

Application of Heat Pumps in Industry

HPP Annex 35

René Rieberer
Institute of Thermal Engineering (IWT)
Graz University of Technology
rene.rieberer@tugraz.at
<http://www.iwt.tugraz.at>

IEA Vernetzungstreffen 2015
Vienna, 29.10.2015

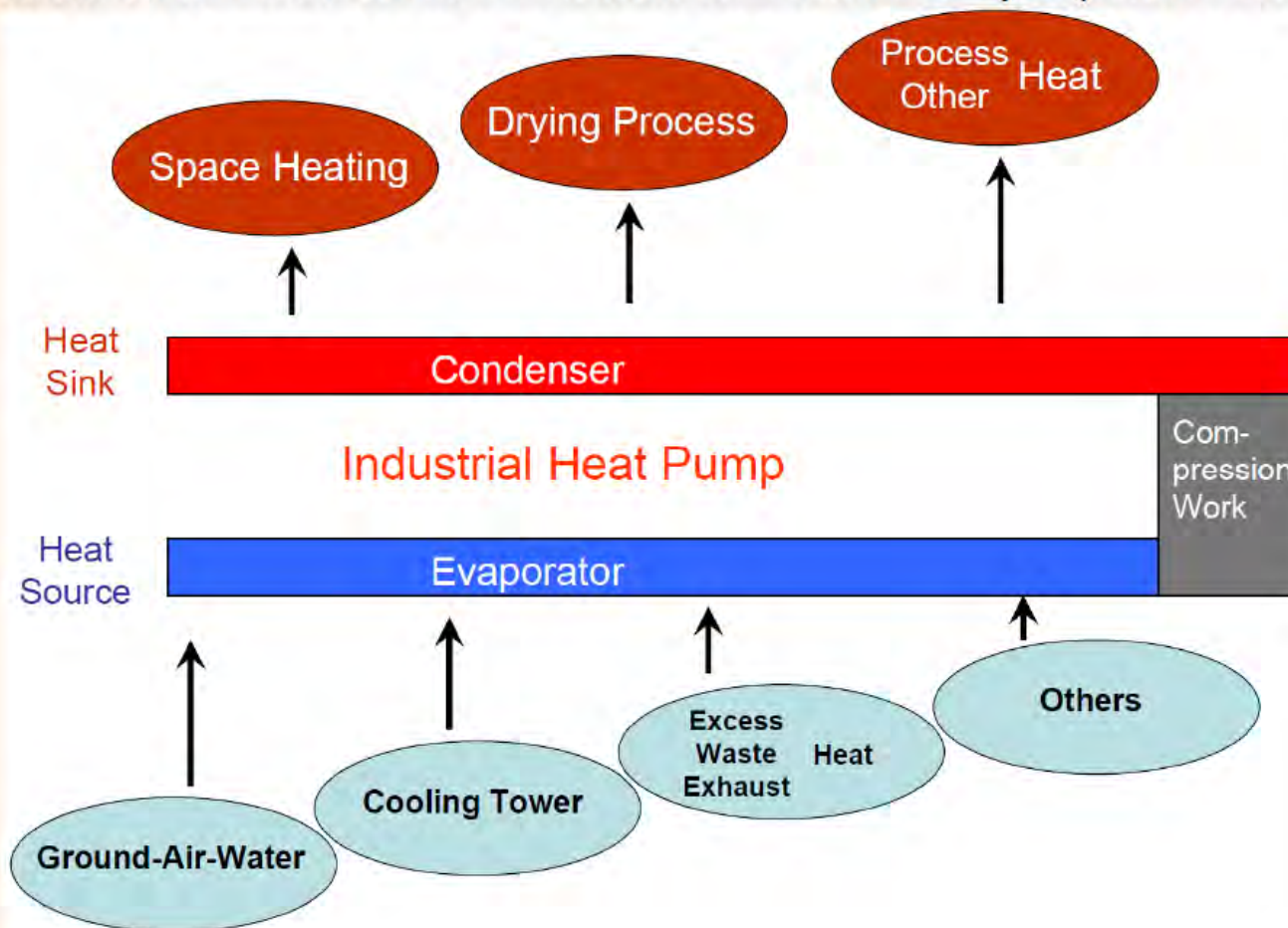
Contents

1. IEA HPP Annex 35 - Overview
2. Energy Situation in the Austrian Industry / Motivation
3. Industrial Heat Pump (IHP) - Technology in Austria
 - + Status
 - + Some applications in Austria
4. Conclusions

IEA HPP IETS Annex 35-13



Heat Source and Heat Sink in Industrial Heat Pumps (“Summary”)



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 Efficiency 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

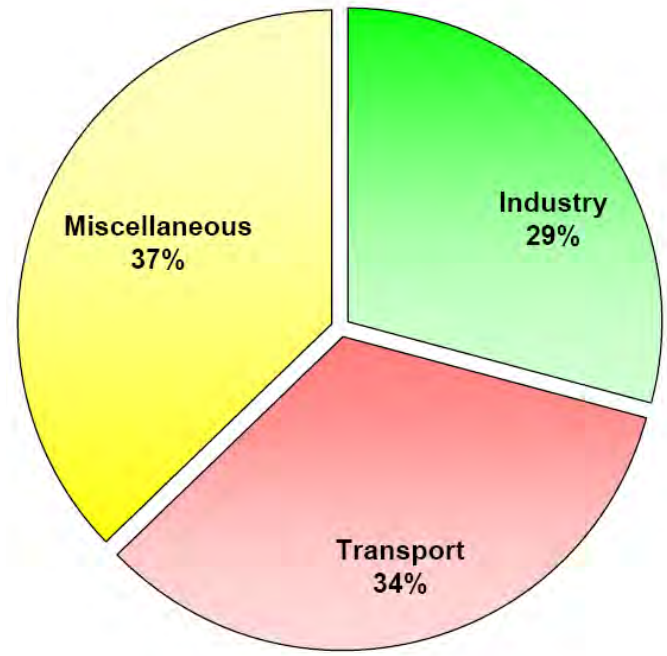
IEA HPP IETS Annex 35-13



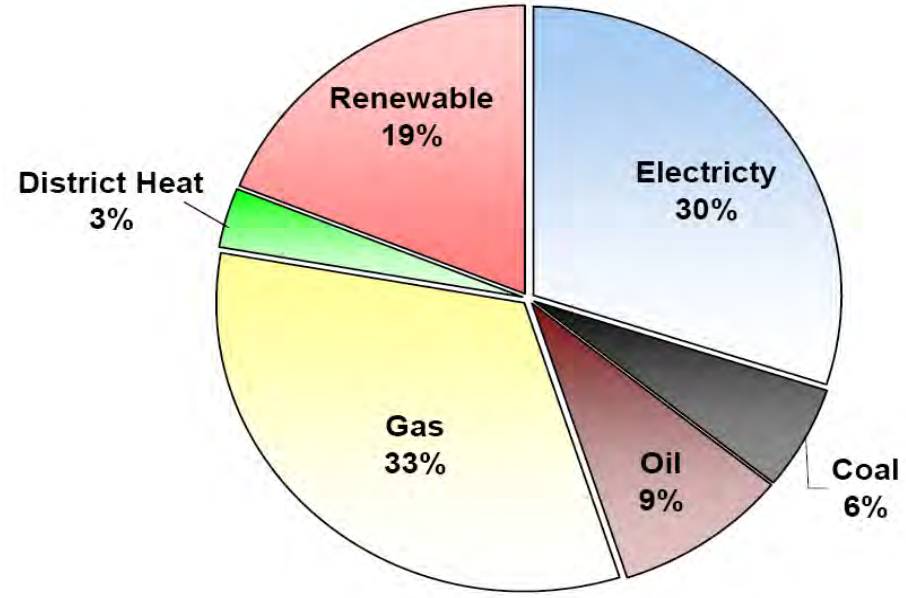
Tasks Structure

- **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

Energy in Austrian Industry



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



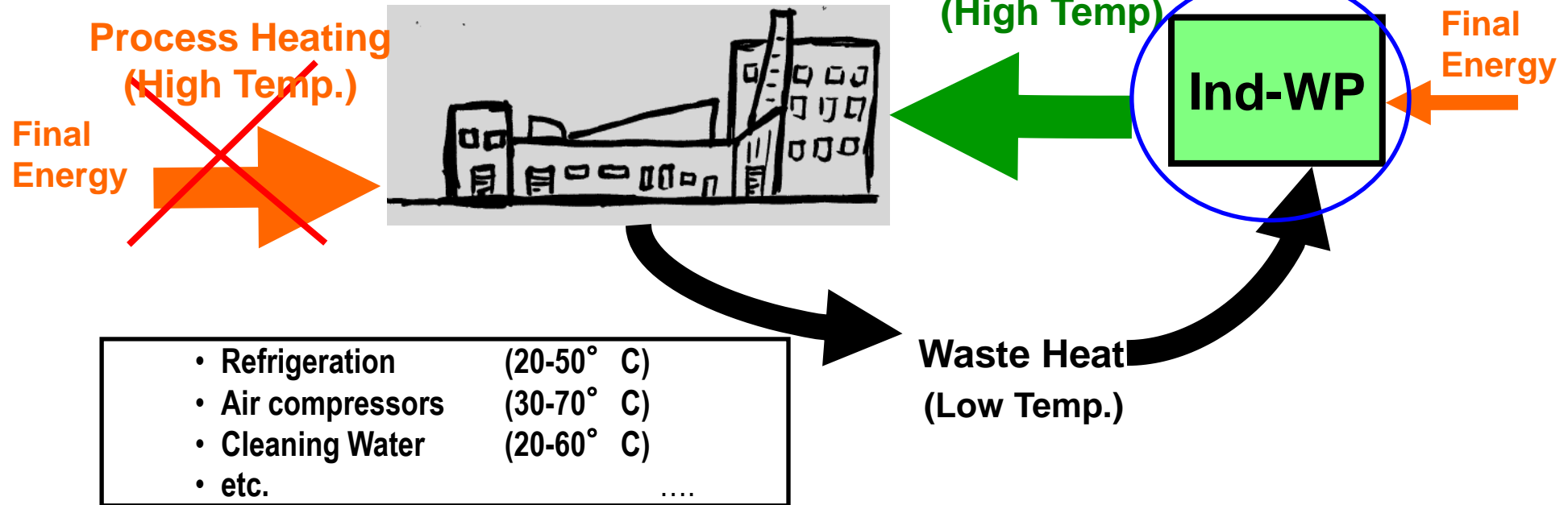
Energy carriers in the Austrian industry
(Source: Statistik Austria, 2010)

Industrial Heat Pumps

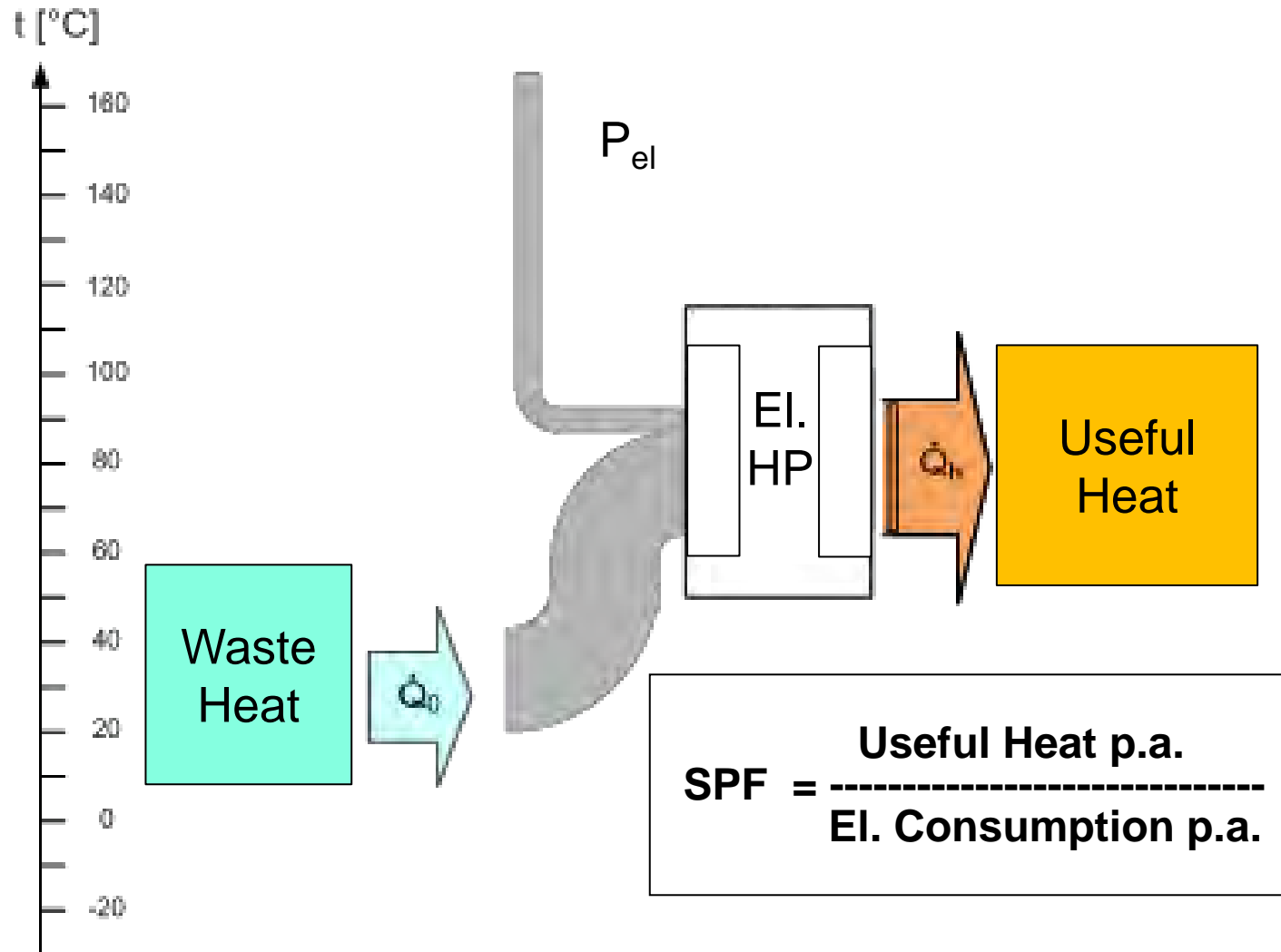
- Pasteurization (70 - 120 C)
- Drying (40 - 250 C)
- Galvanizing (20 - 100 C)
- Bleaching (60 - 100 C)
- etc.

Efficiency:

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



Working Principle of a Compression Heat Pump

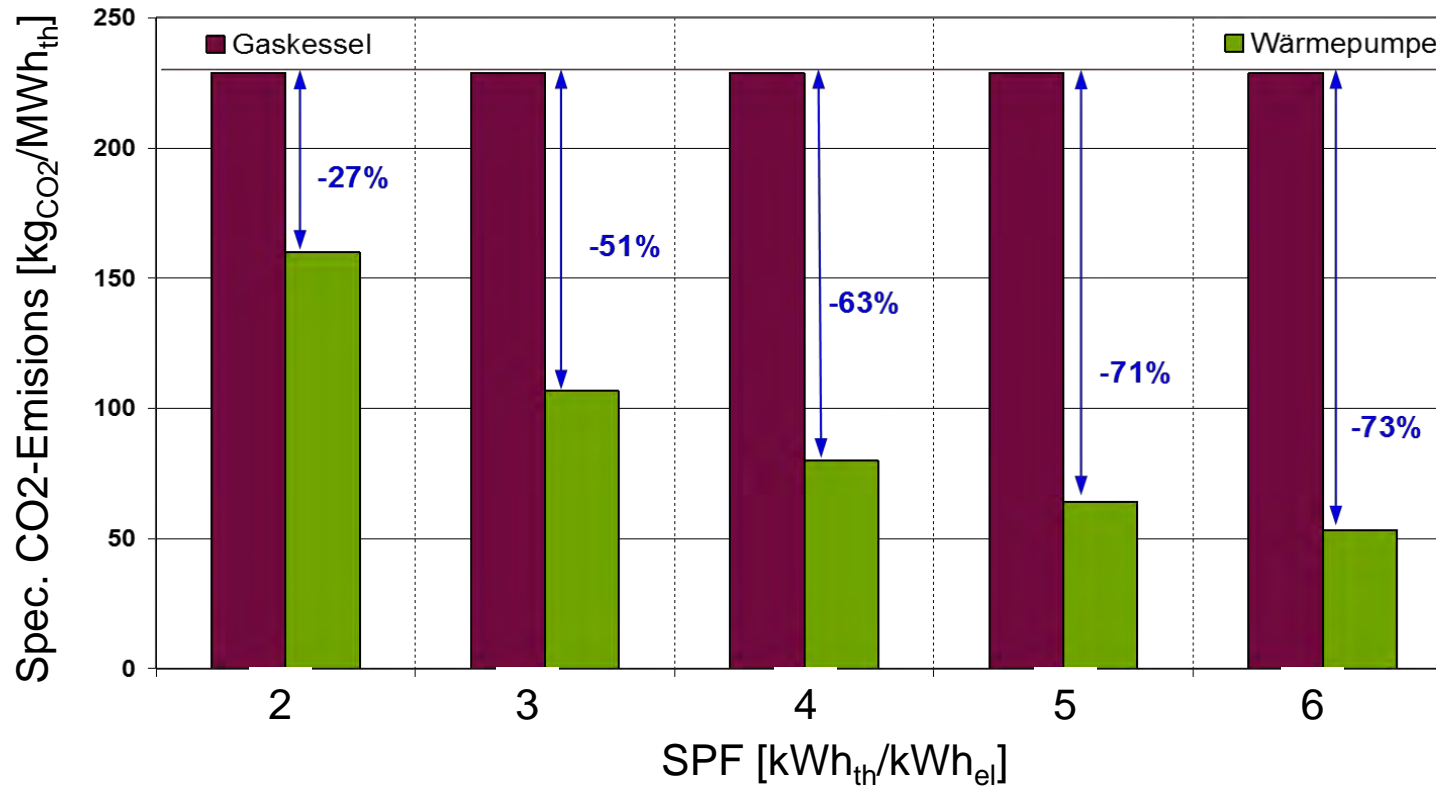


CO₂ Emissions

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

Efficiency:

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



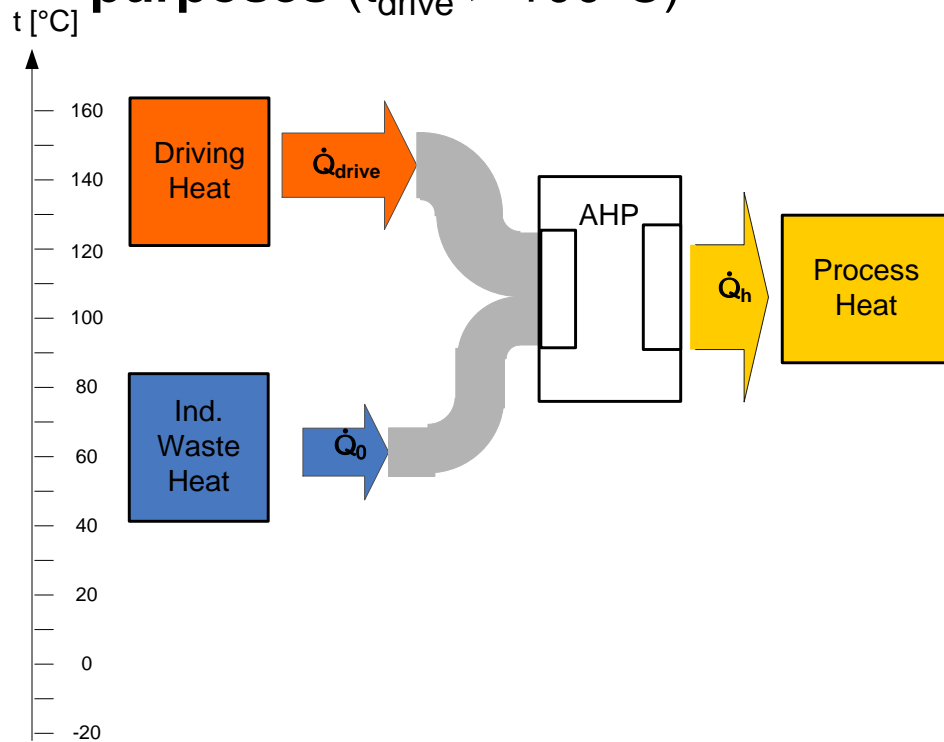
Assumption:

$\eta_{\text{gas}} = 85\%$
 320 gCO₂/kWh_{el} (KPC, 2011)

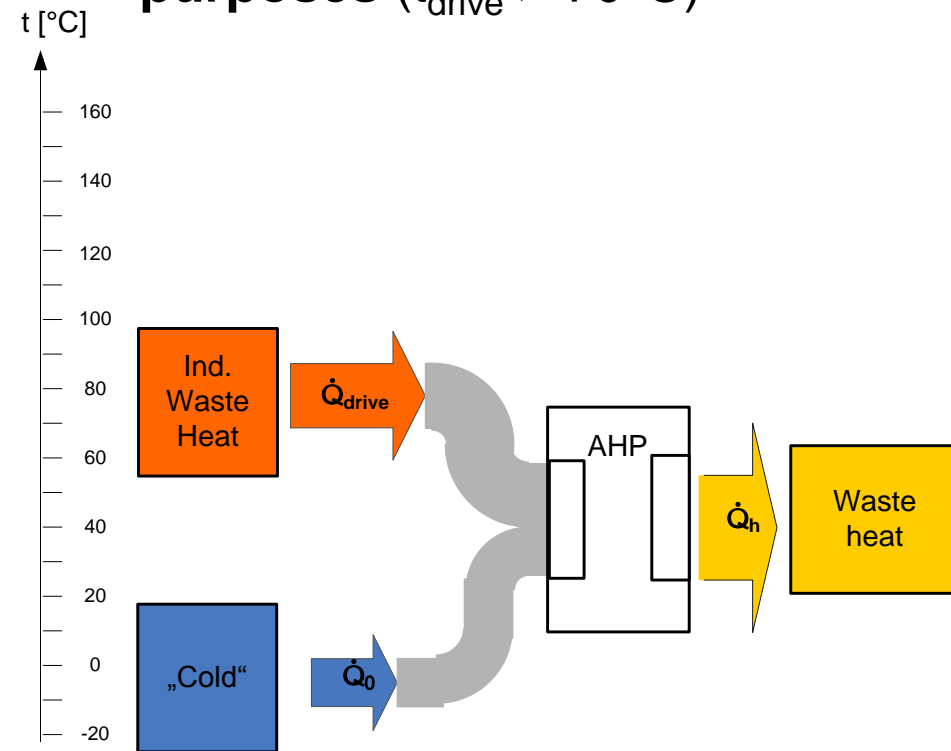
Absorption Heat Pumps in Industry

various application possibilities for

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



using **waste heat for cooling purposes** ($t_{\text{drive}} > 70^\circ\text{C}$)



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**

Compression heat pump in in a brewery:

- NH₃ Compression HP (COFELY)
- 370 kW heating capacity
- Waste heat from:
 - + air compressor
 - + chillers
- Heat upgrade from ca. **40 to 77°C**
- Space and process water heating
- ROI: 5.7a

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**

- ROI: 7.9 a
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)

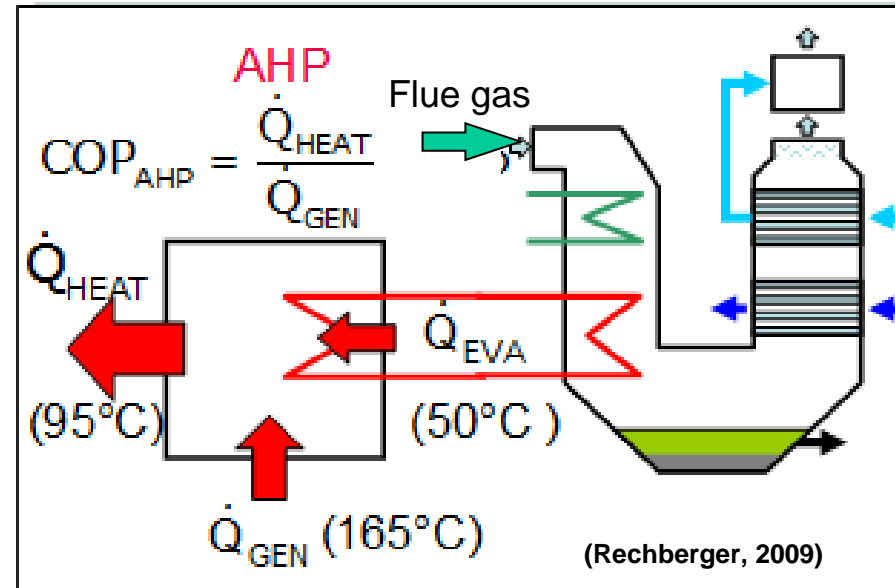
- **Biomass co-generation plant**
 - $30 \text{ MW}_{\text{th}}$
 - 5 MW_{el}



- **$\text{H}_2\text{O}/\text{LiBr}$ – 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)

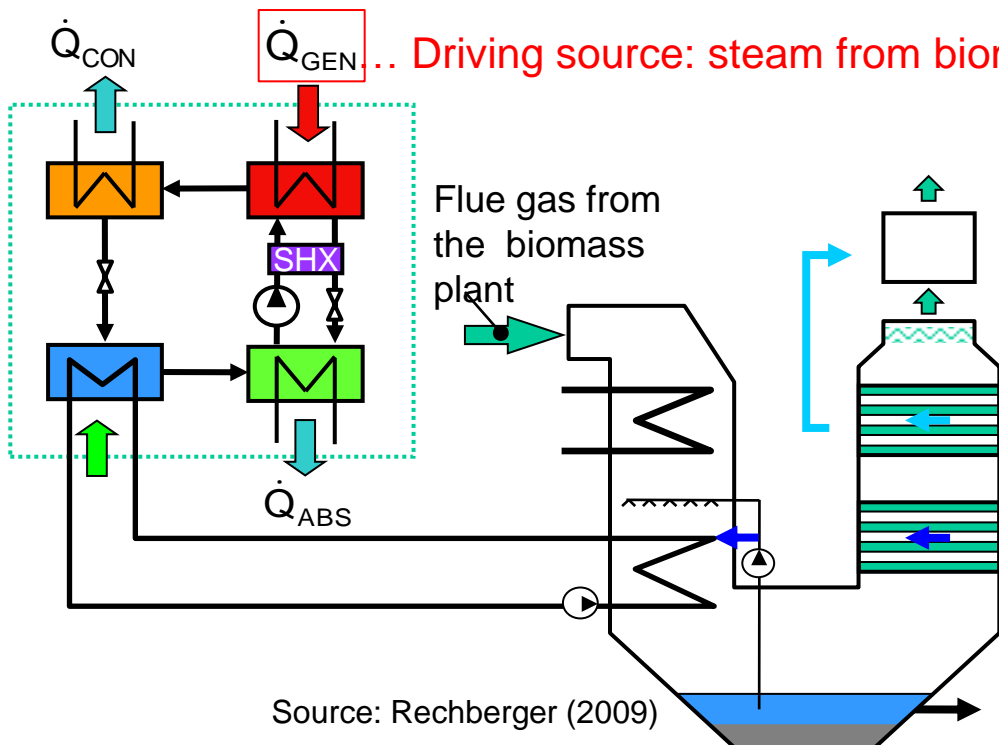
Basic concept of heat extraction by means of an AHP



- 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
- 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

+ 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 CO₂ 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

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”.



Many Thanks to  **AIT** AUSTRIAN INSTITUTE OF TECHNOLOGY

Thank You!

PS: Further information can be found via

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

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