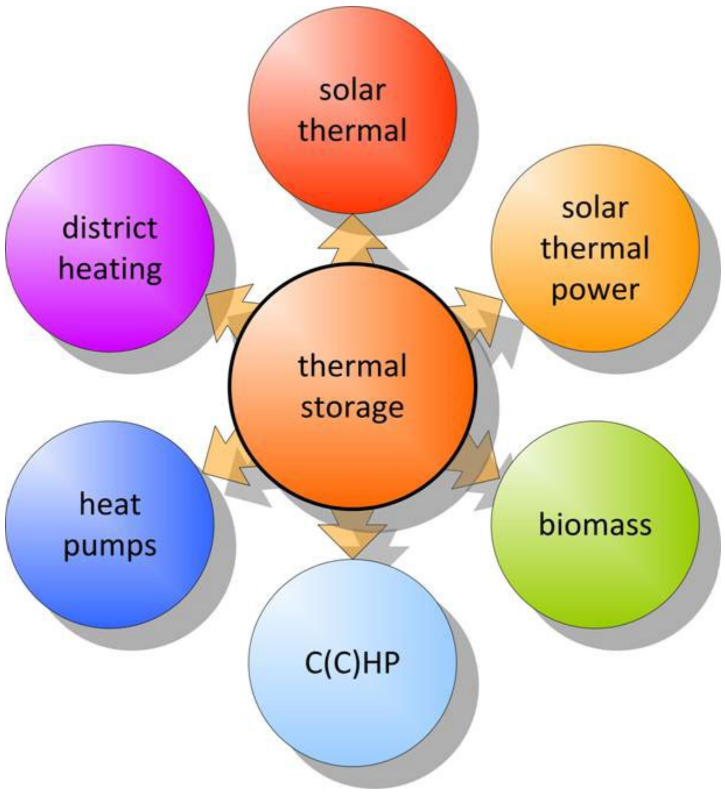
Compact Thermal Energy Storage Materials within Components within Systems

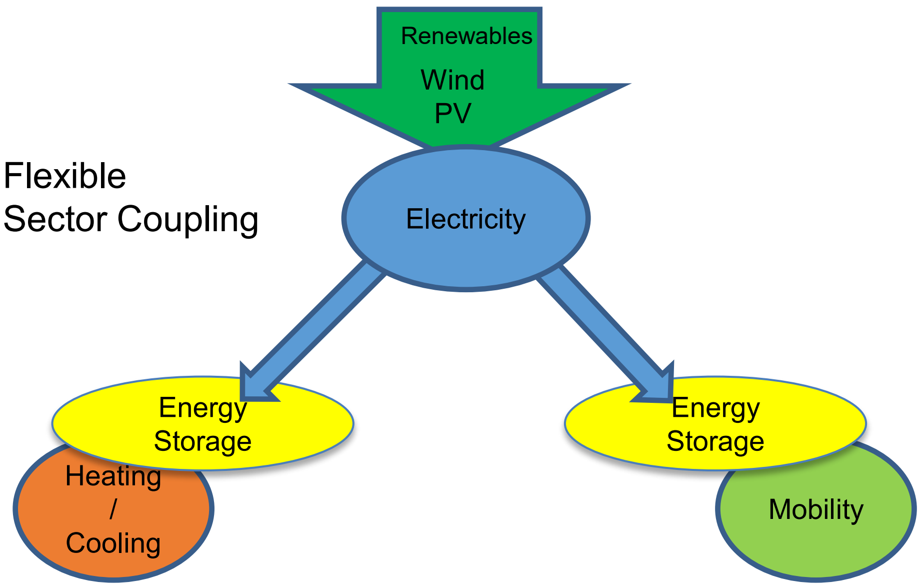
SHC Task67

(fully joint Task with IEA Energy Storage TCP Task 40)

Wim van Helden
Task Duration: 1 October 2021 – 30 September 2024
Collaborative Task with: TCP ES Task40

Thermal Energy Storage is a Key Enabling Technology





Source: ZAE Bayern, IEA ECES Annex 35

Scope

- CTES (Compact Thermal Energy Storage) materials
  - Phase Change Materials (PCM)
  - Thermochemical Materials (TCM)

  CTES material…

  …characterization

  …development

  …improvement

  …testing in components (heat exchangers, reactors)

PCM
(e.g. ice, paraffins, salt hydrates)

TCM
(e.g. zeolite+water, NaOH+water)

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

Task structure

	Subtasks	Subtask Lead
A	Material Characterisation 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, NRCan, 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. of Zaragoza, Spain and Andreas König-Haagen, Univ. Basque Country, Spain (for PCM)

Task67/Task40 Experts at Kick-off Meeting (Oct 2021) and at 2nd Experts Meeting (April 2022)

Subtask A: Material Characterisation and Database

Austria / Daniel Lager

A.1 Standardized measurement procedures and round robin tests

- Four groups were formed that contribute to round-robin tests
- 27 Institutes will perform tests

A.2 CTES Materials database and knowledge platform

- Discussion on must have and nice to have
- First list of experts to contribute to further filling of database

Home | User | News | Workshops | Measurement-Standards & Tools | PCM

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Database PCM

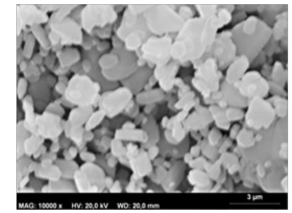
Show 25 entries

Name	Institution	Last Change	Melting Temperature	Heat of Fusion
			[ºC]	[kJ/kg]
CaBr2·6H2O	ZAE-Bayern	Apr 19, 2017	33.29	135.5
gypsum board	Fraunhofer ISE	Oct 18, 2019	18.48	19.4
HDPE natur NT D960/6	Fraunhofer ISE	Oct 13, 2015	128.0	219.0
Lauric acid (dodecanoic acid)	ZAE-Bayern	Apr 19, 2017	43.5	178.2
Lauric acid (Dodecanoic acid)	Fraunhofer ISE	Sep 07, 2017	43.65	180.0
Methyl Stearate (methyl octadecanoate)	Fraunhofer ISE	Sep 07, 2017	36.7	208.0
Micronal DS 5038 X	Fraunhofer ISE	Apr 09, 2018	21.5	96.0
Micronal DS 5040 X	Fraunhofer ISE	Apr 09, 2018	19.07	93.6
n-Octadecane, 99%	Fraunhofer ISE	Sep 07, 2017	27.5	233.0
n-Octadecane, 99.5+%	Fraunhofer ISE	Sep 07, 2017	27.66	237.0
NaNO3	Fraunhofer ISE	Oct 02, 2017	307.0	175.0
Octadecan Parafol 18-97	Fraunhofer ISE	Jun 13, 2017	27.35	231.3
PEG1000	Fraunhofer ISE	Sep 07, 2017	31.0	150.0
PEG600	Fraunhofer ISE	Sep 07, 2017	13.0	137.0
Potassium nitrate (KNO3)	Fraunhofer ISE	Sep 13, 2016	329.6	92.5
RT 70 HC	Fraunhofer ISE	Oct 13, 2015	70.1	256.4

Figure: Screenshot of https://thermalmaterials.org/

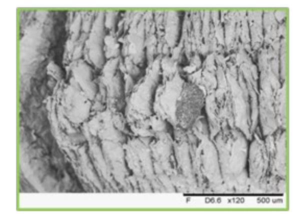
Subtask B: CTES Material Improvement

Spain / Stefania Doppiu



B.1 Exploring potential materials for CTES

Inventory of experts working on novel or improved materials



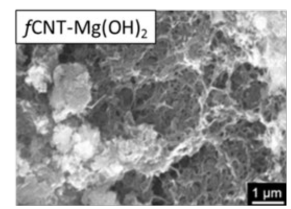
B.2 Improving the performances and increasing versatility: Advanced composites for CTES and best conditioning

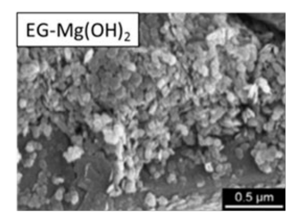
Pure, doped and composite materials

How to map material improvement techniques

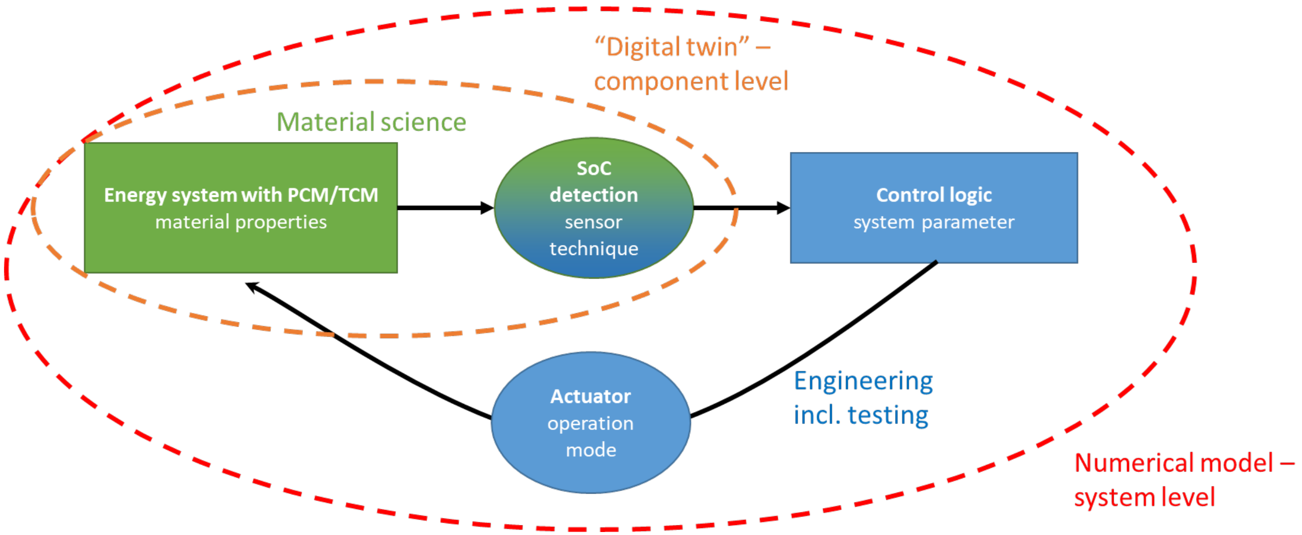
How to define Key Performance Indicators for CTES materials

Discussion on promising material development pathways





Subtask C: State of Charge Determination
Denmark / Gerald Englmair (PCM)
Canada / Reda Djebbar (TCM)



First inventory of physical material properties suited as SoC determinant

Proper reference technique needed for calibration

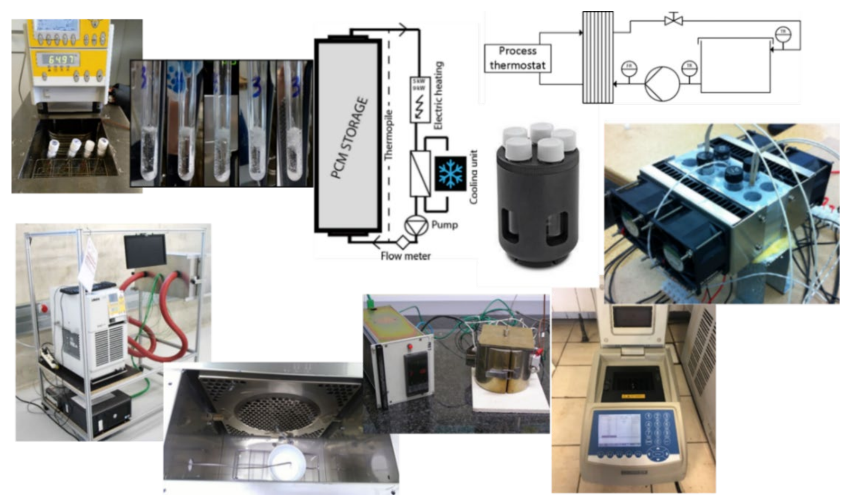
Machine learning / AI needed for proper functioning SoC

Subtask D: Stability of PCM and TCM

Germany / Christoph Rathgeber

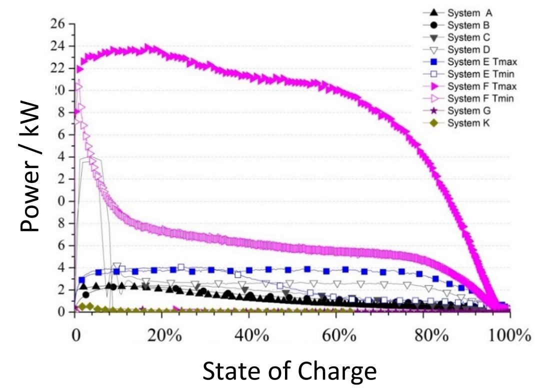
Differentiation needed between stability testing at prototype level and stability testing for material development

Kinetic models to extrapolate thermal degradation can be used to predict long-term behaviour of CTES materials



Subtask E: Effective Component Performance With Innovative Materials

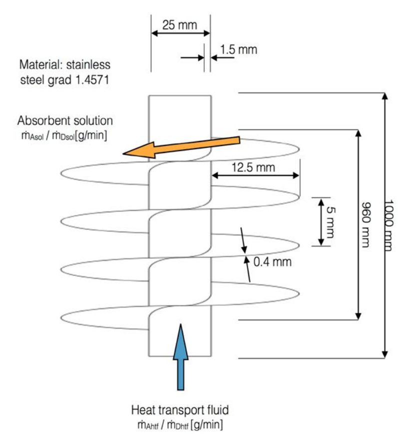
Spain / Ana Lazaro and Andreas König-Haagen (PCM)
Switzerland / Benjamin Fumey (TCM)

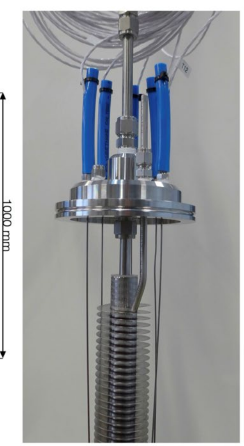


Large variation in storage components with CTES materials

First, representative performance parameters will be defined that can be used for comparison

A collection of available measurement data will be made, as means for testing comparison methods





Participating Countries / Sponsors

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		

SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY

Task Meetings

Meeting #	Date	Location	Number of Participants & Countries/Sponsors
1	27-29 Oct 2021	Vitoria Gasteiz, Spain	24 (in person), 35 (virtual) 15 countries
2	4-5 April 2022	Graz, Austria	38 (in person), 13 countries
3	29-30 Sep 2022	Kassel, Germany	
4	May 2023	Halifax, Canada	
5			
6			
7			

→ **Experts interested in participation: please contact the Task Managers** www.iea-shc.org

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