Fraunhofer UMSICHT

Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT

Knowledge Sharing Workshop - CETP TRI 1 + 6 Flexibility in Industry

ISSDemo: Integrability of high temperature thermal storage for steam in different industries

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Outline

ISSDemo Project

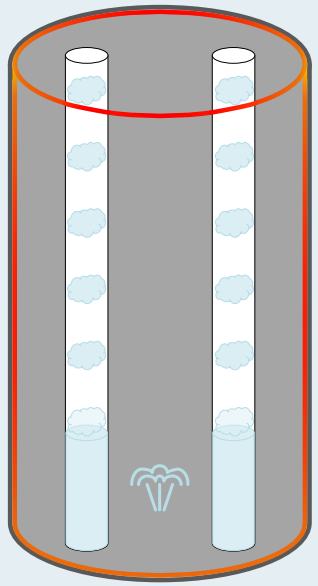
Metal-based Latent Heat Storage

Project Aims

The main project goal is to demonstrate the efficiency and functionality of a thermal energy storage device for high temperature applications (250 °C – 500 °C) and the production of process steam for various industrial applications. The project result will be implementation and demonstration of the technology in an industrial process steam application with a capacity of about 1 MWh. The unit will operate for at least 300 cycles in at least 1,000 operational hours.

Metal-based latent heat storage

- Testing of different alloys with melting temperatures between 250 °C – 500 °C
- Direct steam production
- TRL 5 to 7
- Charging via electricity



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BUILD TO ZERO

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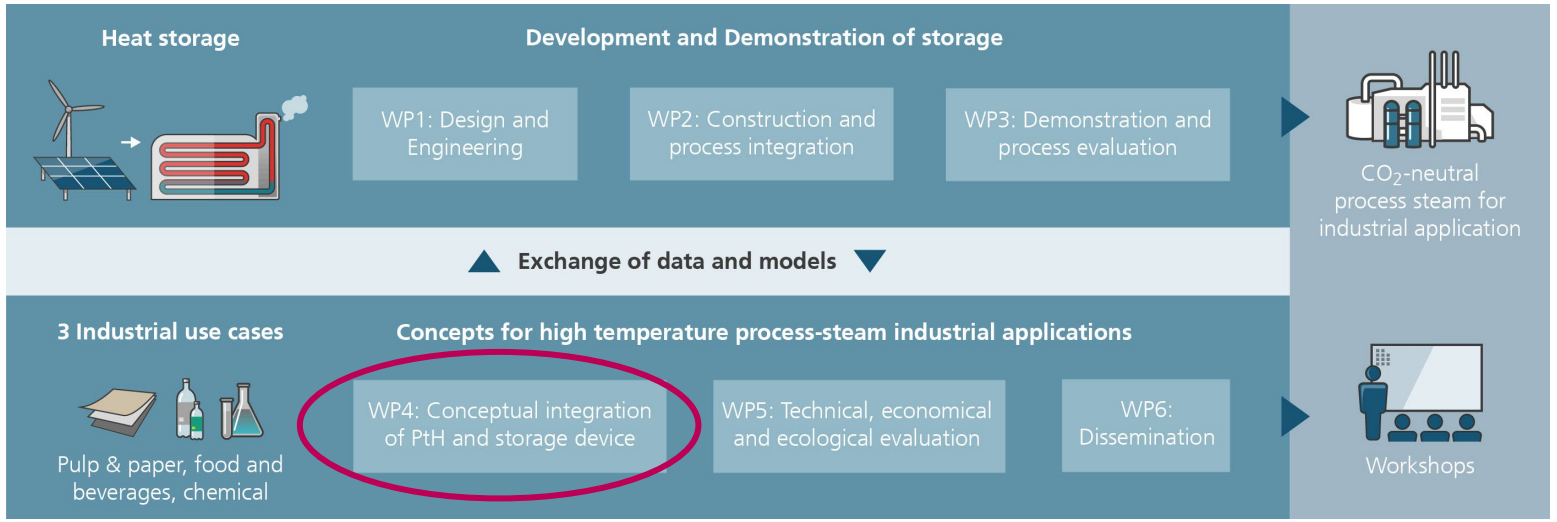
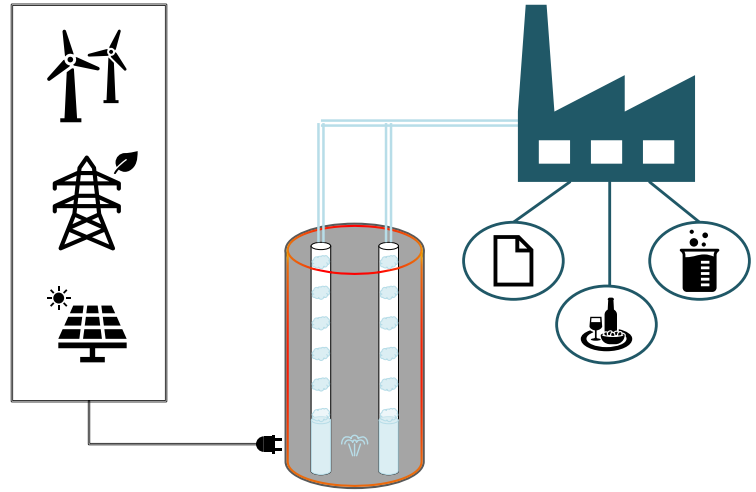
cet Partnership

Co-funded by the European Union

ISSDemo Project

Project Brief – WP 4





WP 4
Conceptual integration of PtH and storage device in three industrial use cases: Pulp & paper, food and beverages, chemical.

Industrial use cases
Modelling a generic industrial energy system for the respective industries using real data and literature research.

Simulation
Modelling and analysing thermal storage in energy system using Modelica in Dymola

Exchange of data and models
Information exchange between storage development and industrial integration to develop and adapt the thermal storage.

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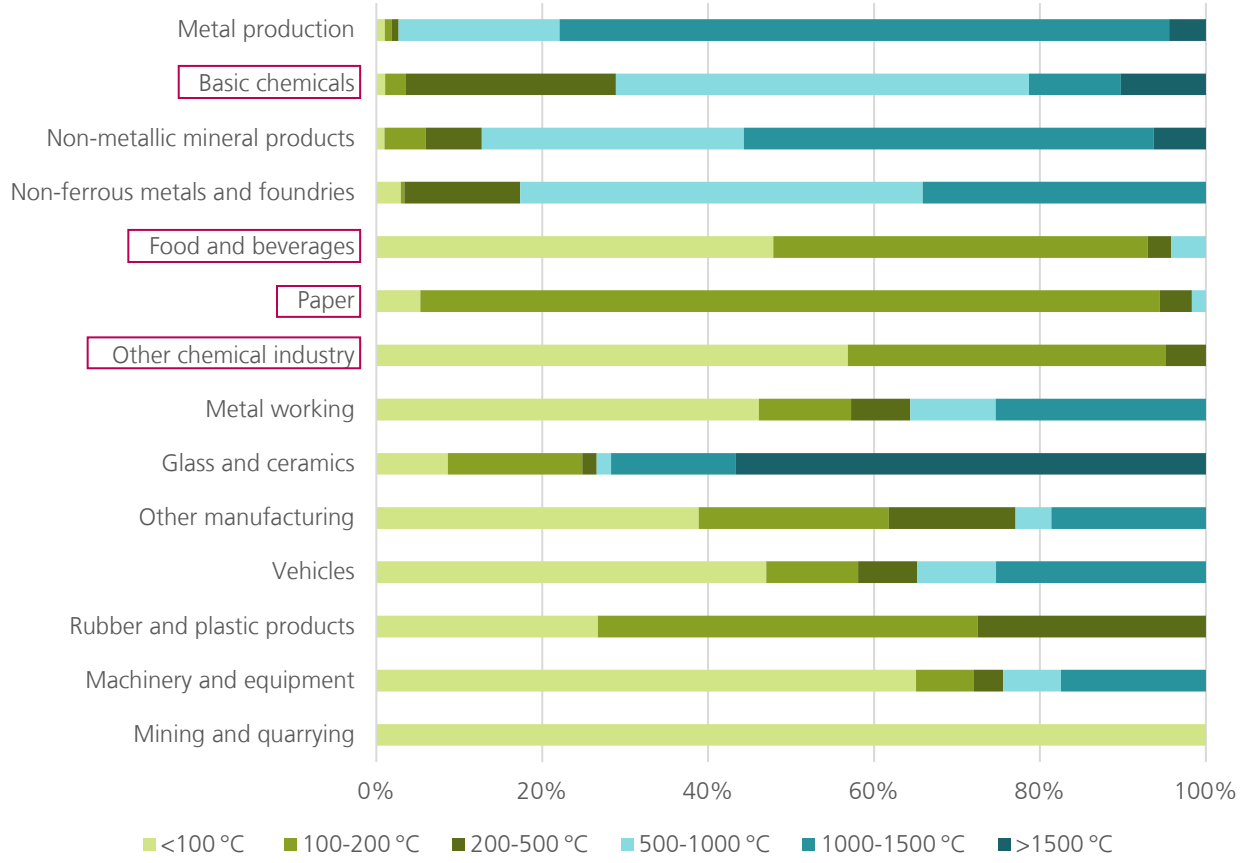
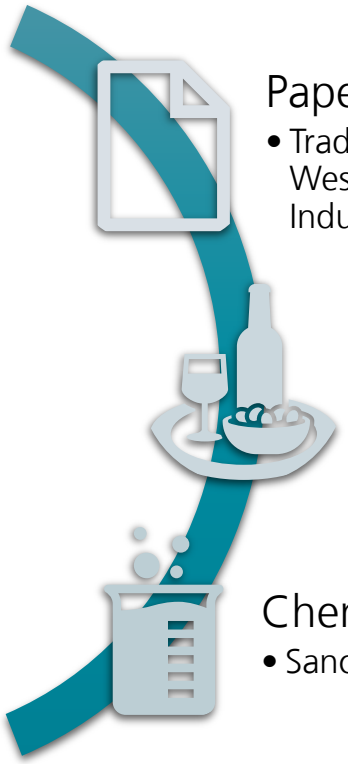
Outline

Latent Heat Storage for Industrial Applications

Overview of Industrial Sectors





Paper & Pulp

- Trade Association of the Rhenish-Westphalian Paper Manufacturing Industry e.V. from Germany

Food & Beverages

- Bitburger Brewery Group

Chemicals

- Sanok Rubber Company SA from Poland

Latent Heat Storage for Industrial Applications

Latent Heat Storage: Advantages for Industrial Integration

Latent heat storage

- Stores and releases the heat during phase change (melting/solidifying) from phase change materials (PCMs)
- Lower development status than sensible heat storages
- Different options of charging and discharging – ISSDemo storage will charge via electricity and store/generate steam

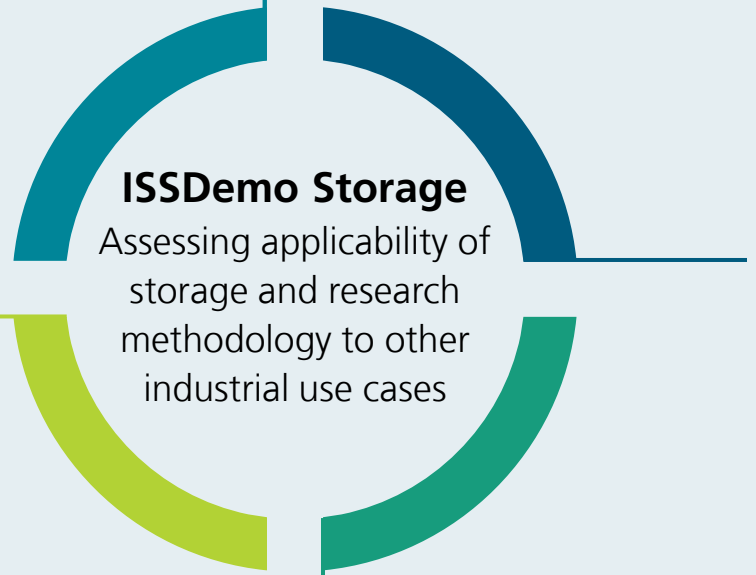
1. Process stability and efficiency due to constant temperature levels and constant steam pressure during discharging
2. Suitable for processes with limited space due to high storage capacity
3. Low energy losses due to minimal temperature differences between working medium and storage medium
4. Suitable for batch and steam processes: No definitive applicability of the different thermal storage options to the different industrial sectors. It depends on many things, such as temperature, processes, desired functionality, cost, etc.

Latent Heat Storage for Industrial Applications

Applicability to other Industrial Sectors

Steam Production
Other industries and processes requiring steam that use fossil fuels for steam generation: Drying, boiling, etc.

Temperatures
Match latent heat storage temperatures (250 - 500 °C) to industrial process temperatures: Chemicals, Food & Beverages, Paper, Rubber & Plastics, Pharmaceutical, etc.



Batch Processes
Beverage processes, dairy processing, pharmaceutical products (e.g. soap,biotech, etc.), other manufacturing

Renewable Energy Integration
Flexibility options after integration of renewable energy such as solar or wind

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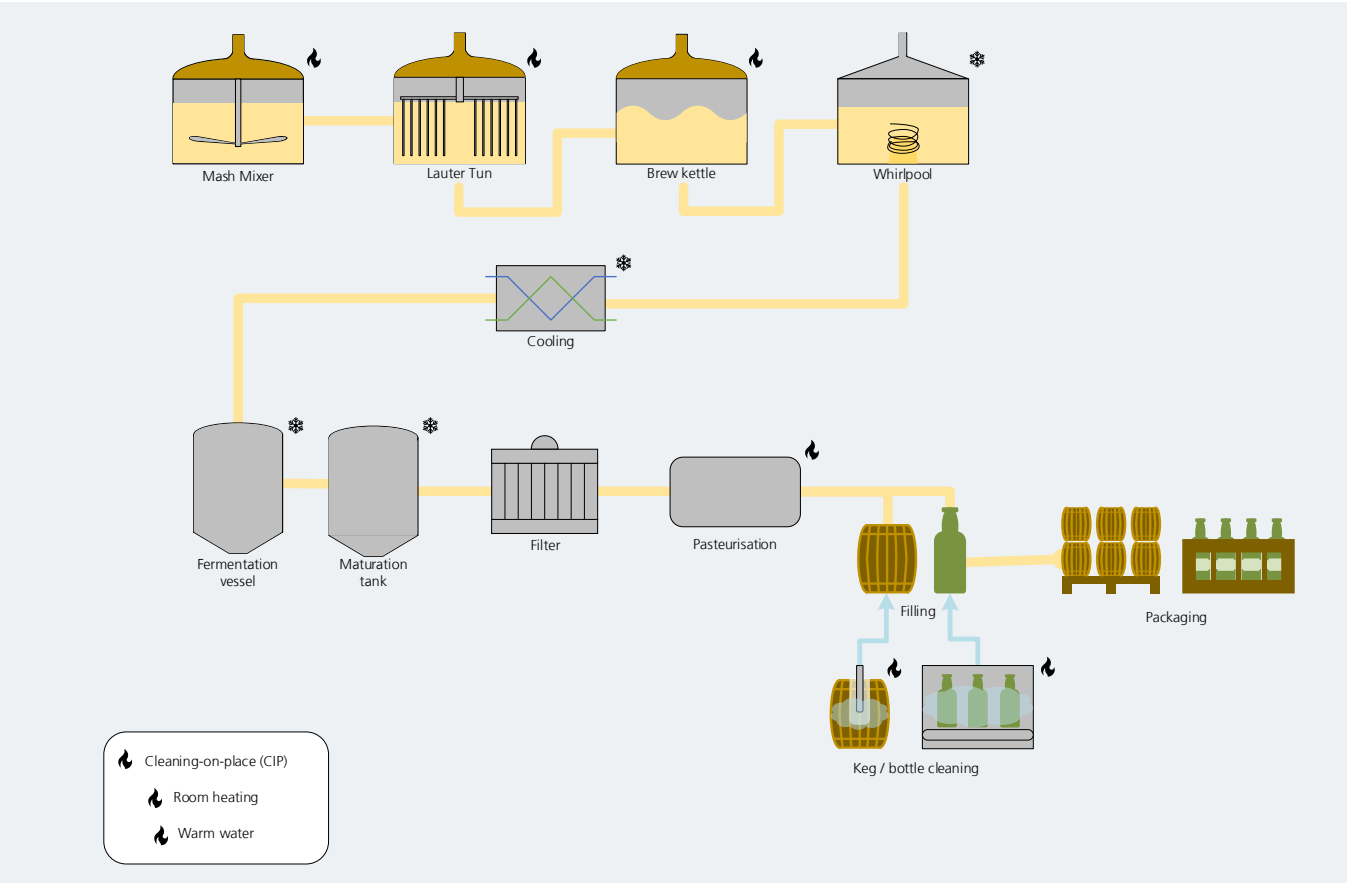
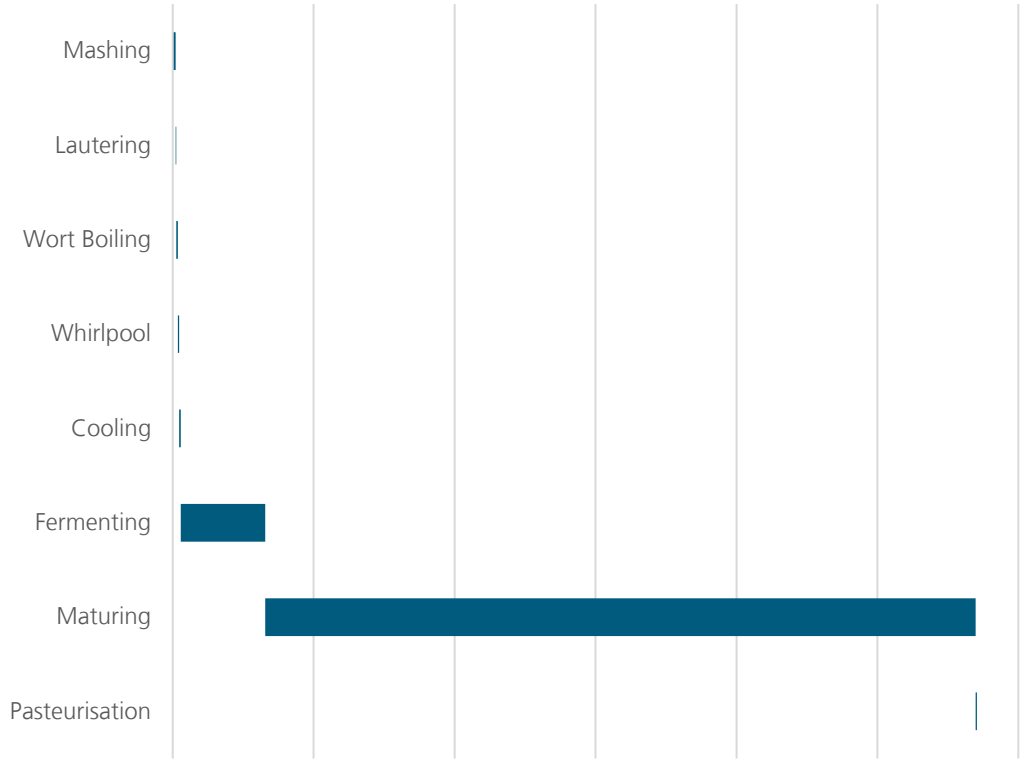
Case Study: Brewery

Brewery Process



Gantt-Chart Brewery Batch Process



Case Study: Brewery

Methodology: Brewery Energy System Simulation

1. **Phase 1, Case Study**
   Integration into Bitburger Brewery System
2. **Phase 2, Brewery Processes**
   Creating Generic Brewery Energy System
3. **Phase 3, Analysis**
   Simulations of Steam Storage in Generic Brewery System

Phase 2

Methodology for obtaining a generalised energy system for different industrial sectors using the example of a brewery with an existant data set.

Methodology

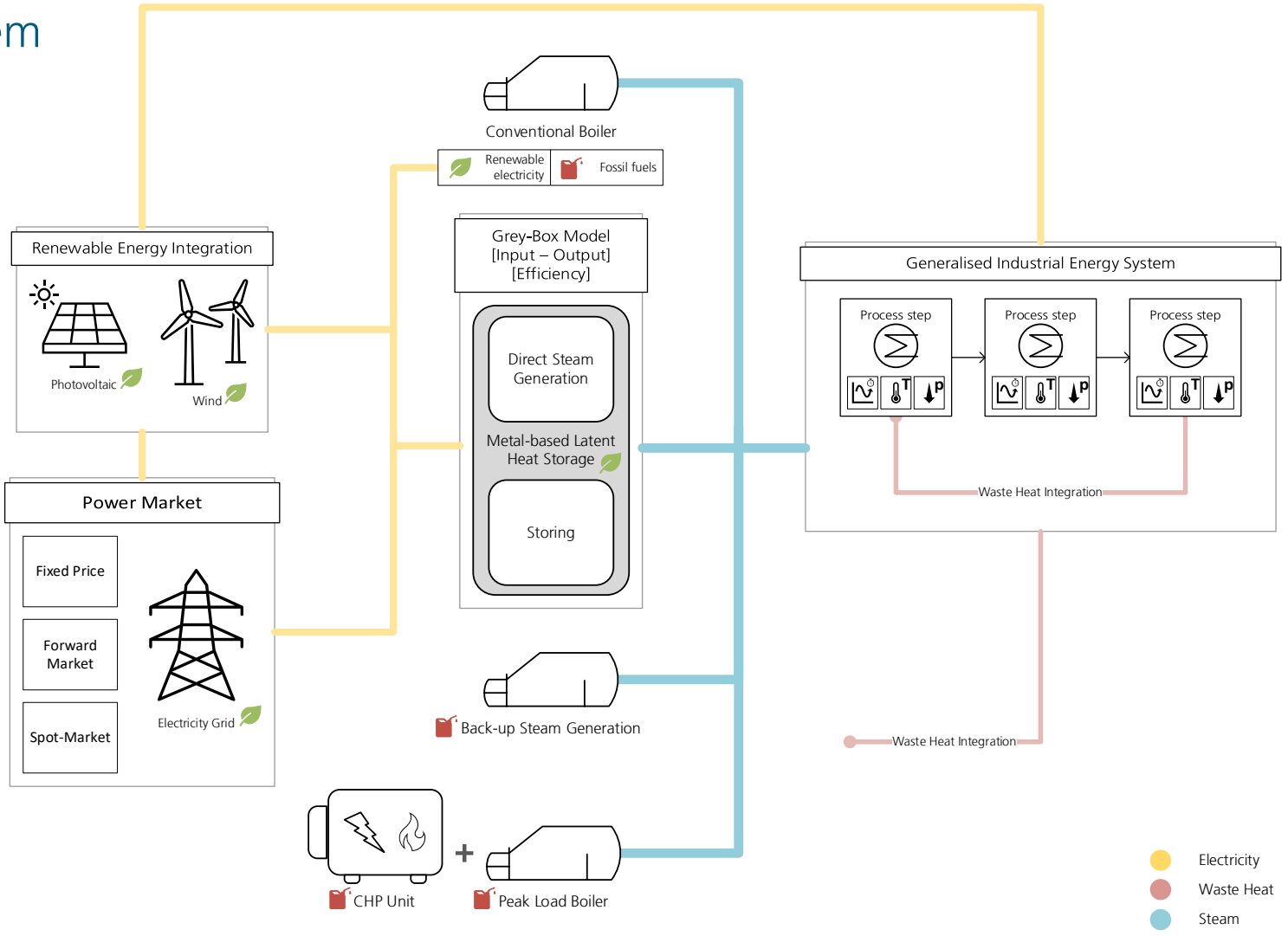
- Define System
- Literature research (variation of processes and systems)
- List parameters and assess impact
- Reduce example system to general components
- Apply methodology (e.g. Scaling)

Case Study: Brewery

Creating Generic Brewery Energy System

Steam Generating Metal-based Latent Heat Storage for Industrial Steam Processes Using Renewable Energy

Analysis and Comparison with Status Quo System



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Excursus: Flexibility

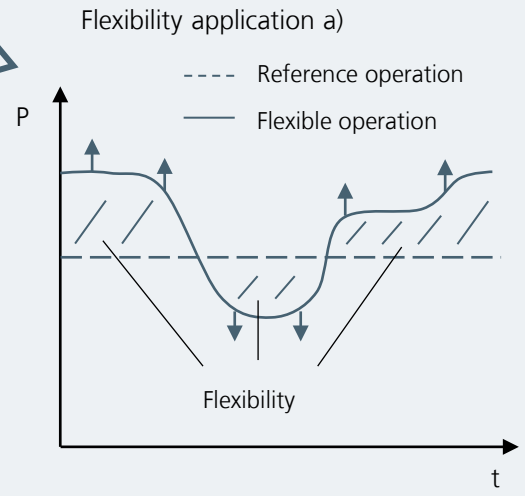
Definition

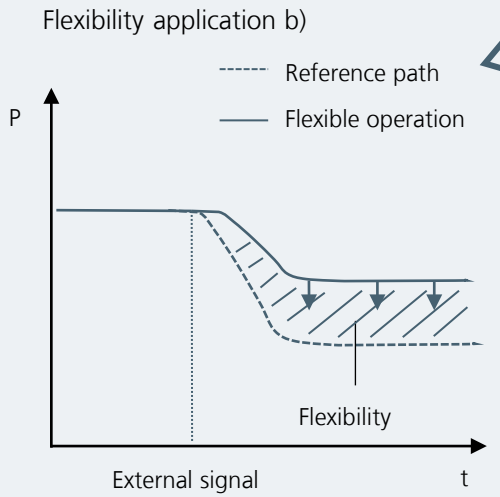
Industrial Use Cases

Scenarios with different flexibility options:

- Peak Shaving
- Batch Processes, Seasonal Production Changes
- Renewable Energy Integration
- Participation in Electricity Markets
- Scalability and Modular Design

Flexibility inherent in the system





Source: Dissertation Sebastian Berg

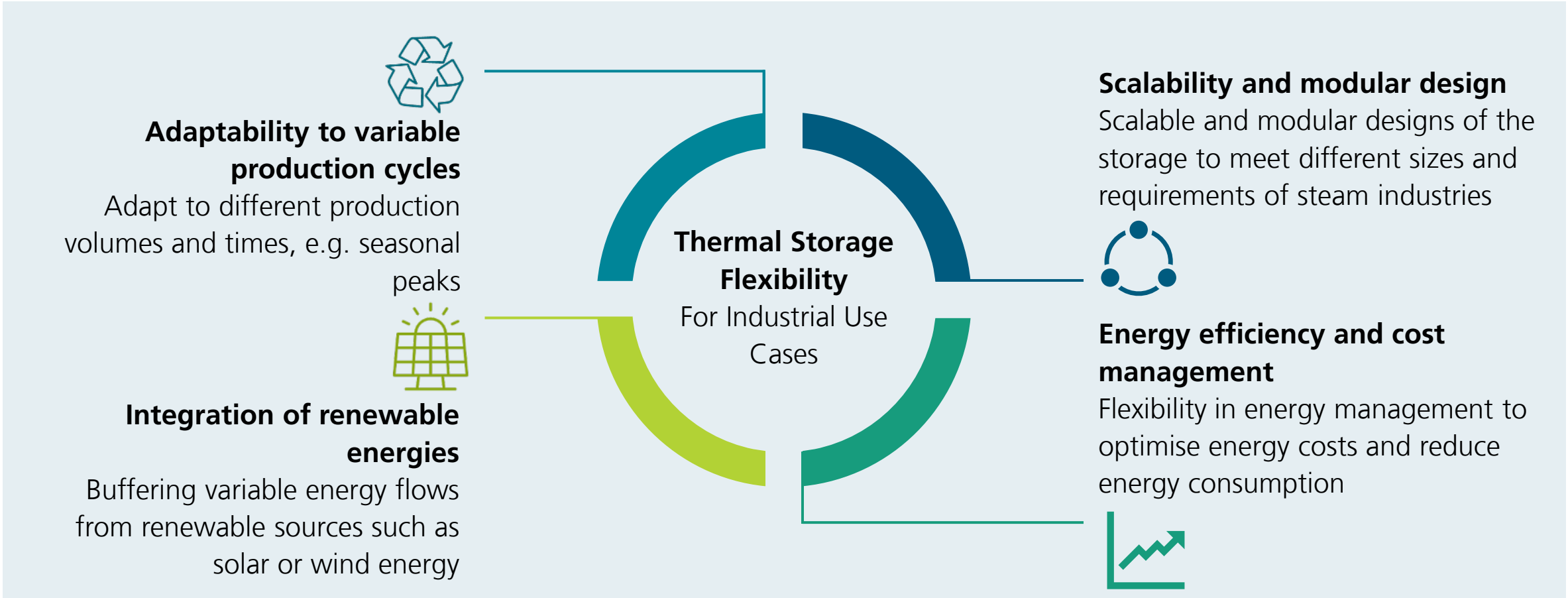
Latent heat storage development

Exchange with WP 1 – 3:

- Storage duration
- Response time (dis-/charging time, steam generation)
- Efficiency
- Control options and energy management system
- Geometry and Sizing

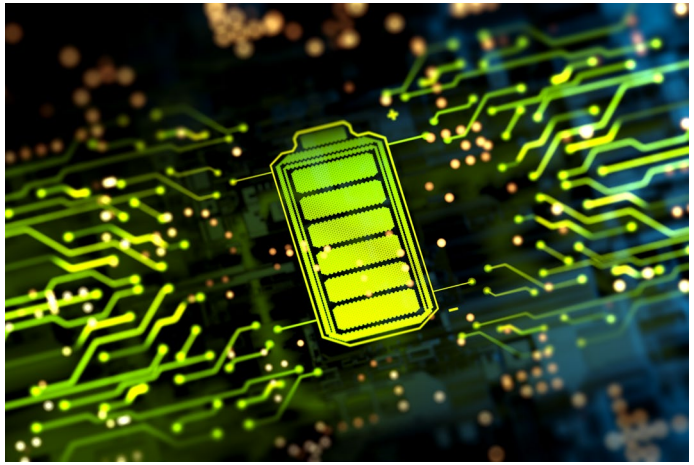
Excursus: Flexibility

Thermal Storage Flexibility for Industrial Use Cases



Excursus: Flexibility

Measuring Flexibility



Systemic

- Increased energy efficiency
- Increased waste heat integration

Ecological

- Reduced use of fossil fuels
- Increased lifetime (cycles) of storage

Economic

- Reduced Levelized Cost of Storage (LCOS)
- Reduced cost for energy

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