Application of Heat Pumps in Industry
HPP Annex 35

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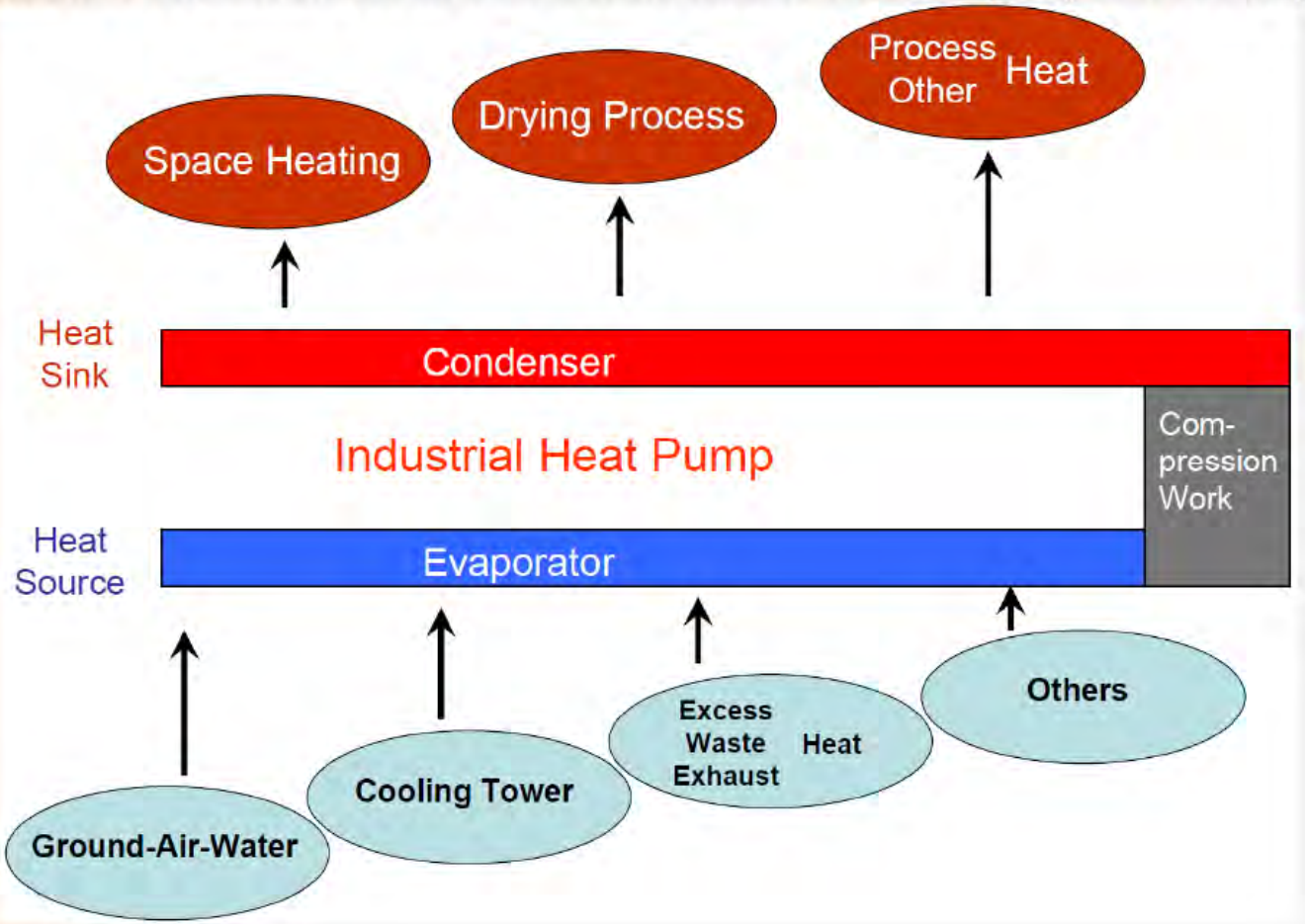
Heat Source and Heat Sink in Industrial Heat Pumps ("Summary")



Source: Jakobs/IZW (2014)

IEA HPP Annex 35 (4/2010 – 4/2015)

IEA HPP IETS Annex 35-13

Participating Organisations

Austria	TU Graz, Institute of Thermal Engineering Austrian Institute of Technology
Canada	Canmet Energy, Hydro-Quebec Research Institute Laboratoire des technologies de l'énergie (LTE)
Denmark	Danish Technological Institute, Refrigeration and Heat Pump Technology
Germany	Information Centre on Heat Pumps and Refrigeration IZW e.V. Institut für Energiewirtschaft & Rationelle Energieverwendung IER, Universität Stuttgart Emerson Climate Technologies GmbH, Aachen thermea.energiesysteme GmbH, Freital
Netherlands	NL Agency Energy and Climate Change
France	European Centre and Laboratories for Energy Effiency Research EDF-R&D-ECLEER
Japan	The University of Tsukuba Central Research Institute of Electric Power
South Korea	Korea Institute of Energy Research, New and Renewable Energy Research Department
Sweden	SP Technical Research Institute of Sweden Energy Technology, CIT Chalmers Industrial Technology , Chalmers Teknikpark, Göteborg

Source: Jakobs/IZW (2014)

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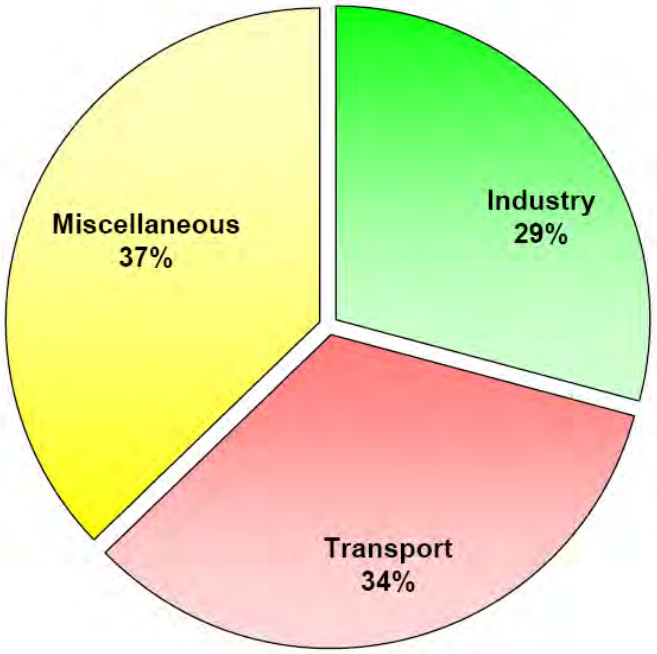
Tasks Structure

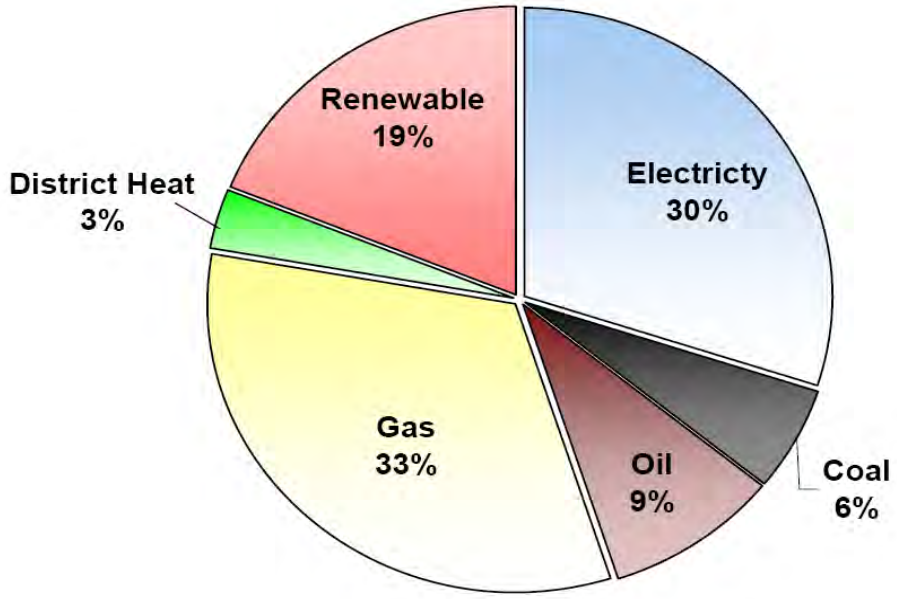
- **Task 1:** Market overview, barriers for application
- **Task 2:** Modeling calculation and economic models
- **Task 3:** Technology, high temperature heat pumps, process technological integration, refrigerants
- **Task 4:** Application and monitoring, easy to install standard solutions, operating experience, energy effects
- **Task 5:** Communication, awareness of potential (policy paper), internet, database, training

Source: Jakobs/IZW (2014)

Energy in Austrian Industry



Austrian energy consumption per sector
(Source: Statistik Austria, 2010)



Energy carries in the Austrian industry
(Source: Statistik Austria, 2010)

Industrial Heat Pumps

Efficiency:

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

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

Process Heating (High Temp)

Process Heating (High Temp.)

Final Energy

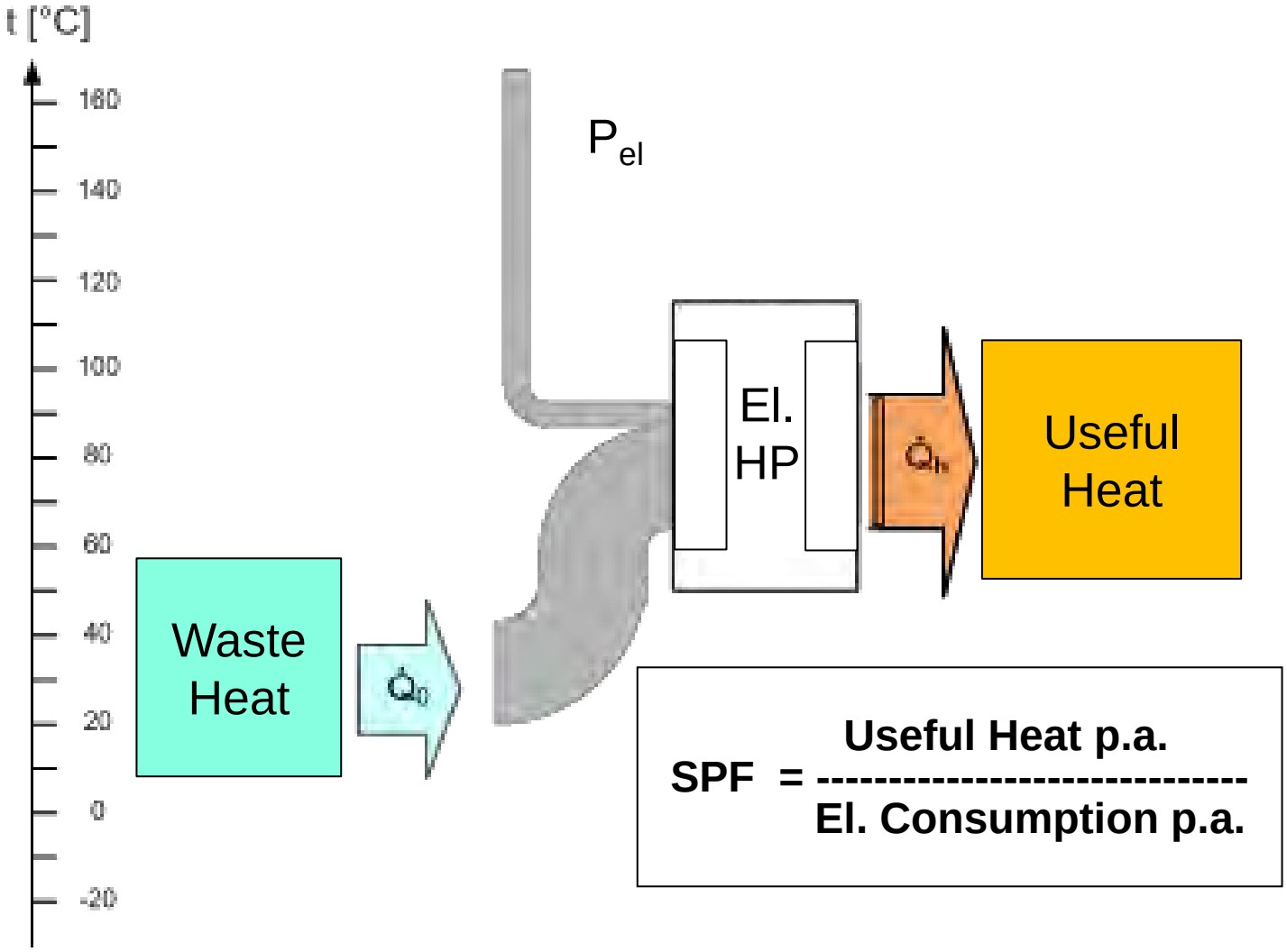
Ind-WP

Final Energy

Waste Heat (Low Temp.)

- Refrigeration (20-50° C)
- Air compressors (30-70° C)
- Cleaning Water (20-60° C)
- etc. ....

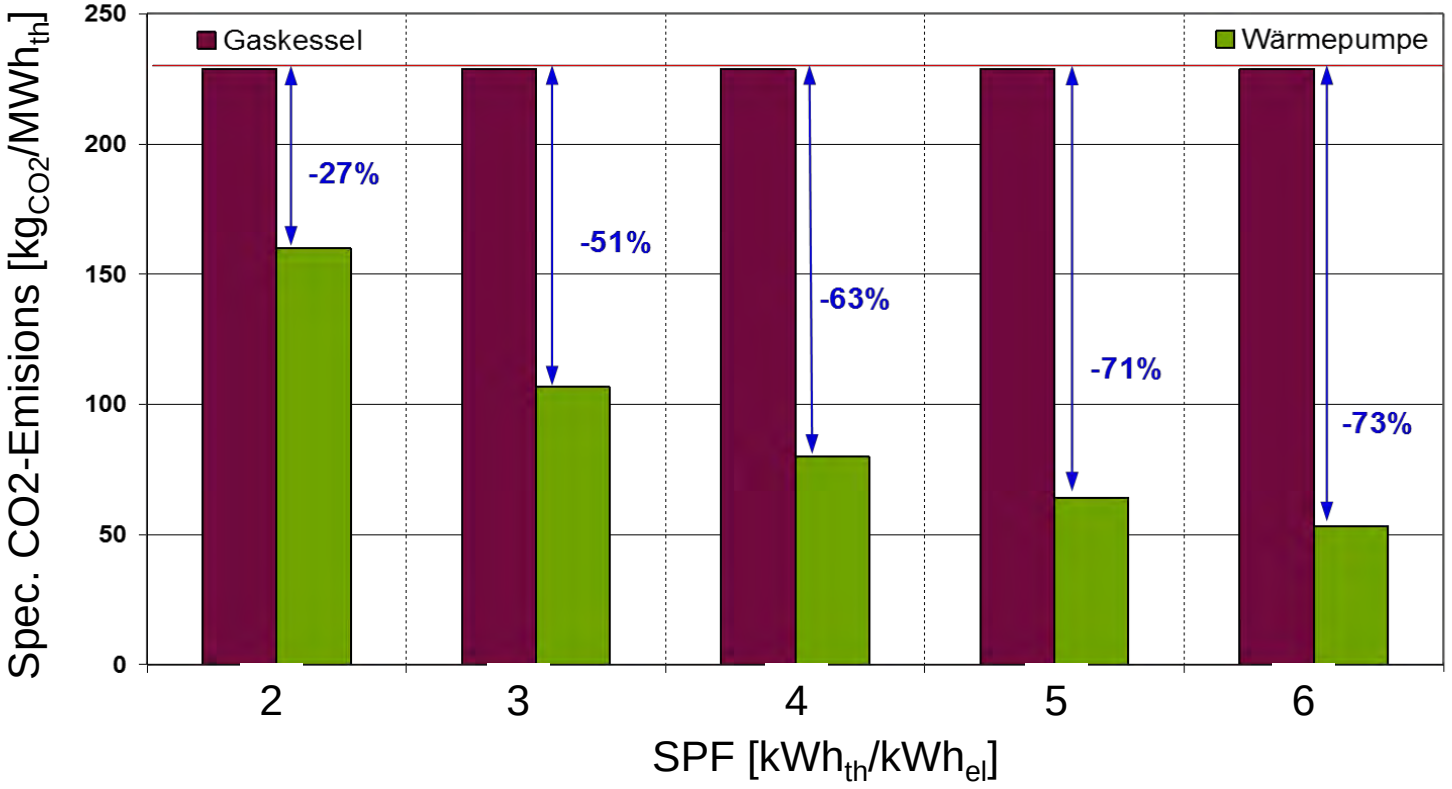
Working Principle of a Compression Heat Pump



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

CO_2 Emissions

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



Efficiency:

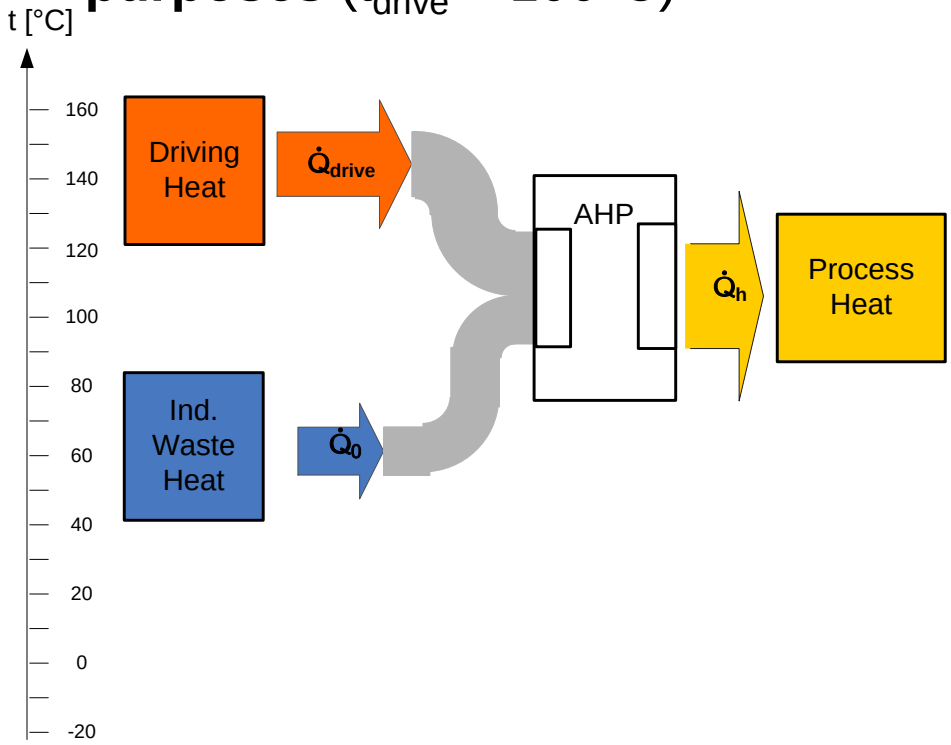
$$SPF = \frac{\text{Useful Heat}}{\text{Driving Energy}}$$

Assumption:
η_{gas} = 85%
320 g_{CO2}/kWh$_{el}$ (KPC, 2011)

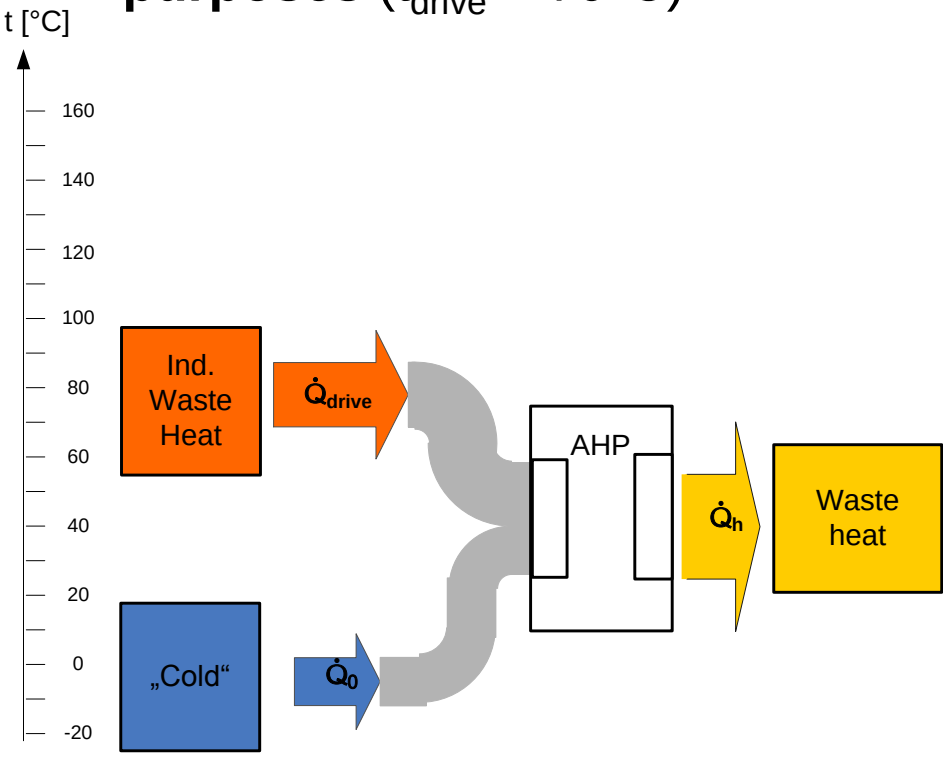
Absorption Heat Pumps in Industry

various application possibilities for

upgrading **waste heat for heating purposes** (t_{drive} > 100°C)



using **waste heat for cooling purposes** (t_{drive} > 70°C)



Industrial Heat Pumps

Challenges / Requirements

- Lack of knowledge
- High temperatures (refrigerants)
- Large capacities (availability on the market)
- Reliability
- Economy

⇒ + Examples of realized systems shall help market penetration

+ R&D will support availability

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 in a wood-processing company**

Some Applications in Austria

Compression heat pump in in a brewery:

- NH_3 Compression HP (COFELY)
- 370 kW heating capacity
- Waste heat from:
  - + air compressor
  - + chillers
- Heat upgrade from ca. **40 to 77ºC**
- Space and process water heating
- ROI: 5.7a

Source: klima:aktiv

Company: MOHREN SEIT 1834

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

Some Applications in Austria

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

Some Applications in Austria

Absorption heat pump (chiller) in an electronic factory:

- H_2O/LiBr - AHP for cooling purposes (YAZAKI)
- Driving source: waste heat from:
  - + air compressor
  - + chillers
- Waste heat temp. level: **75ºC**
- ROI: 7.9 a

Source: klima:aktiv

Company SEIDEL

AHP @ Seidel Elektronic in Deutschlandsberg

AHP for flue gas condensation (1/3)

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

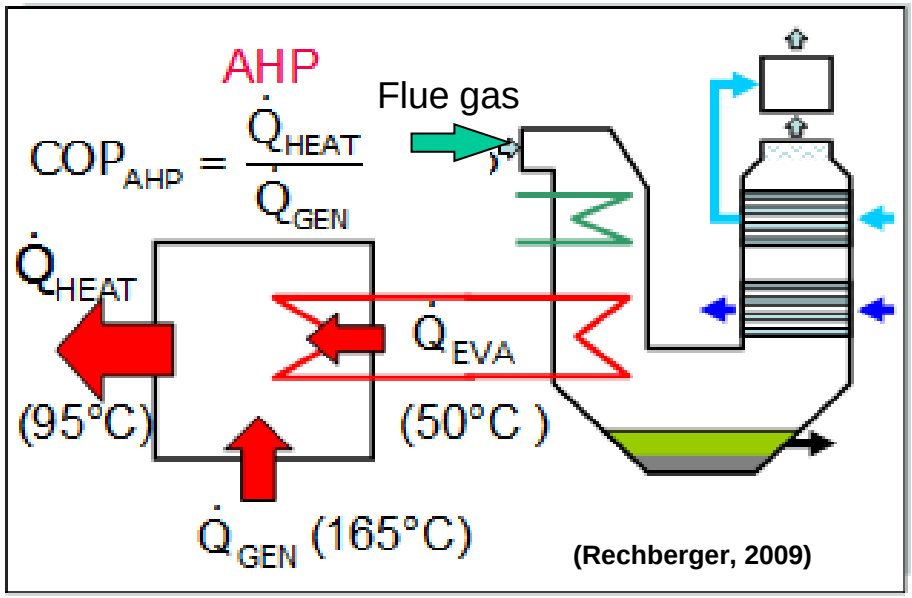
- **Biomas co-generation plant**
  - 30 MW_{th}
  - 5 MW_{el}

- **H_2O/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)

AHP for flue gas condensation (2/3)

Basic concept of heat extraction by means of an AHP

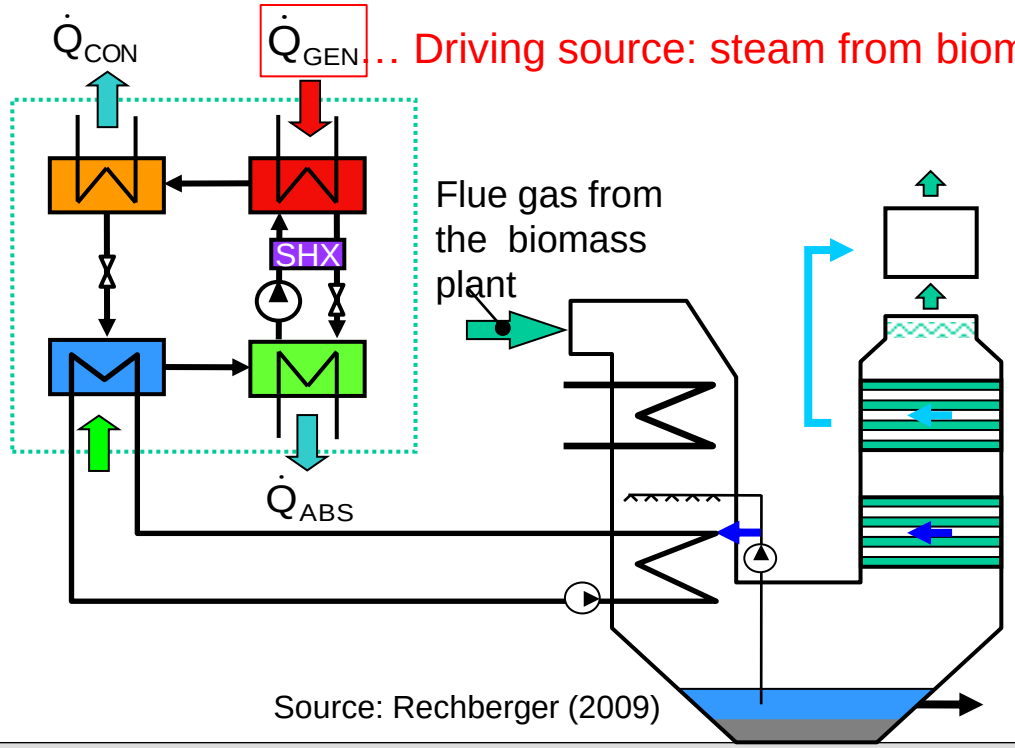


- Heat source: latent heat of flue gas (ca. 50 ºC)
- Heat sink: district heating (ca. 95 ºC)
- Driving source: steam from power plant (ca. 165 ºC)

AHP for flue gas condensation (3/3)

Heat Pump installed @ Schweighofer Fiber (Hallein, Salzburg)

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



Source: Rechberger (2009)

+ in operation since 09/2006

+ High operating hours:

- Ca. 7500 $h_{operation}$/a
- Ca. 6200 $h_{FullLoad}$/a
- Overall: ca. 37 000 $h_{operation}$ up to now

+ SPF = ca. 1.6

Conclusions

- Industry one of the biggest CO_2 emitters in Austria
- High dependency on imported fossil fuels of Austrian Industry
- 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 propose: 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

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Many Thanks to

Thank You!

PS: Further information can be found via

http://www.heatpumpcentre.org/ => Publications
http://www.nachhaltigwirtschaften.at/results.html/id6414