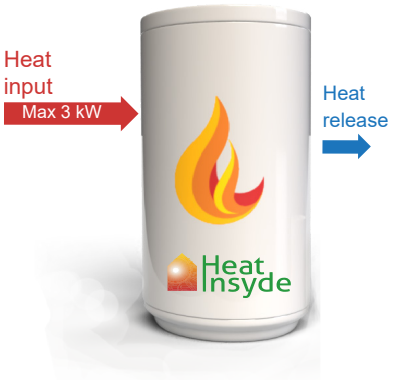
Thermochemical heat storage system - for clean energy when you need it

Charging

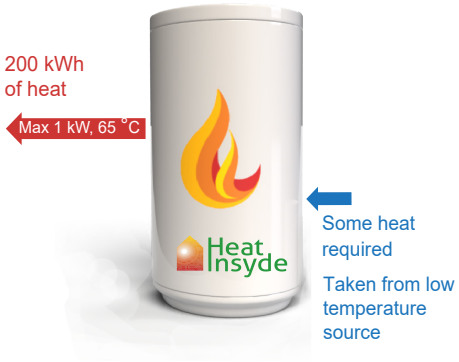


To store heat in the thermochemical material (TCM), a hot source is provided at maximum 150°C, e.g. from low temperature industrial waste heat or from renewable electrical or thermal energy, such as solar thermal or photovoltaic panels. While charging, the system accumulates heat in the TCM to store for later use. At the same time, it also releases some heat at a temperature lower than that of the hot source. Depending on its temperature, this released heat could feed a domestic hot water tank, underfloor heating, or serve to preheat cold water in another tank provided for this purpose. If the working temperatures are too low, the heat can be disposed in the environment.

During a complete charge, 200 kWh of heat are stored and 150 kWh of heat at a lower temperature are released. To run the auxiliaries needed to store heat (fans & pumps), the system also consumes electricity for the charging process.

Discharging

To recover the stored heat from the TCM, it needs to absorb water vapour. This vapour needs to be generated by external heat sources. The system provides 200 kWh of heat at temperatures up to 65°C but to do this, 150 kWh of heat below the desired output temperature need to be injected. This low-temperature heat should come from a source that cannot be valorised otherwise, e.g. the low temperature at the bottom of a stratified water tank or low-temperature waste heat, such as in grey water. In applications of district heating and cooling (DHC) or combined heat and power (CHP), it could be the return temperature.



Scalability

HEAT-INSYDE is limited in its input and output power in its original scale due to compacity constraints. However, these constraints are no longer present when considering larger capacities. Thus, input and output power become equal and can reach up to 10% of the capacity for larger-scale devices (e.g., up to 100 kW for an 1 MWh capacity).

Capacity	200 kWh	1000 kWh
Volume (whole system)	2.71 m^3	8.25 m^3
Energy density (TCM)	200 kWh/m^3	
Energy density (whole system)	73 kWh/m^3	120 kWh/m^3
Max input power	3kW	100 kW
Max output power	1 kW at 65 °C	100 kW
Electrical input	10% of heating power input/output	
Electrical input (full charge or discharge)	20 kWh	100 kWh

Overview

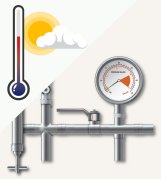
HEAT-INSYDE is an EU-funded project that is developing an affordable, compact and sustainable heat storage solution (heat battery). Renewable energy generation, e.g., through wind turbines and solar panels, has a major disadvantage: it is weather dependent, meaning that supply does not always meet demand. The HEAT-INSYDE technology brings a solution to make use of renewable energy also on windless and cloudy days, storing energy for on-demand use. The basic principle of such a technology is to use a TCM that is dehydrated to store energy, which it can release upon hydration.

Key advantages

SUSTAINABLE

The TCM is a non-toxic, cheap and earth-abundant material consisting of the common salt potassium carbonate.

VERSATILE

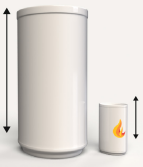


The system can provide either heating or cooling by reversing hot and cold sources.

STABLE

Heat stored in the TCM is stable for long periods of time, without loss of heat.

COMPACT



Its energy density capacity is ideally suited for storing large amounts of energy in confined places.

Learn more

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HEAT-INSYDE

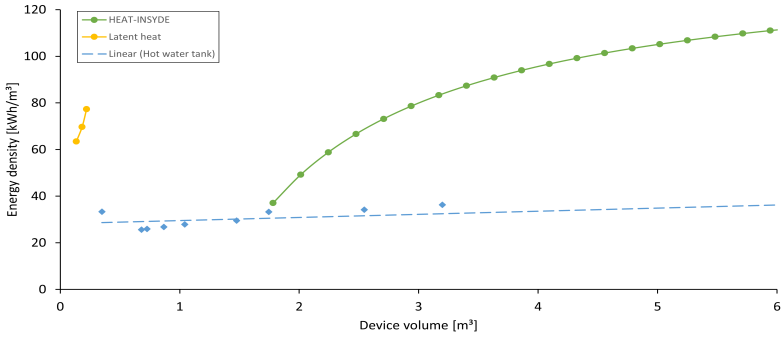
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869810.

Flexibility and reactivity

HEAT-INSYDE can be seen as a module that can be easily installed in a building. For collective housing, it means that no underground work is required. As for the system's reaction time, it enters into regime within 10 minutes. However, it is more suited for relatively constant charges/discharges: the best heat transfer efficiency is reached when constantly charging or discharging. Hence, another shorter-term thermal device like a hot water tank should be used for short bursts of demand.

Energy density

In terms of its energy density, the entire system is by definition always lower than the TCM's energy density, evaluated at 200 kWh/m³. In the case of HEAT-INSYDE, the energy density of the whole system follows the curve shown below, where it is compared to two other storage solutions more commonly found in the residential segment, storing at a temperature of 60°C.



Above 3 m³, HEAT-INSYDE has a better energy density than common residential solutions. It also benefits from a scaling effect, increasing its energy density non-linearly and reaching 120 kWh/m³ for volumes of 8 m³ and above. Therefore, HEAT-INSYDE could be adopted when energy density is key, like in places where only retrofit of confined areas are considered, or to reach a reasonable storage capacity while avoiding heavy investments induced by large-scale sensible heat storage (tank, pit, boreholes, etc.).

Application areas

The HEAT-INSYDE heat storage system can be an interesting asset in the following situations:

- **District heating and cooling (DHC):** new generation DHC systems work at HEAT-INSYDE's operating temperatures. The latter can act as a buffer for both heating and cooling. Its high energy density reduces the floor surface required for implantation of seasonal storage, making it an alternative for small DHC to avoid having to build underground SHS.
- **Coupling to waste heat:** depending on waste heat temperature, HEAT-INSYDE can use waste heat as a hot (>100°C) source to charge the system. This makes HEAT-INSYDE an attractive business opportunity to recover waste heat from industry if coupled with a transport vehicle .
- **Coupling with solar collectors:** HEAT-INSYDE allows to store excess heat produced by solar collectors, therefore reducing the storage volume initially required for the technology and enhancing the global efficiency of the system.
- **Coupling with micro-combined heat and power (CHP):** Cogenerations are lacking flexibility in the way that they cannot go at low heating power (<50% of nominal power) while sometimes producing too much electricity. HEAT-INSYDE could both absorb excess in electricity by charging itself while providing the low temperature needs, like in summer. During peak demands in winter, HEAT-INSYDE can also provide a boost and help the CHP.

Project coordinator

Prof. Olaf Adan, Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO), NL

Project partners

- Technische Universiteit Eindhoven, NL
- Caldic Benelux NV, BE
- Ventilairsec, FR
- Commissariat a l'energie atomique et aux energies alternatives, FR
- Gemeente Eindhoven, NL
- Stichting Sint TRUDO, NL
- Przedsiebiorstwo Robot Elewacyjnychfasada Sp. zoo., PL
- accelopment Schweiz AG, CH
- Bureaux d'etudes solaires SPRL, BE
- Belgisch laboratorium van elektriciteit-sindustrie, BE
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- Cellcius BV, NL
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