EFFICIENT PROCESSES WITH WASTE HEAT RECOVERY

106 EJ industrial energy consumption worldwide (2012)

52 EJ = 49% utilization

54 EJ = 51% losses
waste heat in waste water and off-gases, radiation, friction, resistance, etc.

INDUSTRIAL HEAT PUMPS IN AUSTRIA

64 CASE STUDIES

- Food industry: 17
- Food trade: 2
- Fruit juice: 3
- Milk processing: 3
- Deep freeze food: 3
- Bakery: 2
- Brewery: 2
- Meat processing: 3
- Utility: 11
- Health and tourism: 7
- Administration: 6
- Construction industry: 1
- Automotive industry: 2
- Plastics industry: 2
- Wood industry: 2
- Pulp and paper: 1
- Electronics: 5
- Metal industry: 10
HEAT SOURCES AND SINKS

**Heat sources**
- Ambient: 2
- Flue gas condensation: 12
- Geothermal heat: 2
- Heat recovery: 9
- Process cooling: 26
- Waste heat chillers/air compressors: 10
- Seasonal storage: 3

**Heat sinks**
- Process heating and others: 5
- Process heat: 4
- Hot water supply: 3
- District heat: 19
- Building heating: 33
COMPRESSION HEAT PUMPS

source 20°C  source 30°C  source 40°C  source 50°C

source 10°C

source ≤10°C

source 11-20°C

source 21-30°C

source 31-40°C

heat supply temperature, °C

coefficient of performance

30 40 50 60 70 80 90 100

2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0
Heat pumps with a COP of 3.5 – 5.5…

- reduce CO₂ emissions by 70-81 %

- reduce energy costs by 33-58 %
  (gas 3,4 ct/kWh, electricity 8,8 ct/kWh)

- reduce energy costs by 59-74 %
  (gas 3,4 ct/kWh, electricity 5,4 ct/kWh)

compared to a natural gas boiler.
CARNOT EFFICIENCY

![Graph showing Carnot efficiency vs. temperature lift, K. Different symbols represent different refrigerants: NH3, R134a, R1234ze, R236a, R245fa, R410A.](image)
APPLICATION EXAMPLES
METAL INDUSTRY + DISTRICT HEAT

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](http://www.energie-graz.at/energie/fernwaerme/projekte/reininghaus), 10.05.2017
Unger, H., 2018, Energiemodell Reininghaus – Abwärmeauskopplung Marienhütte durch Energie Graz, Technischer Kurzbericht
BIOMASS PLANT + DISTRICT HEAT

Biomass cogeneration plant Klagenfurt East
• Bioenergie Kärnten
• SOLID
• Riegler & Zechmeister

Absorption heat pump with a total heating capacity of 20 MW (Ebara, installed in 2017)

• Heat source: Flue gas condensation, 45/35°C
• Heat sink: district heating, 60/70°C
• Driving temperatures: 130/120°C

Photo: https://www.solid.at/de/referenzen/absorptionswaermepumpe
Link: www.bioenergie-kaernten.at
Production of meat and sausages

• F. Krainer
• AMT Kältetechnik GmbH

CO₂ heat pump since 2018, cooling capacity 600 kW, heating capacity 800 kW

• Heat source: brine to cool products and raw materials, -6°C
• Heat sink: hot water for cleaning purposes, 60°C

POTENTIALS
INDUSTRIAL HEAT DEMAND

Energy carriers for industrial applications, 2016

WASTE HEAT IN INDUSTRIAL PROCESSES

### PROMOTING AND INHIBITING FACTORS

<table>
<thead>
<tr>
<th>endogenous</th>
<th>exogenous</th>
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<tr>
<td><strong>promoting</strong></td>
<td><strong>inhibiting</strong></td>
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<tr>
<td>• subsidies for commercial sector</td>
<td>• insufficient networking among manufacturers, planners and users</td>
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<td>• pilot and demonstration plants for innovative concepts</td>
<td>• low level of awareness of the technical possibilities and economic feasible application potential</td>
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<td>• high efficiency of industrial processes with waste heat recovery</td>
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CONCLUSIONS

- about 70 examples for industrial heat pumps in Austria
- food industry
  - simultaneously heating and cooling
  - heating capacity in the range of several 10 – 100 kW, mostly internal heat consumption (space heating)
- power plants that supply district heat
  - flue gas condensation
  - absorption and compression heat pumps
- industrial companies supplying district heat
  - usually in the MW range, supply temperatures of 60 - 95°C
- more efficient processes and considerable reductions in CO₂ emissions
THANK YOU!

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