

# APPLICATION ORIENTED ENERGY STORAGE SELECTION - APPESS

## Swiss Symposium Thermal Energy Storage

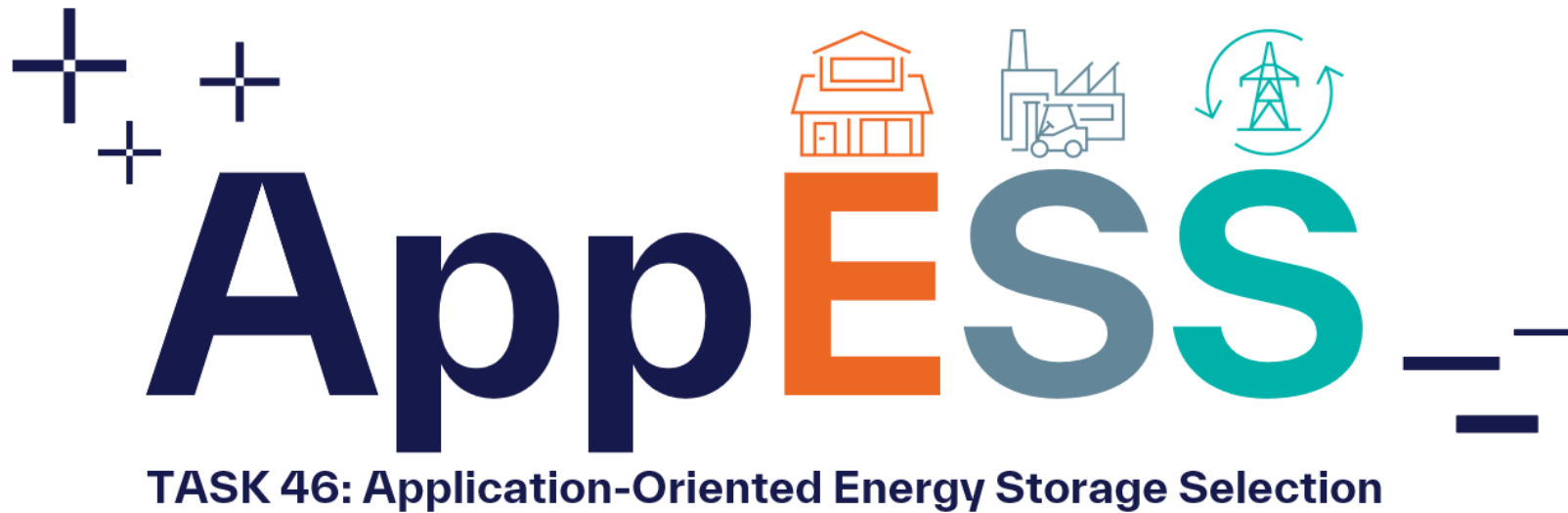
Lucerne, Switzerland,  
January 30 2026

Andreas Hauer



# INTRODUCTION TO TASK 46 APPESS

New Logo:



# GOAL

**Answer questions like...**

- **Which energy storage technologies offer the technical and economical best solution?**
- **Which energy storage solutions have the most impact on the energy transition?**
- **Which fields of application for energy storage are the most relevant?**

# GOAL

**...and the Main Question:**

**Which storage technology offers the best technical and economic solution in the specific application, and how relevant is this identified application-storage pair (or “match”) for the energy system?**

# GOAL

**Develop a methodology for**

- **Structuring energy storage applications following their**
  - **Technical**
  - **Economical**
- requirements**
- **Identifying the best energy storage solutions based on their properties for the most relevant application**
- **Quantifying their potential benefit to the future energy system**

# Integrated Energy System – Demand is important!

## Past

### Supply

Fossil Fuels



### Demand

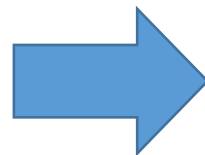
Electricity  
Mobility  
Thermal

The system has to provide what is needed, where and when it is needed!

## Future

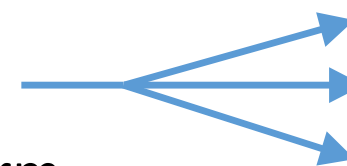
### Supply

Renewable Energies  
(PV, Wind, Solarthermal, CSP, Hydro, Bio...)



### Distribution / Storage Transformation

Shift in **Time**  
and Location  
and Energy Form

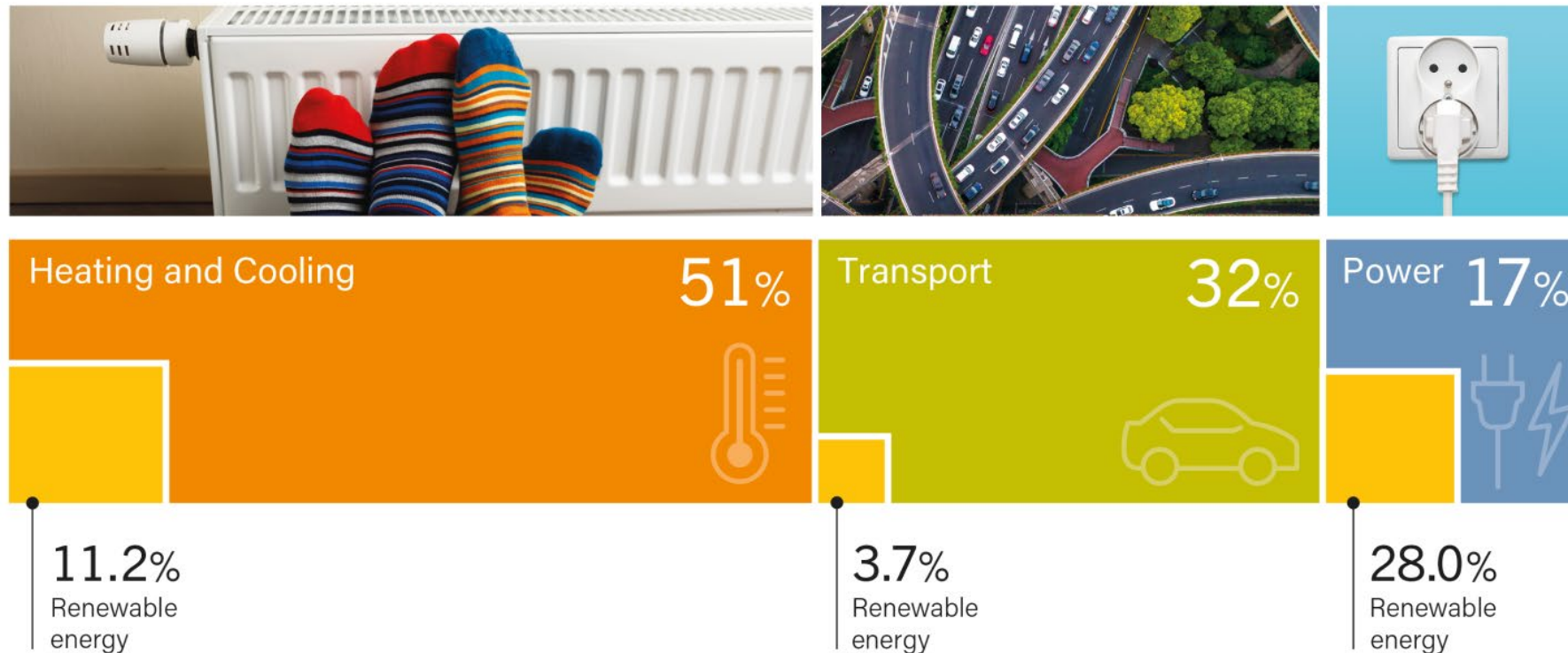


### Demand

Electricity  
Mobility  
Thermal

# Integrated Energy System – Demand is important!

## Renewable Energy in Total Final Energy Consumption, by Final Energy Use, 2019



Note: Data should not be compared with previous years because of revisions due to improved or adjusted methodology.

# It makes a difference!

The „direction“ we look at the energy system is crucial!

From the supply side:

- Past = fossil fuels provide all we need
- Future = variable renewables provide mostly electricity
- There is a need for electrical energy storage!

• From the demand side:

- We need 50 % thermal, 25 % electricity and 25 % mobility
- Huge variety of „solutions“, taylor-made (!)
- Distributed / local systems



# Energy System from the Supply Side!

**Source/  
Supply  
(Electricity, Heat)**



**Thermal Storage  
Electrical Storage  
Chemical Storage**



**Demand  
(Heat/Cold,  
Electricity,  
Mobility)**

# Energy System from the Supply Side!



PV / Wind  
(Electricity)



Electrical Energy  
Storage



Industrial Drying  
Process

Industrial Drying Process:  
Demand on hot and dry air (150-180 °C)

# Energy System from the Demand Side!

**Source/  
Supply  
(Electricity, Heat)**



**Thermal Storage  
Electrical Storage  
Chemical Storage**



**Demand  
(Heat/Cold,  
Electricity,  
Mobility)**

# Energy System from the Demand Side!



PV / Wind / **Solarthermal**  
Waste Heat



Mobile Sorption  
Storage



Industrial Drying  
Process

Mobile Sorption Storage:

Cost 50-100 €/kWh capacity (Battery 150-250 €/kWh capacity)

# SCOPE

## All energy storage technologies

- Electrical
- Thermal
- Chemical

## All relevant energy storage applications in the energy system

- Centralized, decentralized

**Supply = 100 % Renewable Energies**

**Demand = All sectors**

- Electricity
- Heating & Cooling
- Mobility

# OBJECTIVES

- **Structure application requirements and match it with energy storage properties** (e.g. Carnot battery for flexible share of electricity / heat at the source and the consumer side)



# OBJECTIVES

## Fields of Applications

Heat/Cold, Electricity, Mobility

### KPIs

- **How much** RE shall be integrated? (capacity)
- **How fast** shall the energy be supplied? (power)
- **For how long** shall the energy be shifted? (duration)
- ...
- **How much CO<sub>2</sub> emissions can be avoided?** (cost)

## Energy Storage Technologies

TES, EES, CES

### KPIs

- **How much** energy can be stored? (capacity)
- **How fast** can the energy be stored? (power)
- **For how long** can the energy be stored? (duration)
- ...
- **At what cost** can the energy be stored? (cost)

**Match-Making-Matrix**

# OBJECTIVES

- Illustrate identified matches by best practice examples



Mobile Sorption Storage for Industrial Drying Processes



Large PTES for District Heating Systems

Stationary Battery System for Ultra Fast Charging



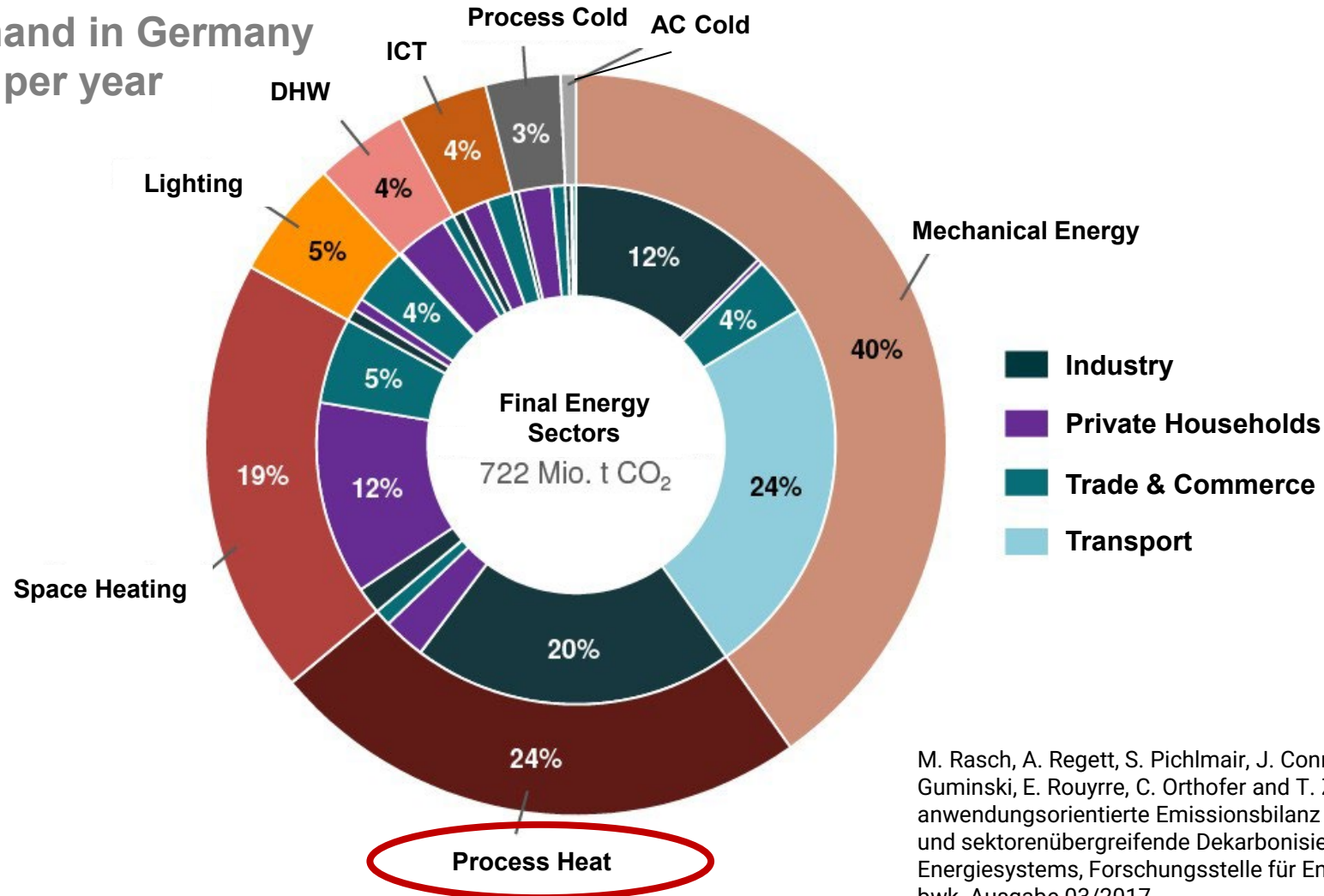
## OBJECTIVES

- **Quantify potentials through the relevance of specific energy storage technologies in specific application and compare it with respect to the system flexibility they can provide:**
  - **Prioritizing selected energy storage solutions within their application and quantify the benefit for the energy system**
  - **What are the most relevant energy storage solutions?**

# OBJECTIVES

## Relevance of Application / Energy Demand Sectors and CO2 Emissions

Final energy demand in Germany about 2,600 TWh per year

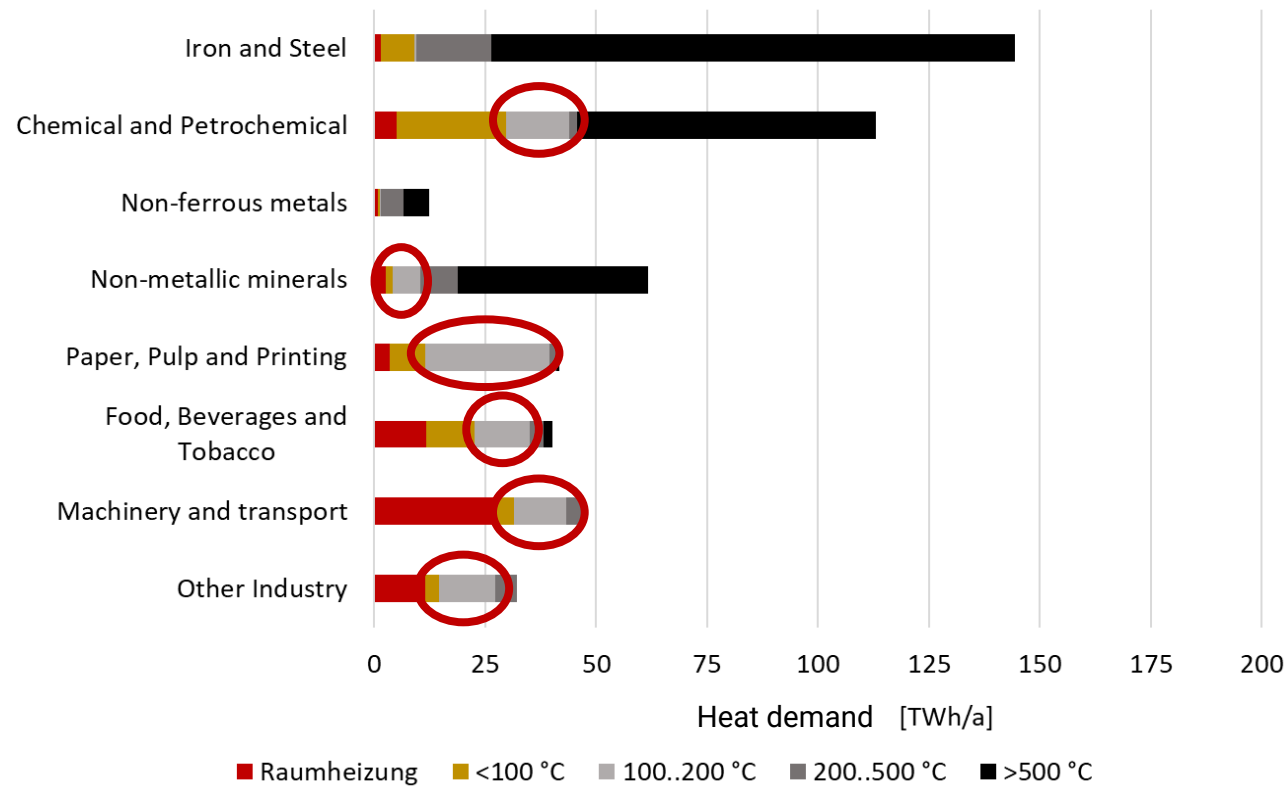


M. Rasch, A. Regett, S. Pichlmair, J. Conrad, S. Greif, A. Guminski, E. Rouyre, C. Orthofer and T. Zipperle, Eine anwendungsorientierte Emissionsbilanz – Kosteneffiziente und sektorenübergreifende Dekarbonisierung des Energiesystems, Forschungsstelle für Energiewirtschaft FfE, bwk, Ausgabe 03/2017

# OBJECTIVES

## Example: Process Heat / Potato Crisps Production

Industrial heat demand 2015 for different sub-sectors and temperature ranges



Fleiter, Tobias, et al. *Heat Roadmap Europe, Deliverable 3.1: Profile of heating and cooling demand in 2015*. 2017.

# INTRODUCTION TO THE WORKSHOP



# PRESSURIZED HOT WATER STORAGE IN SWITZERLAND

## Renergia Zentralschweiz AG

Project duration: September 2022 – in operation  
Project partner: Renergia Waste-to-Energy Plant,  
4 District Heating Networks,  
Perlen Papier AG

### Application:

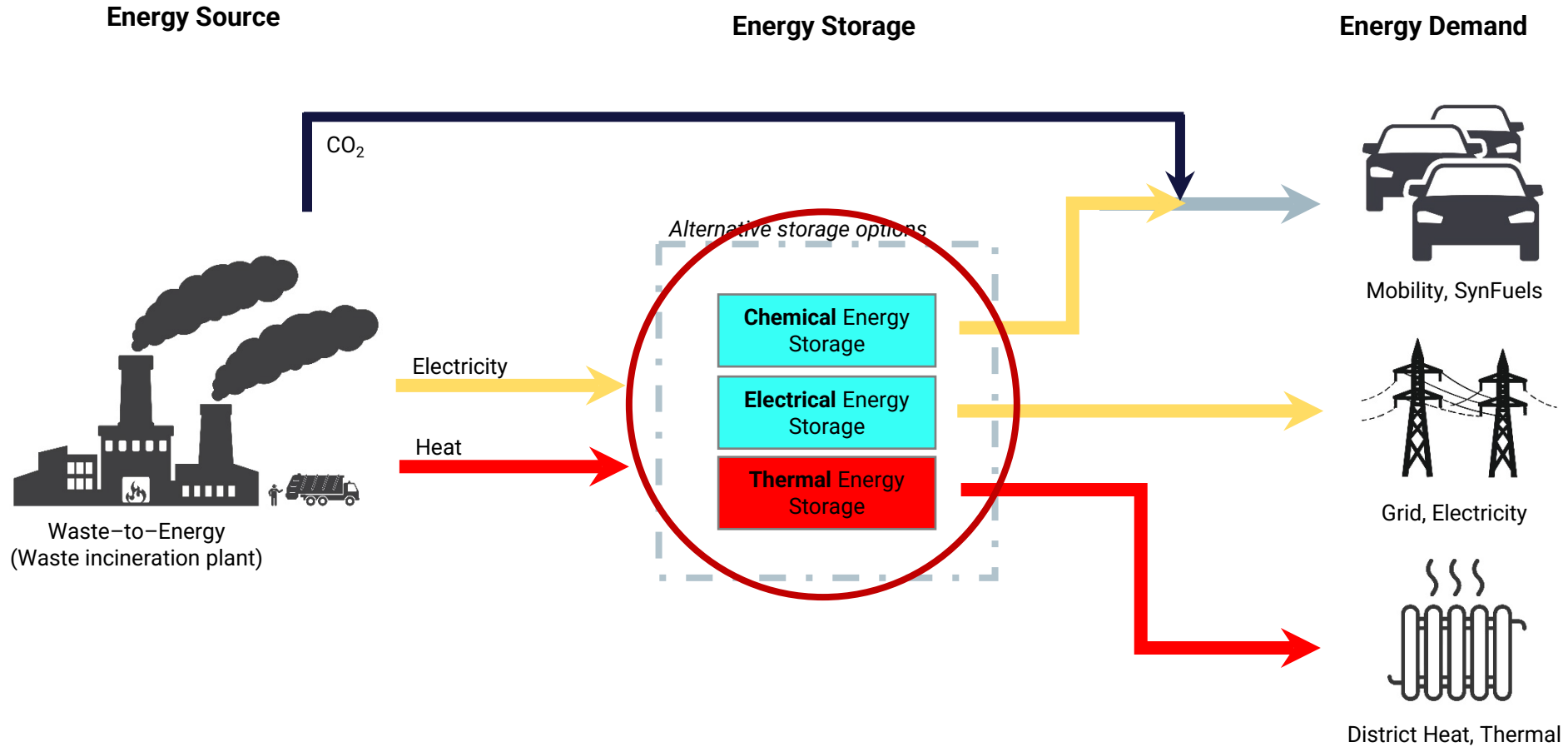
- 33 m high, capacity of 5 million litres, storage temperature up to **145 °C** using residual heat from the waste incineration plant
- Storage capacity of approx. **400 MWh**, enabling flexible supply for the district heating network and optimized heat and electricity generation.

### Project goals:

- Increase energy efficiency by utilizing previously unused waste heat.
- Improve supply security for the district heating network and industrial partners such as Perlen Papier AG.
- Reduce fossil fuel consumption (e.g. natural gas) in the regional heating system.



# USE CASE - WASTE INCINERATION PLANT – ENERGY SYSTEM

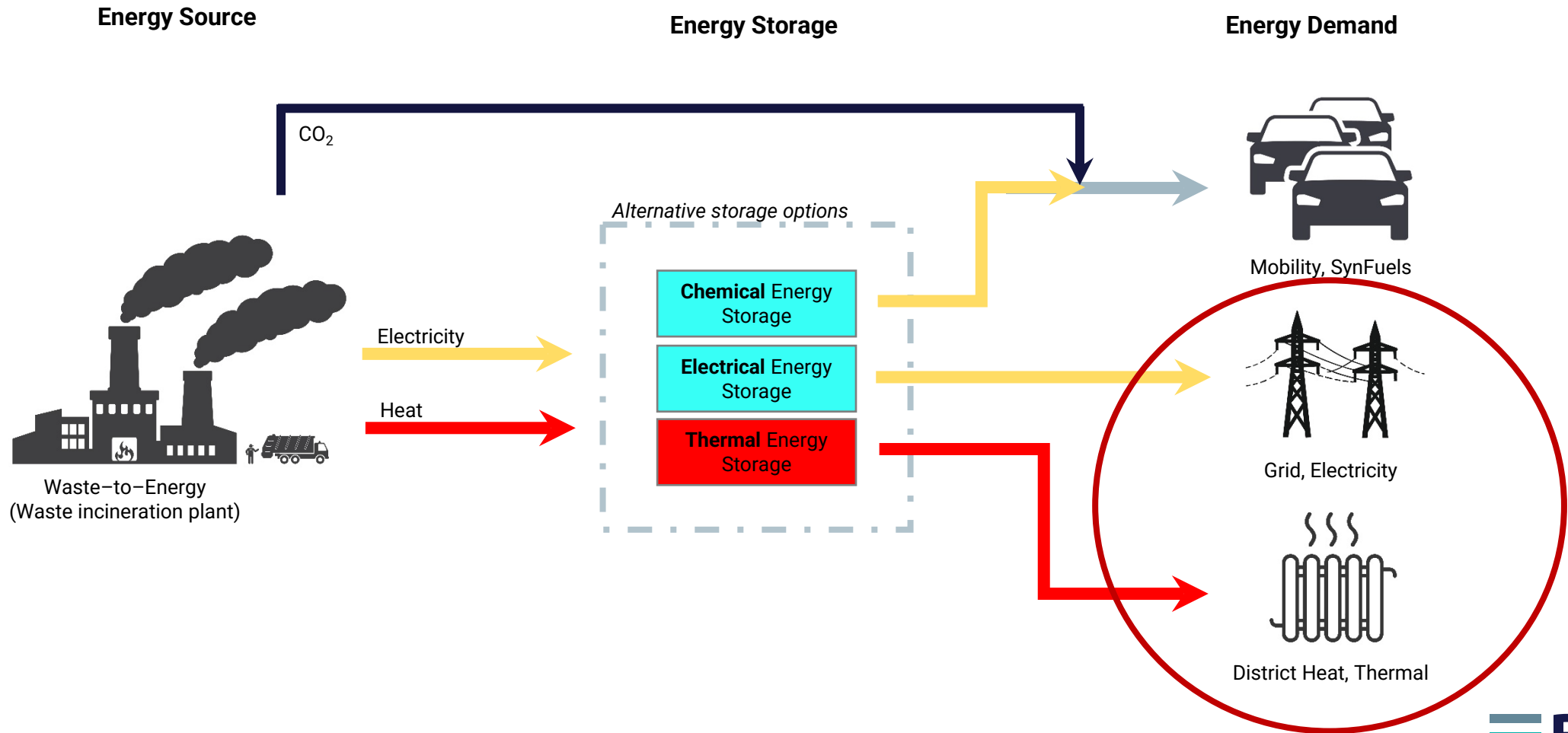


# INTRODUCTION TO THE WORKSHOP

## Main Question:

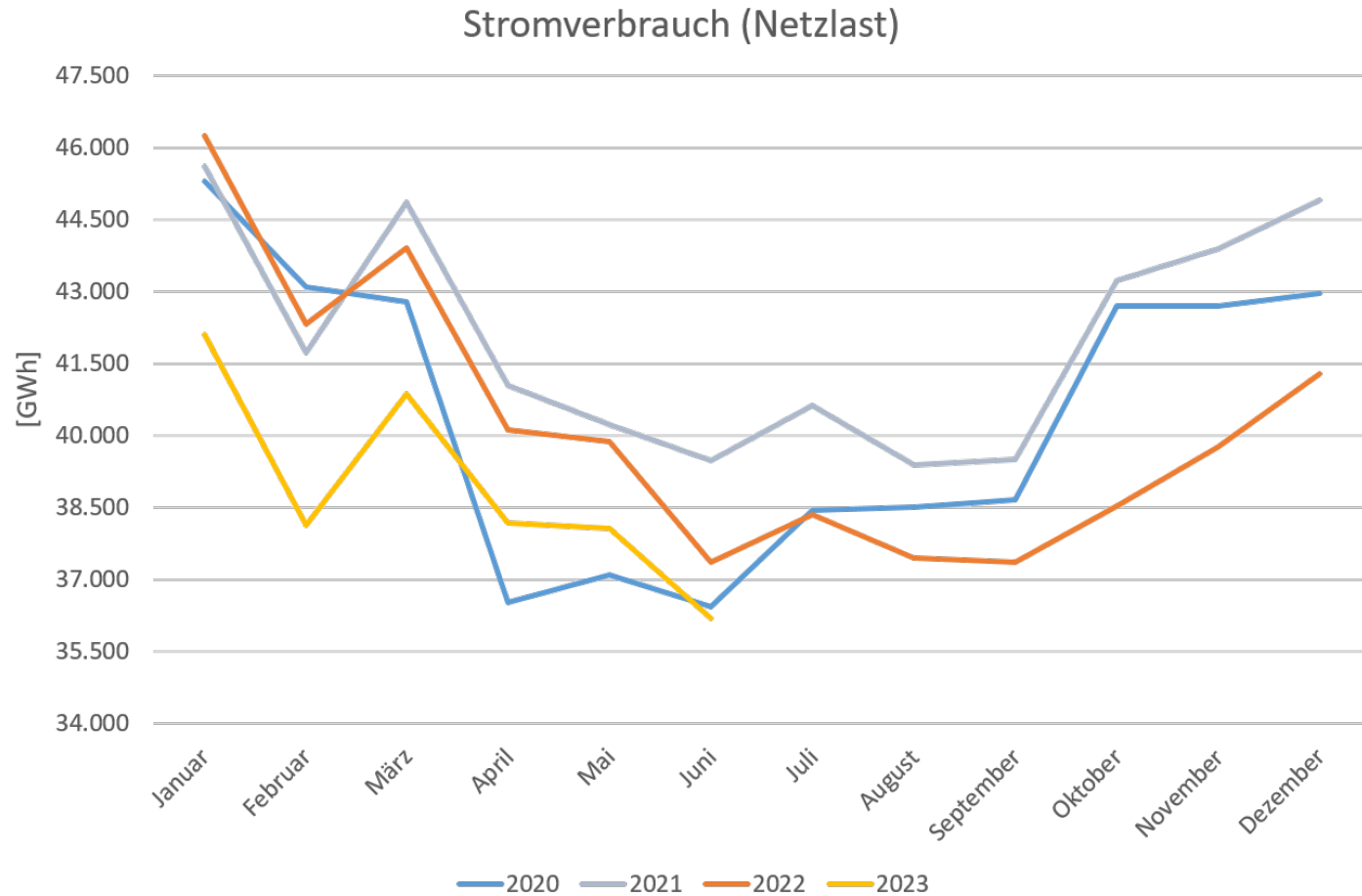
**Which energy storage technology is most suitable for storing surplus energy from the Waste-to-Energy plant so that it can be used flexibly within the regional energy demand?**

# USE CASE - WASTE INCINERATION PLANT – ENERGY SYSTEM



# WASTE-TO-ENERGY PLANT: DEMAND SIDE

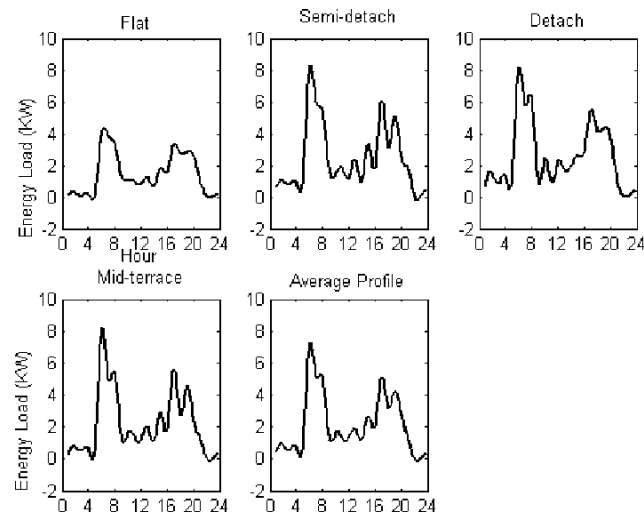
## Demand Side Characteristics: Electricity



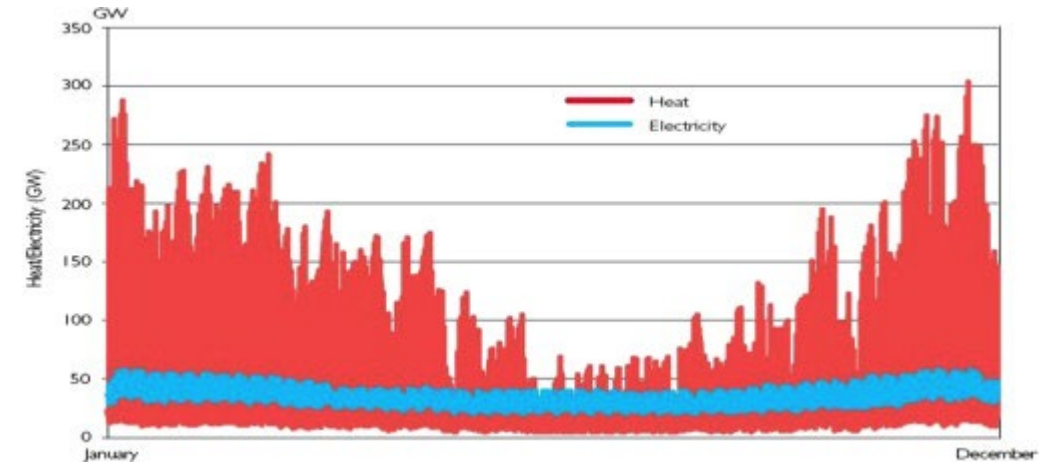
# WASTE-TO-ENERGY PLANT: DEMAND SIDE

## Demand Side Characteristics: District Heating

- Temperature 80-90 °C
- Hot Water Storage (Tank, PTES, UTES, Aquifer...)
- Winter-Summer Profile (seasonal)
- Daily Profile (short-term)



Yao, Runming & Steemers, Koen. (2005). A method of formulating energy load profile for domestic buildings in the UK. Energy and Buildings

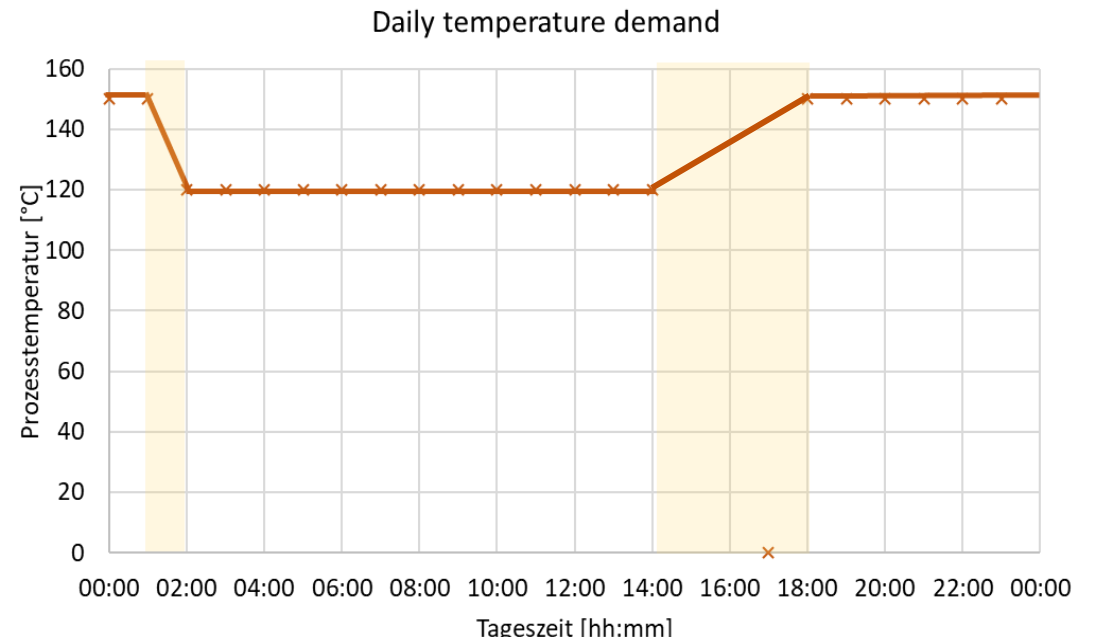
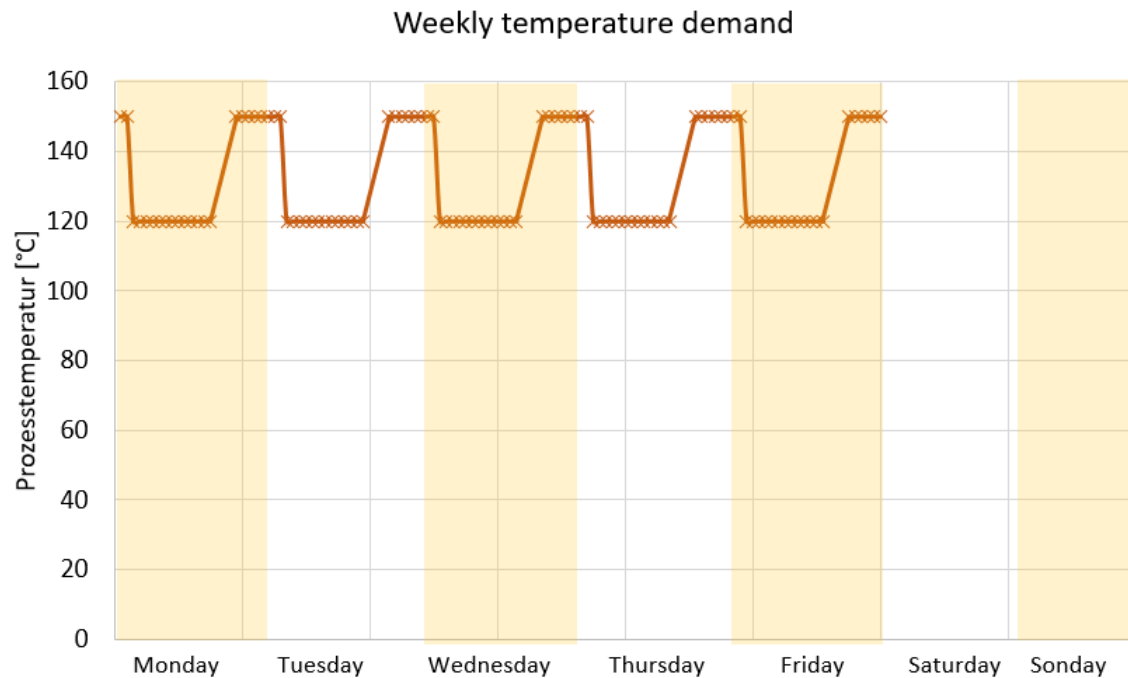


Chaudry, Modassar & Abeysekera, Muditha & Hosseini, Seyed & Jenkins, Nick & Wu, Jianzhong. (2015). Uncertainties in decarbonising heat in the UK. Energy Policy. 85. 10.1016/j.enpol.2015.07.019.

# WASTE-TO-ENERGY PLANT: DEMAND SIDE

## Demand Side Characteristics: Process Heat in Food Industry

- Temperature 120-150°C °C
- Intermittent demand overheated Steam
- Weekly / daily temperature profile



## INTRODUCTION TO THE WORKSHOP

**Question to answer in the workshop:**

**How would you weigh the KPIs / criteria  
in order to choose the best suitable energy storage  
technologies for this use case?**

# USE CASE - KPI / DECISION CRITERIA

## **KPI / Decision Criteria**

**Storage efficiency (round-trip efficiency)**

**Cycle stability and aging**

**Storage performance and dynamic behavior**

**Achievable storage capacity**

**Space requirements**

**Local social acceptance**

**Investment and operating costs per usable kWh**

**Environmental impact over lifetime (LCA)**

**Technology readiness level (TRL)**

**Sectoral multiple use and energy system benefits**

**Integration effort**

**System complexity**

## **Definition**

Ratio of energy output to energy input over one full charge–discharge cycle.

Degradation of performance and capacity over repeated charging cycles.

Ability to charge, discharge, and respond quickly to fluctuating input.

Suitability for short-term, daily, or seasonal energy storage.

Physical space needed per unit of usable stored energy.

Public acceptance based on visibility, safety, and perceived risks.

Total capital and operating cost per usable kilowatt-hour.

Environmental effects across the full life cycle of the system.

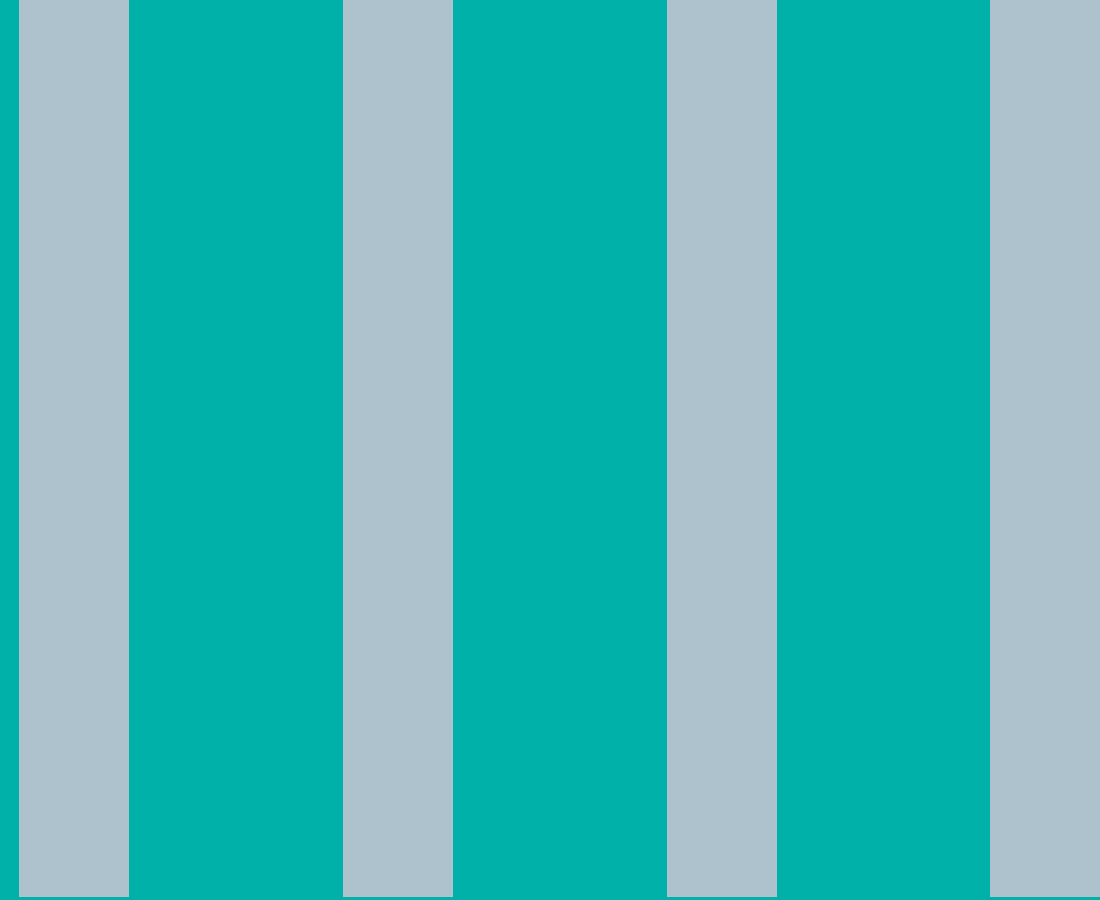
Maturity level from research stage to commercial deployment.

Potential to couple sectors and provide system-wide benefits.

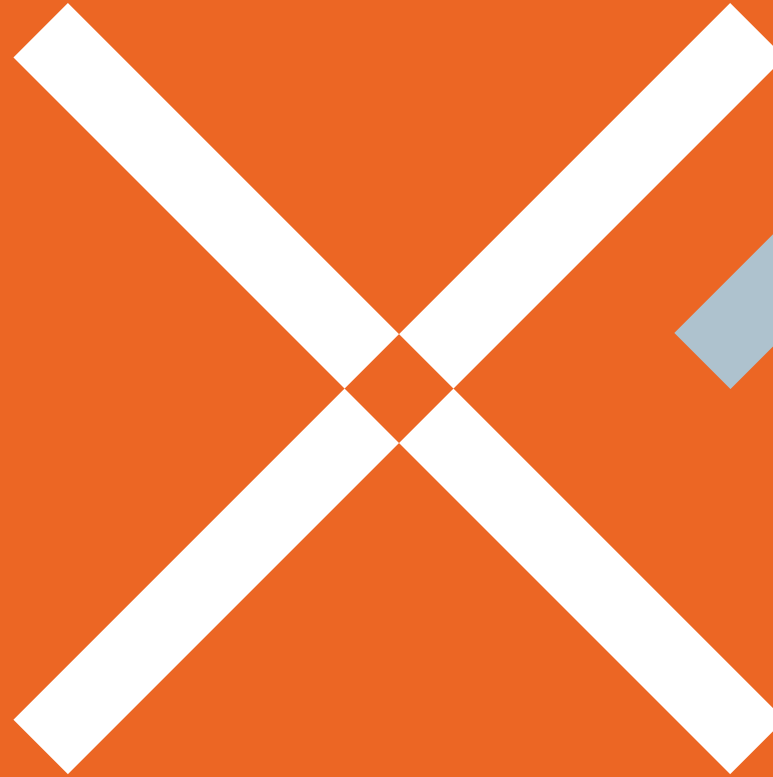
Effort required to integrate into existing energy systems.

Technical complexity of design, control, and operation.

# APPLICATION ORIENTED IMPLEMENTATION OF ENERGY STORAGE SYSTEMS - APPES



THANK YOU VERY MUCH  
FOR YOUR ATTENTION!



# OBJECTIVES

## Relevance of Application / Energy Demand Sectors and CO2 Emissions

Distribution of CO<sub>2</sub> emissions among the „Sectors“:

- **Electricity** **24%**
  - Lighting 5 %
  - ICT 4 %
  - Mech. Energy in Ind./T&C 16 %
- **Thermal** **> 50 %**
  - DHW 4 %
  - Process Cold 3 %
  - **Process Heat 24 %**
  - Space Heating 19 %
  - AC <1 %
- **Mobility** **24 %**

