
Sommersymposium 2018 am 28. Juni 2018

»Hochtemperaturspeicherung mittels PCM«

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Abteilung Energietechnik



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

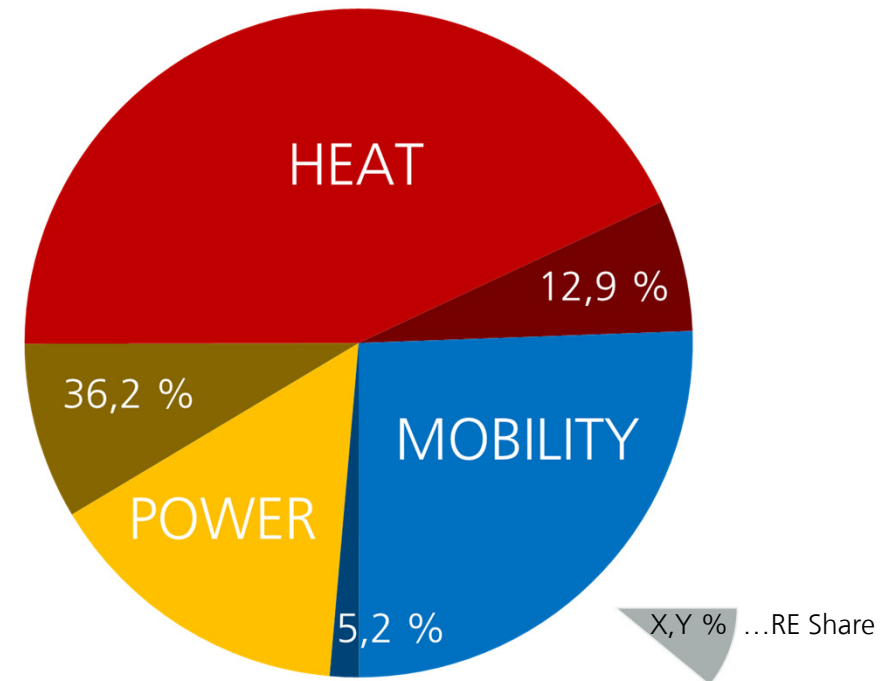


Figure 1: German end energy demand in the three main sectors and their RE share; Source: BEE

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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

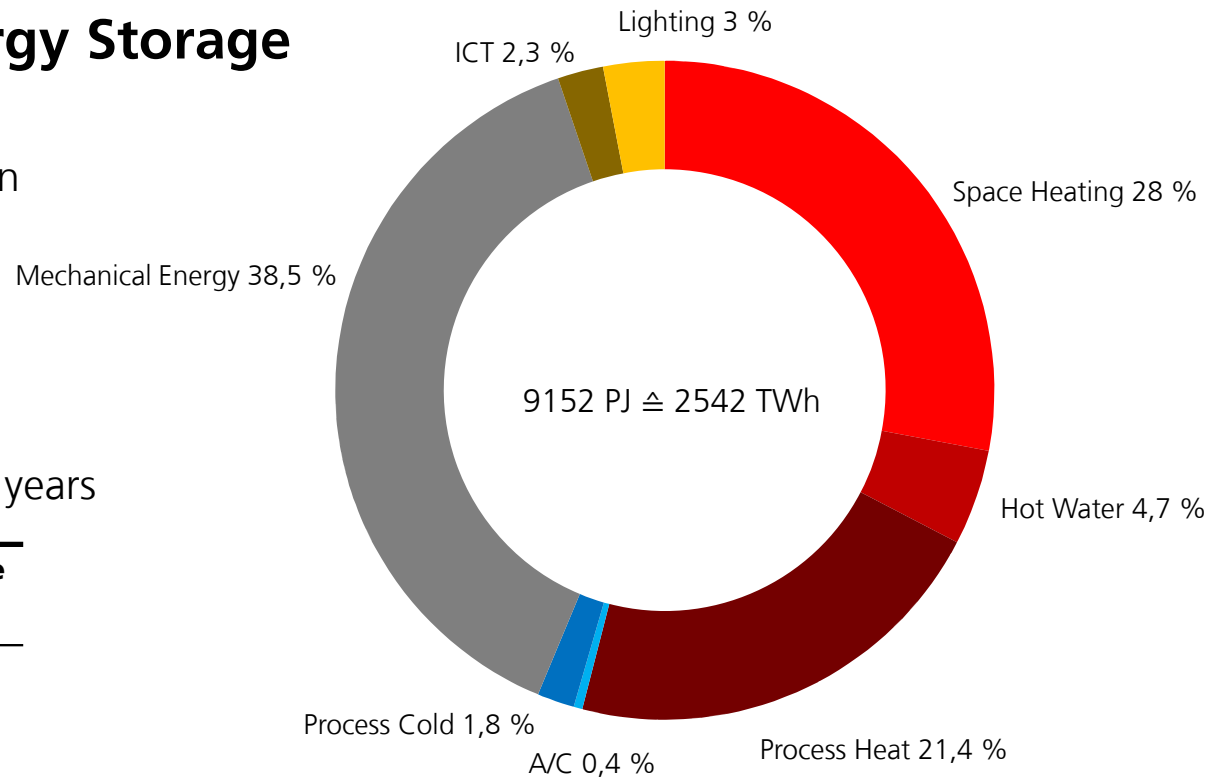


Figure 2: German end energy demand in the application areas;
Source: BMWi Energiedaten 1/18

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

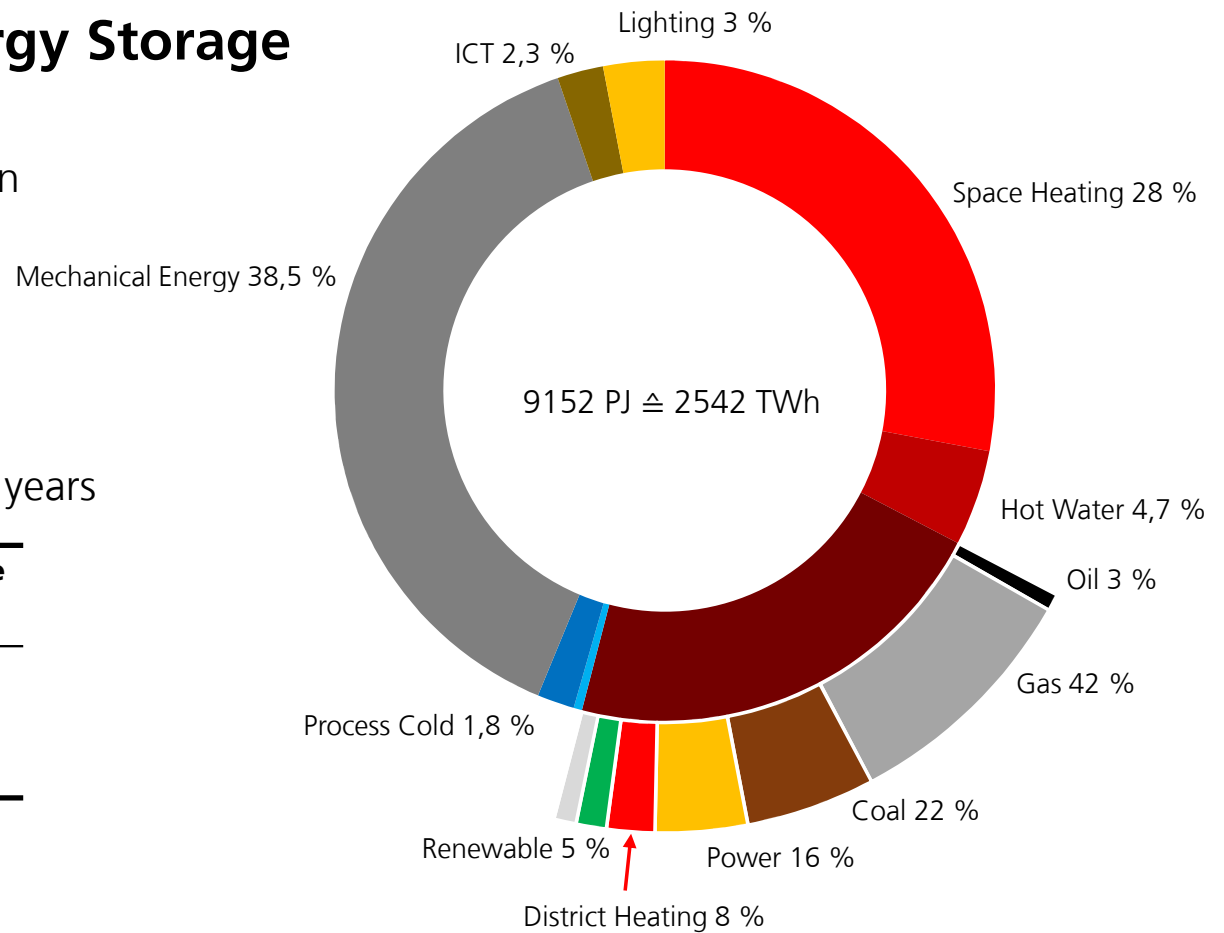


Figure 3: German end energy demand in the application areas and energy carriers for process heating; Source: BMWi Energiedaten 1/18

Thermal Energy Storage Principles

Overview and Examples

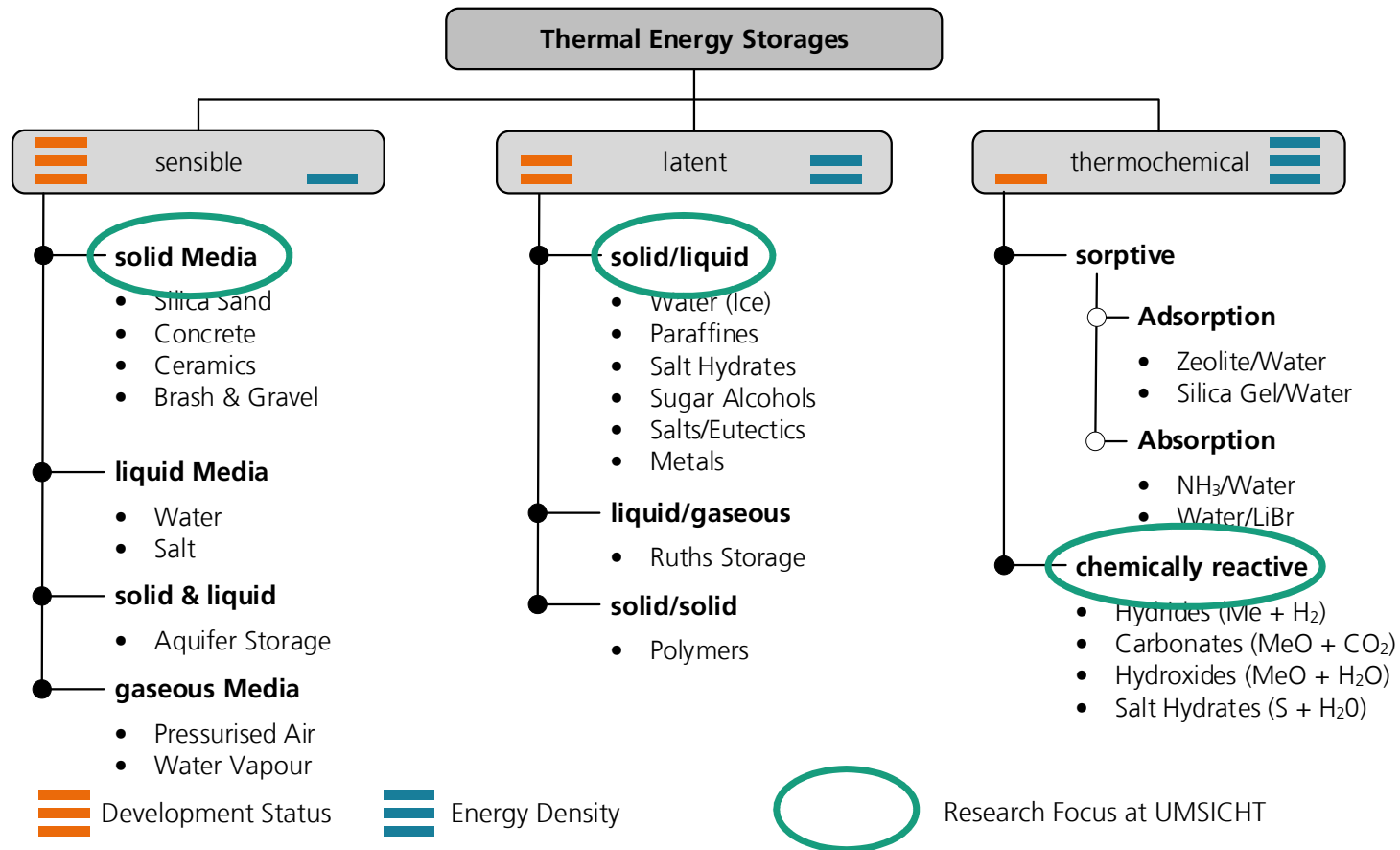


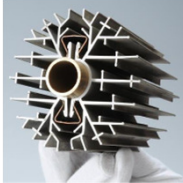
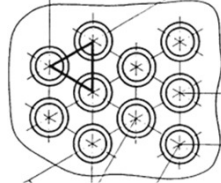



Figure 4: Thermal energy storage principles and selected examples

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					

Advantages of LHTES

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



Research Focus at UMSICHT

High Temperature Thermal Energy Storage at UMSICHT

Project TheMatIK

TheMatIK = “**T**hermische Speicher**m**aterialien 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
 - i. Material development and stability tests
 - ii. CFD-Simulation
- Test facility (ca. 1 000 kg of PCM) and test series in BHP Sulzbach-Rosenberg
- Overall process simulation

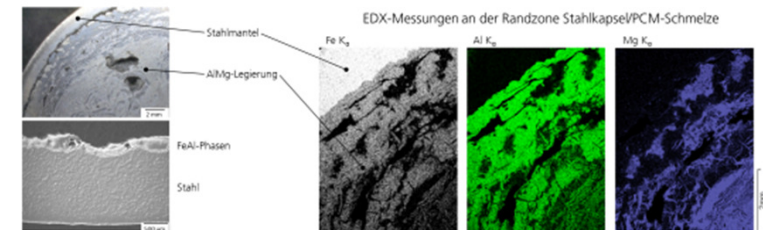


Figure 5: EDX-Analysis of metallic PCM and encapsulation

Materialforschung für die Energiewende
10/2016 – 9/2019

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High Temperature Thermal Energy Storage at UMSICHT

Project TheMatK – Integration Principle for Charging



INDUSTRIAL CHP

INDUSTRIAL PARK

GRID

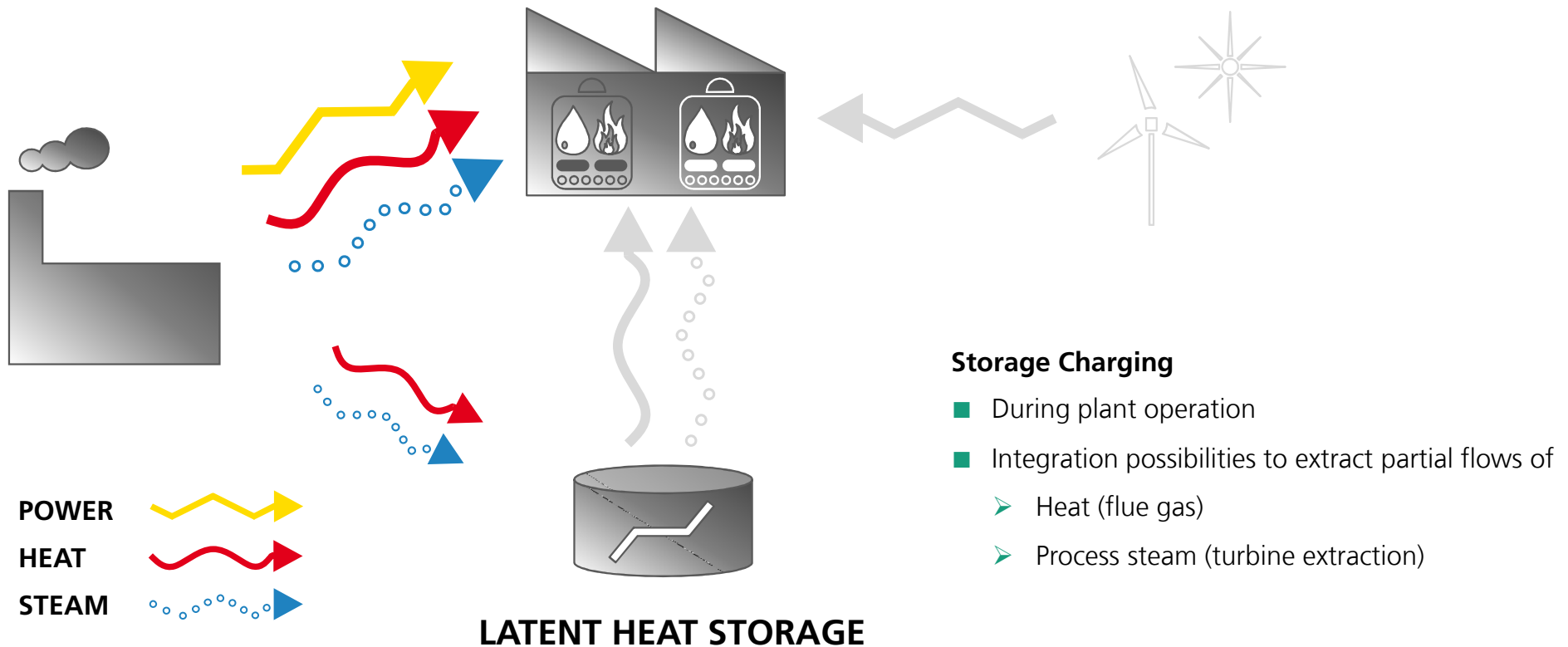


Figure 6: TheMatK integration scheme of a latent thermal energy storage during charging mode

High Temperature Thermal Energy Storage at UMSICHT

Project TheMatK – Integration Principle for Discharging



INDUSTRIAL CHP

INDUSTRIAL PARK

GRID

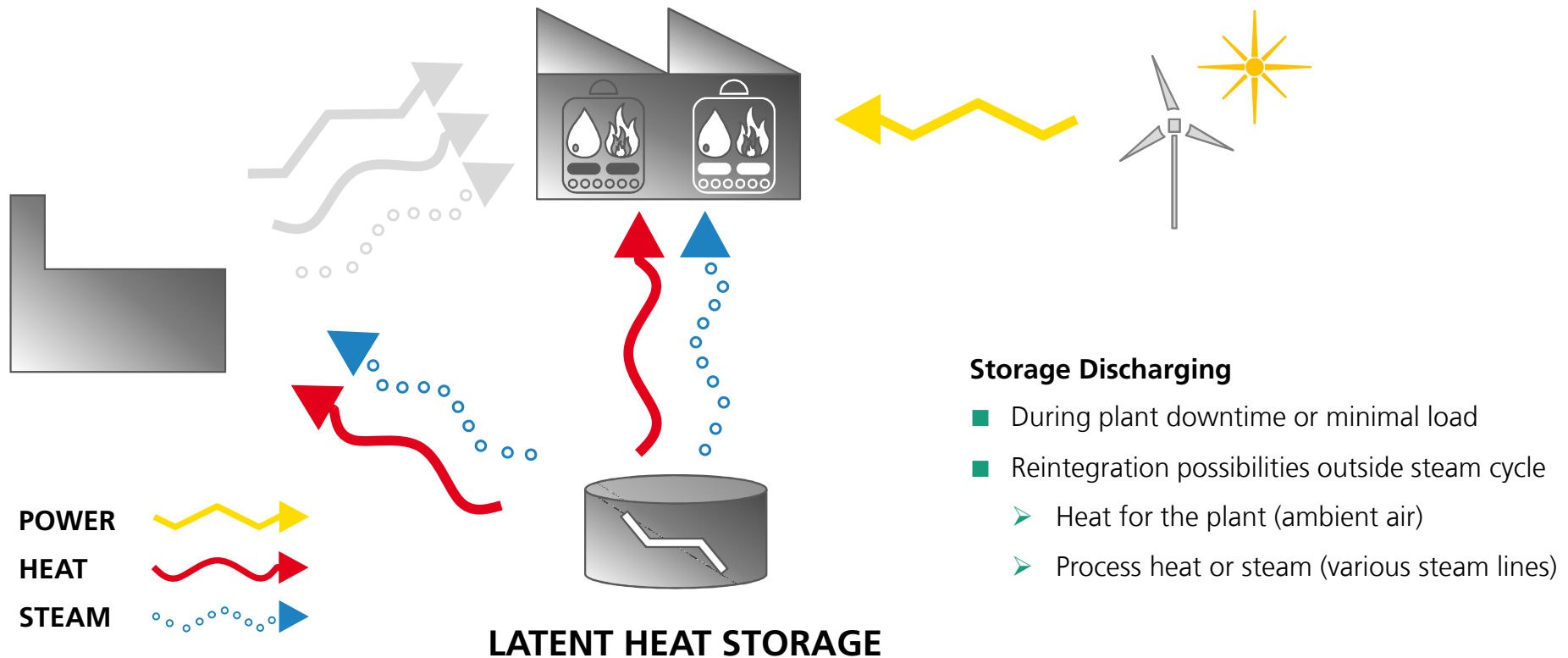


Figure 7: TheMatK integration scheme of a latent thermal energy storage during discharging mode

High Temperature Thermal Energy Storage at UMSICHT

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

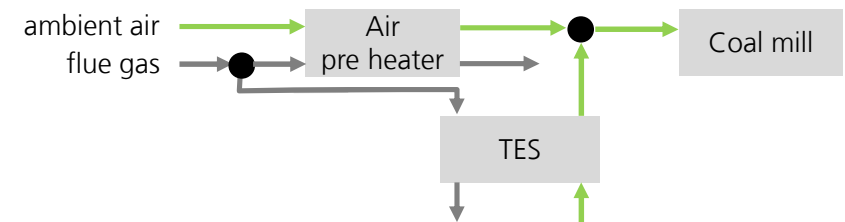


Figure 8: Integration scheme for coal mill preheating

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

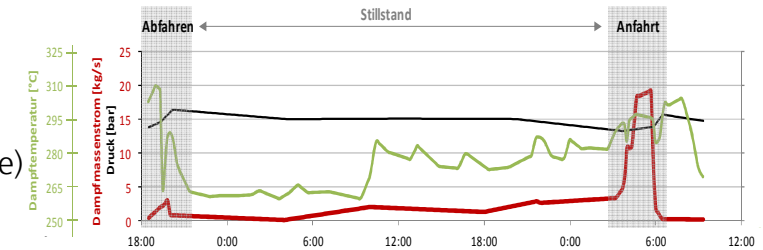


Figure 9: Steam from auxiliary boiler during plant shut down

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

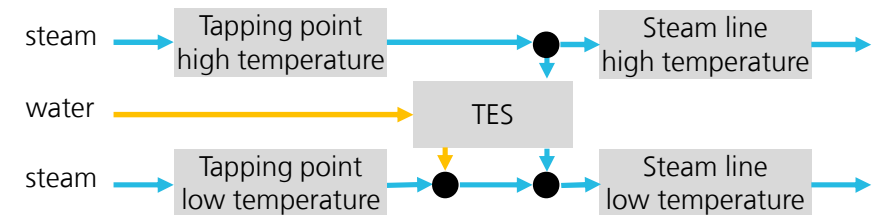


Figure 10: Integration scheme to ensure process steam supply

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)

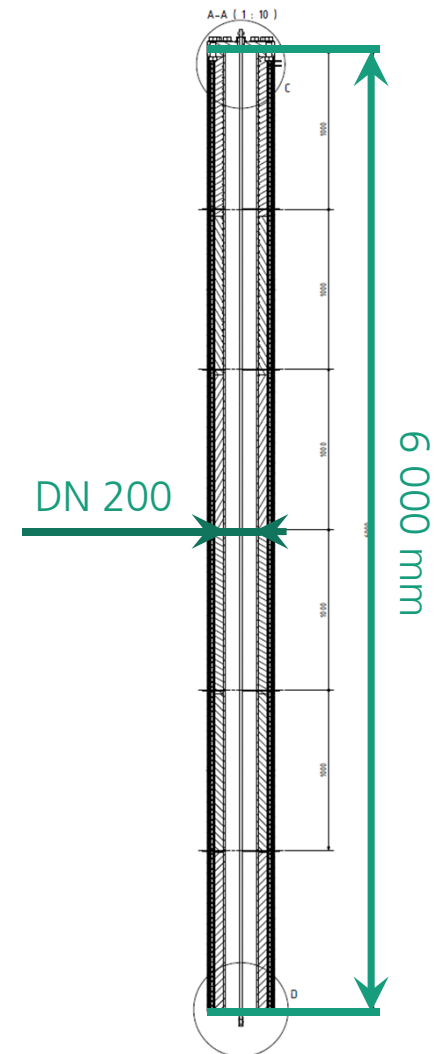


Figure 11: CAD drawing of the TheMatIK test storage

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Many thanks for your attention!

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