AEE INTEC

Compact Thermal Energy Storage –

International Developments in General and CREATE in Particular

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Leader, Technology Development department

CREATE

‘Compact REtrofit Advanced Thermal Energy Storage’

EU funded project, 2015 - 2020

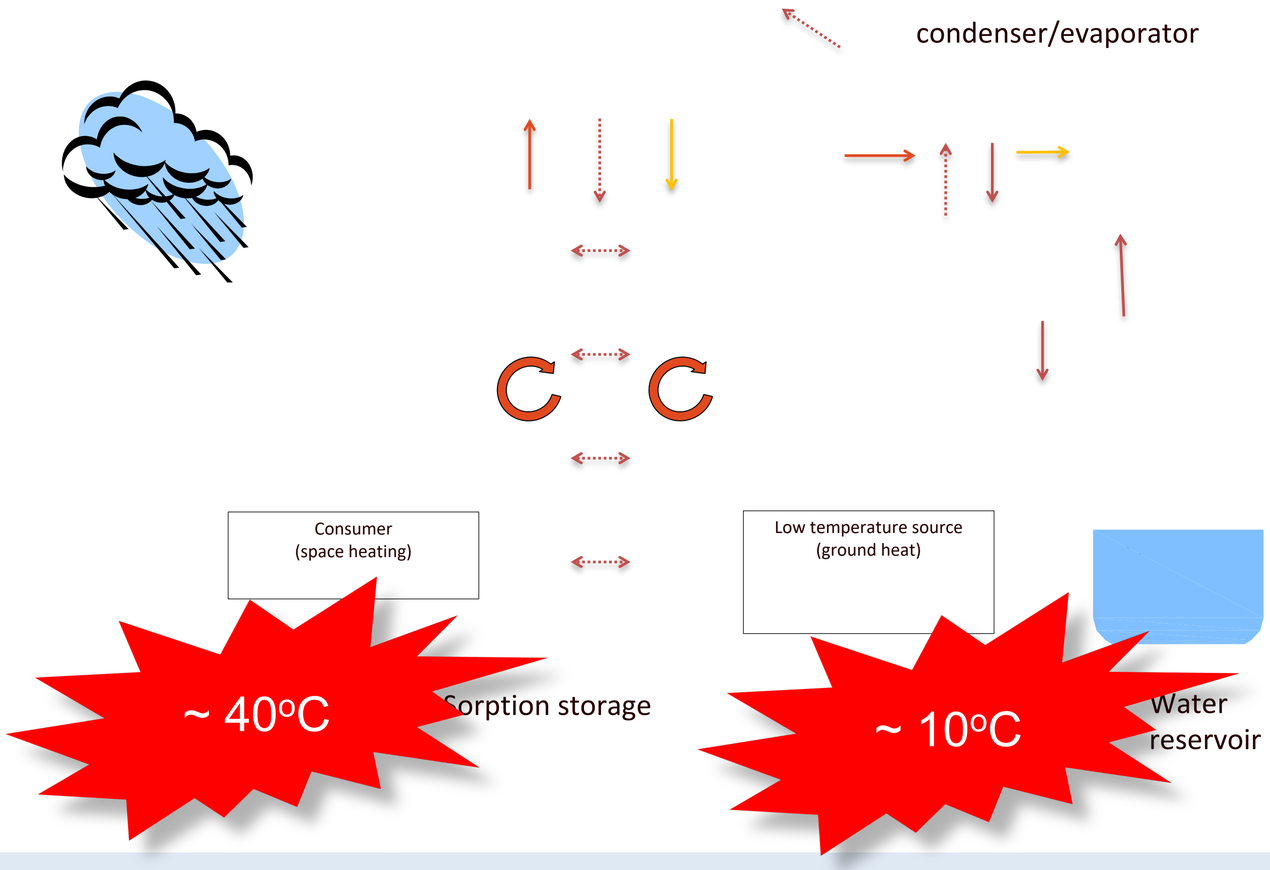
Target:

Development and demonstration of a **seasonal heat storage system** based on **salt hydrates** for single and multifamily houses with the following requirements:

- Cost-effective
- Compact
- No heat loss during storage

Material development

Salt hydrate should be able to deliver room heating and tap water temperatures



Materials selection

Approach: 563 reactions have been screened
Selected candidate: **Potassium carbonate – K_2CO_3**

- Energy density @ material level: 1.3 GJ/m^3, 361 kWh/m^3
- Output temperature with: 60^{o}C (with 10^{o}C water)
- Health/safety issues: none
- Material costs: ~ 1 €/kg

For more information:

https://doi.org/10.1016/j.apenergy.2017.04.080

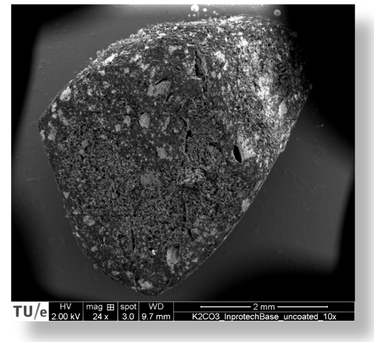
Materials optimisation and processing (TU/e, Caldic, DOW)

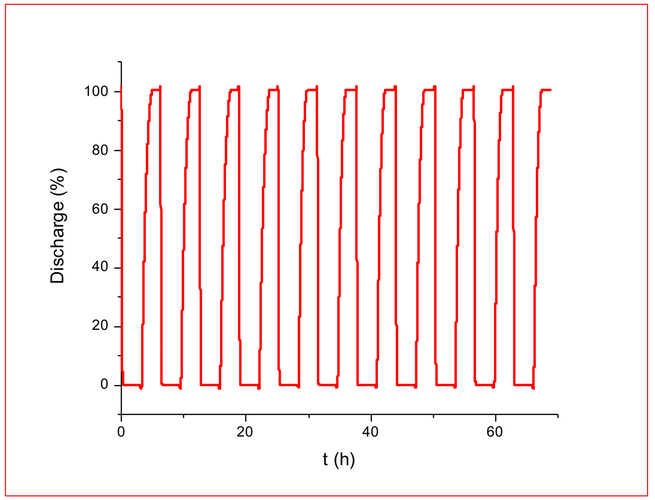
compaction (Caldic)

Hydrated powder (K_2CO_3)

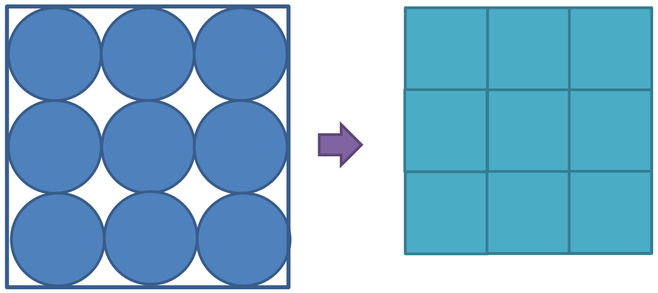
Binder

Particle E/V:
1.3 GJ/m^3





Technical Development: Storage vessel



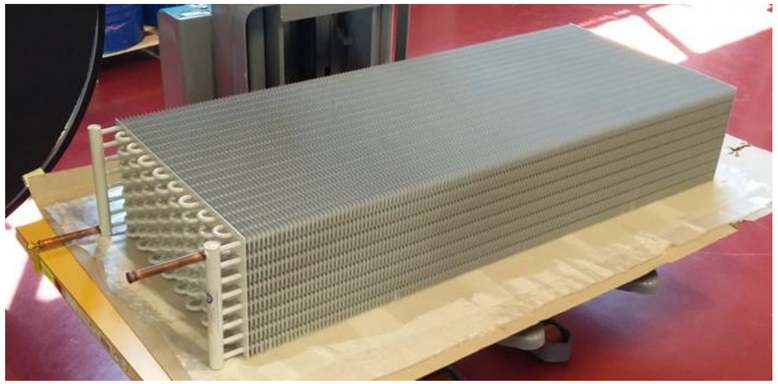
Prismatic storage design reduces space needs by more than 20%.

Internal fin heat-exchanger as structural element

Power requirement: 2.5kW

Module size: 1.85m x 0.95 x 0.35m → 400 liter module

Working pressure: ~10mbar

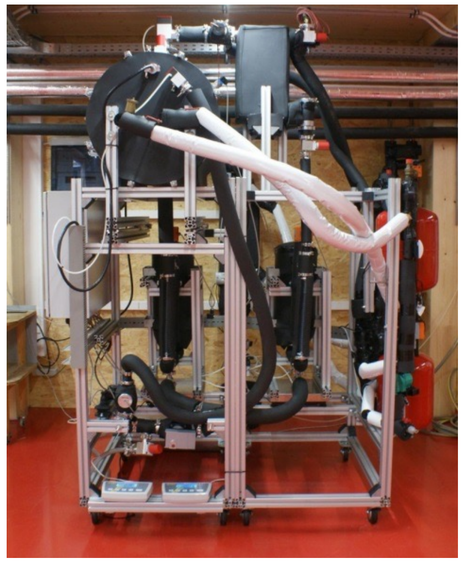


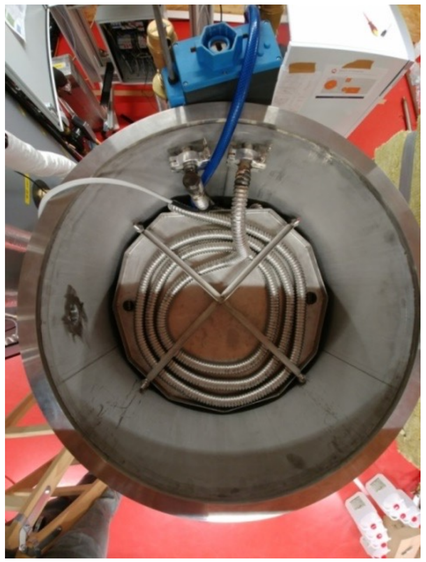
Technical Development: Evaporator /Condenser

Experimental investigation and evaluation of four different evaporator/condenser types (finned, microchannel, falling film, corrugated tube)

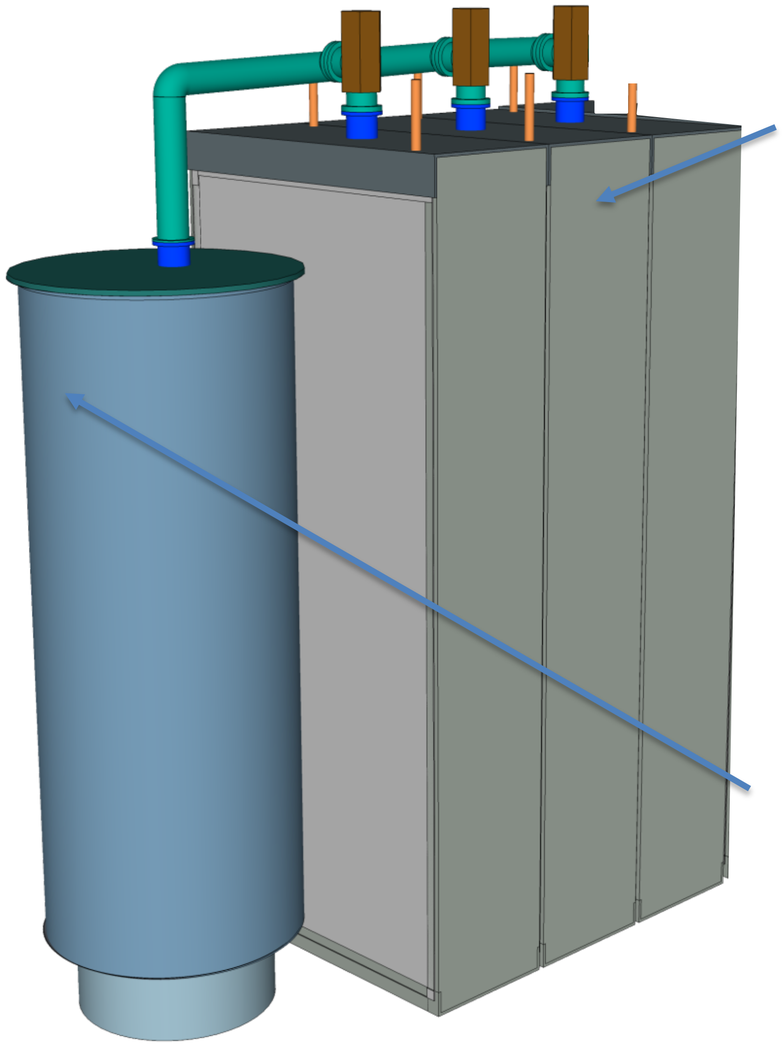
Corrugated tube E/C combines simple and powerful design:

- 15m resp. 50m corrugated tube in 3 resp. 6 trays as E/C





CREATE – System Design



Prismatic and modular expandable storage module design

3 modules with 400 litre K_2CO_3 storage material each

Central "corrugated tube" - evaporator/ condenser design

Pumped system

Process water tank: ~200Liter

Storage System – Laboratory Experiments

Experimental investigation of one storage module in 2018

Multiple Dehydration and Hydration runs

Charging temp: 80°C-100°C

Discharging temp.: <50°C

Significant correlation between temperature and power

No degradation of the material and performance after more than 20 runs

Demonstrating the CREATE Storage System

After single module tests, build up of a full CREATE storage system with 3 modules and a total of 1.200 litres of K_2CO_3

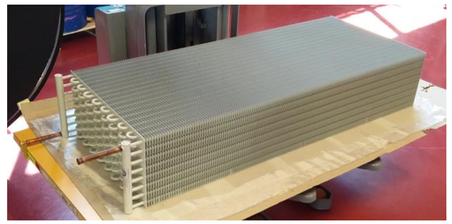
Hardware in the loop experiments in Gleisdorf until July 2019

Integration of the CREATE storage system in an orphanage in Warsaw August 2019

Demonstration of the storage system in Warsaw until April 2020

Successful, flawless demo period: no malfunctioning of the system

CREATE Storage System
Key Facts



CREATE Storage System:

- Modular expandable storage module design
- 3 modules with 400 litre K_2CO_3 storage material each
- Capacity: ~145kWh*
- Central "corrugated tube" - evaporator/ condenser design
- Pumped system

Significant correlation between temperature and power

Maintenance-free operation, no material degradation

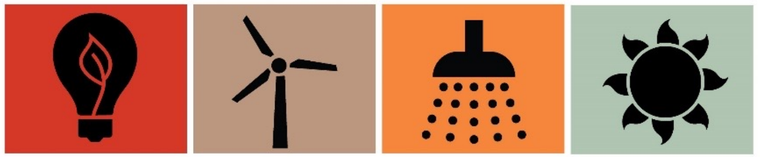
Avg. heating power up to **2.766W***

Storage density of **115kWh/m³** *(HX-level)

*Hardware in the Loop Experiments

Visit our website www.createproject.eu

CREATE



Compact REtrofit Advanced Thermal Energy storage

RINA. Excellence Behind Excellence.

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 680450

Compact Thermal Energy Storage
-- still needed --

Ongoing research and development in order to arrive at compact, cost-effective thermal storage.

Collaboration between two IEA Technolog Collaboration Programmes:

SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

+

energy storage
IEA Technology Collaboration Programme

Task67 / Task 40

Compact Thermal Energy Storage Materials within Components within Systems

Oktober 2021 – September 2024

T67T40 Objectives

- to have a better understanding of the factors that influence the storage density and the performance degradation of CTES materials
- to be able to characterize these materials in a reliable and reproducible manner
- to have methods to effectively determine the state of charge of a CTES
- to have better knowledge on how to design optimized heat exchangers and reactors for CTES technologies

What is the work breakdown?

SubTask		Lead
A	Material Characterization and Database	Daniel Lager, AIT, Austria
B	CTES Material Improvement	Stefania Doppiu, CIC energiGUNE, Spain
C	State of Charge – SoC Determination	Gerald Englmair, DTU, Denmark (for PCM) Reda Djebbar, CanmetEnergy, Canada (for TCM)
D	Stability of PCM and TCM	Christoph Rathgeber, ZAE Bayern, Germany
E	Effective Component Performance With Innovative Materials	Benjamin Fumey, Empa, Switzerland (for TCM); Ana Lazaro, Univ. Zaragoza, Spain; Andreas König-Haagen, Univ. Basque Country, Spain (for PCM)

Challenges

Subtask A: Material Characterisation and Database

Design reliable and reproducible characterisation and test methods

Subtask B: CTES Material Improvement

Find and understand techniques to systematically improve materials performance

Subtask C: State of Charge Determination

Develop measurement methods in combination with numerical methods to reliably determine the state of charge of PCM and TCM storages

Subtask D: Stability of PCM and TCM

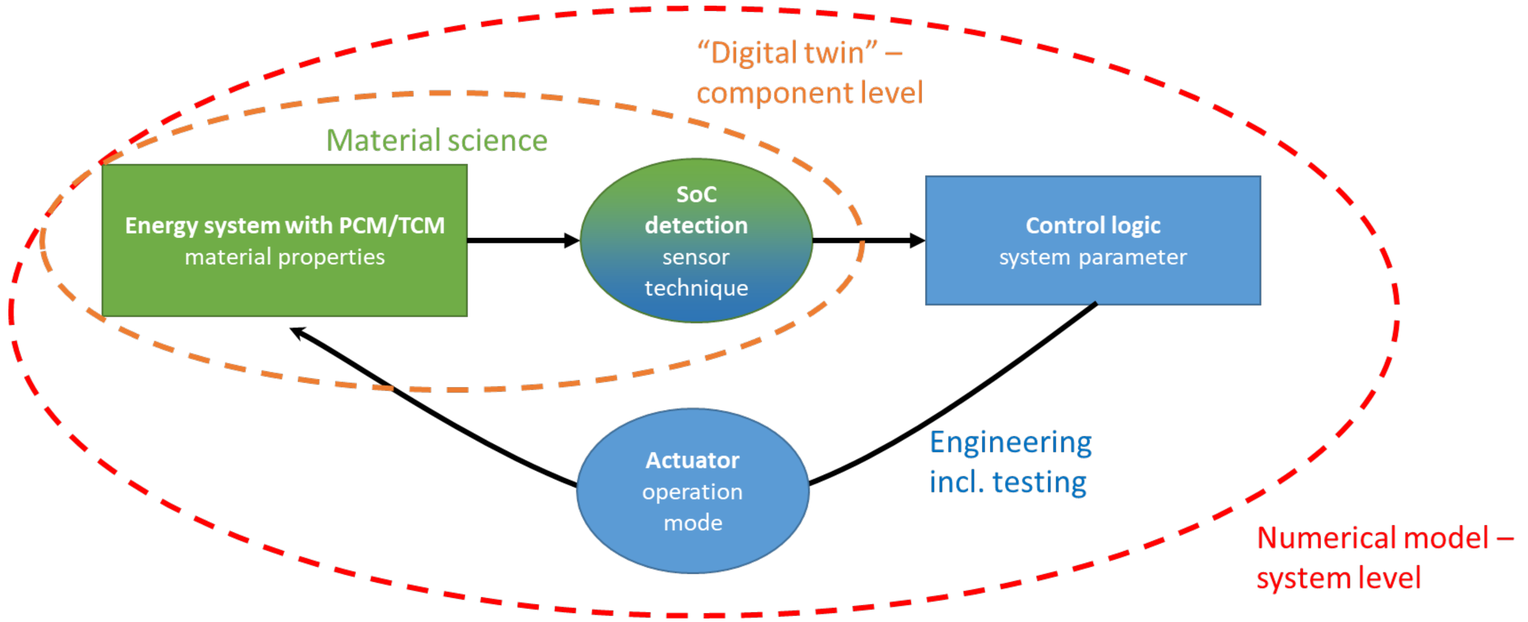
Understand the mechanisms that determine the stability and use these to improve it

Subtask E: Effective Component Performance With Innovative Materials

Find ways to asses component performance and develop methods to design improved components

Subtask C: State of Charge Determination

Denmark / Gerald Englmair (PCM) and Canada / Reda Djebbar (TCM)



First inventory of physical material properties suited as SoC determinant

Proper reference technique needed for calibration

Machine learning / AI needed for proper functioning SoC

T67T40 participation

About 100 participating experts, from 15 countries

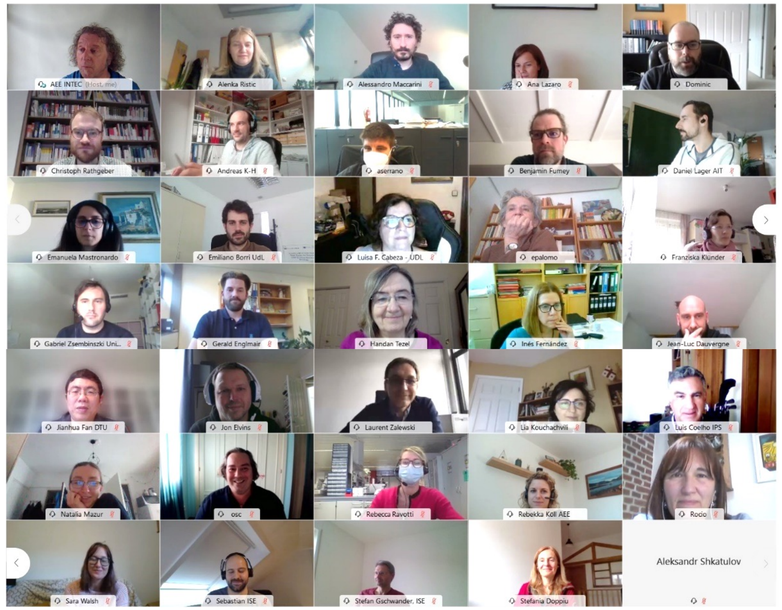
Kick-off meeting held in Vitoria-Gasteiz, Spain
27-29 October 2021

Next meeting: Graz, Austria
4+5 April 2022
(in connection to the ISEC2022)

Country/Sponsor	Number of Research Institutes	Number of Universities	Number of Companies
Austria	2	2	
Canada	1	3	
Denmark	1	1	
France	1	6	
Germany	3	3	1
Italy	2	1	
Netherlands	1	1	
Norway	1		
Portugal	1	1	1
Slovenia	1		
Spain	2	4	
Sweden		1	
Switzerland	1	1	
United Kingdom		4	1
United States	1		

Invitation

Researchers and developers of PCM and TCM technologies are cordially invited to join us!



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