Hall 8

CHILLVENTA

Chillventa Specialist Forums 2024
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CONNECTING EXPERTS.

ADDED VALUE OF INDUSTRIAL HEAT PUMPS

HOW MATHEMATICAL OPTIMIZATION TOOLS CAN SUPPORT HEAT PUMP INTEGRATION

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9.10.2024, Nürnberg

INDUSTRIAL TRANSITION – A NEED FOR CHANGE

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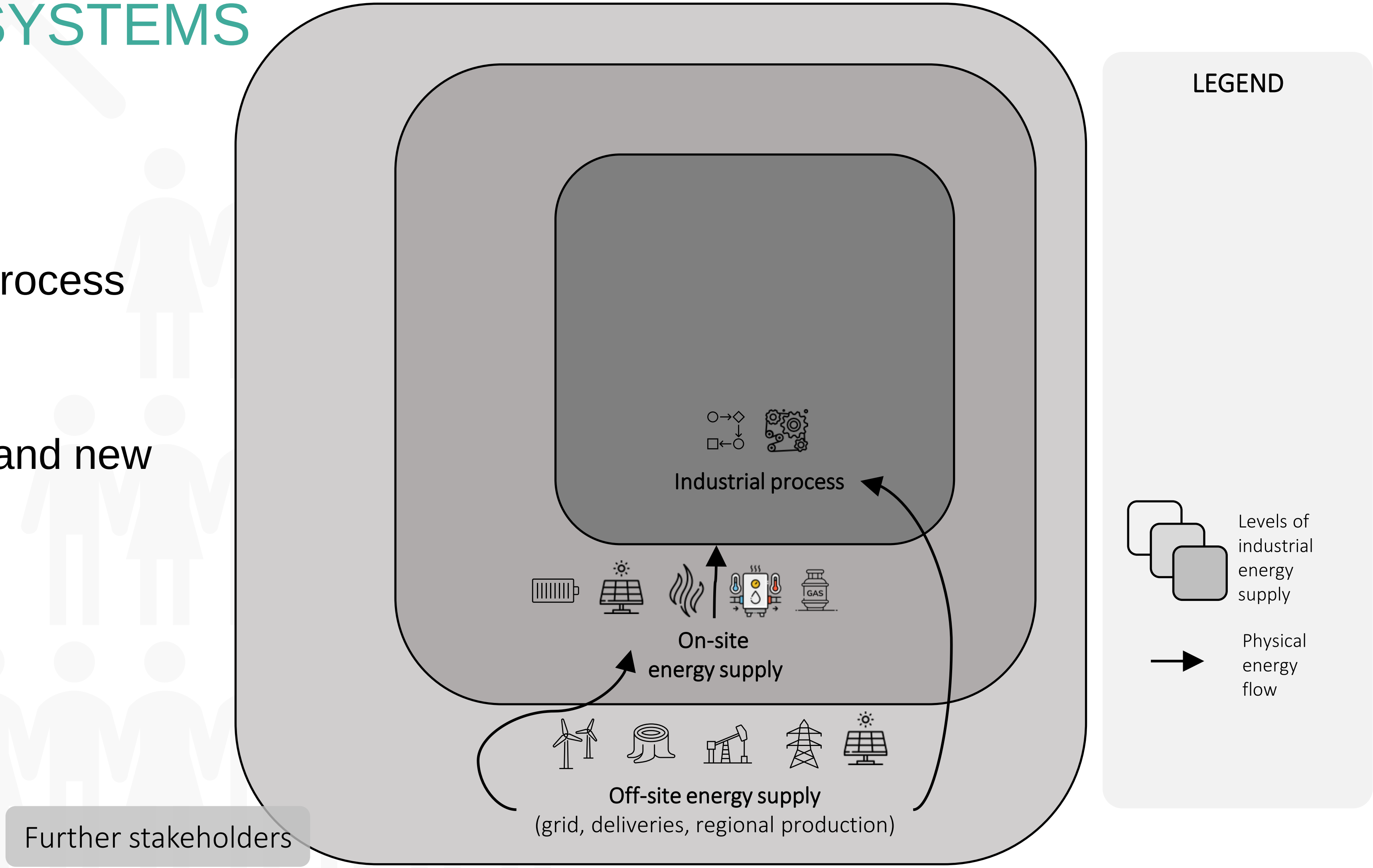
Challenges vs. opportunities

- Available and affordable clean energy as a prerequisite for a competitive industry
- New innovative technologies, e.g. industrial heat pumps

INDUSTRIAL TRANSITION OF ENERGY SUPPLY SYSTEMS

Increasing sustainability

- Requirements from core process and the outside world
- Established technologies and new components for supply
- Various strategies for decarbonization

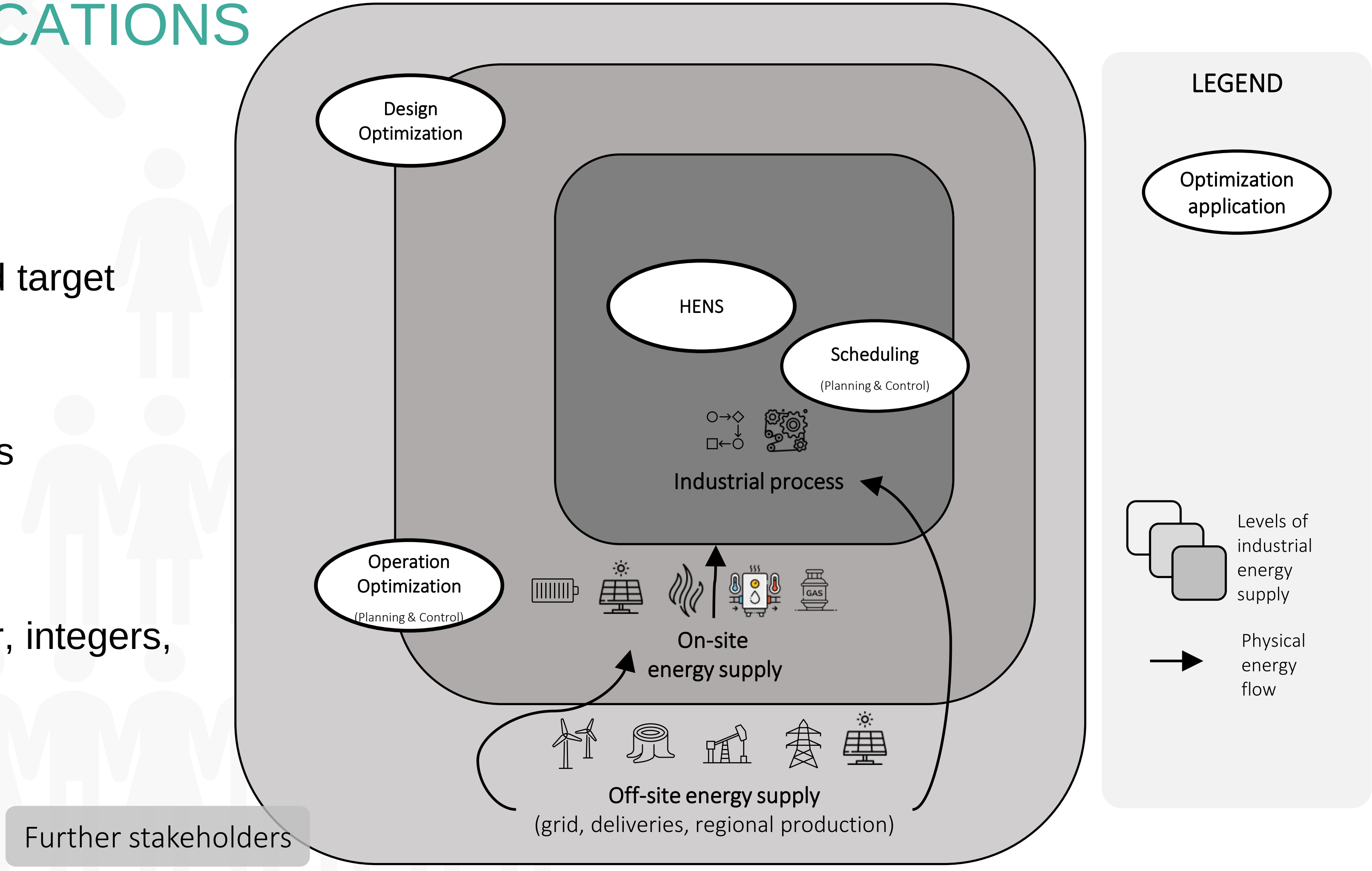


Knöttner (2024): Development of methods and componentes for future industrial energy supply with flexibility

MATHEMATICAL OPTIMIZATION FOR INDUSTRIAL APPLICATIONS

Relevant decision support tool

- Optimal solution for a defined target criterion under restrictions
- Various industrial applications
  - *What is modeled?*
- Model characteristics – linear, integers, heuristic, etc.
  - *How is modeled?*



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INDUSTRIAL TRANSITION - THE ROLE OF OPTIMIZATION

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Different tools to support decision processes

Increasing level of detail and accuracy →

Optimization models

Support for site conceptualization under technical, ecologic and economic frame conditions

Physical simulation models

Answering detail questions for subsystems and components

Detail engineering

Design of main and auxiliary equipment (piping, heat exchangers, etc.)

← Increasing size of considered system and interdependancies

MATHEMATICAL OPTIMIZATION FOR INDUSTRIAL APPLICATIONS

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Support to answer questions such as…

How can the industrial energy supply be decarbonized – partly or fully?

How can heat pumps contribute to industrial decarbonization and where does a heat pump provide the greatest added value in the production?

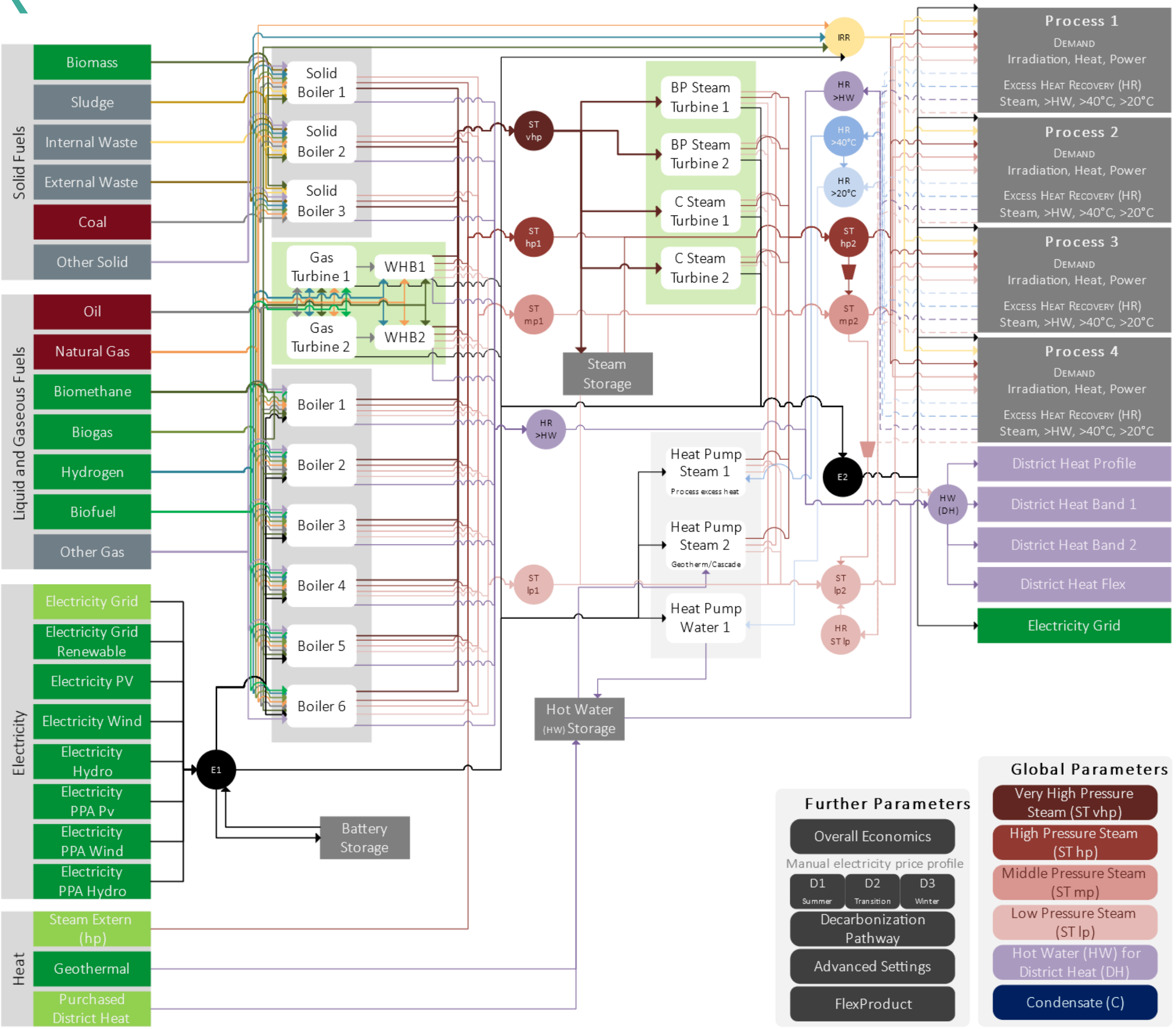
Which temperature level should be supplied by the heat pump and at which level shall excess heat be recovered?

How can fluctuating demand requirements be fulfilled best?

INDUSTRIAL USE CASE
PULP AND PAPER SECTOR

Optimization model with graphical user interface

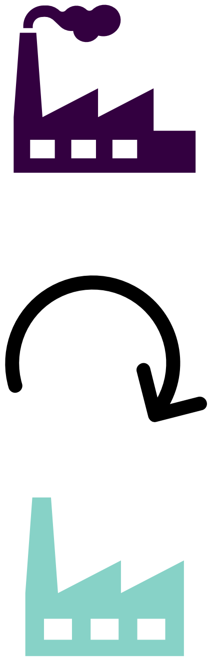
- ✓ A **user-friendly** but a still representative tool - simplified but applicable **for non-optimization experts**
- ✓ **Customizable** - realized with company specific user profiles and options to specify, parametrize and save specific configurations
- ✓ Initially configured for paper factories, also suitable for other types of production sites of this sector
- ✓ Technologies and fuels are chosen based on **current supply concepts** in the paper sector and **possible adaptions**



HEAT PUMPS IN THE PULP AND PAPER SECTOR

Insights from the optimization tool

- Heat pumps would mainly substitute boilers and combined heat and power plants in this sector with high capacities (>10 MW_{th})
- The economically driven integration of heat pumps is highly impacted by
  - Energy prices (e.g. ratio between fuel and electricity)
  - Process parameters (steam pressure and temperature)
- Heat pumps are typically part of cost-efficient, decarbonized energy supply systems under frame conditions such as
  - Sufficient power consumption capacity from the grid
  - Absence of (biogenous) residual energy carriers from production (e.g., sludge, biogas, residues, etc.) and external waste



IMPACT OF INDUSTRIAL HEAT PUMPS

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Examples from different sectors

Pulp & Paper

Sources humid air, wastewater, environment

Sinks drying section (steam)

Success Stories

- ✓ 80-100% CO_2 reduction possible with heat pumps
- ✓ Primary energy reduction of up to 60%

Food

Sources excess heat (chillers), wastewater

Sinks washing, cooking, drying (water, steam)

Success Stories

- ✓ Up to 50% CO_2 reduction with heat pumps economically viable
- ✓ Payback time 7-8 years

Textile

Sources humid air, wastewater, environment

Sinks drying, washing (water, steam)

Success Stories

- ✓ Up to 70% CO_2 reduction possible with heat pumps and simultaneous reduction in operational costs

CONCLUSION

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Optimization as decision support

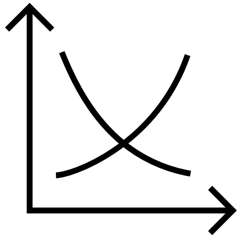
Applicability of optimization for heat pump integration is exemplarily shown for the paper sector

PREREQUISITE for OPTIMIZATION

- Detailed site analysis to set up comprehensive (design) optimization models

ADVANTAGES of OPTIMIZATION

- Understanding of interactions and dependencies in (decarbonized) energy supply systems
- Identification of beneficial heat source and sink combinations
- Simultaneous consideration of technical, economical and ecological criteria



THANK YOU!

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