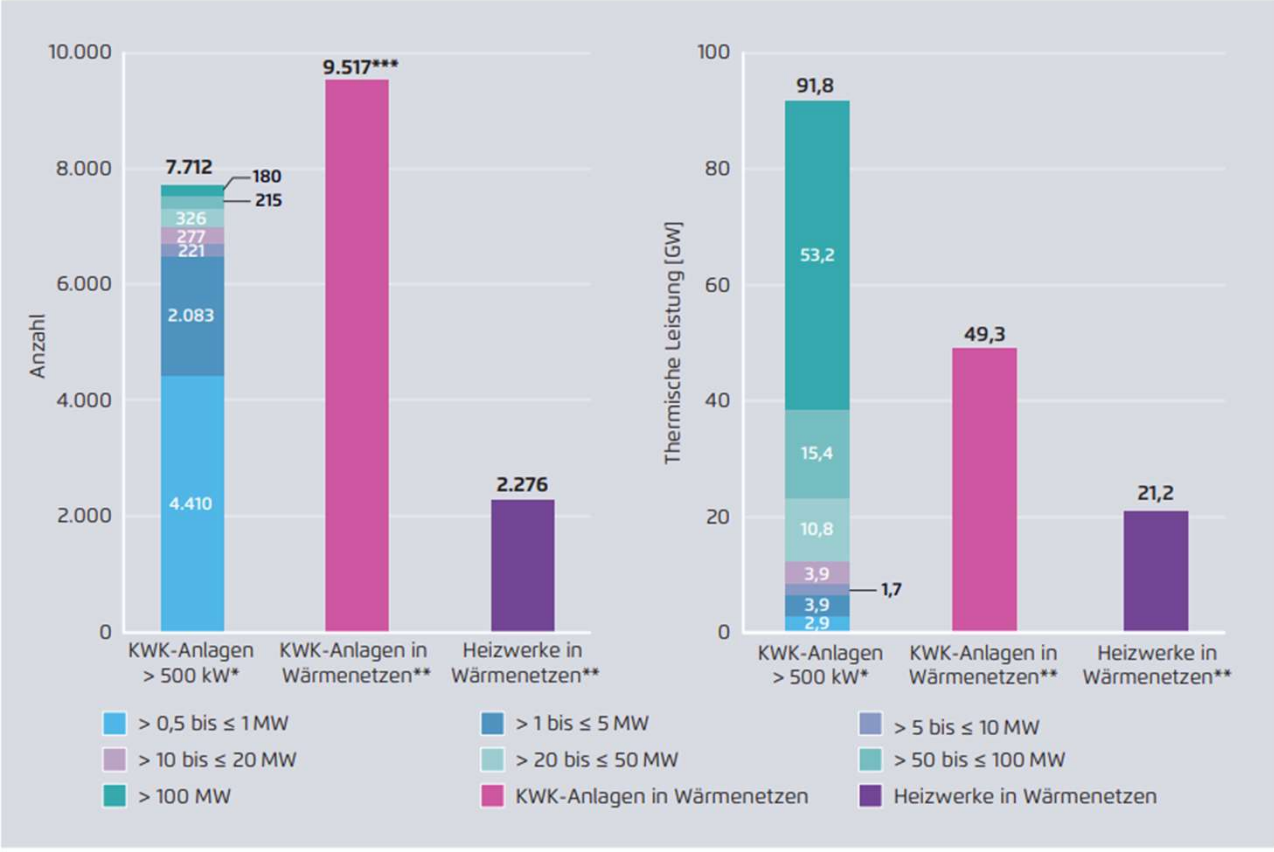
Trend

- Fraunhofer IEG Study on Big Heat Pump Roll-out GER 2023:

  heating installations most likely to be replaced by 2045

  - >6000 x 0.5 MW
  - >9000 x 5 MW
  - >2000 x 9 MW
  - >1200 x 10…>100 MW

Anzahl und thermische Leistung von KWK-Anlagen größer 500 kW sowie von KWK-Anlagen und Heizwerken in Wärmenetzen — Abbildung 3



Fraunhofer IEG basierend auf * BNetzA (2023a), ** AGFW (2022). *** enthält Mehrfachzählungen, soweit in Heizwerken mehrere Energieträger eingesetzt wurden

Market & Trends

Sectors

Supermarket and Commercial Refrigeration

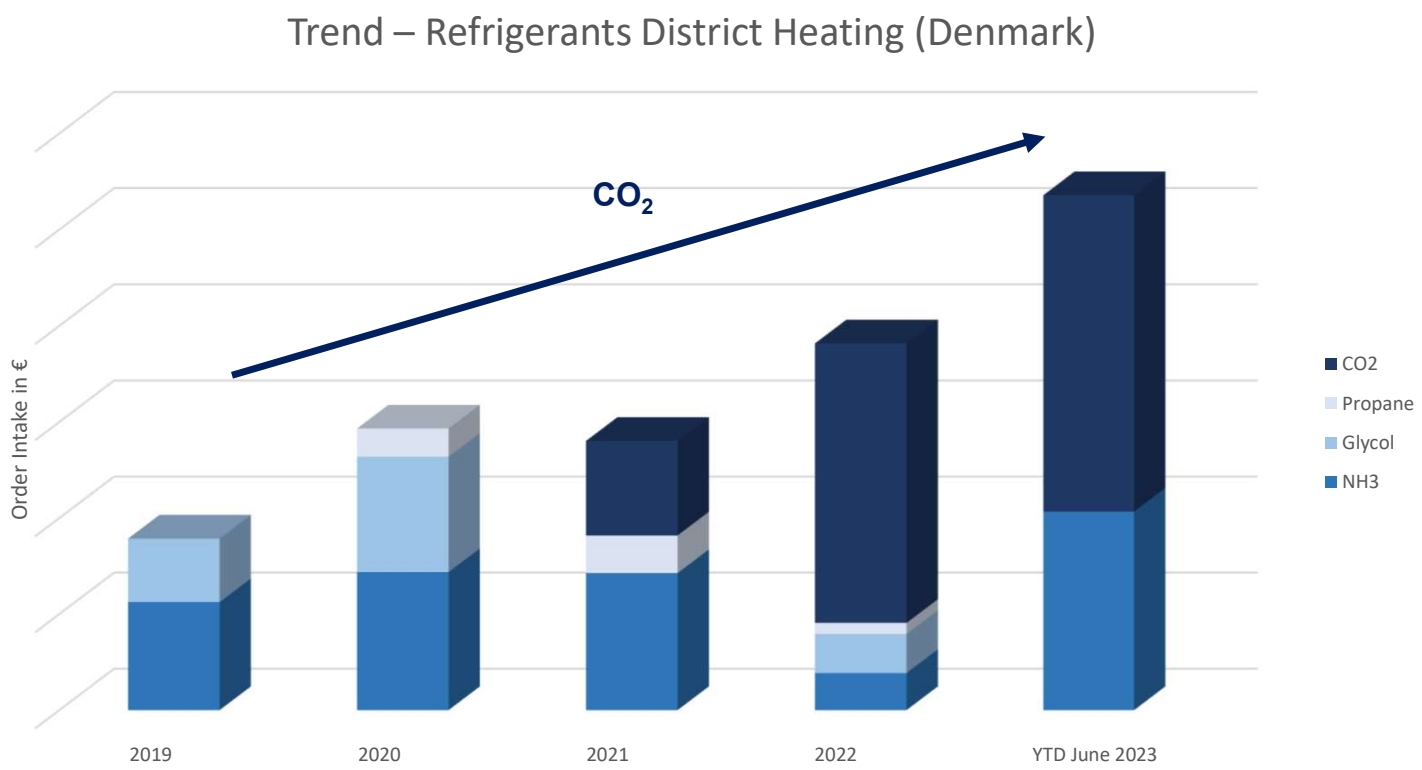
Industries

District Heating

Buildings

Market & Trends

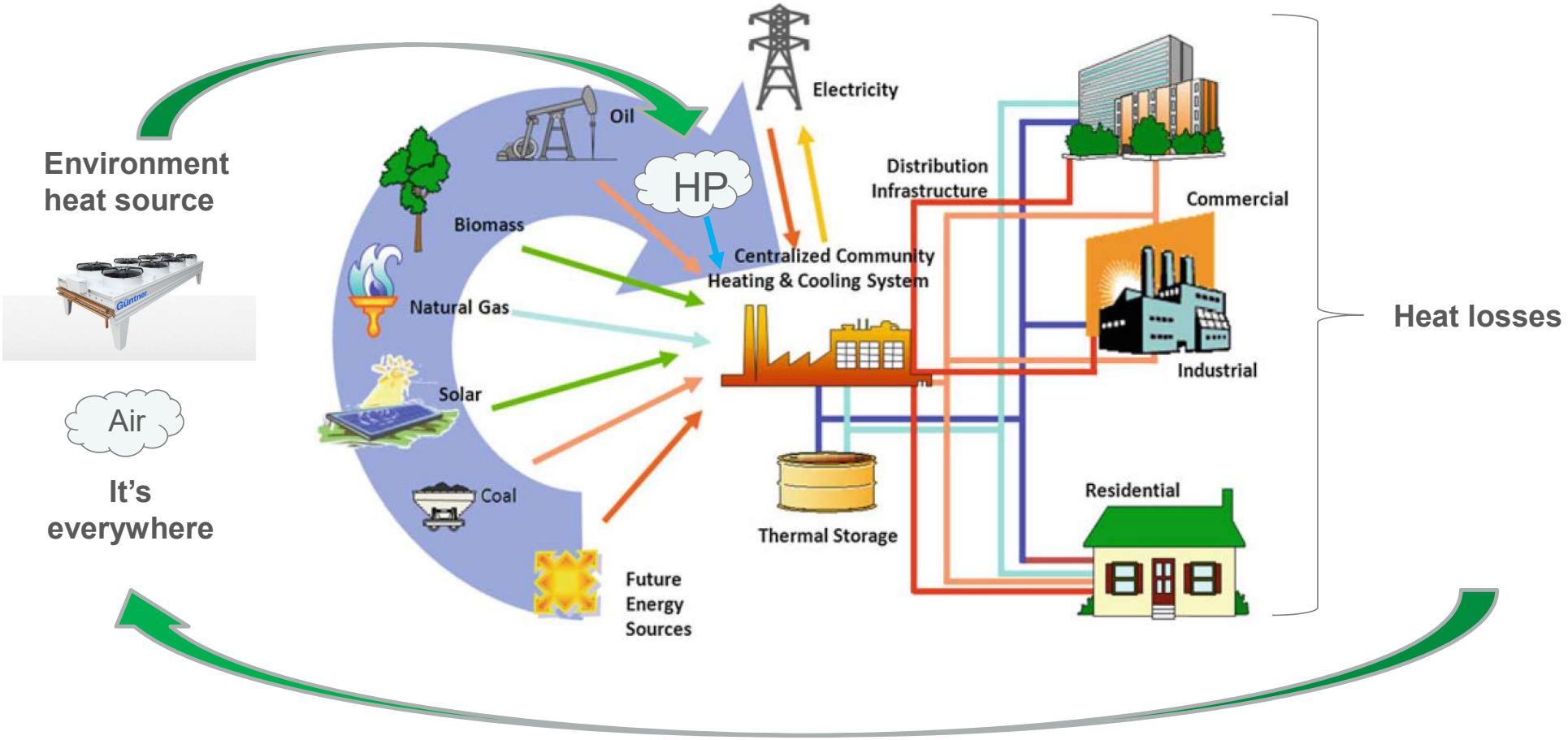
Trend – Refrigerants District Heating



Güntner GmbH & Co. KG

Market & Trends

District Heating



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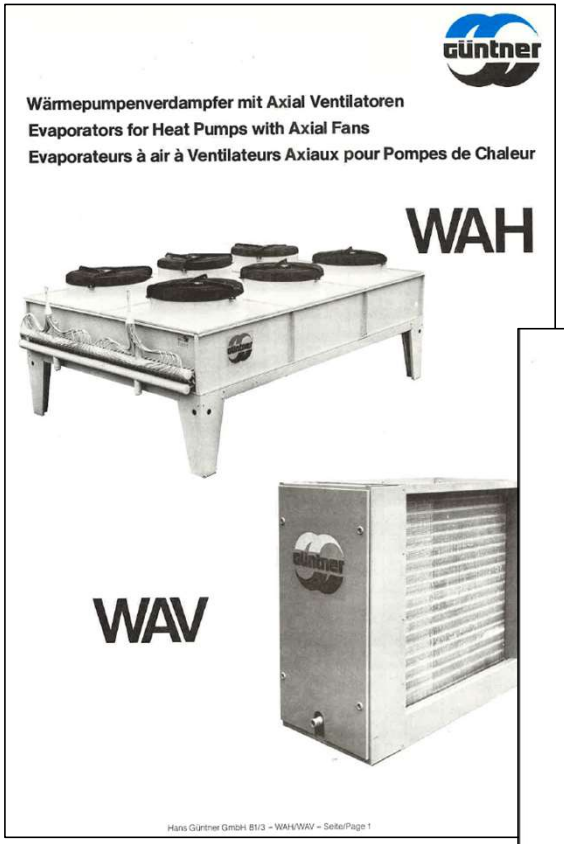
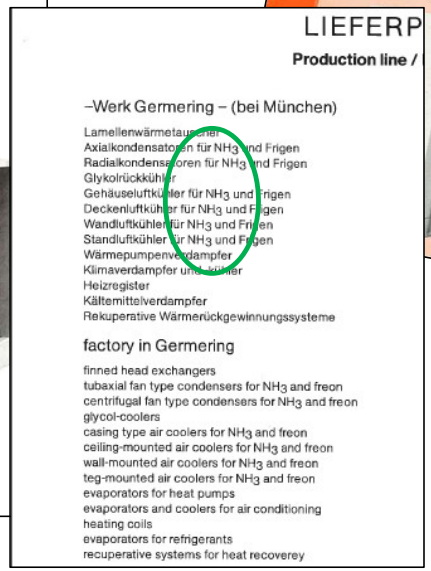
History of Experience

>40 Years Heat Exchangers for Heat Pumps



1981



1990

1994

Best Practice Examples

NH_3 – Pump Industrial

Dronninglund
- Q_{evap} = 5 MW
- Flat-type
- NH_3 pumped
- 20 pcs; 260 fans


Dronninglund


Faaborg

Faaborg
- Q_{evap} = 8.2 MW
- Flat-type
- NH_3 pumped
- 32 pcs; 320 fans
- Installation in inhabited area -> silent

Smørum
- $Q_{collector}$ = 5.5 MW
- V-shape
- Sec.: Ethylene Glycol / Pri.: NH_3
- 16 pcs; 288 fans
- Designed for best air flow

Upcoming:
NH_3 pump; Q_{evap} = 21 MW
- **Flat-type**
- **NH_3 pumped**
- **72 pcs; 864 fans**


Smørum

Best Practice Examples

CO_2 – DX Industrial

Mejlby Q_{heat} = 1,200 kW

Havneby Q_{heat} = 600 kW

https://www.linkedin.com/company/fenagy/posts/?feedView=all

CO_2 – DX;

- Q_{evap} = 0.4 MW / 0.8 MW
- @dT = 7 K; COP = 3.3
- $T_{W;\ supply}$ = 40 °C → 70 °C
- 4x Flat-type, each
- Warm glycol defrost
- Fast installation (extra long feet)

Best Practice Examples

CO_2 – DX Industrial

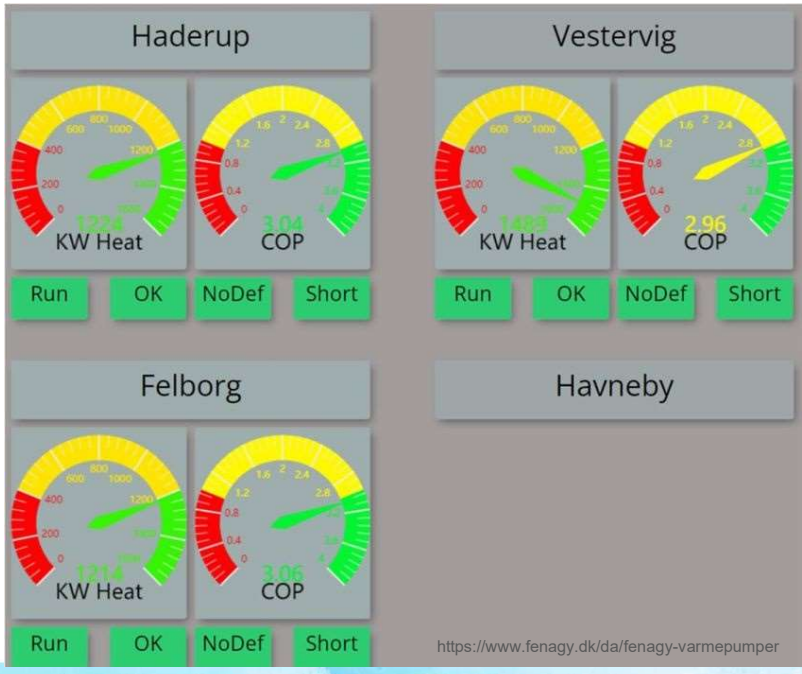
Vestervig Q_{heat} = 1,400 kW

Project specific installation layout for optimum air flow behaviour

Combination of multiple heat sources for optimal usage of regenerative energy

Haderup Q_{heat} = 1,200 kW

Project monitoring by customer → full transparency



Best Practice Examples

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CO_2 – DX;

- Q_{evap} = 0.4 MW / 0.8 MW
- @dT = 7 K; COP = 3.3
- $T_{W;\ supply}$ = 40 °C → 70 °C
- 4x Flat-type, each
- Warm glycol defrost
- Fast installation (extra long feet)

Best Practice Examples

CO_2 – DX BIG Projects

Vildbjerg Q_{heat} = 6 MW; 18 pcs

Broerup Q_{heat} = 4 MW; 14 pcs

https://www.linkedin.com/company/fenagy/posts

Saeby Q_{heat} = 6 MW; 18 pcs

Upcoming project with Q_{heat} ~ 10 MW, 32 pcs

Best Practice Examples

CO_2 – DX Commercial

Supermarket Germany; CO_2
Q_{GC} = 153 kW @dT = 2 K
Q_{evap} = 26 kW @dT = 7 K

Sandwich-Design: Gas cooler + heat pump evaporator on top

- Operation of GC and evap. at same time (while reusing heat)
- Independent circuits
- Independent fin spacings

Supermarket Germany; CO_2
Q_{GC} = 43 kW @dT = 2 K
Q_{evap} = 25 kW @dT = 7 K

One-Coil-Design: Gas cooler + heat pump evaporator using same coil

- Highest efficiency + cost effectiveness using the whole HX surface for both operations
- Defrost effectively integrated via HG
- 120/130 bar design

Hotel Norway; Glycol; $Q_{abs.}$ = 180 kW @dT = 8 K

Cubic

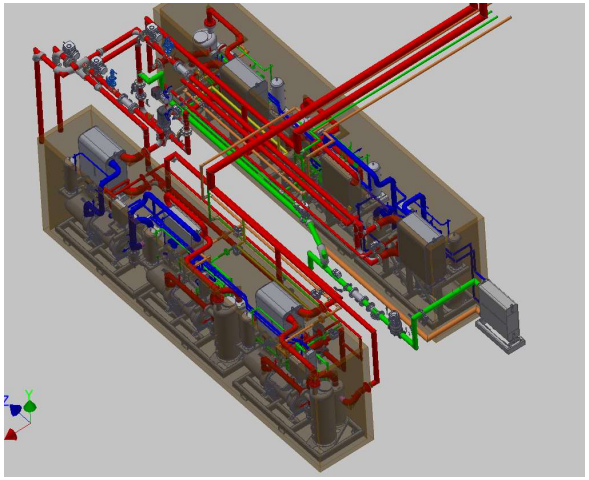
- Perfect for cold ambient air
- Highest defrost efficiency and
- Long operating periods
- Wind-, snow-, rain-proof

Best Practice Examples

Propane – DX Industrial

Løgstrup District Heating

- Q_{heat} = 2.5 MW
- Propane DX
- V-shape
- HG defrost



https://www.hp-summit.de/de/events/vortrag/air-source-heat-pump-for-district-heating-with-hc-case-study-by-frascold-27-/768167#top; Solid Energy

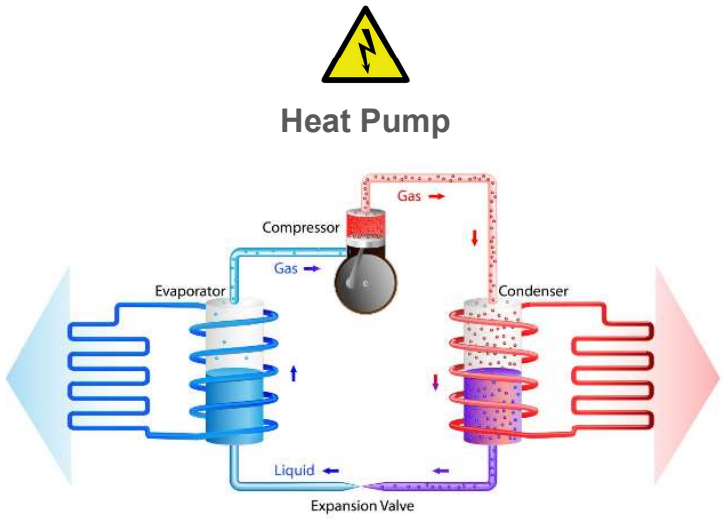
Project analysis from 2020:

- $SCOP_{HP}$ = 3.14
- @ T_W = 36 °C/70 °C
- Heat production = 11,716 MWh
- Natural gas savings* = 795,516 €
- ROI** = 4 years

* 67.9 €/MWh gas
"Socio-economic calculation assumptions" – 2020.ens.dk
** list prizes

Best Practice Examples

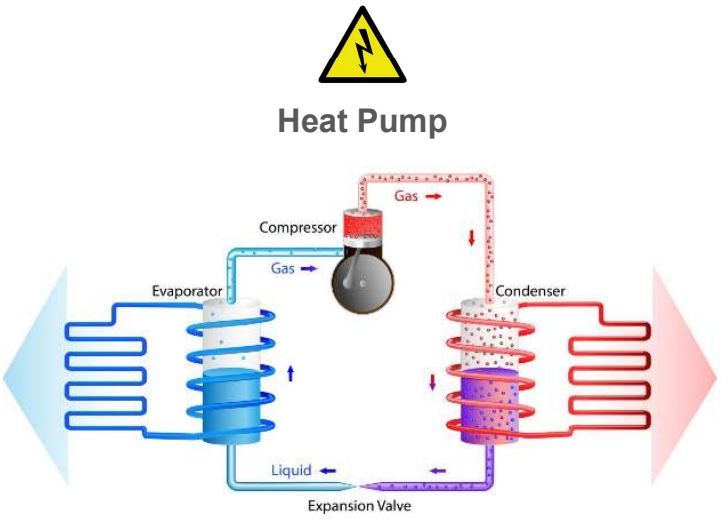
Heat Source with Nat. Ref.



Best Practice Examples

Heat Source with Nat. Ref.

Güntner powers already a heat source of **> 191 MW** for nat. ref. industrial heat pumps in Denmark (in 2020-2023)



This means with an SCOP of ~3 → **280 MW heat** for ~110,000 households

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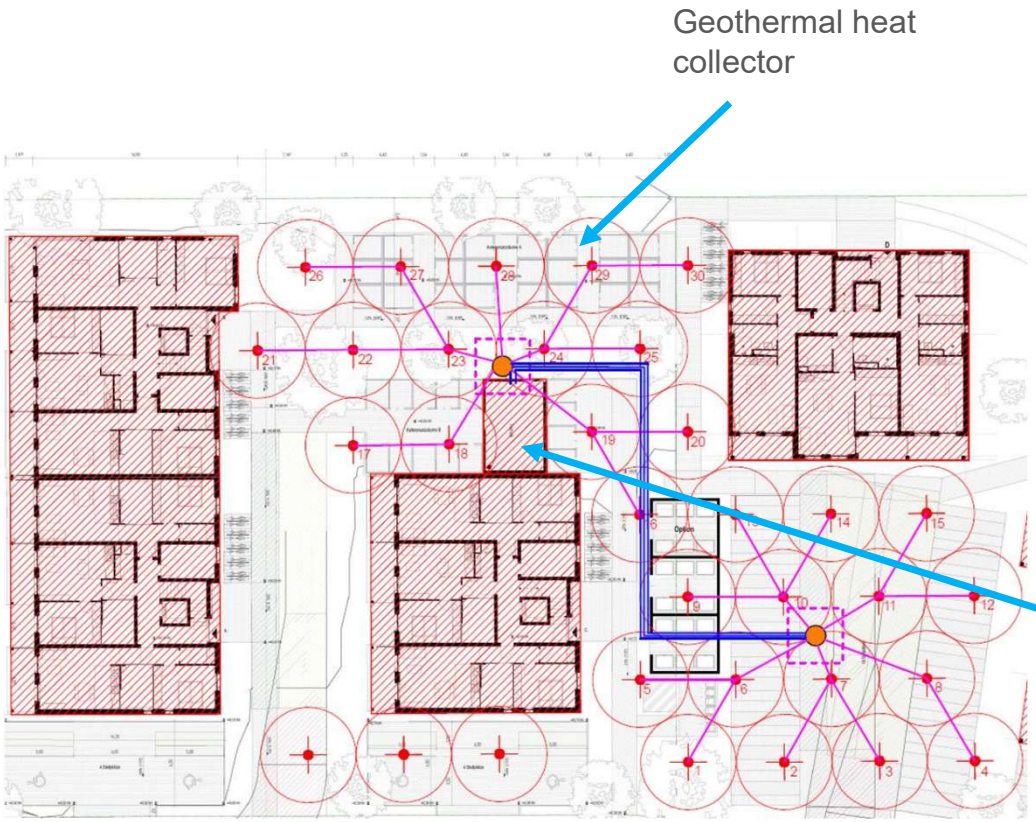
Multiple Heat Source Concept

Space Heating



https://grosswaermepumpen-kongress.com/wp-content/uploads/2022/06/03_W%C3%96RDEMANN.pdf

Multiple Heat Source

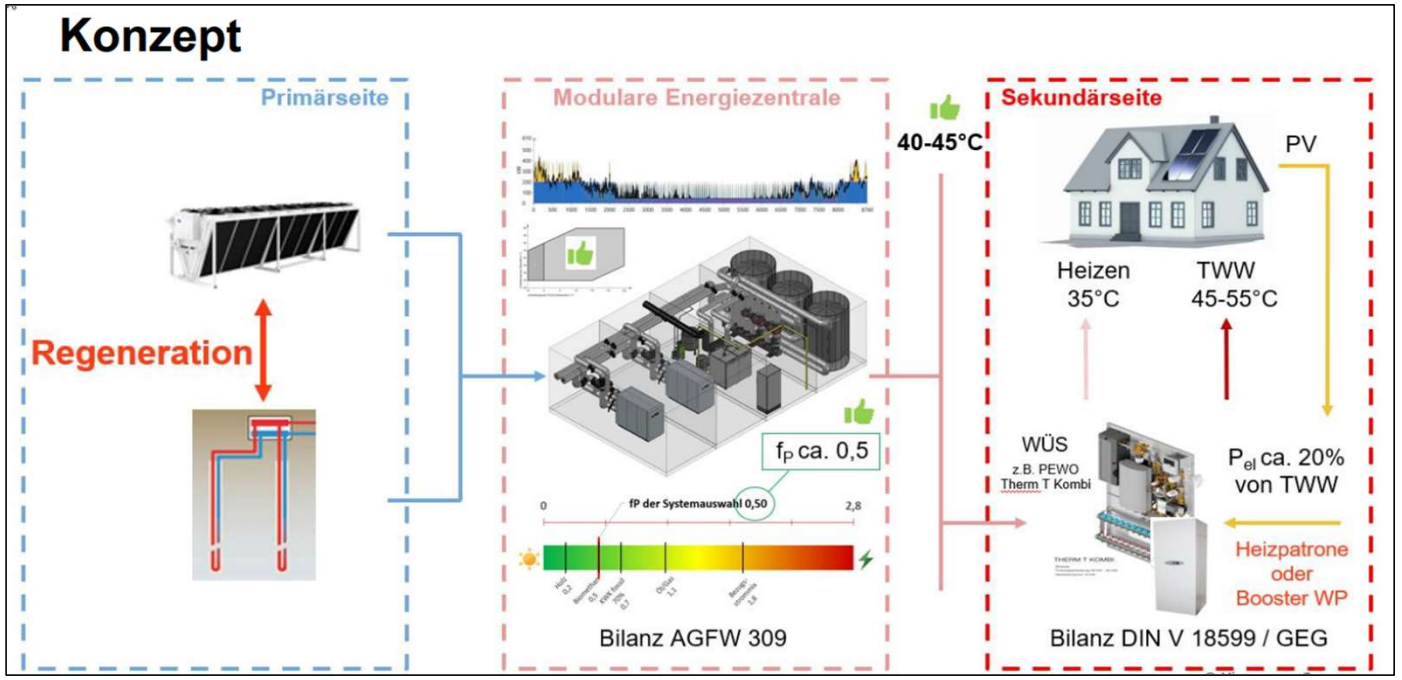
Space Heating

- Heated living space: 5,348 m²
- $Q_{heat,\ max}$ = 240 kW
- Heating energy 320,070 kWh/a
- Boreholes reduction

  ~45 pcs → 30 pcs
- Reduction invest for heat source

  380 k€ → 225 k€

-40 %



https://grosswaermepumpen-kongress.com/wp-content/uploads/2022/06/03_W%C3%96RDEMANN.pdf

V-shape

- $Q_{collector}$ = 111 kW @ dT = 8 K
- Glycol
- Operation at T_A > 5 °C
- Summer: Regeneration of geothermal probes

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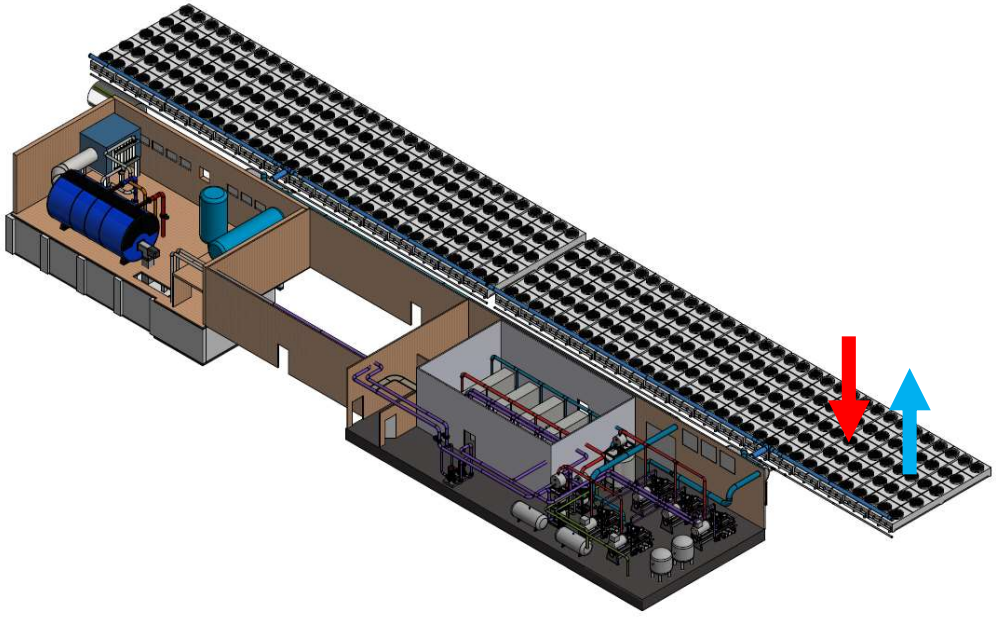
Technical Air-Side Considerations

Air Circulation – Layout



The layout has an impact on the efficiency of the heat exchangers.

The air flow must be ensured by proper installation, considering:

- Distance among the units
- Height from the ground
- Buildings and walls near the heat exchangers

CFD modelling for

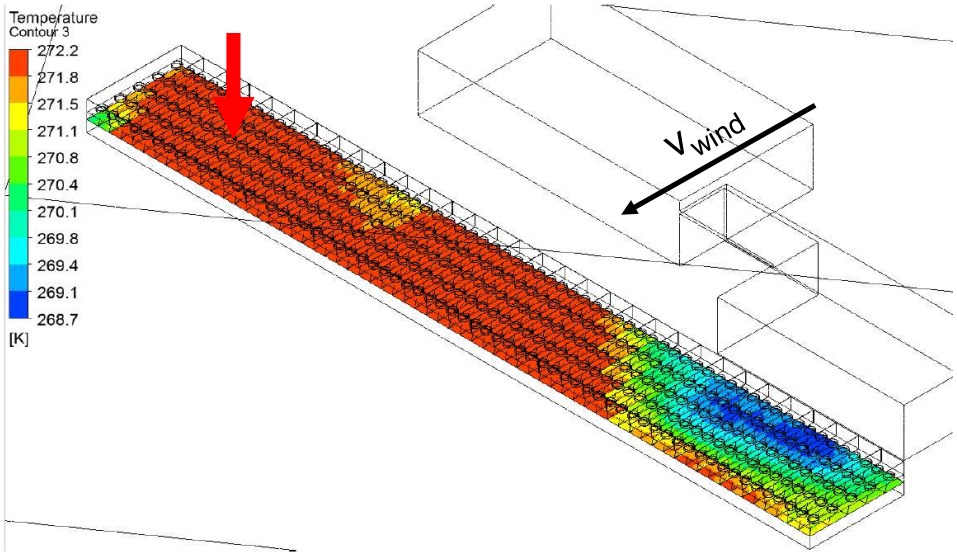
- blow-through (forced draft)
- draw-through (Induced draft)

Technical Air-Side Details

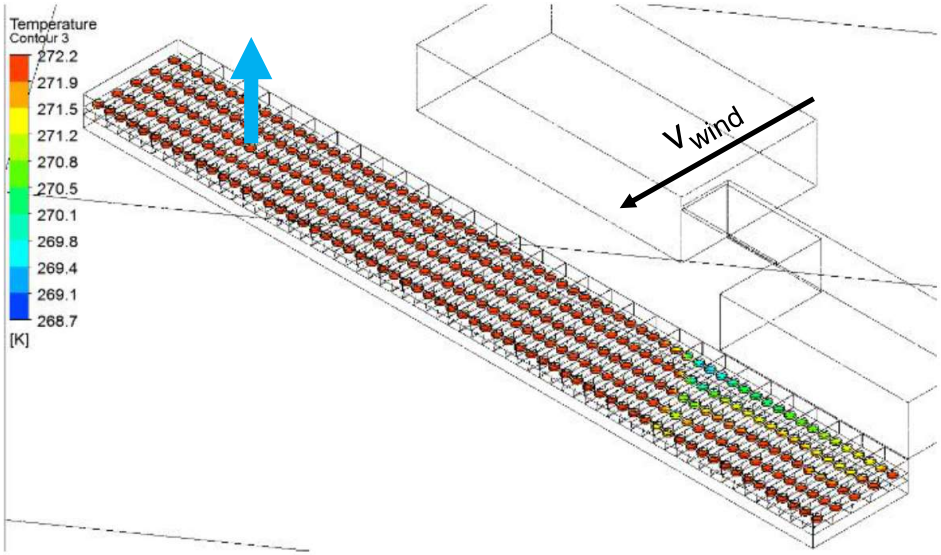
Air Circulation – Layout

The impact of wind on the performance depends on the solution you choose:

blow-through (forced draft)



draw-through (Induced draft)



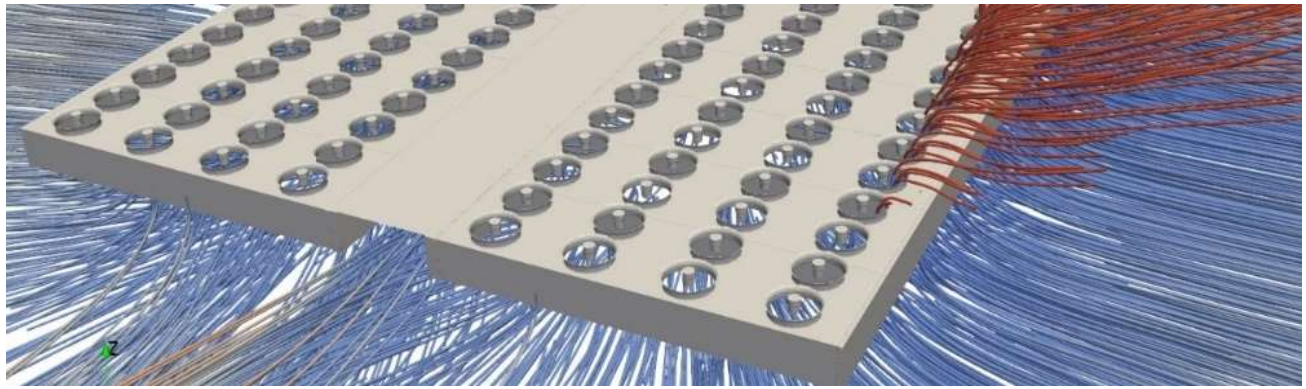
Draw-through fans, in most cases, operate more efficiently and reduce air circulation.

Technical Air-Side Details

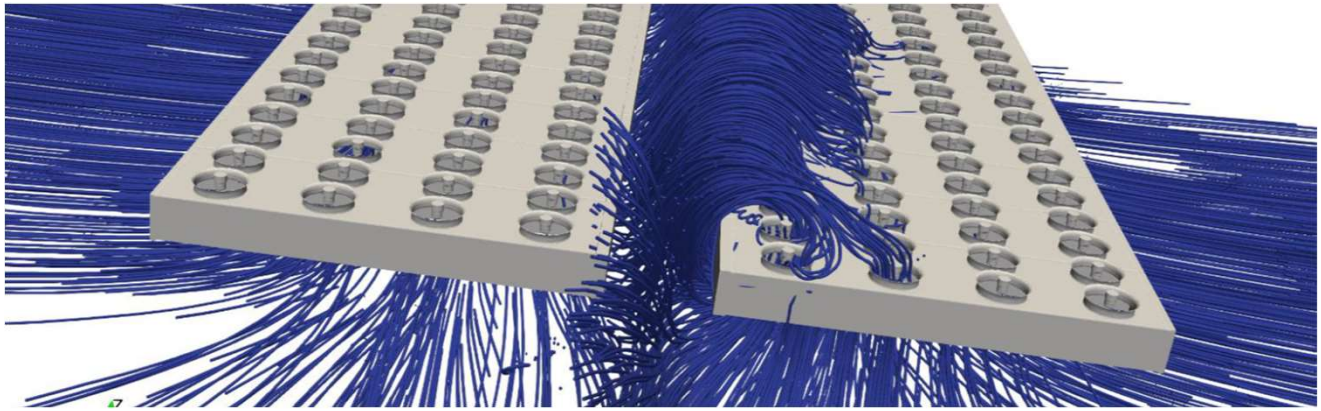
Air Circulation – Open/Closed Gap

CFD analysis demonstrates that, in most cases, closing the gap between the units helps avoiding air circulation between out- and inlet. This ensures the proper operation of the units.

Closed gap



Open gap



Challenges for Air-Side Heat Pumps

- Defrost / Icing optimization
- air recirculation reduction
- Wind factor
- Footprint reduction
- Sound emission reduction

COP

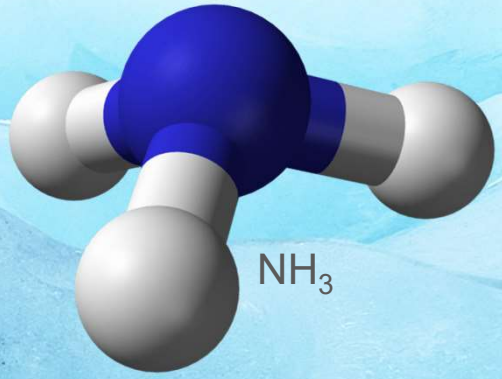
Conclusion

- The experience in the application is available (+40 years)
- The technology was proven for demanding applications
- The HP market is attractive in the long term (legislation)
- Complex challenges require '**innovative concepts**'
- Extremely important to work together on each project from beginning on

Always a Solution Ahead

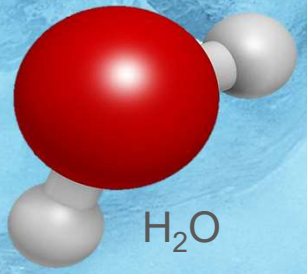
For a Sustainable Future

Ammonia



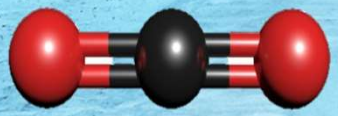
NH_3

Water



H_2O

Carbon Dioxide



CO_2

Propane

C_3H_8

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

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