Sommersymposium 2018
am 28. Juni 2018

»Hochtemperaturspeicherung mittels PCM«

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Abteilung Energietechnik

TECHNIK im ZELT

Fraunhofer UMSICHT

High Temperature Thermal Energy Storage

Motivation

- Energy Transition not only a Power Transition
- Overall RE Share in Germany 15,4 %
- EU-Commitment 18 % for 2020

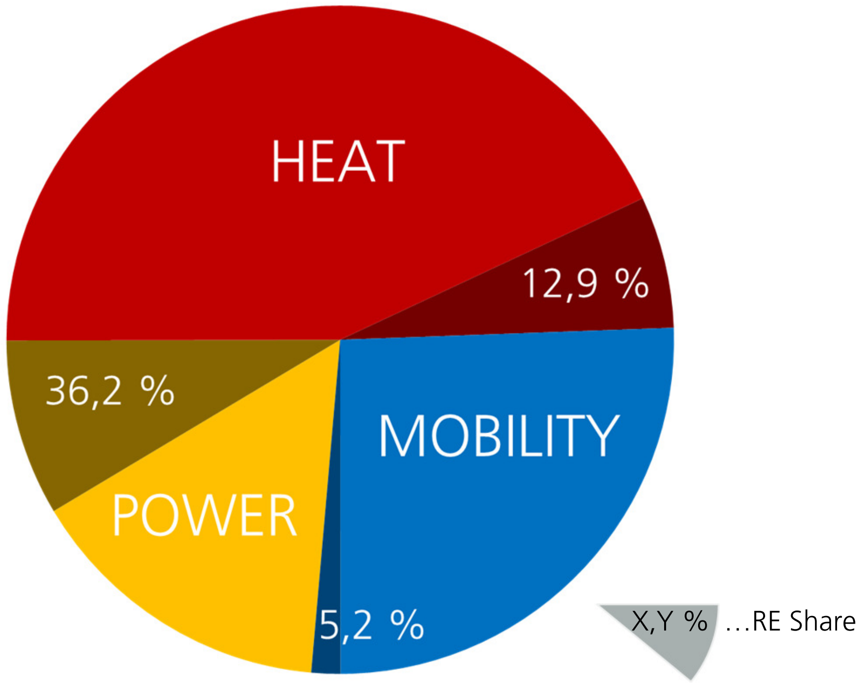

Figure 1: German end energy demand in the three main sectors and their RE share; Source: BEE

High Temperature Thermal Energy Storage
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- Stagnating energy demand for process heat
- RE share in process heat not changing since years

	1996	2008	2016	Change
		in %		
Space heating	36,6	30,27	27,94	- 23,7
Hot Water	5,20	4,67	4,70	- 9,6
Process Heat	19,60	21,02	21,40	+ 9,2

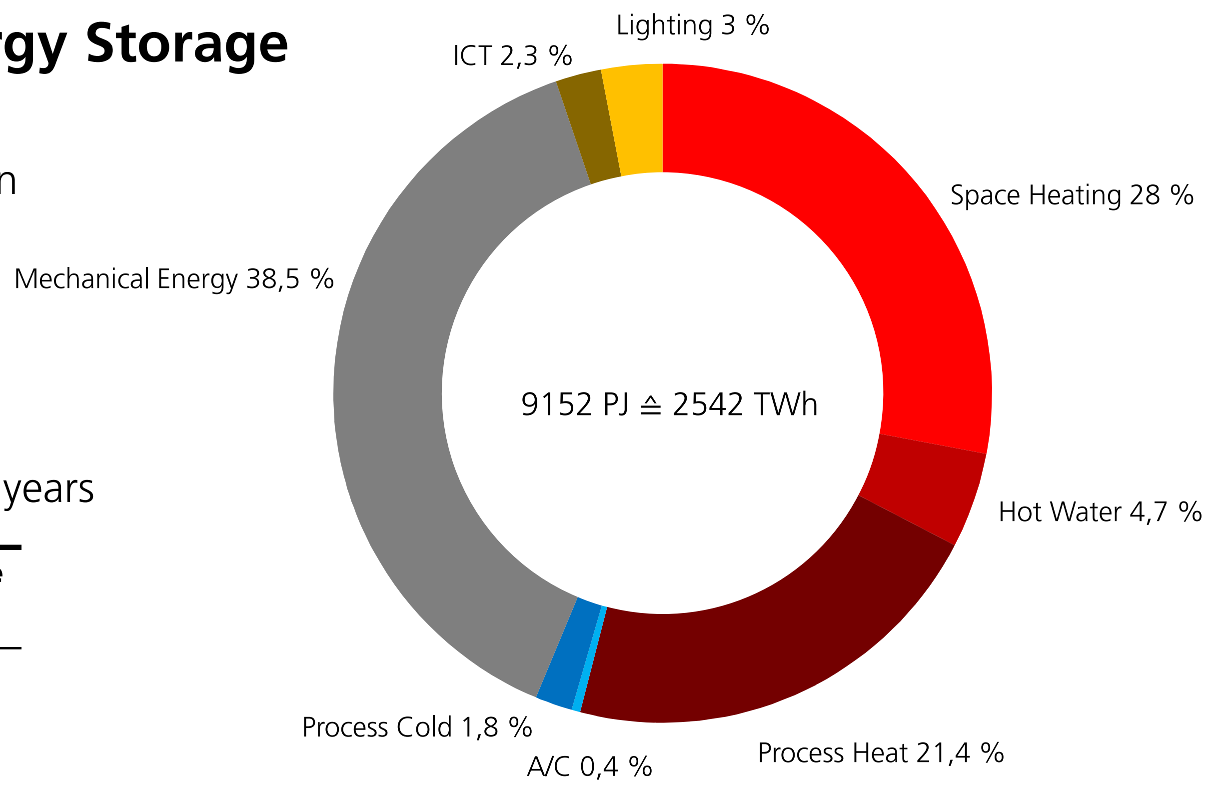

Figure 2: German end energy demand in the application areas;
Source: BMWi Energiedaten 1/18

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➢ Use of (HT)TES leads to
  - Fossil fuel savings
  - Integration of renewable energy sources

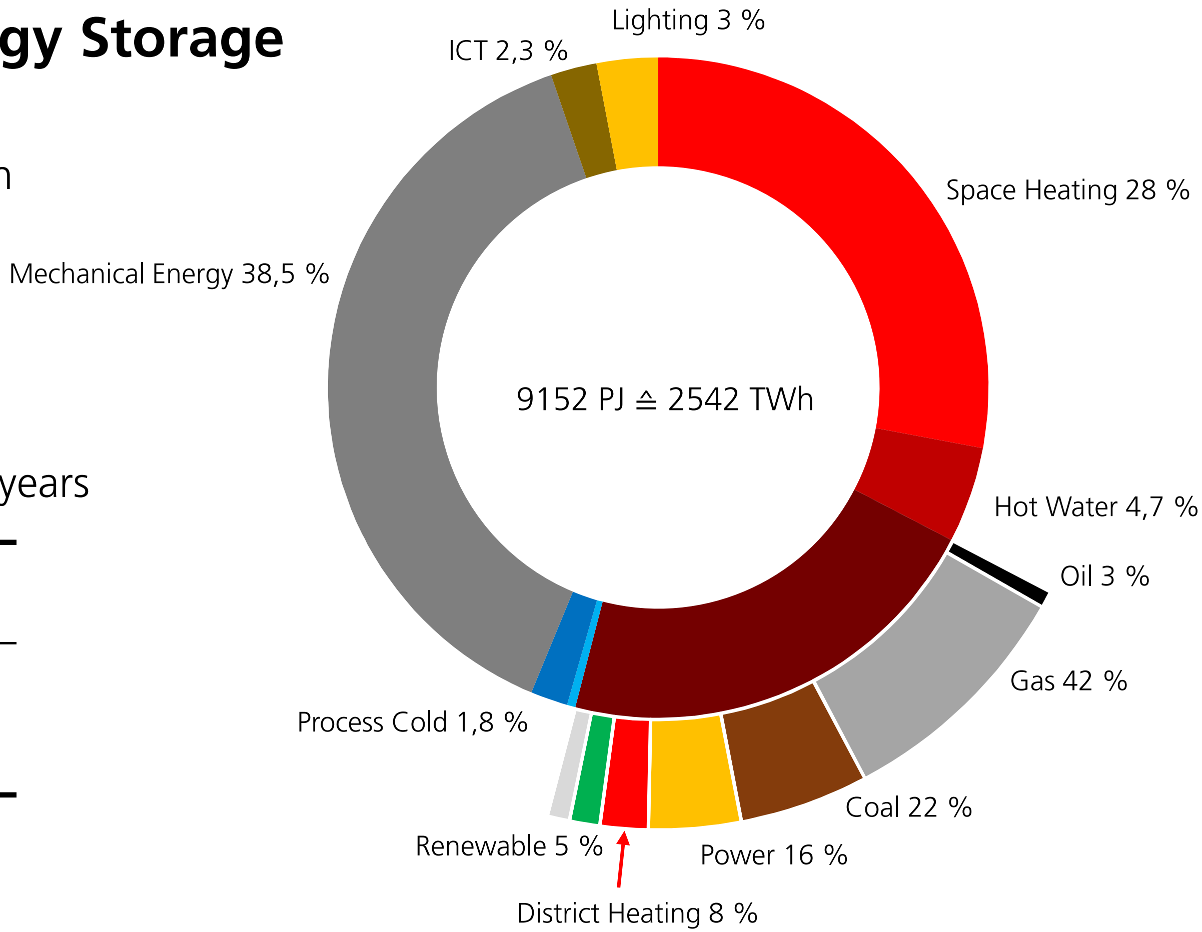


Figure 3: German end energy demand in the application areas and energy carriers for process heating; Source: BMWi Energiedaten 1/18

Thermal Energy Storage Principles

Overview and Examples

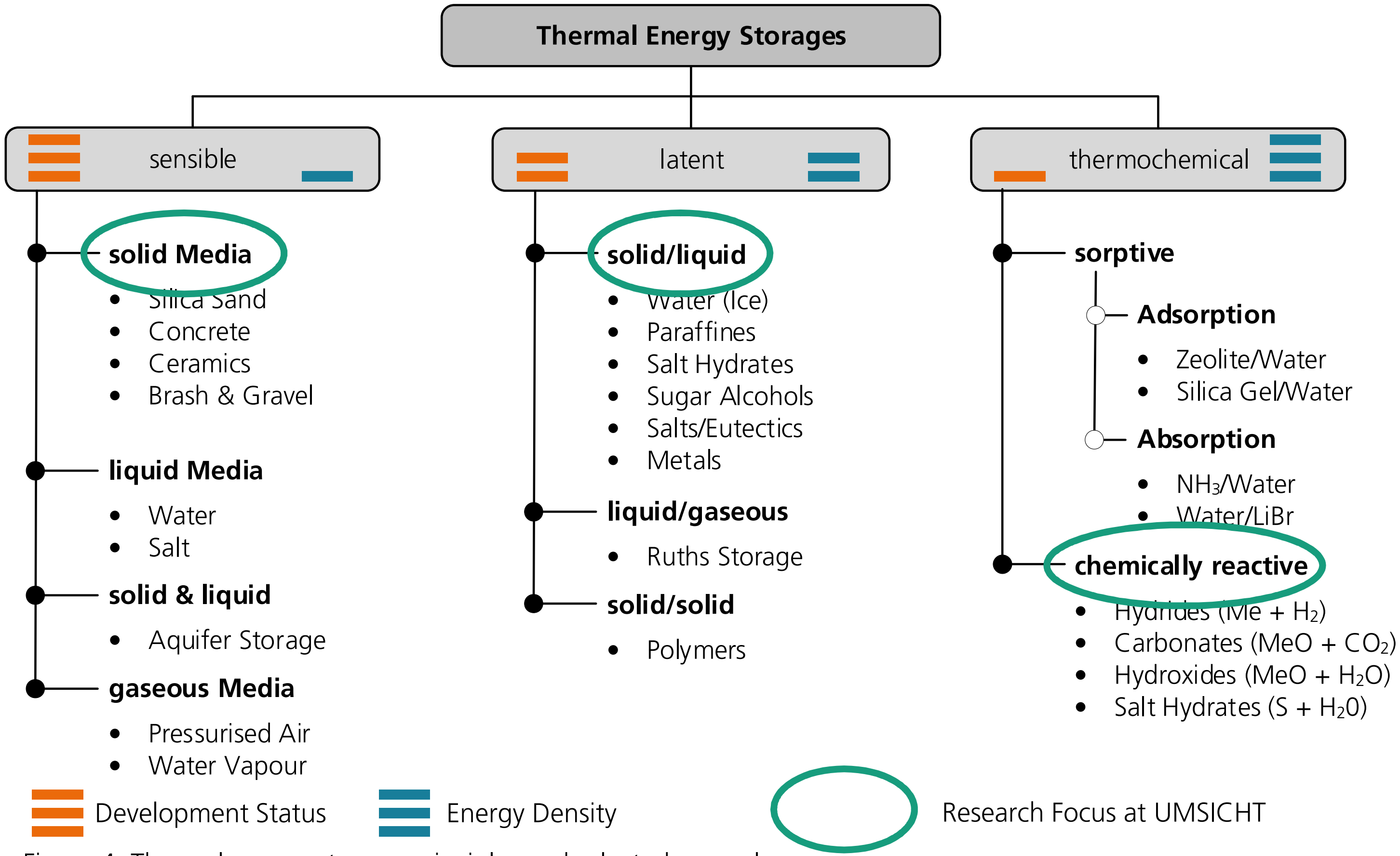
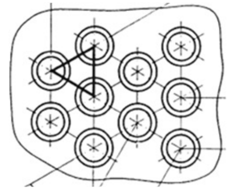


Figure 4: Thermal energy storage principles and selected examples

High Temperature Thermal Energy Storage Technologies

State of the Art

Table 1: State of the art technologies for high temperature thermal energy storage; Source: Own compilation based on BVES fact sheets

	sensible		latent		thermochemical
	Regenerator	Molten Salt	Salt	Metal	Hydroxide
Storage Density in kWh/m³	70 – 150	75 – 200	50 – 200	80 – 330	100 – 400
Storage Capacity in MWh	< 1 000	< 5 000	< 500	tbd	tbd
Temperature Range	400 – 1600 °C	150 – 560 °C	130 – 330 °C	250 – 550 °C	250 – 800 °C
Examples					

Research Focus at UMSICHT

Advantages of LHTES

+ High storage density in a narrow temperature range
+ Charging and discharging on constant temperature level
+ No additional auxiliary energy needed

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High Temperature Thermal Energy Storage at UMSICHT

Project TheMatIK

TheMatIK = "**Th**ermische Speicher**mat**erialien zur Flexibilisierung **i**ndustrieller **K**raftwerke"

- Motivation
  - Increasing share of renewable energies in the German power grid
  - Decreasing economic feasibility of fossil fuelled power plants and CHP
  - ➢ Fossil fuelled plants still necessary to ensure grid stability
  - ➢ Integration of a **metal based** latent heat storage to "flexibilise" CHP operation
    - \+ High heat conductivity → no additional heat transfer structures
    - \+ High volumetric energy density → less required space

- Main targets
  - Evaluation of different integration possibilities not affecting the steam cycle
  - Metallic PCM and encapsulation combinations for every integration
    1. Material development and stability tests
    2. CFD-Simulation
  - Test facility (ca. 1 000 kg of PCM) and test series in BHP Sulzbach-Rosenberg
  - Overall process simulation

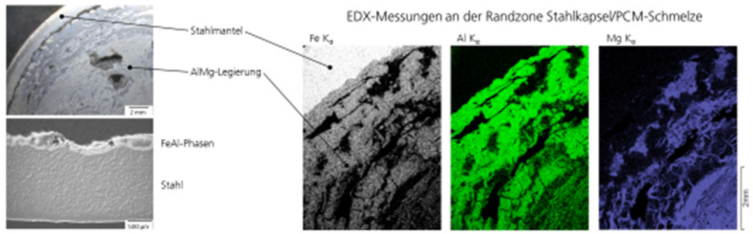

Figure 5: EDX-Analysis of metallic PCM and encapsulation

Materialforschung für die Energiewende
10/2016 – 9/2019

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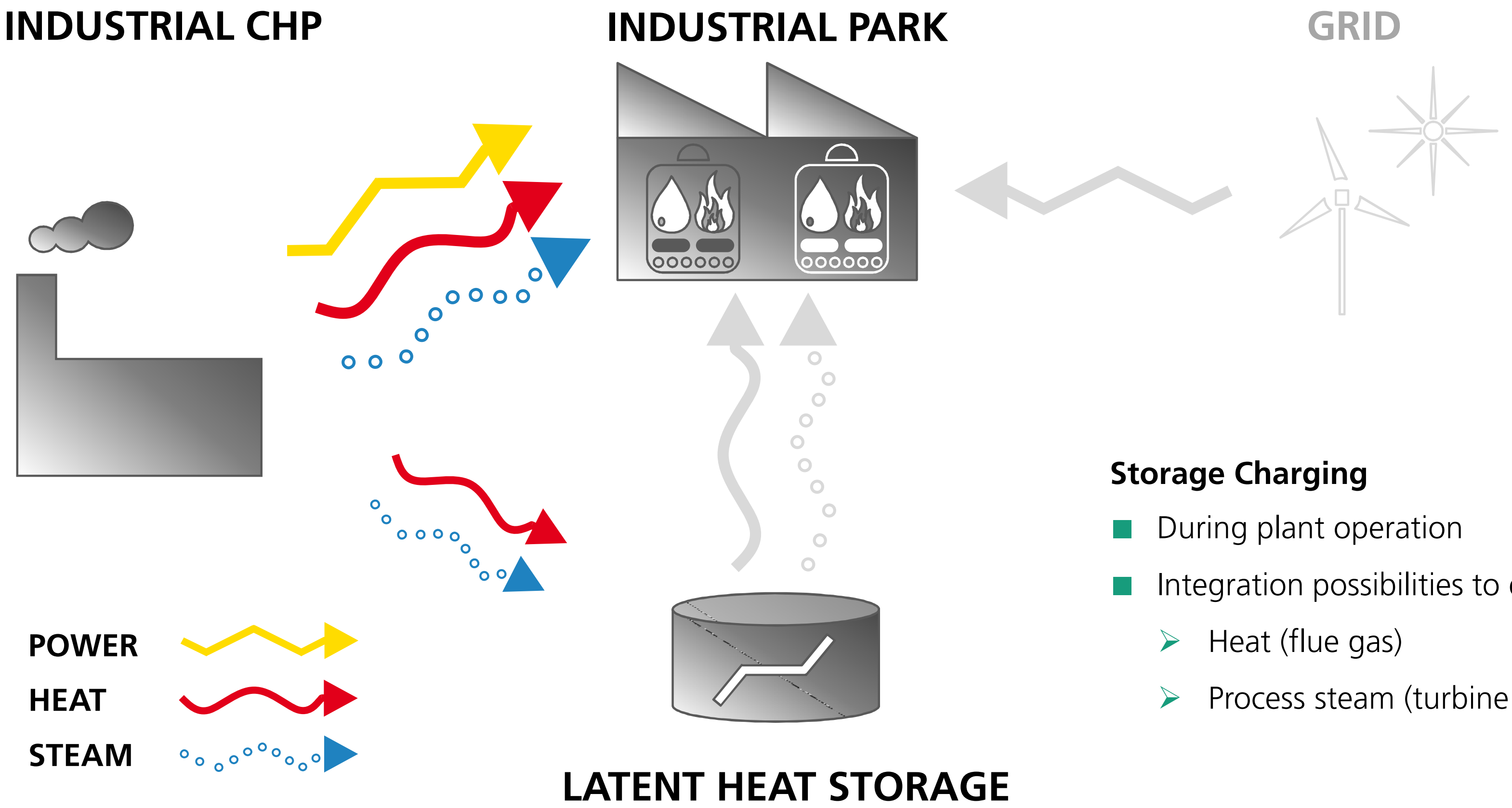
High Temperature Thermal Energy Storage at UMSICHT

Project TheMatIK – Integration Principle for Charging



Storage Charging

- During plant operation
- Integration possibilities to extract partial flows of
  - Heat (flue gas)
  - Process steam (turbine extraction)

Figure 6: TheMatIK integration scheme of a latent thermal energy storage during charging mode

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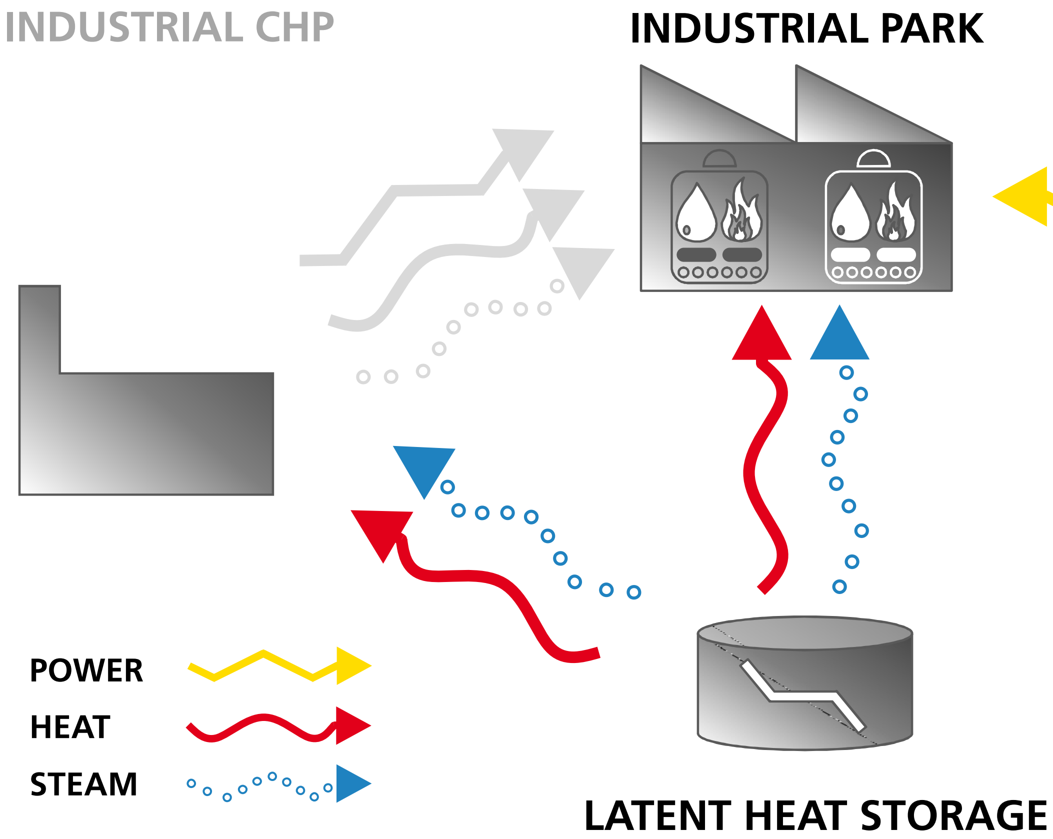
Project TheMatIK – Integration Principle for Discharging



Storage Discharging

- During plant downtime or minimal load
- Reintegration possibilities outside steam cycle
  - Heat for the plant (ambient air)
  - Process heat or steam (various steam lines)

Figure 7: TheMatIK integration scheme of a latent thermal energy storage during discharging mode

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Project TheMatIK – Investigated Integrations & Challenges

1. Pre heating of mill air
   - ➢ Storage charging: Flue gas from coal firing
   - ➢ Storage discharging: TES heats up ambient air to dry coal
   - ! Coal flue gas polluted with dust

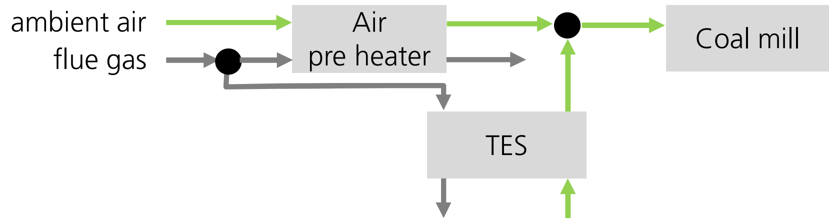

Figure 8: Integration scheme for coal mill preaheating

2. (Fully) Replacing the auxiliary boiler (oil fired)
   - ➢ Storage charging: Tapping point during normal operation and shut down
   - ➢ Storage discharging: heating of power plant parts (and steam to start the turbine)
   - ! High storage capacity needed

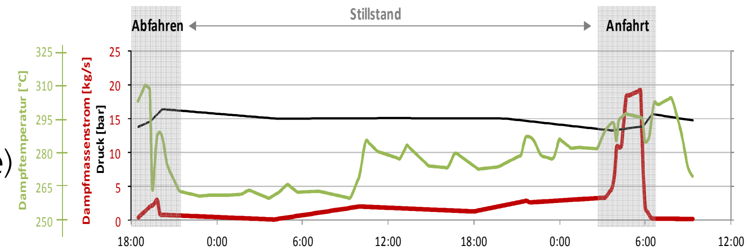

Figure 9: Steam from auxiliary boiler during plant shut down

3. Ensuring process steam supply between CHP and industrial park
   - ➢ Storage charging: Steam line
   - ➢ Storage discharging: TES supplies steam until auxiliary boiler is on full load
   - ! High thermal dynamic needed

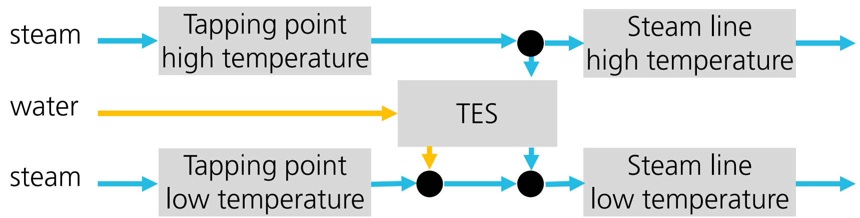

Figure 10: Integration scheme to ensure process steam supply

High Temperature Thermal Energy Storage at UMSICHT

What we offer and provide

- Research activities in sensible, latent and thermochemical thermal energy storages
  - From 60 °C to 550 °C (recently, but not limited)
  - Stationary and mobile applications
- Material characterisation
  - Thermal analysis (DSC, TGA)
  - Optical analysis (EDX, REM)
  - Stability and cycling tests
- Material development (metallic PCM & encapsulation)
- Consulting & assessment (material & storage level)
- Dimensioning, construction & demonstration (test facilities for all three storage principles)

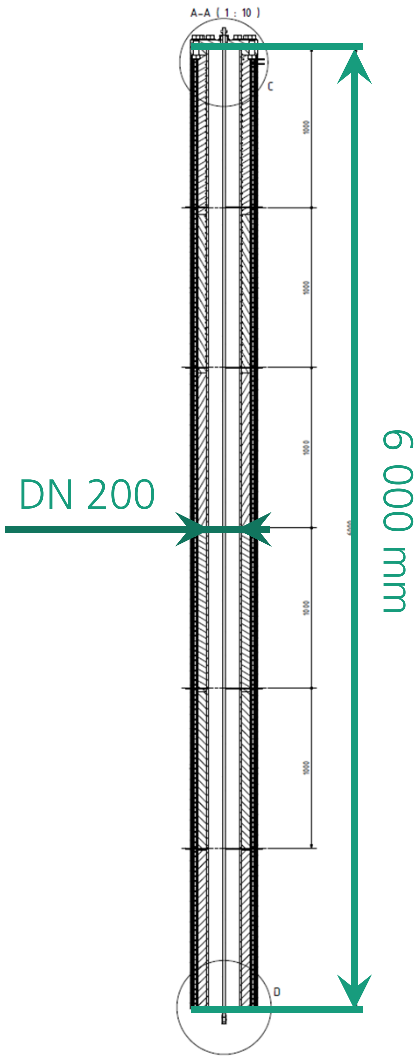

Figure 11: CAD drawing of the TheMatIK test storage

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Many thanks for your attention!

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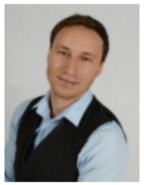

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