EU HIGH TEMPERATURE HEAT PUMP DEMONSTRATIONS

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AIT Austrian Institute of Technology GmbH

ACEEE IHP Workshop, 11th July 2023

BMK

1.400 employees

7 Centers

Austria‘s largest RTO

Applied Research

Infrastructure Systems

System Competence

Federation of Austrian Industries (through VFFI)

Next Generation Solutions

4 Subsidiary Enterprises

LKR, NES, SL, Profactor 51%

176 m EUR total revenue

Tomorrow Today

AIT CENTER FOR ENERGY
FACTS & FIGURES

FUNDING FRAME (CO-FINANCED)

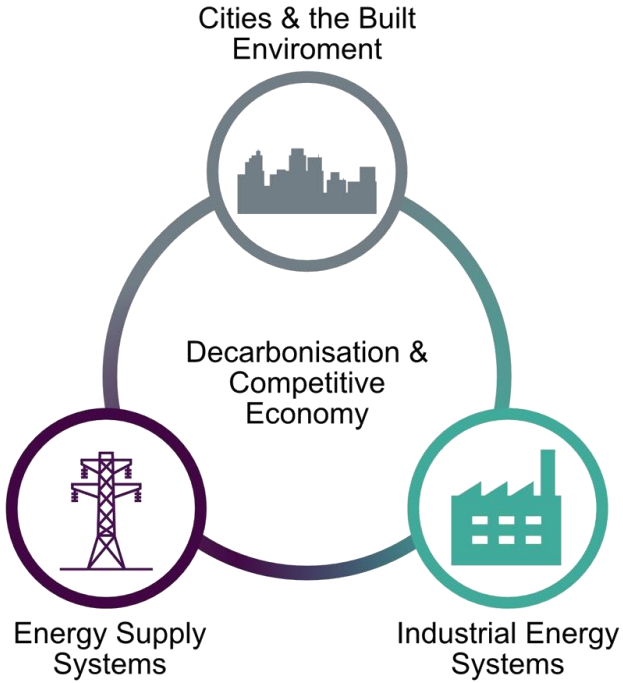
56 % NATIONAL

44 % INTERNATIONAL

RESEARCHERS & SCIENTISTS

250+

engineering, physics, architecture, IT, economics



RESEARCH FIELDS

12

SCIENTIFIC PUBLICATIONS

270+ per year

NATIONALITIES

25+

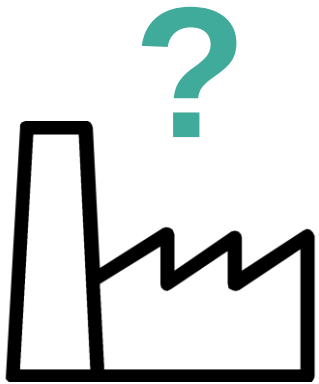
High temperature heat pumps

HIGH TEMPERATURE HEAT PUMPS @ AIT

- more than 10 years of research experience
- from lab scale prototypes to industrial demonstration

Challenges:

- high heat supply temperatures
- temperature resistant refrigerants, materials and components
- process integration and efficient cycles



Requirements for industrial applications:

- high availability
- economic viability
- security of supply

INDUSTRIAL HEAT PUMP DEMONSTRATORS

DryFiciency

- H2020, 2016-2021
- hot water up to 160 ºC
- successful component development
- 8000 h demonstration

Bamboo

- H2020, 2018-2023
- steam up to 150 ºC
- steam generation with flash tank
- successful demonstration

NEFI AHEAD

- FFG, 2022-2025
- steam up to 184 ºC
- full scale demonstrator (1.7 MW)
- start up planned in 2024

DRYFICIENCY: INDUSTRIAL DEMONSTRATION

High temperature heat pumps up to 160ºC

Closed loop heat pump

Open loop heat pump

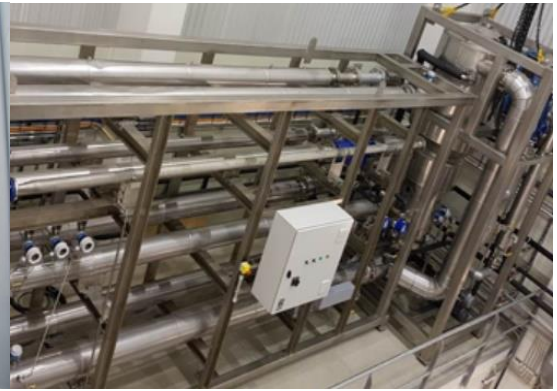
Brick drying

Wienerberger AG
Uttendorf (AT)

Starch drying

AGRANA Stärke GmbH
Pischelsdorf (AT)

Bio sludge drying

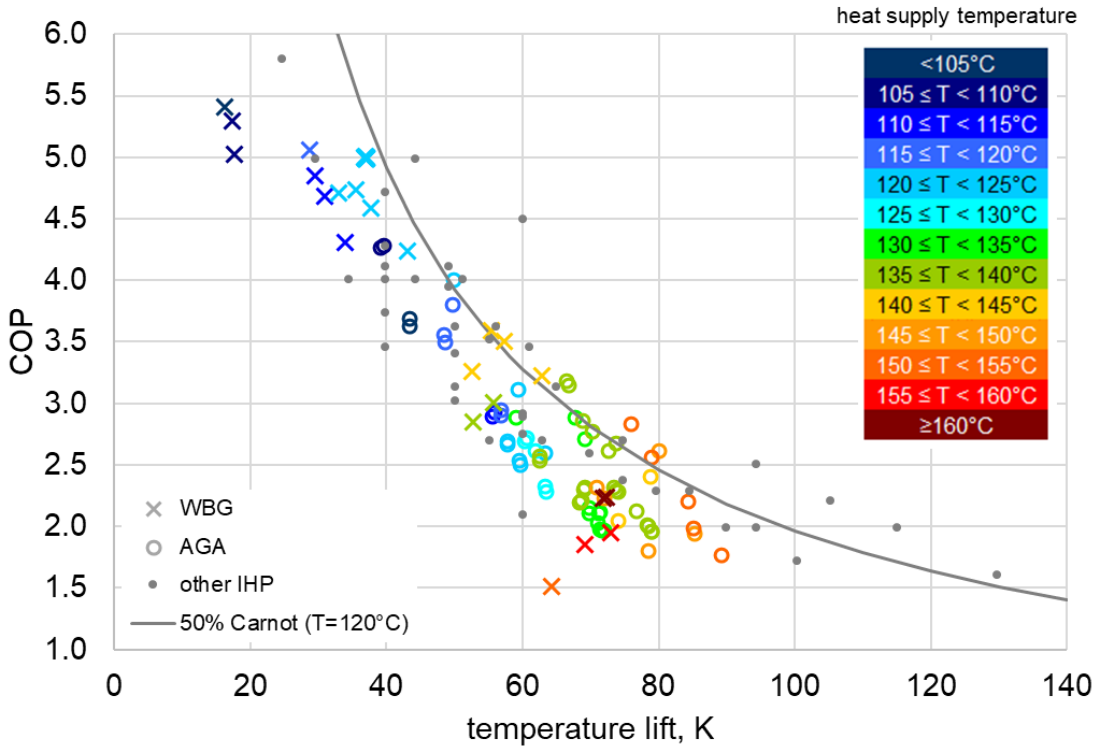


Scanship A/S
Drammen (NO)

The project has received funding from the European Union's Horizon 2020 programme for energy efficiency and innovation action under grant agreement No. 723576.

DRYFICIENCY: INDUSTRIAL DEMONSTRATION

High temperature heat pumps up to 160ºC

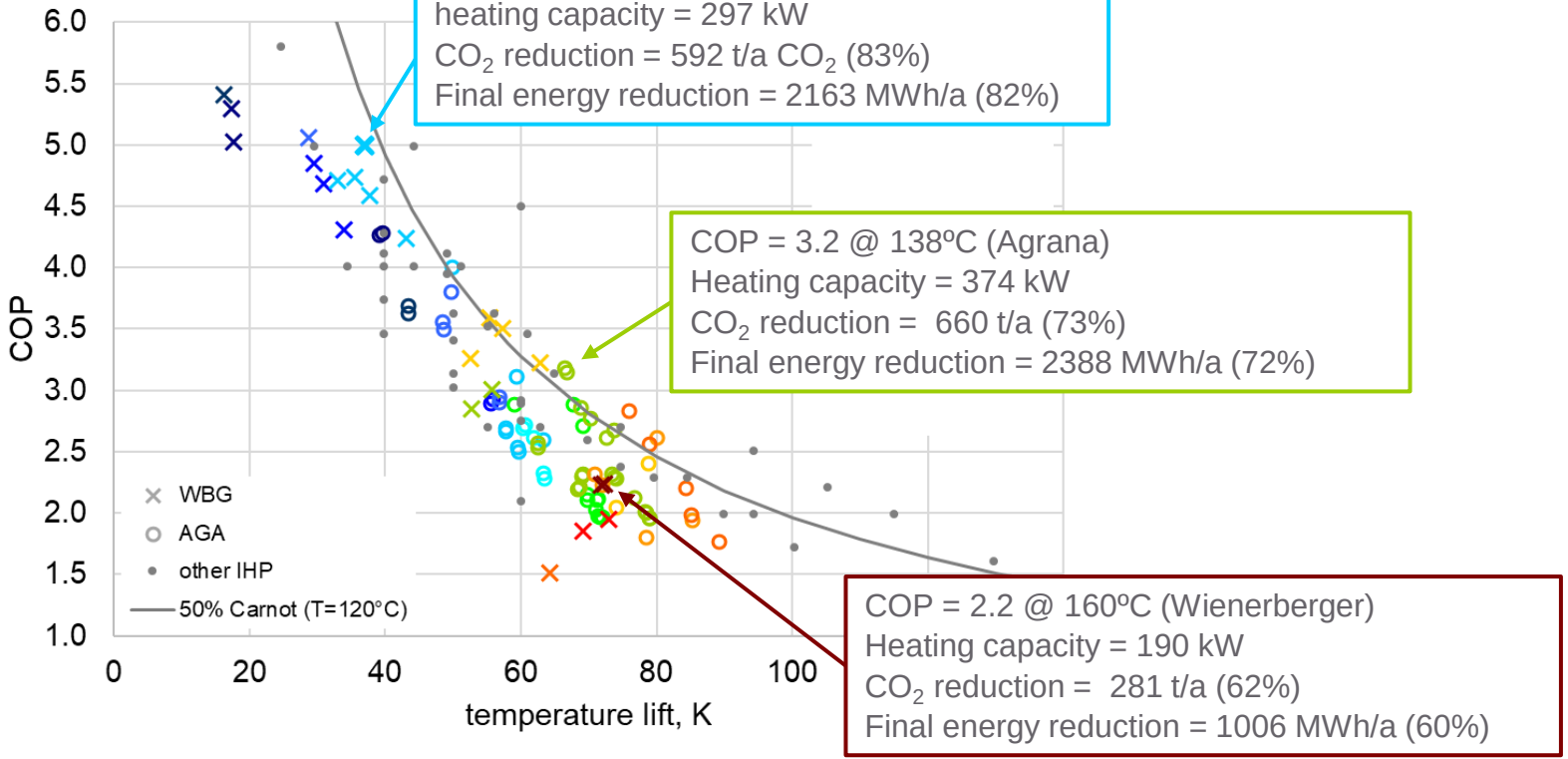


each data point represents > 10 h of stationary operation

- Successful component development for high-temperature applications: Compressors, lubricants and refrigerants
- Successful demonstration of heat pumps with more than 8000 operating hours for both demonstrators
- Final energy reduction and CO_2 emission up to 80% compared to natural gas

other IHP from Arpagaus et al. High temperature heat pumps: Market overview, state of the art, research status, refrigerants, and application potentials, Energy (152), p.985-1010, 2018.

DRYFICIENCY: INDUSTRIAL DEMONSTRATION

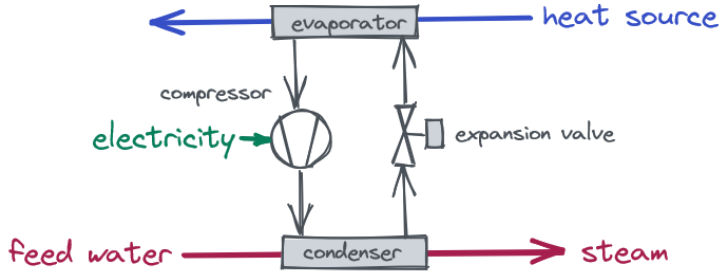


STEAM GENERATION WITH HEAT PUMPS

- steam is a major energy carrier in industry
- significant multiplication potential due to integration in existing steam networks
- steam generation in a heat pump
  - in the condenser
  - in a flash tank
- combination with MVR system

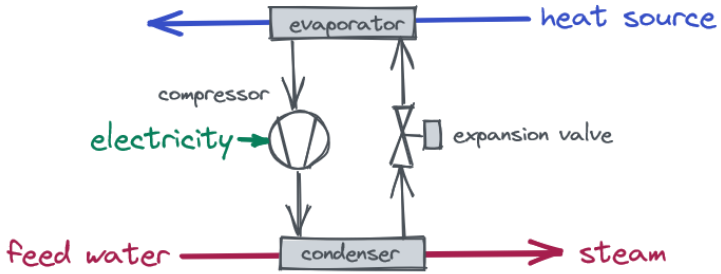
STEAM GENERATION

in the condenser

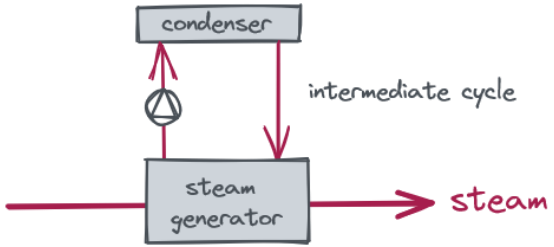


STEAM GENERATION

in the condenser

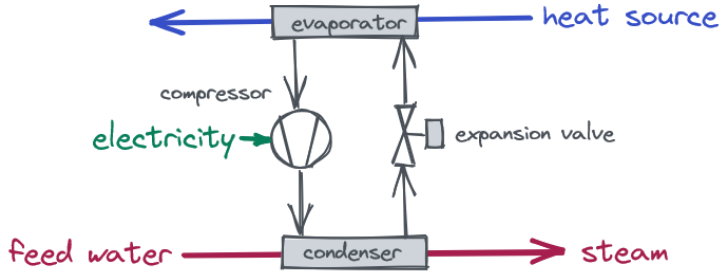


intermediate cycle

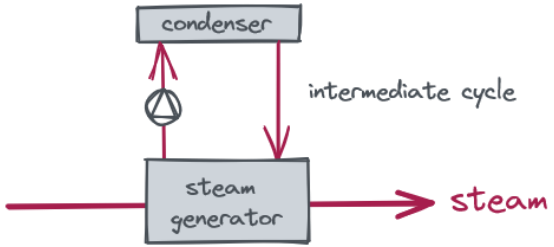


STEAM GENERATION

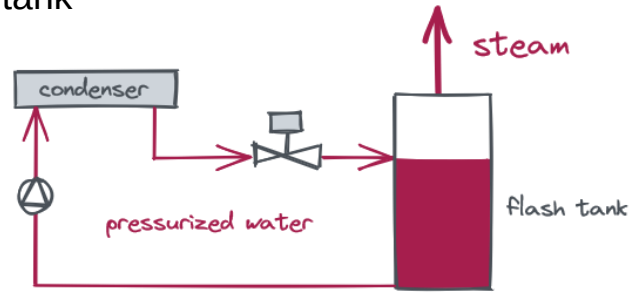
in the condenser



intermediate cycle

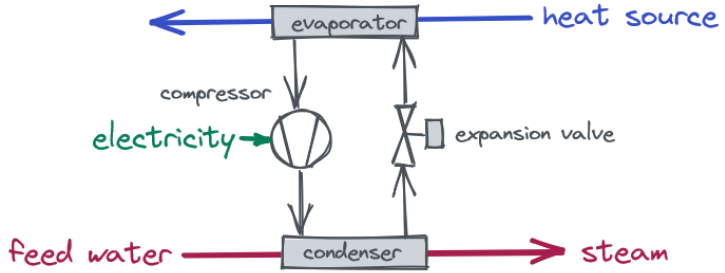


flash tank

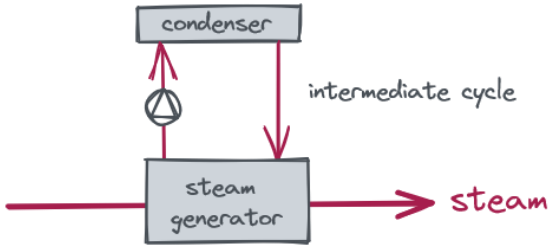


STEAM GENERATION

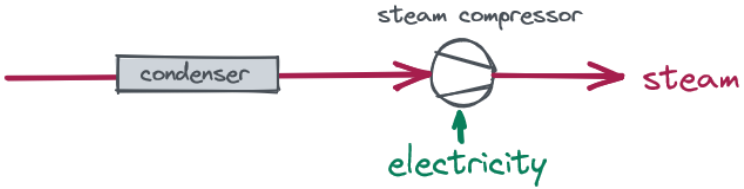
in the condenser



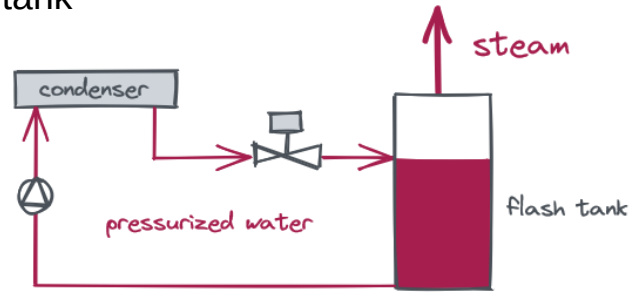
intermediate cycle



steam compression (MVR)



flash tank



STEAM GENERATION WITH FLASH TANK

BAMBOO

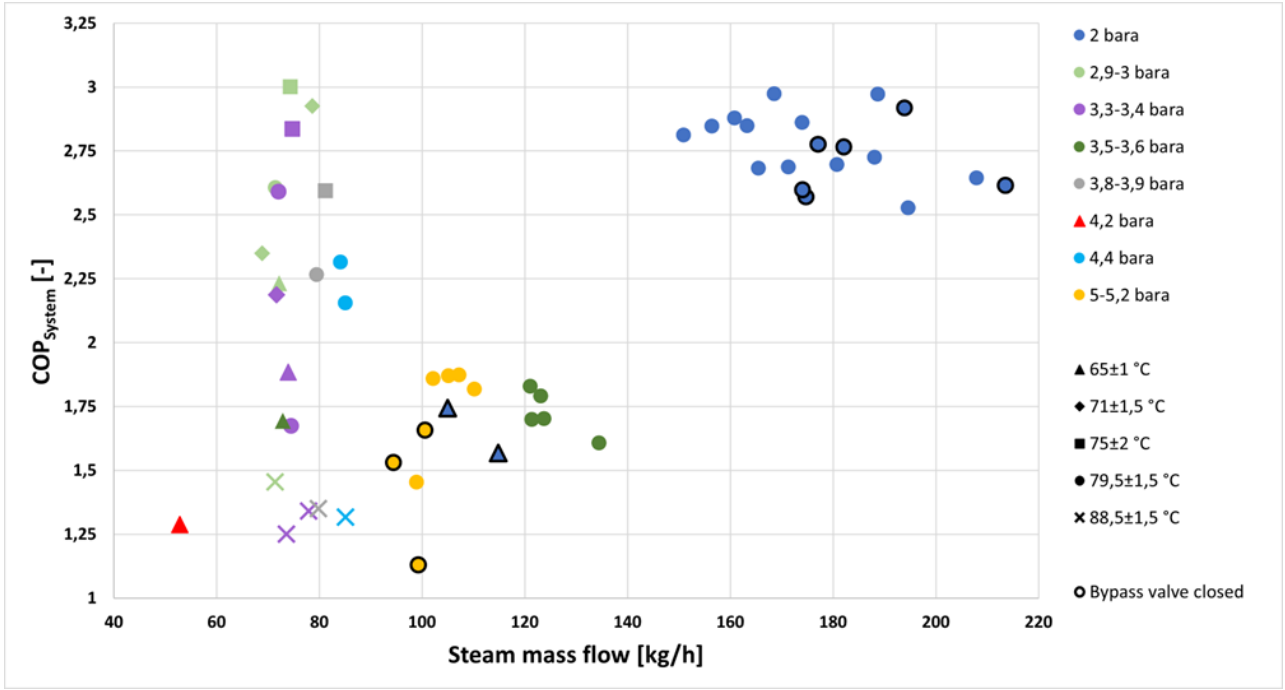
- High temperature heat pump:
  - Up to 5 bar_a saturated steam
  - Saturated steam mass flow up to 200 kg/h
  - Refrigerant R1336mzz(Z)
- Flash tank unit especially designed and crafted for HTHP
- Test operation in laboratory of EDF LAB Les Renardières
- Further tests in a semi-industrial laboratory environment

Flash tank unit for steam generation

Heat pump

J. Riedl et al., Messergebnisse einer dampferzeugenden Wärmepumpe mit Flash Tank, DKV-Tagung 2022, 16.-18.11.2022, Magdeburg, DE
The project is funded by the European Union under the H2020 programme (No. 820771).

PROJECT BAMBOO: STEAM GENERATING HEAT PUMP SYSTEM – MEASUREMENT RESULTS



J. Riedl et al., Messergebnisse einer dampferzeugenden Wärmepumpe mit Flash Tank, DKV-Tagung 2022, 16.-18.11.2022, Magdeburg, Deutschland
The project is funded by the European Union under the H2020 programme (No. 820771).

AHEAD: ADVANCED HEAT PUMP DEMONSTRATOR

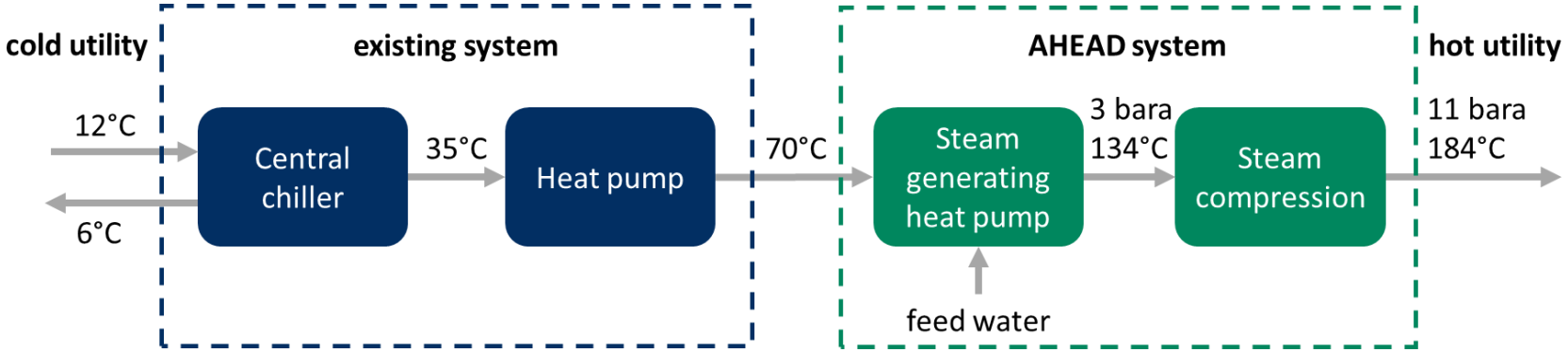
- steam production at 11 bar (184 °C) based on heat pumps
- integrated at a production site of Takeda in Vienna
- reduction of CO_2 emissions by up to 90%
- scientific monitoring and optimisation for more than 4000 h planned

https://nefi.at/en/project/ahead

This project is supported with the funds from the Climate and Energy Fund and implemented in the framework of the RTI-initiative “Flagship region Energy”

AHEAD: ADVANCED HEAT PUMP DEMONSTRATOR

- steam generating heat pump by SPH using butane as refrigerant
- combined with MVR to supply steam at 11 bar (184 °C) with 1.7 MW heating capacity
- heat and cold supply based on natural refrigerants only



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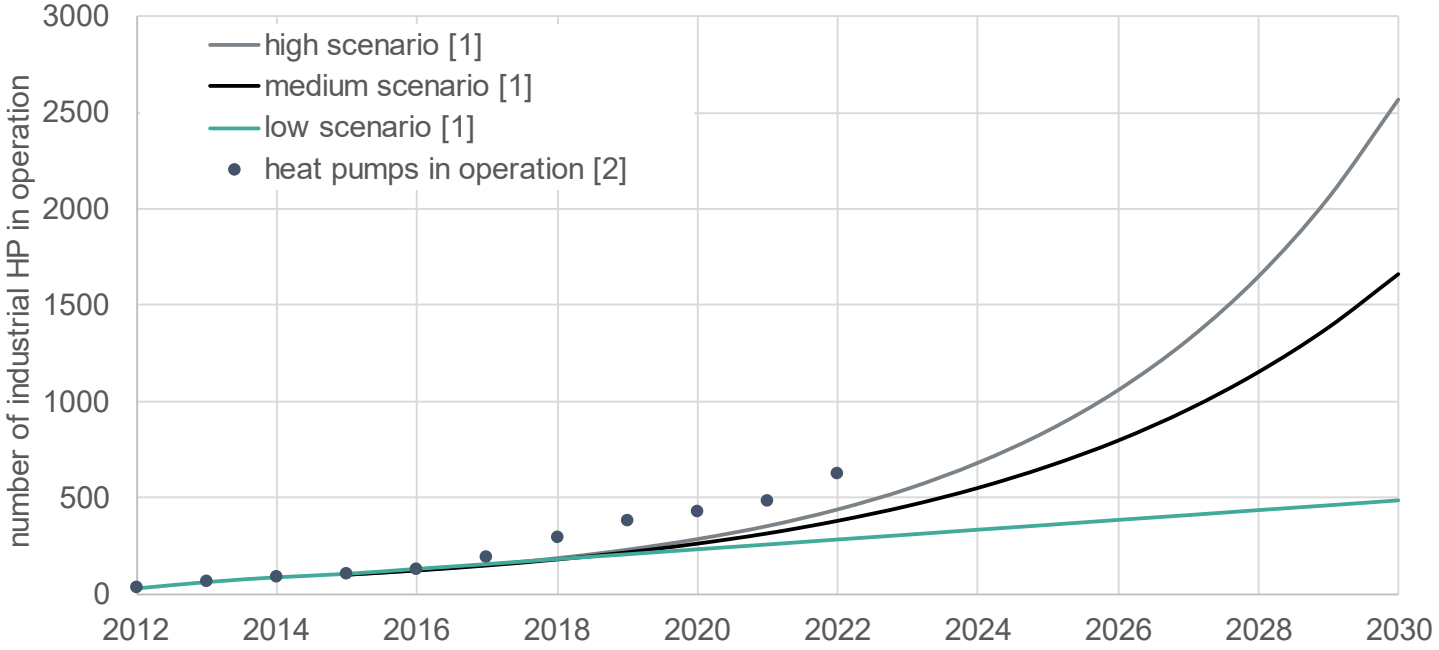
Industrial heat pumps in Austria

INDUSTRIAL HEAT PUMPS IN AUSTRIA



[1] Hartl et al. Österreichische Technologie- und Umsetzungsroadmap für Wärmepumpen, Berichte aus Energie- und Umweltforschung Nr. 8/2016, im Auftrag des BMVIT, Juni 2016
[2] Biermayr et al. Innovative Energietechnologien in Österreich Marktentwicklung 2022, Berichte aus Energie- und Umweltforschung Nr. 36a/2023 , im Auftrag des BMK, Mai 2023

FOOD INDUSTRY

Dairy

- Berglandmilch eGen / Tirol Milch Wörgl
- Joint project with Stadtwerke Wörgl
- Installed by Frigopol in 2015

3 heat pumps with a total

- cooling capacity: 3.2 MW
- heating capacity: 4.2 MW

- Heat source: flue gas condensation and chillers, up to 45°C
- Heat sink: 78°C, for district heating

Foto: Frigopol

Weitere Informationen: A. Baumhakel, J. Herunter, Frigopol Kälteanlagen GmbH, www.frigopol.com

FOOD INDUSTRY

Brewery

- Puntigamer
- C&P Immobilien AG
- KELAG Energie&Wärme GmbH

2 heat pumps with a total heating capacity of 1220 kW (Frigopol, installed in 2018)

- Heat source: ammonia chiller, 14-25°C
- Heat sink: 46 and 75°C, residential area (Brauquartier Puntigam)

Foto: https://www.puntigamer.at/brauereifuehrung/#lg=1&slide=6, 30.05.2018

Koglbauer, Zanker, District heating by heat recovery from the brewing process of the brewery Puntigam, ISEC 2018, Graz, p118-124.

METAL INDUSTRY

Rolling Mill

- Steel and rolling mill Marienhütte GmbH
- Energie Graz GmbH & Co KG

2 heat pumps (Friotherm) with a total heating capacity of 11 MW

- Heat source: process waste heat (cooling baths)
- Heat sink: district heating at 70 and 95°C, residential area (Graz City center and Reininghaus)

Photo: http://www.energie-graz.at/energie/fernwaerme/projekte/reininghaus , 10.05.2017

Unger, H., 2018, Energiemodell Reininghaus – Abwärmeauskopplung Marienhütte durch Energie Graz, Technischer Kurzbericht

POWER PLANTS

Wien Energie

Kraftwerk Simmering (installed capacity of 1.2 GWel / 1 GWth)

Start up by end of 2018

2 heat pumps with a total heating capacity of 27-39 MW

- Heat source: cooling circuit of the power plants, river water also possible, 6-27°C
- Heat sink: district heating, up to 95°C

CONCLUSIONS

Heat pumps are a future-proof technology for process heat supply:

- Reduction of CO_2 emissions and increase in efficiency
- Electrification of heat supply
- On site waste heat recovery
- Integration is decisive for efficient solutions

Ongoing development:

- More manufacturers and products entering the market
- Higher temperatures
- Steam generation

Demonstration projects to establish new technologies

THANK YOU!

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