

Anwendungsmöglichkeiten von Wärmepumpen in der Industrie (IEA HPP Annex 35)

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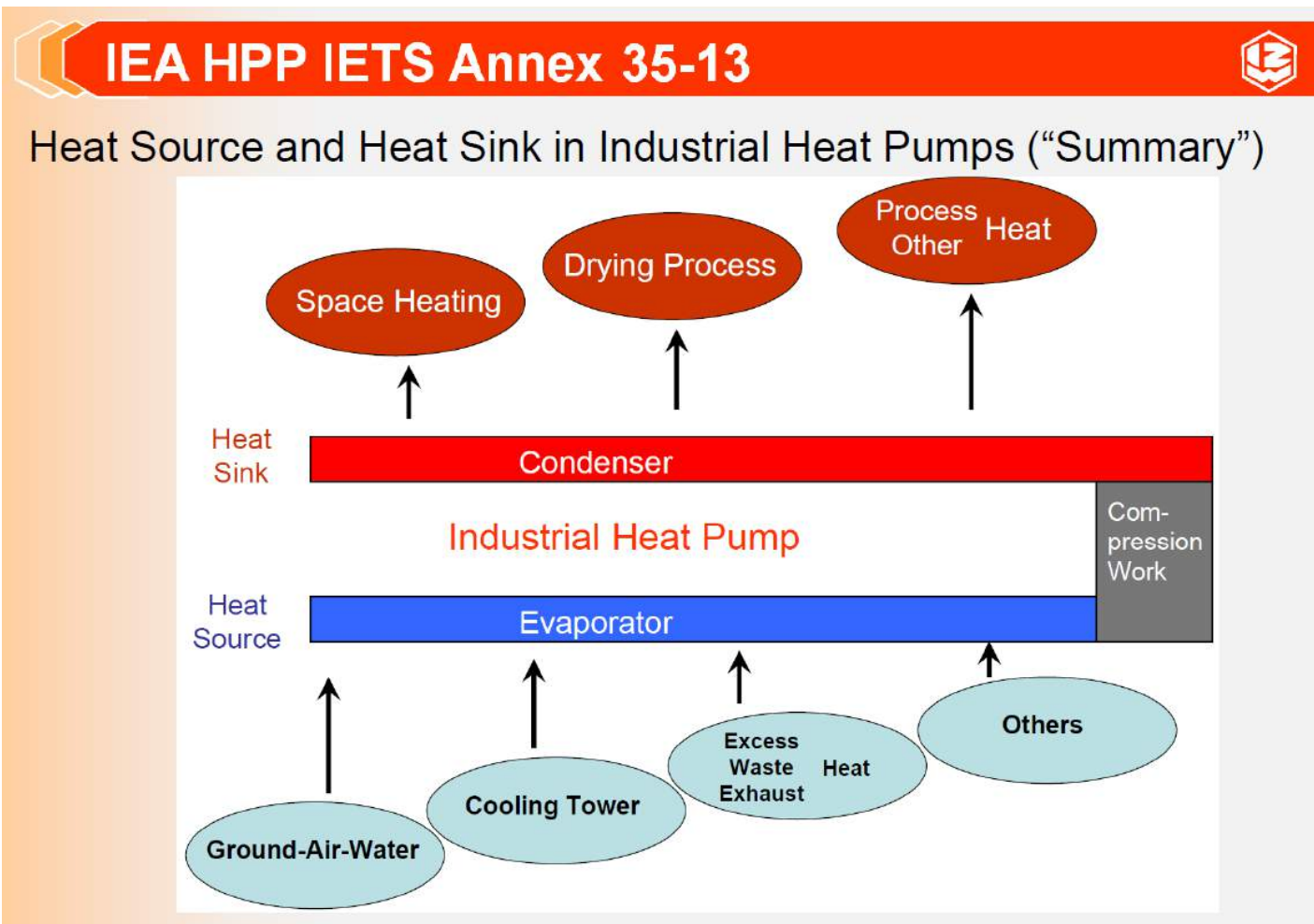
Highlights der Energieforschung 2016: „Die Rolle der
Wärmepumpe im zukünftigen Energiesystem“

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Industrial Heat Pump



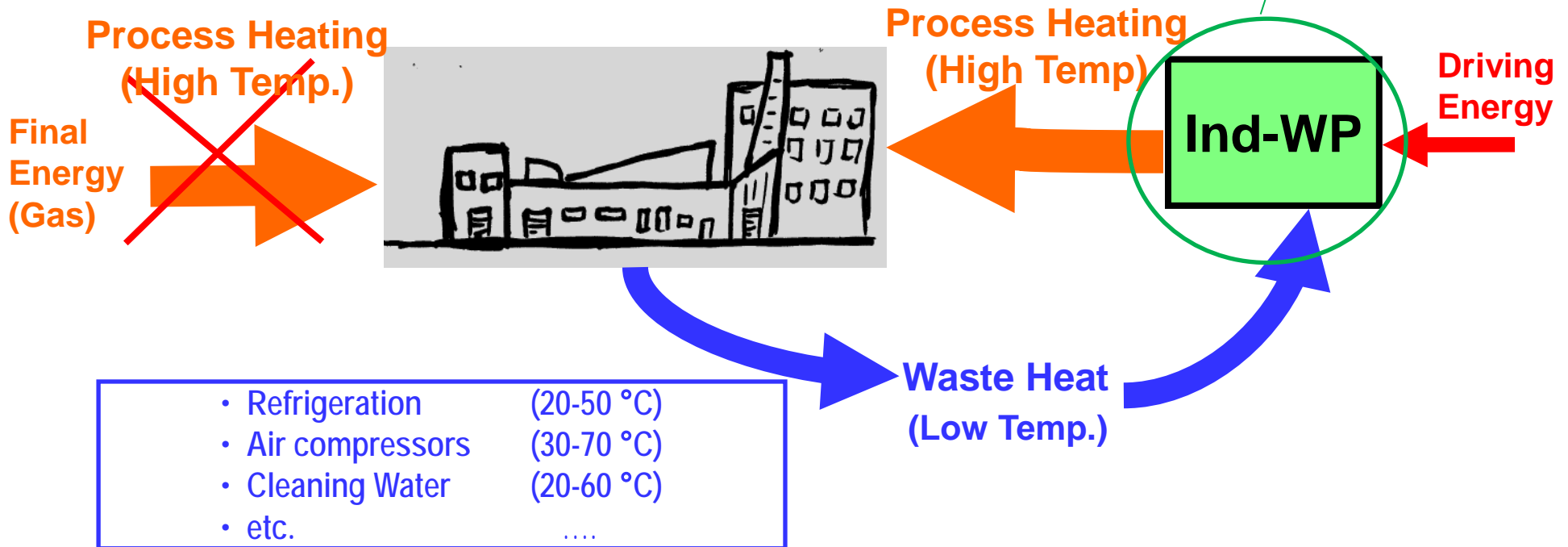
Source: Jakobs/IZW (2014)

Industrial Heat Pump

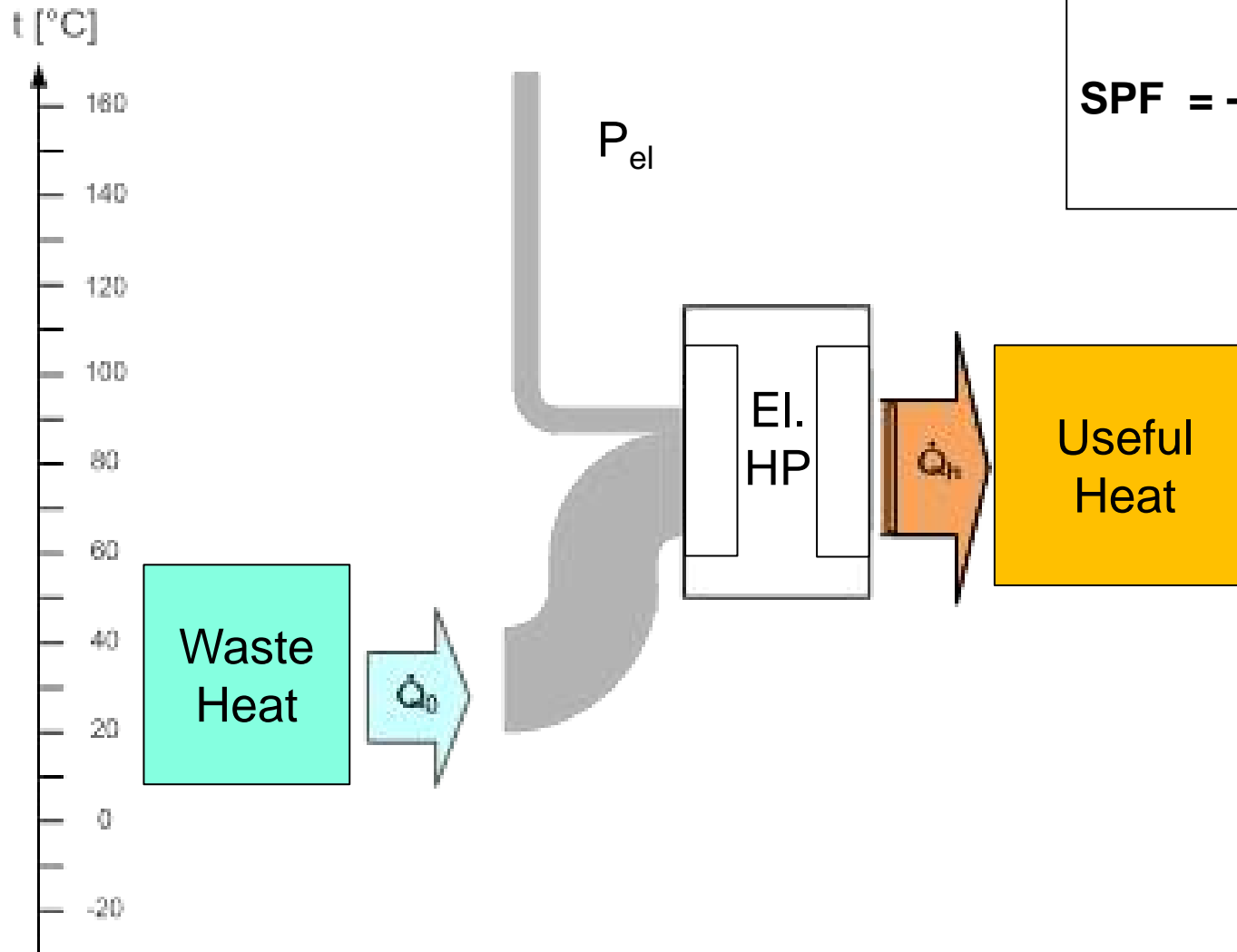
- Pasteurization (70 - 120 °C)
- Drying (40 - 250 °C)
- Galvanizing (20 - 100 °C)
- Bleaching (60 - 100 °C)
- etc.

Efficiency (Seasonal Performance Factor):

$$SPF = \frac{\text{Useful Heat}}{\text{Driving Energy}}$$



Working Principle of an Electr. (Compression) Heat Pump

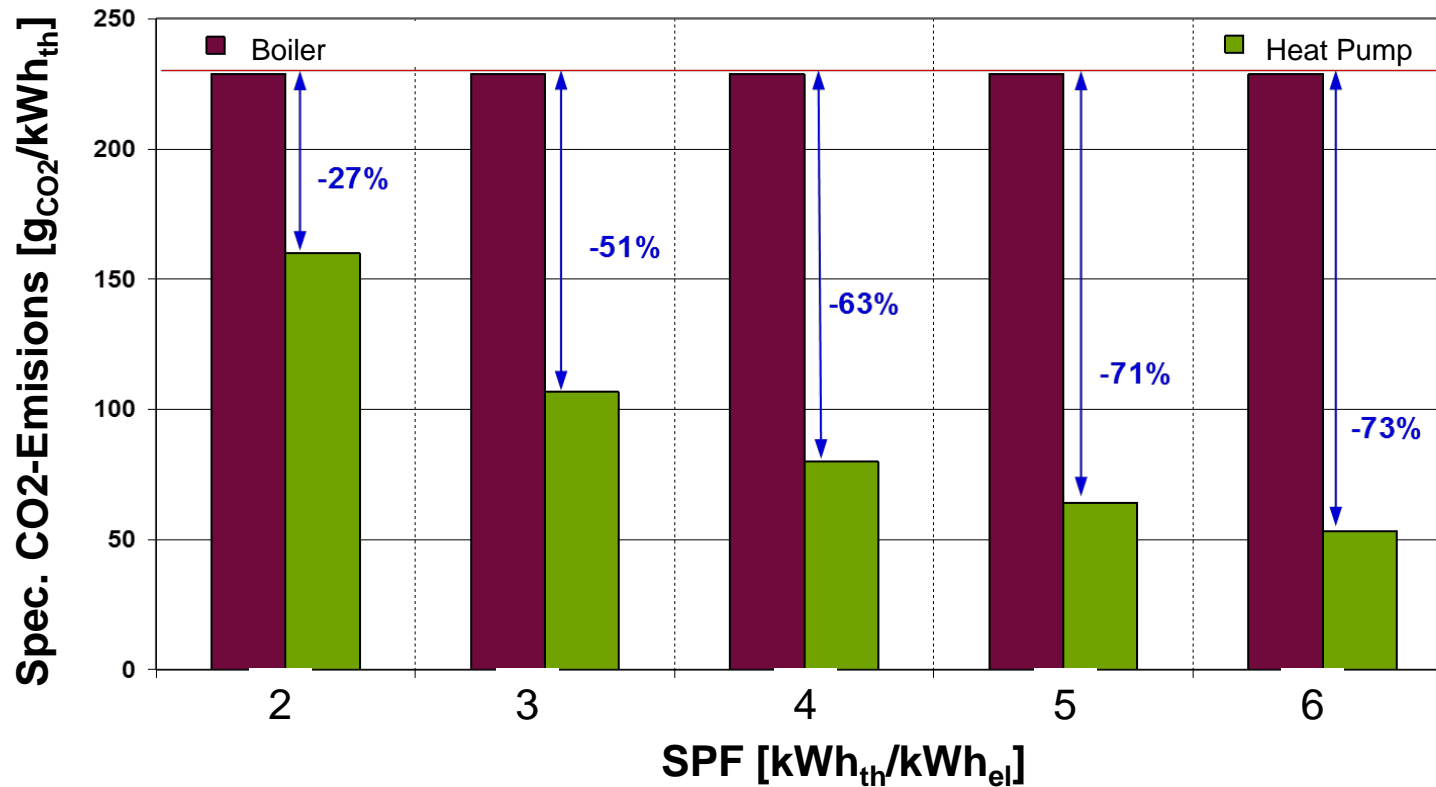


$$\text{SPF} = \frac{\text{Useful Heat p.a.}}{\text{El. Work p.a.}}$$

CO₂ Emissions

E.g. **Electr. Compression HP** vs. **Gas-fired Boiler**

$$\text{SPF} = \frac{\text{Useful Heat p.a.}}{\text{El. Work p.a.}}$$

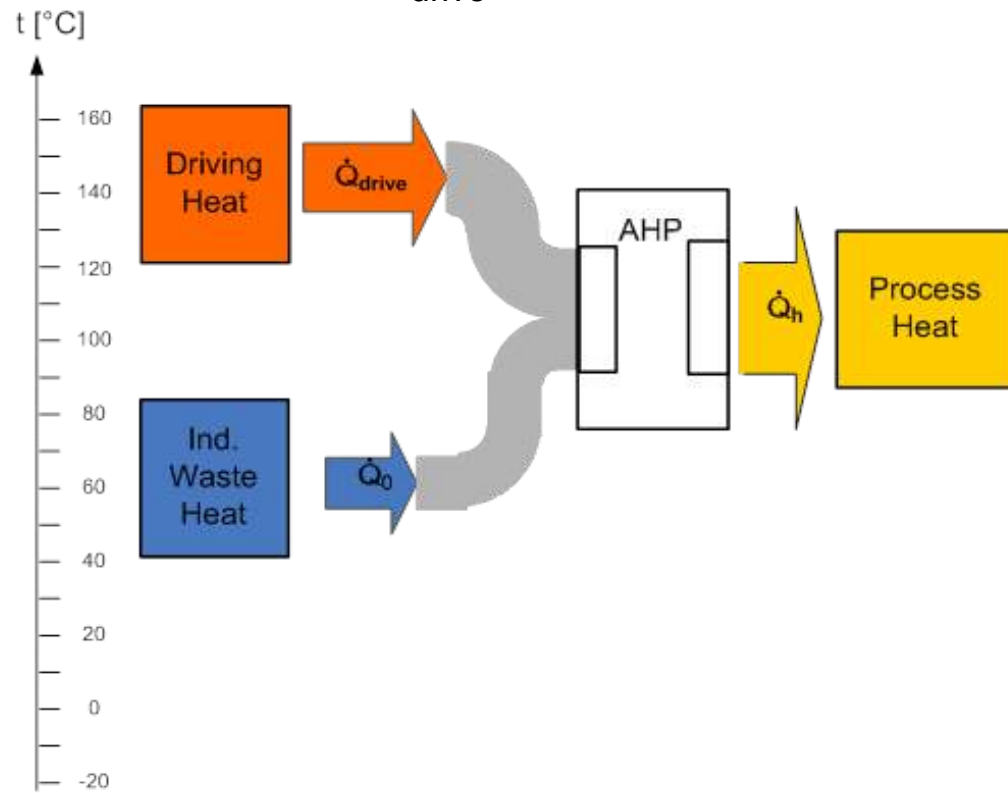


Assumption:

$\eta_{\text{gas}} = 85\%$
 $320 \text{ gCO}_2/\text{kWh}_{\text{el}}$ (KPC, 2011)

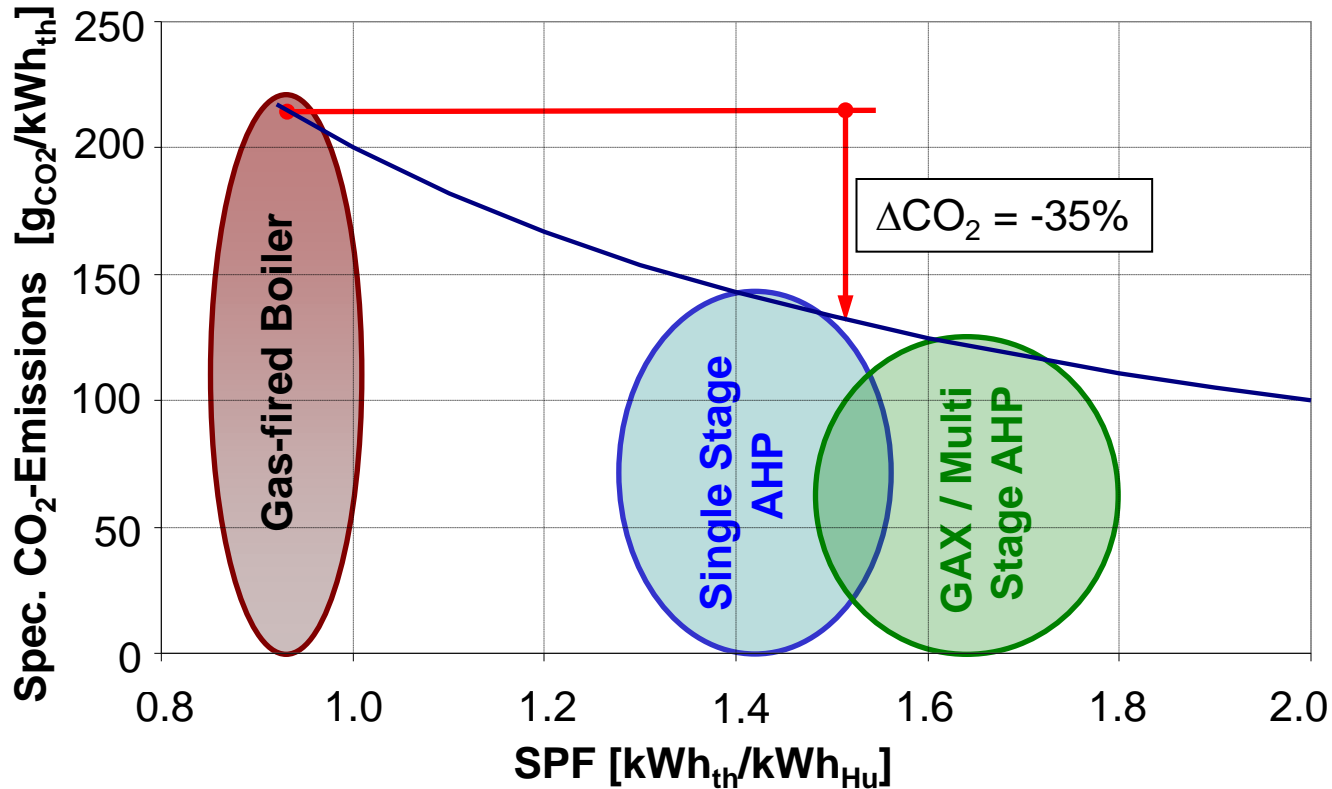
Working Principle of an Absorption Heat Pump (AHP)

Upgrading **waste heat** for heating purpose ($t_{\text{drive}} > 100^\circ\text{C}$)



CO₂ Emissions

E.g. Gas-driven Absorption HP vs. Gas-fired Boiler



Efficiency:

$$SPF = \frac{\text{Useful Heat p.a.}}{\text{Driving Energy p.a.}}$$

Assumption:

CO₂-Emission : 200 g/kWh_{Hu-Gas}

Industrial Heat Pumps

Challenges / Requirements

- Lack of knowledge
- High temperatures (refrigerants, components)
- Rel. large capacities (availability on the market)
- Reliability
- Economy

Aim of the Annex 35 (4/2010 – 4/2015, “Phase 1”):

- + Documentation of realized systems shall support market penetration
- + R&D to improve availability

Participating Countries (Phase 1): AUT (AIT & IWT – TU Graz), CAN, DNK, DEU, NLD, FRA, JPN, KOR, SWE

Some Applications in Austria

- Temperature level upgrade by means of **compression HPs** in a meat factory, a **brewery**, an **metalworking company**
- **Add-on compression heat pump** for a chiller of an artificial ice rink
- **Cascade compresssion HP for bi-generation** in a freezer warehouse
- **Compression HP for heating & cooling** in a multifunctional office building
- **Absorption heat pump (AHP) in an electronic factory for cooling**
- **AHP for flue gas condensation in a wood-processing company**

Compression heat pump in in a brewery:

- NH₃ Compression HP (COFELY)
- Waste heat from:
 - + air compressor
 - + chillers
- Heat upgrade from ca. 40 to 77°C
- 370 kW heating capacity
- Space and process water heating

Source: *klima:aktiv*

Company:  **MOHREN**
SEIT 1834



HP @ Mohrenbrauerei (Source: *klima:aktiv*, 2012)

Compression HP in a metalworking company (automotive industry: cable, wire – production)

- R134a compression HP
- Compressor type: Screw
- Year of installation: 2009
- Heat source: process heat / aluminium wire drawing machine
- Heat source temperature: 25/20 °C
- Heat sink temperature: 55°C
- Heating capacity: 139.5 kW



Company Gebauer & Griller

Absorption heat pump (chiller) in an electronic factory:

- H₂O/LiBr - AHP for cooling purposes (YAZAKI)
- Driving source: waste heat from:
 - + air compressor
 - + chillers
- Waste heat temp. level: **75°C**

Source: klima:aktiv

Company 



AHP @ Seidel Elektronik in
Deutschlandsberg

AHP for flue gas condensation (1/3)

Example: Waste heat recovery in a biomass plant in Hallein (Salzburg)

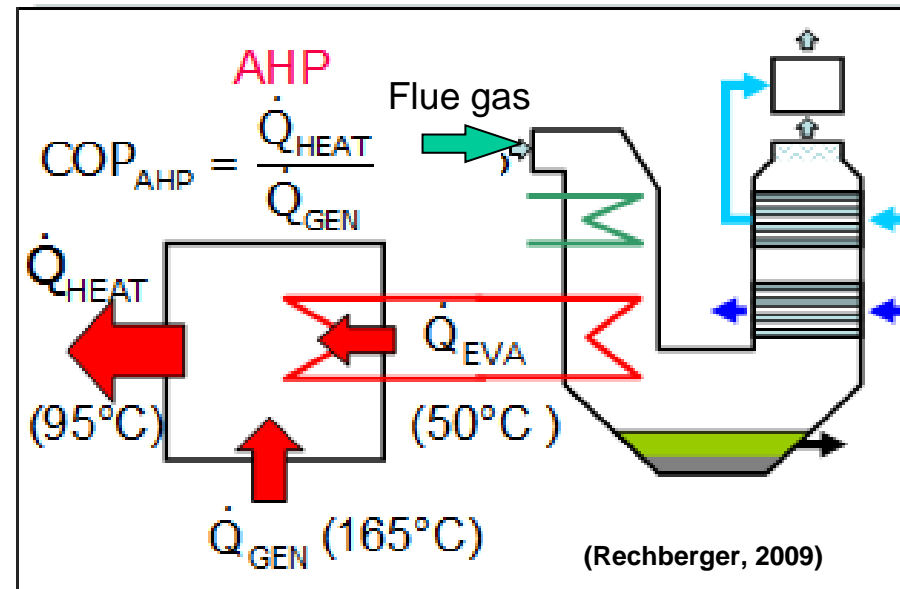
- **Biomass co-generation plant**
 - $30 \text{ MW}_{\text{th}}$
 - 5 MW_{el}



- **$\text{H}_2\text{O}/\text{LiBr}$ – AHP for flue gas condensation**
 - Utilization of waste heat of flue gas
 - Upgrade to useful temperature level
 - Heat supply to the district heating network of Salzburg

(Source: schweighofer-fibre.at)

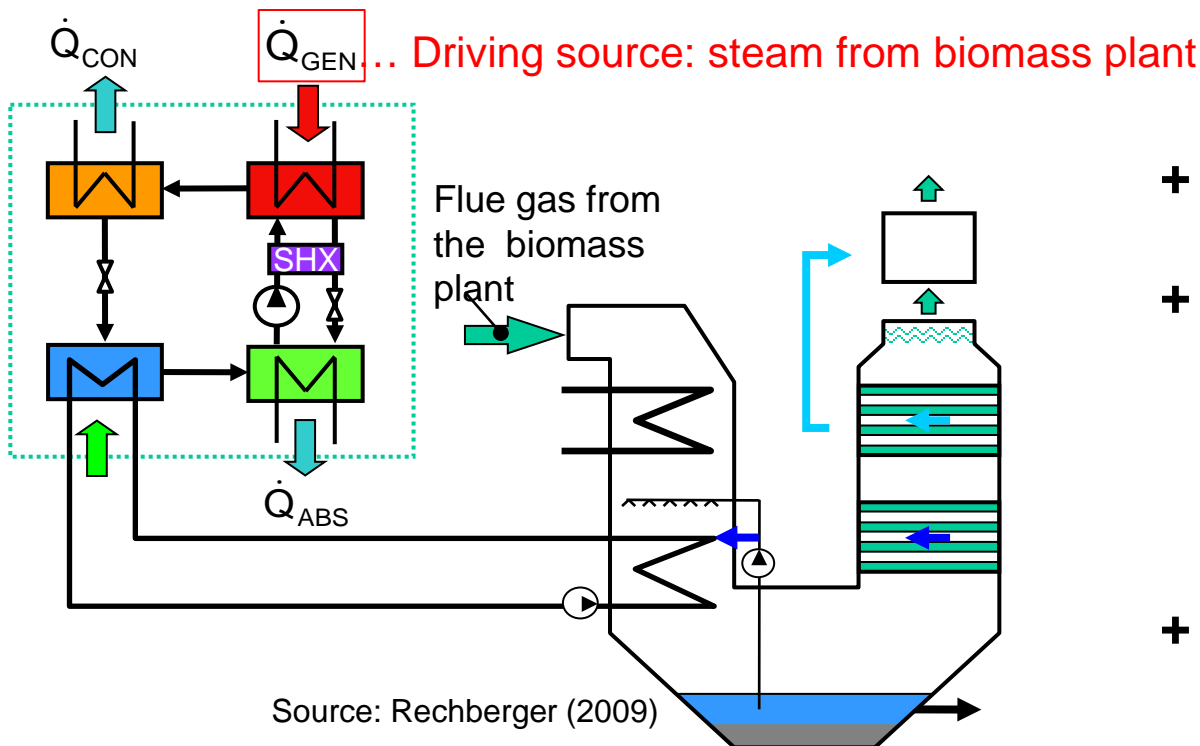
Basic concept of heat extraction by means of an AHP



- Heat source: latent heat of flue gas (ca. 50 °C)
- Heat sink: district heating (ca. 95 °C)
- Driving source: steam from power plant (ca. 165 °C)

Heat Pump installed @ Schweighofer Fiber (Hallein, Salzburg)

- Type: Single-stage H₂O/LiBr – AHP (Innven)
- Heating capacity ca. 7.5 MW_{th}
- Driving energy: ca. 4.5 MW_{th} (generator) + ca. 20 kW_{el} (full load)
- Utilized waste heat capacity: ca. 3 MW (evaporator)



+ In operation since 09/2006

+ Operating hours:

ca. 7500 h_{operation} p.a.

ca. 6200 h_{FullLoad} p.a.

+ SPF = ca. 1.6

Conclusions

- Industry one of the biggest CO₂ emitters in Austria
- High dependency on imported fossil fuels
- HPs offer a large ecological potential
- Several barriers for HPs (still) exist
- IHPs in Austria not widely used, but several plants in operation
- Various possibilities for waste heat recovery
 - + heating purpose: upgrade of heat via compression or absorption HPs
 - + cooling purpose: use of waste heat as driving source for AHP
- R&D and demonstration projects will support market penetration

Acknowledgement

The work on “HPP Annex 35” was financially supported within the framework of the “IEA Research Cooperation” on behalf of the “Austrian Federal Ministry for Transport, Innovation and Technology”.



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OF TECHNOLOGY

Thank You!

PS: Further information can be found via

<http://www.heatpumpcentre.org/> => Publications

<http://www.nachhaltigwirtschaften.at/results.html/id6414>