Low Temperature Switchable Latent Heat Storage (sLHTES)

Material development and storage concept

M. Walter, C. Teicht, S. Pappert

Fraunhofer Institute for Chemical Technology ICT, Joseph-von-Fraunhofer-Str. 7, 76327 Pfinztal, Germany

In the context of the increasing electrification of the heating sector in Germany and Europe, heat pumps are playing an increasingly important role.
57 % of residential buildings built in Germany in 2022 will be equipped with heat pumps1. These are usually combined with surface heating systems. Two thirds of the heat required is for space heating and therefore at a low flow temperature of 35 °C to 40 °C. In the area of heat storage, there is currently still a lack of a customized and affordable storage concept.

Highly flexible and modular phase change material (PCM) based thermal energy storage system for efficient heating applications in the built environment (NewHeatIntegrated)

The objective of the EU **NewHeatIntegrated** project is to develop a compact, switchable two-stage latent heat storage system (sLHTES) based on two modified salt hydrates with phase transition temperatures of approx. 58 °C for hot water and 35 °C for space heating (see Fig. 1). The low temperature stage for the heating circuit can be charged with a flow temperature of 40°C. At this lower temperature, the average seasonal coefficient of commercially available air source heat pumps is significantly higher than at the flow temperatures of approx. 55 °C required for sensible storage tanks[2].
Another advantage of the LT-sLHTES is the high volumetric storage density (table 1), which allows a reduction of the storage volume by approx. 66% compared to corresponding sensible heat storage tanks with the same storage capacity[3].
In addition to the storage material, the design of the heat transfer surfaces and the selection and treatment of the materials for these and the storage tank are central to the development of the project.
An AI-based control unit with comprehensive sensor technology will be developed to optimize the operation of the system in terms of heat distribution to the user and storage charging.
The storage system will be fully integrated and monitored at three demonstration sites in Vaasa (Fi), Ostrava(CZ) and Schwarzenbach (D).

The following international partners are involved in NewHeatIntegrated:

nolla_E BME DR. GOLBS & PARTNER Vaasan yliopisto UNIVERSITY OF VAASA VSB TECHNICAL UNIVERSITY OF OSTRAVA

The research project started in 10/2023 and will be funded for three years as part of the CET Partnership Joint Call 2022. The German partners are funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK) via the project management organization Jülich under the ***funding code 03EN6042A.***

Bundesministerium für Wirtschaft und Klimaschutz

ptj Projektträger Jülich Forschungszentrum Jülich

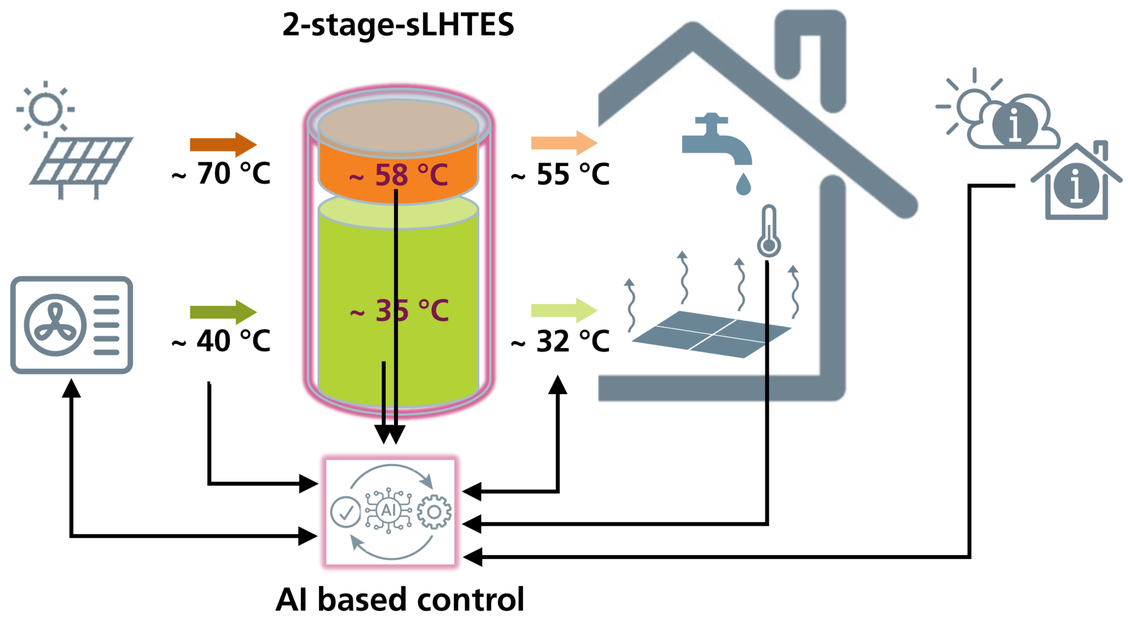

Fig. 1: Schematic representation of the two-stage sLHTES and the control unit as it is to be developed in the NewHeatIntegrated project.

Table 1:technical specifications of the innovative sLHTES developed in the NewHeatIntegrated project

Technical specifications of the two-stage sLHTES	
Heat storage density	**100 kWh/m³**
Storage capacity 58 °C (latent only)	4,5 kWh
Storage capacity 35 °C (latent only)	10,5 kWh
heat output	max. 50 kW

Heat storage with supercooled and switchable PCM (sPCM)

In latent heat storage systems with PCM, the phase change between solid and liquid phase is used to store thermal energy. Some salt hydrates are suitable as PCM, whereby these materials continue to store the thermal energy in the state of the supercooled melt when the temperature falls below the melting temperature (compare Fig. 2). This means that the heat can be stored for almost any length of time without losses. The switchable PCM (sPCM) is actively crystallized by an actuation system and thus releases the stored heat to the environment at melting temperature. For the temperature level of ~ 35 °C, di-sodium hydrogen phosphate dodecahydrate, which shows great potential, will be modified as a sPCM with high phase change enthalpy, high cycle stability and reliable supercooling stability.

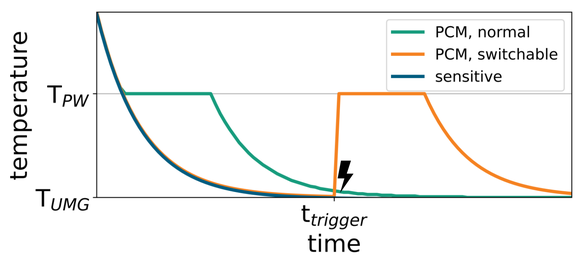

Fig. 2: Exemplary storage temperature over time for different heat storage concepts: sensitive TES, ideal LHTES with plateau at phase transition temperature, sLHTES with stable subcooling and controllable heat dissipation

More information on the research topics in the field of energy-efficient storage systems and all aspects of latent and thermochemical heat storage

Contact: moritz.walter@ict.fraunhofer.de
For further information follow the link below or scan the QR-Code.
https://www.ict.fraunhofer.de/vergelte-Phase-Change-Materials

1 V. Pawlik, Anteil von Wärmepumpen in neuen Wohngebäuden in Deutschland bis 2022, 17.11.2023, https://de.statista.com/statistik/daten/studie/237364/umfrage/bedeutung-der-waermepumpen-im-neubau-in-deutschland/

2 D. Günther et al., WP Smart im Bestand, Fraunhofer ISE, 2021

3 Compared to a water based heat buffer storage with a specific heat capacity of ~4200 kJ/(m³*K) and a typical temperature spreadm of ~ 40 K.