Ipari folyamatok veszteség hője, mint energiaforrás

Waste heat from industrial processes as energy source

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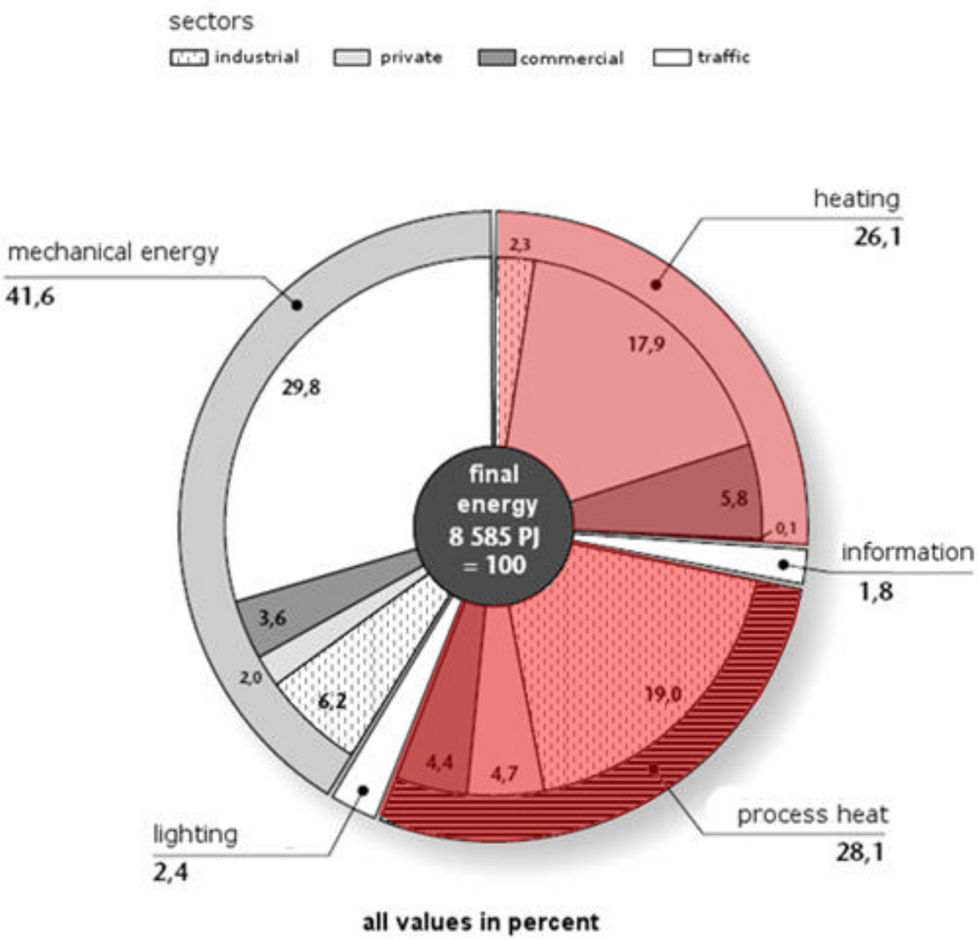
Waste Heat

Relevance of Waste Heat as Energy Source

Technical Solutions for its Re-utilization

Relevance of Heat as Final Energy

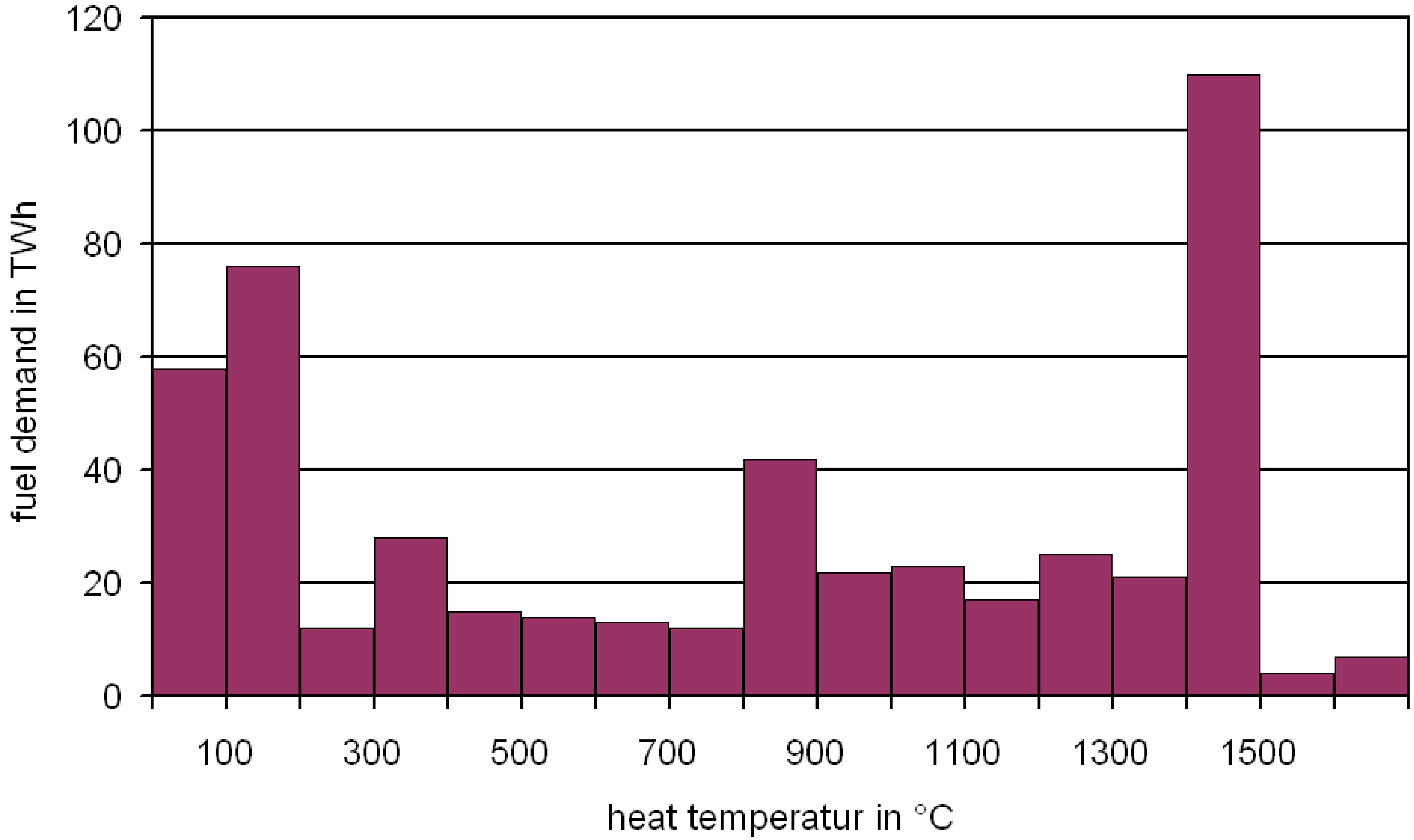


total amount of the final energy demand in Germany

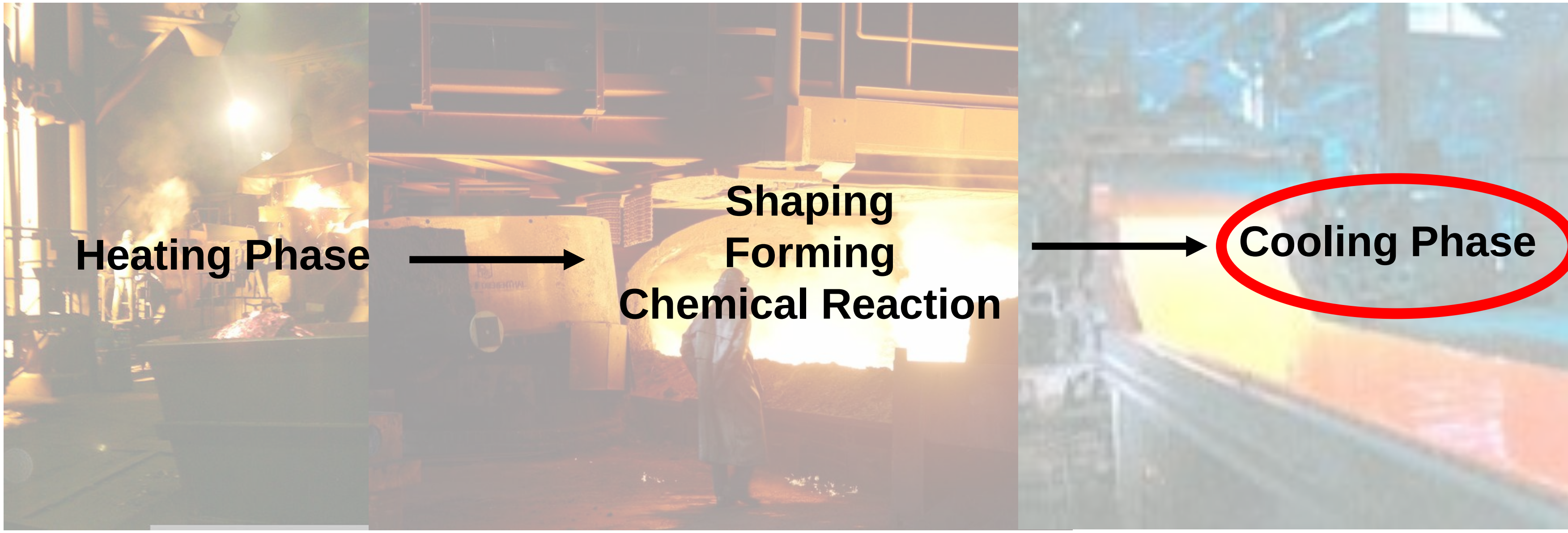
P. Tzscheutschler, M. Nickel, I. Wernicke, H.G. Buttermann: Energieverbrauch in Deutschland 2007 – Daten, Fakten, Kommentare; BWK; No. 6; 2009

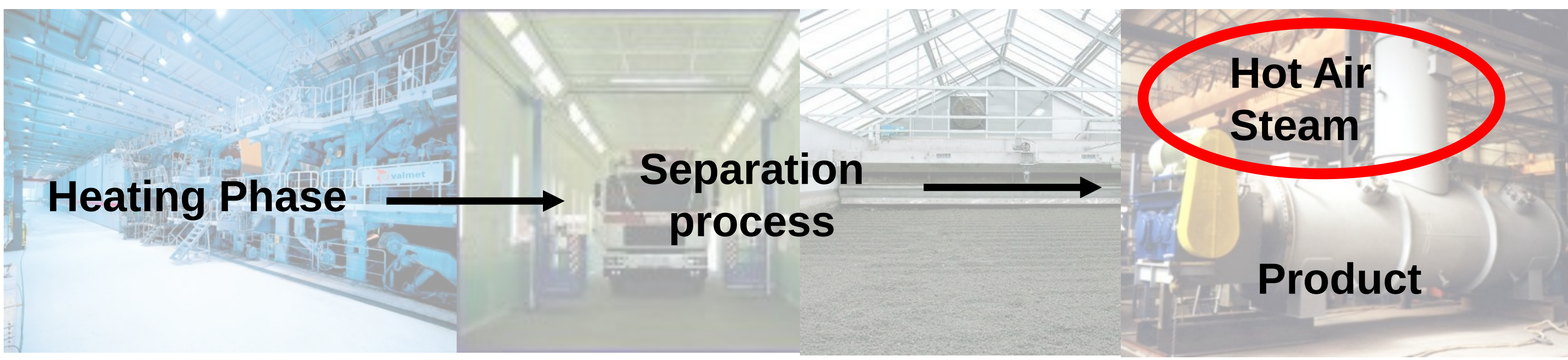
Relevance of Heat as Final Energy

Temperature level and required amount of process heat for industrial processes



Relevance of Heat as Final Energy





Possibilities for Waste Heat Utilization

Assessment of a heat source

- temperature level (50°C … 2.000 °C)
- heat quantity at a certain location
  (1 kW …. 1.000 MW, disperse … concentrated)
- temporal appearance
  unfrequent … frequent … permanent

Possibilities for Waste Heat Utilization

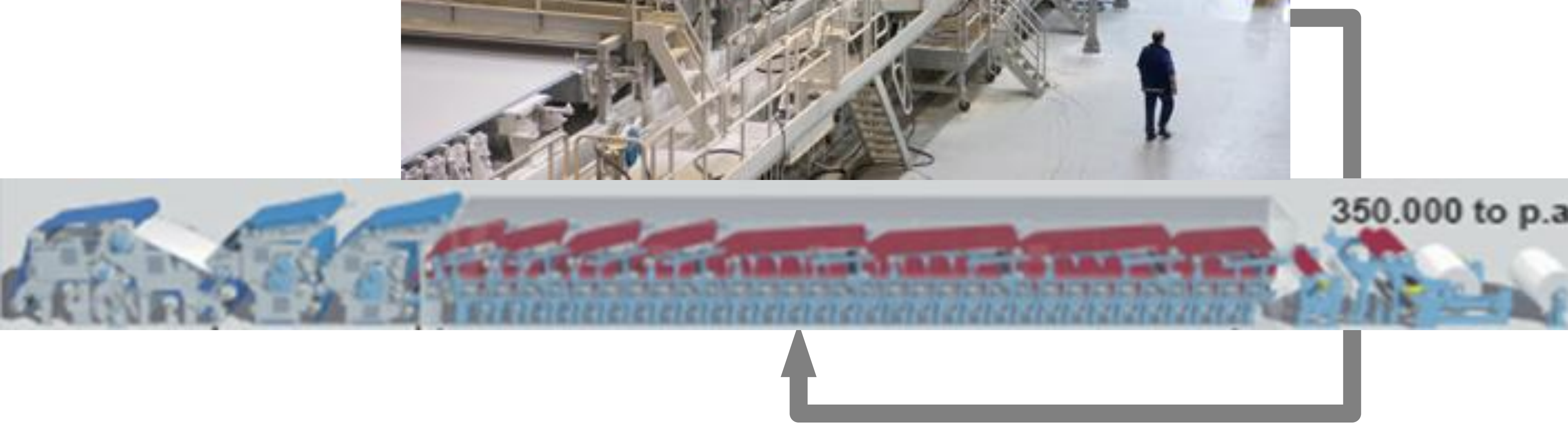
Excess Heat

- direct utilization as heat in or close by the process
- utilization as heat in other process within or outside the company
- conversion to electric power

Direct Heat Utilization

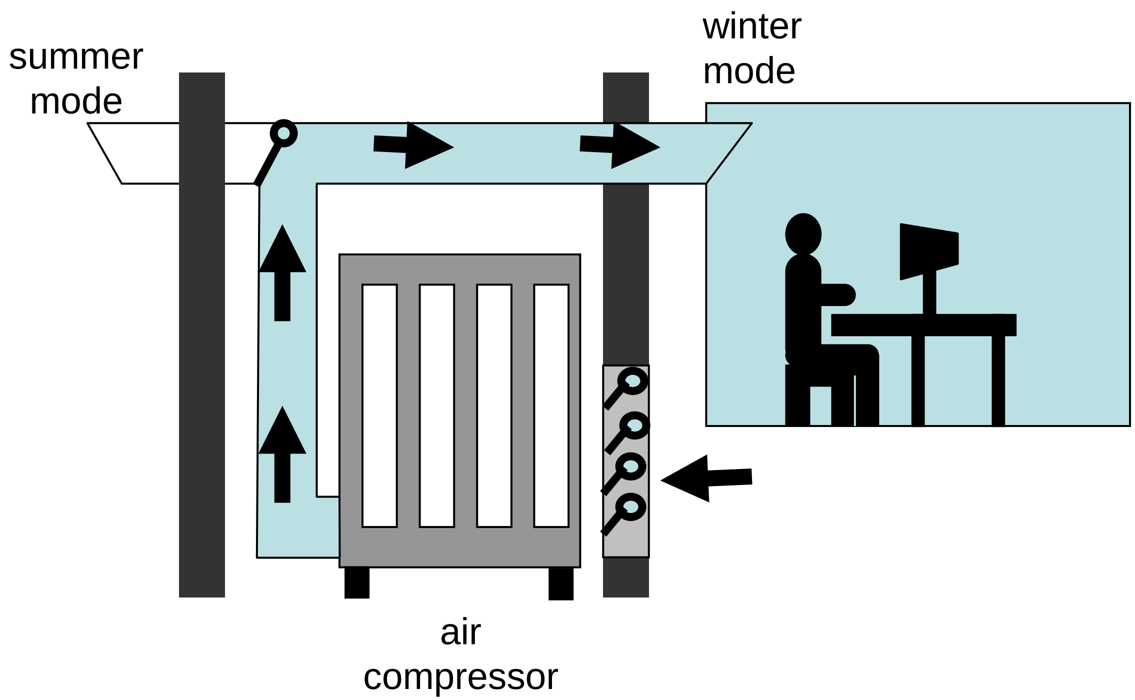
Direct Heat Utilization

Example 1:
Heat Recovery in a Papermachine



Direct Heat Utilization

Example 2:
Heat Recovery
from
air compression
for
heating purposes



Direct Heat Utilization

Advantages

- temporal and local fit of heat demand and supply
- the energy stays in the process/company

sink and source are in the same area of responsability

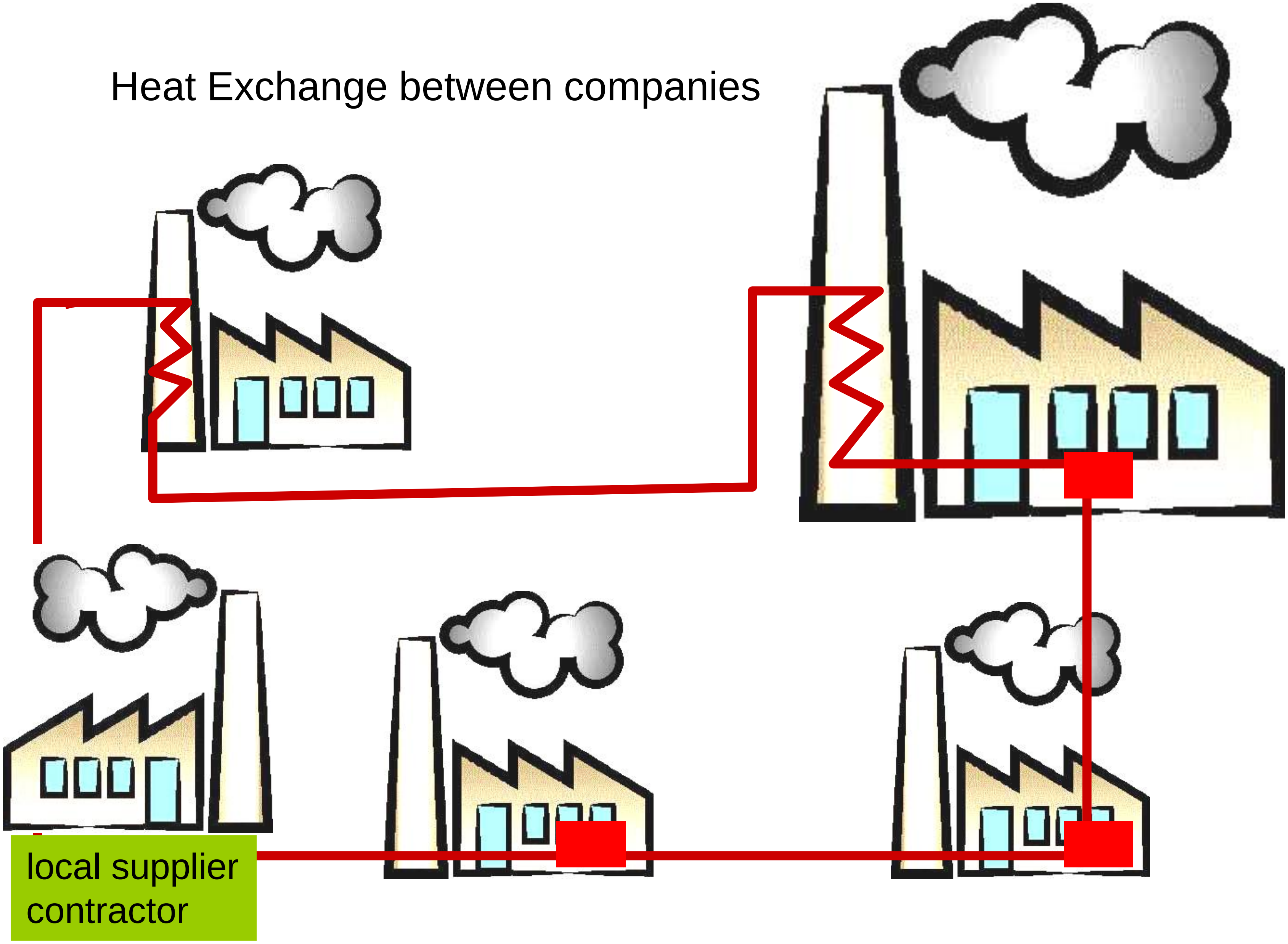
no financial compensation

Disadvantage

- no heat sink is available
- the temperature difference from source to sink is high

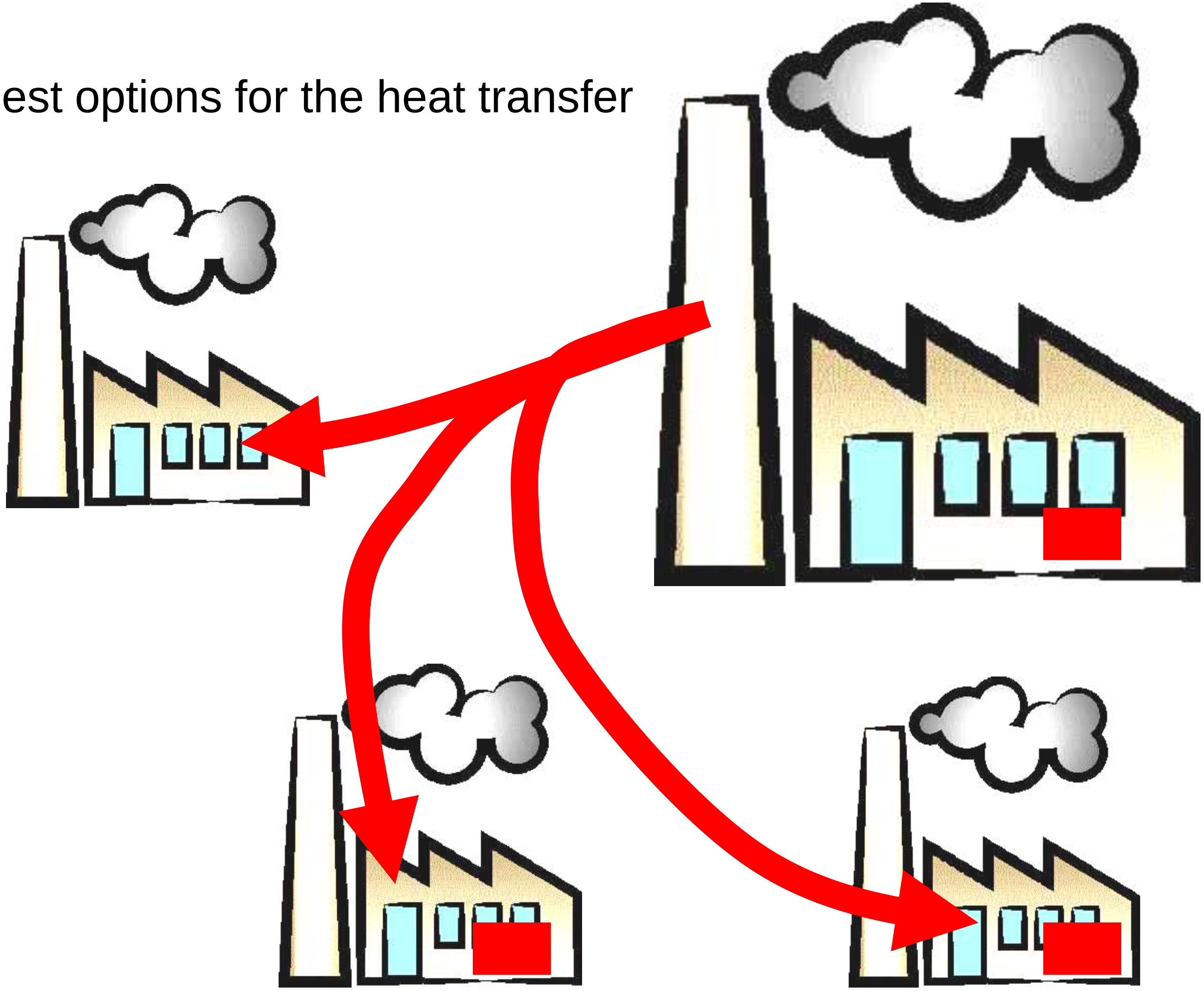
External Heat Utilization

Heat Exchange between companies



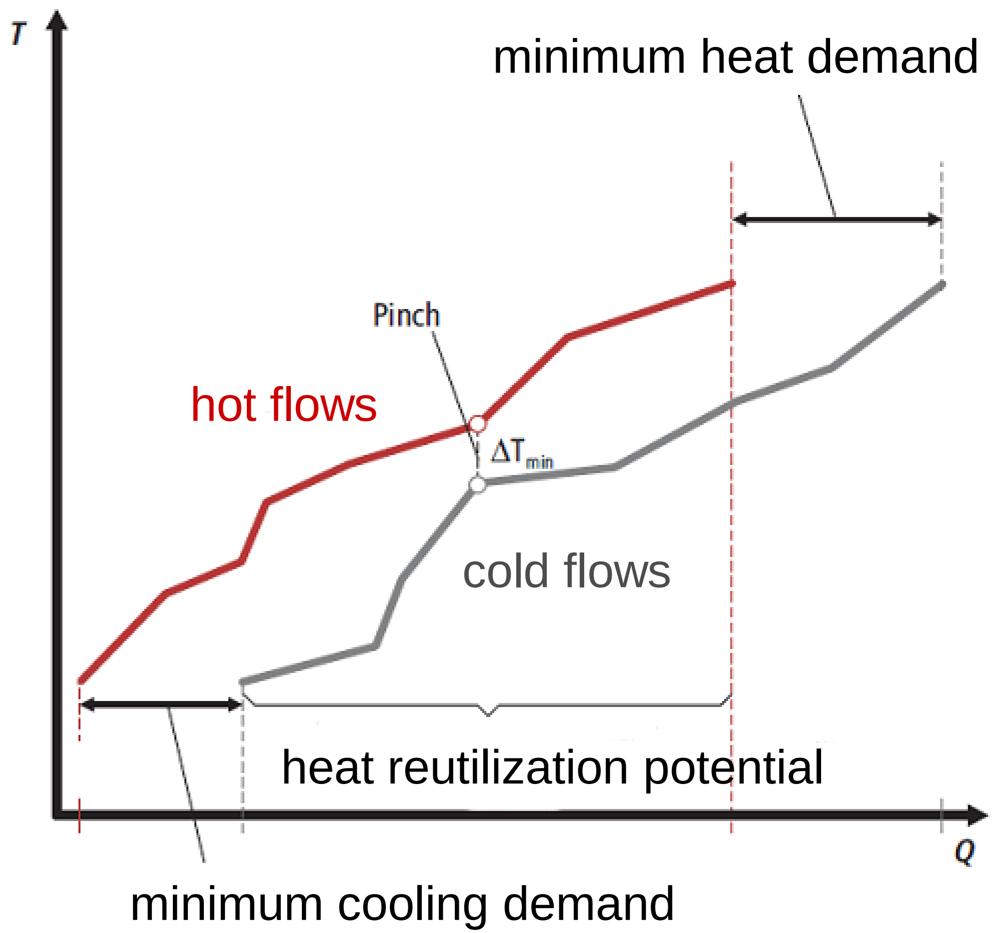
External Heat Utilization

Best options for the heat transfer



External Heat Utilization

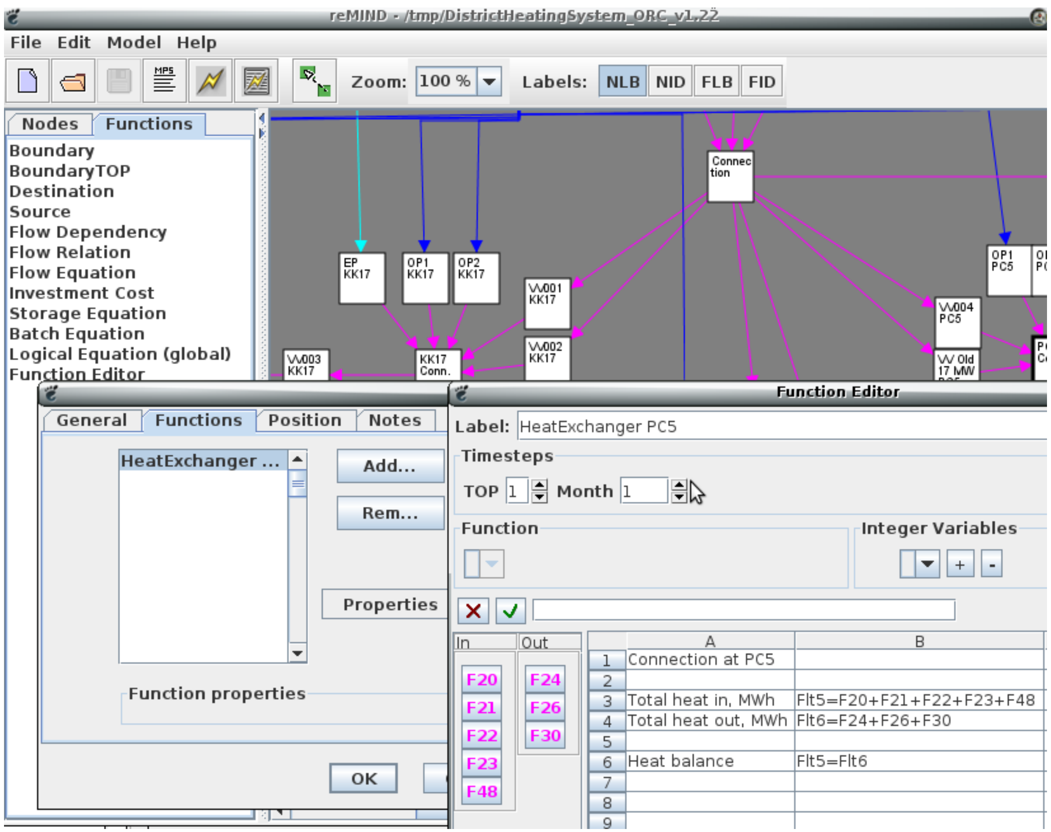
Pinch Analysis



The Pinch Methodology is a method to optimize the combination of complex heat sources and sinks.

External Heat Utilization

Numerical Optimization of Complex Energy Networks



Numerical optimization of sources and sinks
Example „reMind“

Karlsson M.: The MIND method: A decision support for optimization of industrial energy systems - Principles and case studies, Applied Energy, Vol. 88, No. 3, pp 577-589, Elsevier, 2011

External Heat Utilization

Advantages

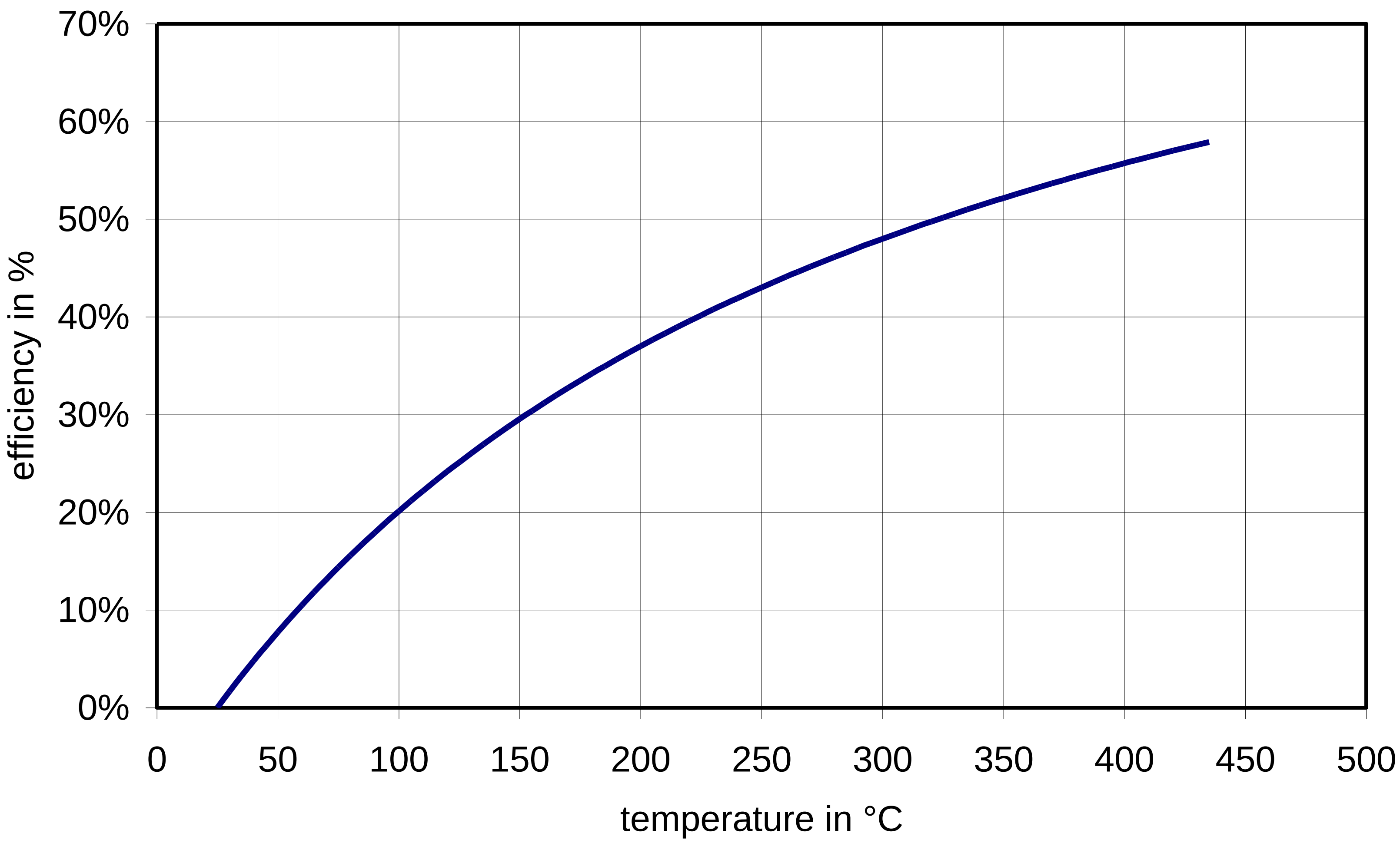
- **additional heat sinks**
- **possible reduction of the temperature difference between sources and sinks (= better utilization of exergy)**

Challenges

- **Demand and Supply might change due to economic frame conditions**
- **Financial settling of the exchange of energy between companies (taxes, …)**
- **People are required to think in the entire system, not only in their own processes.**

Conversion from Heat to Power

Theoretical, maximum efficiency (Carnot-Cycle)



Conversion from Heat to Power

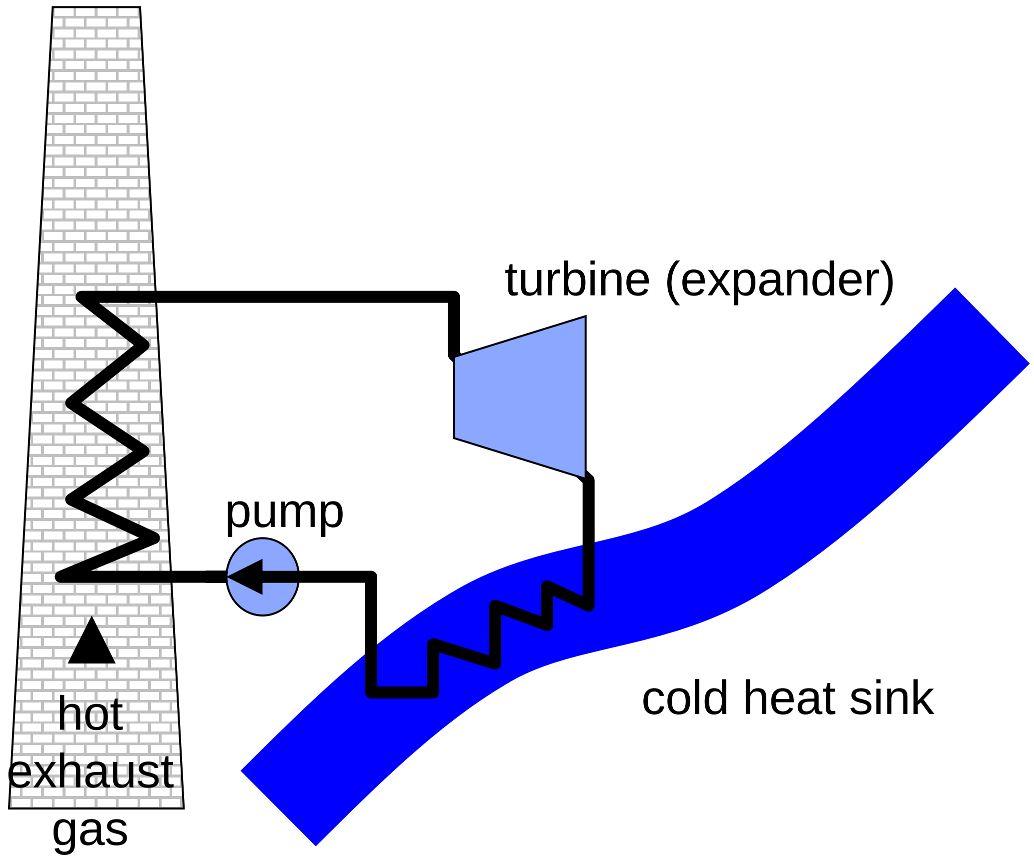
Technical Options

Direct Thermo-electric Conversion (Pelltier Effect)

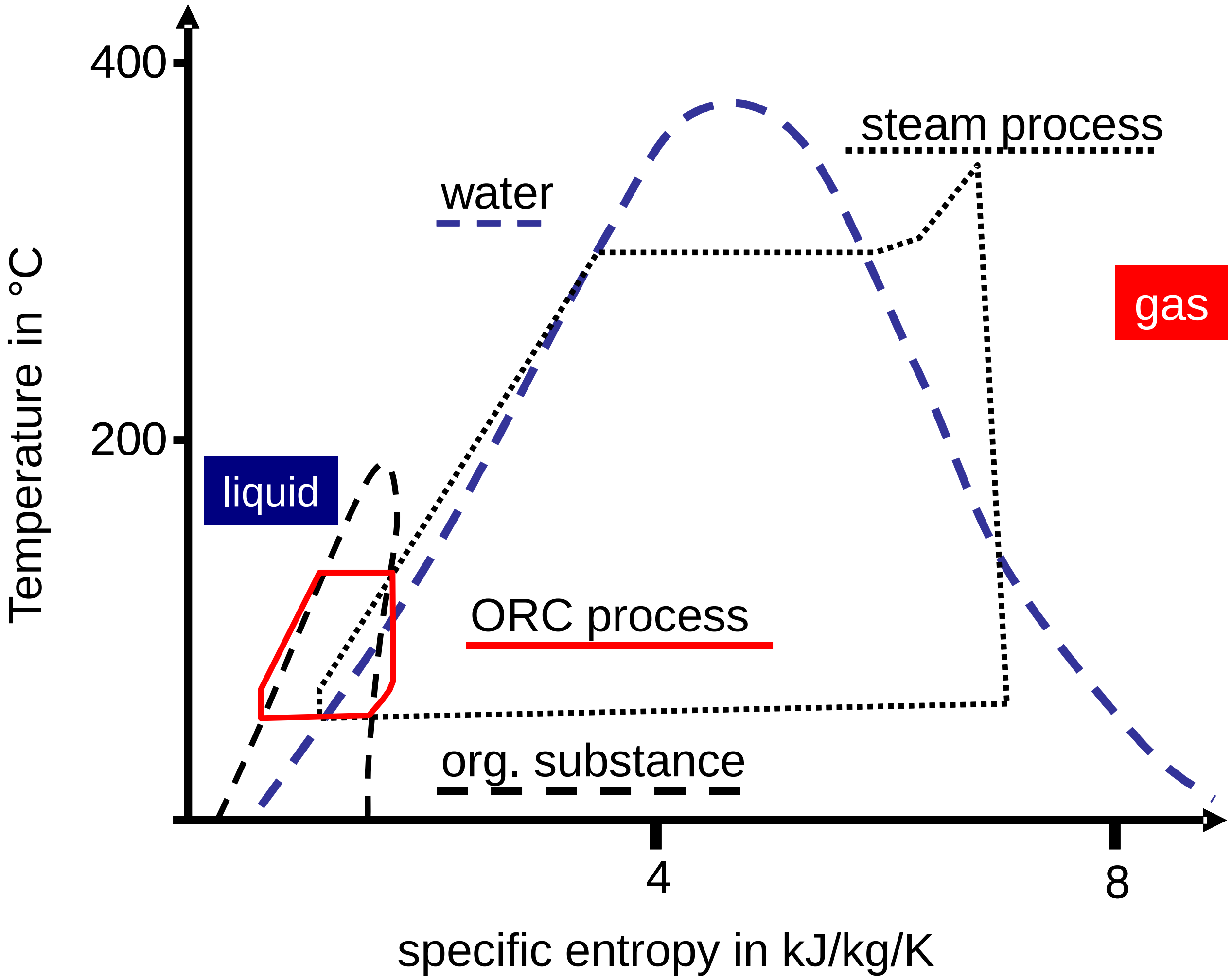
Thermodynamic Cycle

- **Steam Cycle (Clausius Rankine Cycle)**
- **Organic Rankine Cycle (ORC-Process)**
- **Kallina Cycle**

Conversion from Heat to Power



Conversion from Heat to Power



Conversion from Heat to Power: ORC-Technology

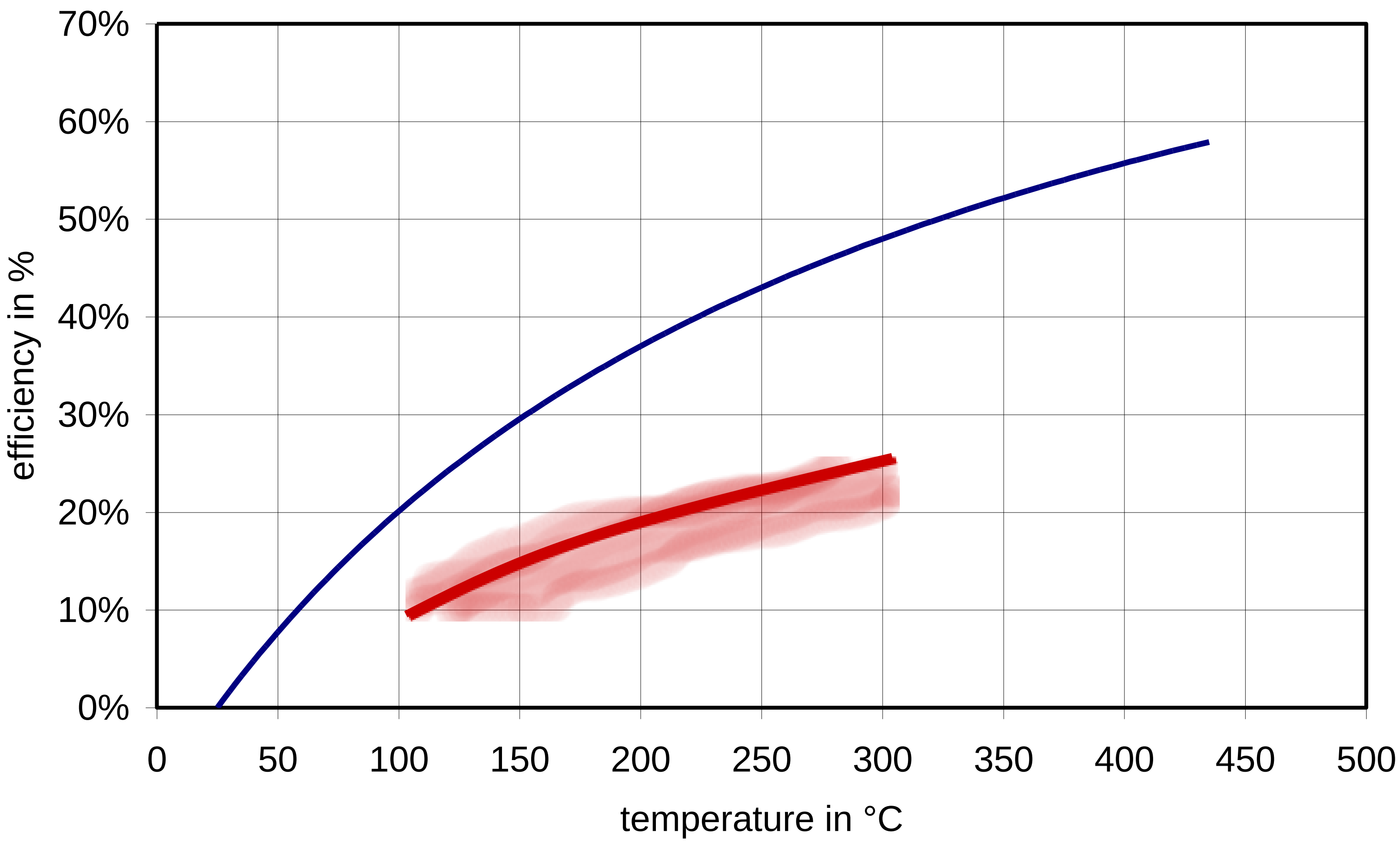
scaling up and down

Conversion from Heat to Power: ORC-Technology

	St. Anthony (USA)	RHI Radenthein (A)	Gerresheimer Essen Gmbh
			
commissioning	2006	2009	2010
spec. investment cost	2000 €/kW$_{el}$	5500 €/kW$_{el}$	k.A.
electric power	5,5 MW	1 MW	0,57 MW
heat source	**gas transfer station**	**industrial furnace**	**melting line glas production**

Conversion from Heat to Power

Theoretical, maximum efficiency (Carnot-Cycle) and real values



Conversion from Heat to Power

Advantages

- **heat re-utilization is possible in the case where no further heat sink is available**
- **technique itself has improved in respect of efficiencies and prices**

Challenges

- **A heat recovery for utization as heat in another process will always be first choice**

Future Perspective

→ the techniques for heat recovery and heat re-utilization are available and will be continously improved

→ Rising energy prices, decreasing amount of energy resources and further restrictions in respect of CO_2-emissions will force us to improve the utilization of excess heat

A change from process-orientation to system-orientation is required

Thank You!

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