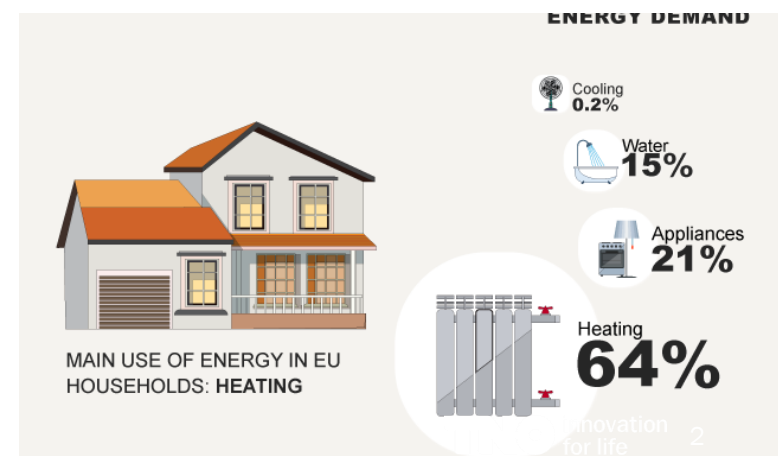
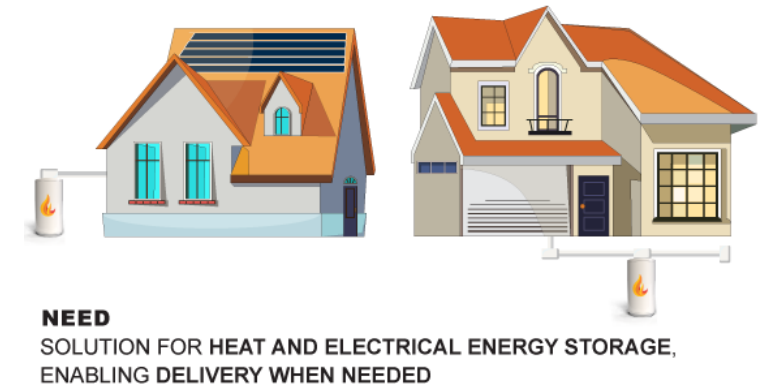
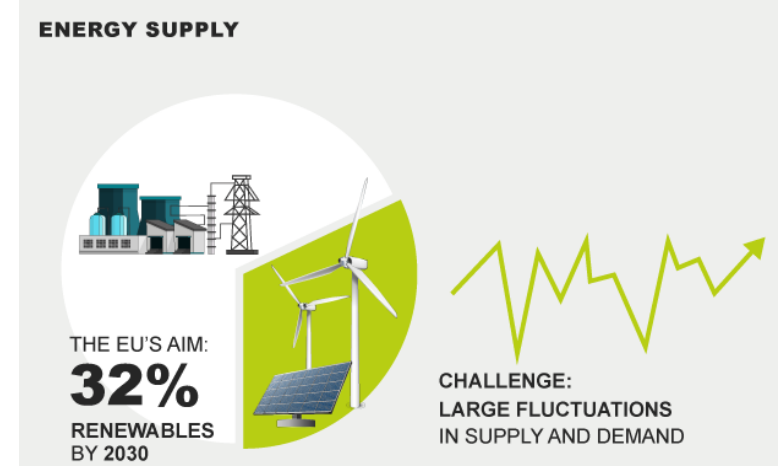


› **COMPACT THERMAL ENERGY STORAGE IN THE
RENOVATION WAVE – WHY, WHAT AND HOW**
RUUD CUYPERS, TNO

22 April 2021

› WHY DO WE NEED HEAT STORAGE? TO BALANCE ENERGY SUPPLY & DEMAND IN THE BUILT ENVIRONMENT

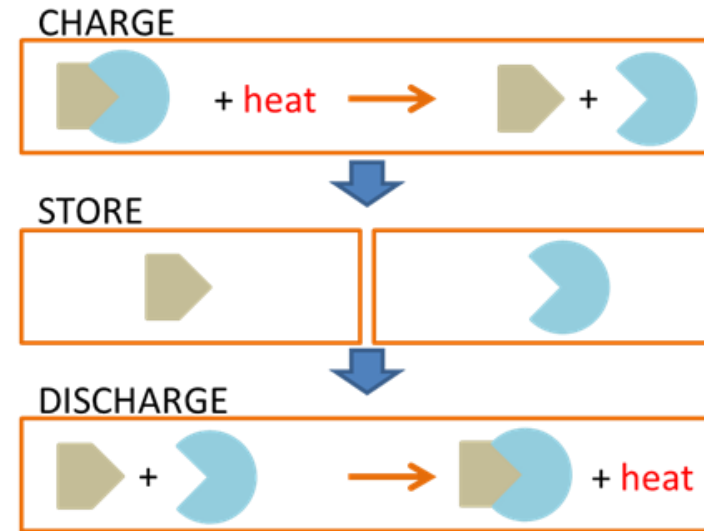
- › Phase out fossil energy; renewables have fluctuating nature
- › Need to overcome intermittency & increase flexibility
- › Large share of domestic energy demand is heating
 - › day/night, weeks, months, seasonal storage?
- › Heat battery: compact, affordable & efficient heat storage
 - › Increasing owner's share of renewable energy use
 - › Increasing flexibility, energy independency, autarky
 - › Power-to-heat enables E-network peak-shaving
 - › Heat-to-heat enables H-network optimization



› WHAT ARE WE DEVELOPING?

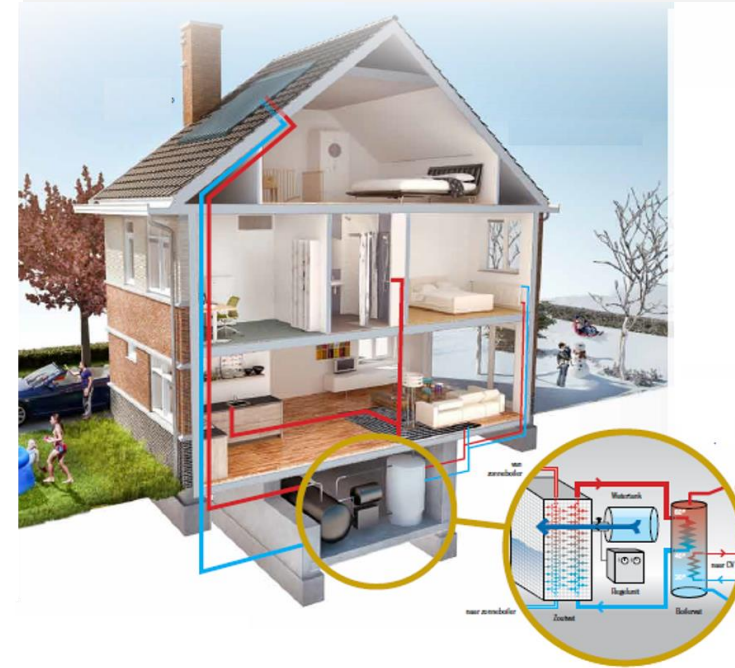
DECENTRAL COMPACT THERMAL ENERGY STORAGE FOR THE BUILT ENVIRONMENT

- › A heat battery based on thermochemical materials
 - › Compact: To fit both new-built and retrofitted buildings
 - › Affordable: Cheap & abundant materials
 - › Efficient: High E/V, low-loss energy storage, utilizing excess energy for later space heating / DHW production
- › Flexible use
 - › Electricity (direct / through HP)
 - › Heat (Solar thermal, waste heat, heat network)
 - › Scalable / modular size



› HOW DO WE DEVELOP THIS TECHNOLOGY? TWO EXAMPLES OF ONGOING DEMONSTRATION PROJECTS

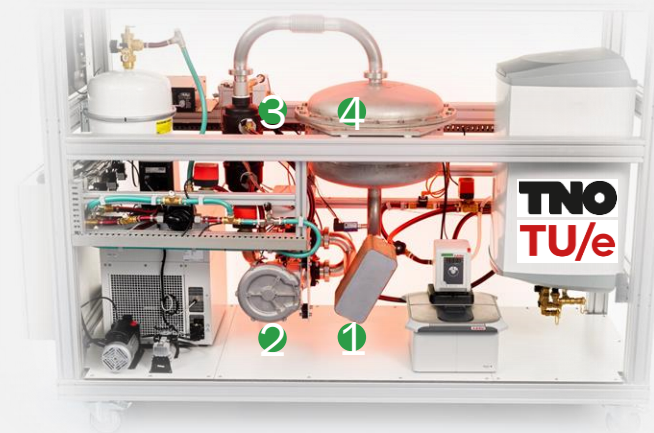
- › Examples of multi-stakeholder projects on compact Thermal Energy Storage @ TNO (& partners)
- › Heat Insyde (EU H2020 G.A. 869810; www.heat-insyde.eu)
 - › 2019 – 2024
 - › 12 R&D and industrial parties from 6 EU countries
 - › Demonstration of technology in 3 different climate zones
- › SSUSG (EU EFRO OP-Zuid)
 - › 2018 – 2020
 - › 5 R&D and industrial parties in Province Noord Brabant
 - › Demonstration of technology in a tiny house



› **SHOWCASE 1: HEAT INSYDE**

DEMONSTRATION OF TECHNOLOGY IN 3 DIFFERENT CLIMATE ZONES IN THE EU

- › Advance a ground-breaking closed-loop heat storage concept to Technology Readiness Level 7
- › Multicyclic stable TCM, compact systems, energy management & interfacing
- › Deliver an affordable, highly compact and sustainable solution with robust performance, integrated in decentral system.
- › Combine compact storage with a highly efficient heat pump effect ($COP > 10$) delivering hybrid functionality.
- › Create new opportunities for grid flexibility, with configuration in both heat and electricity systems.



- ① Heat Exchanger
- ② Ventilator
- ③ Evaporator/Condensor
- ④ Reactor

› SHOWCASE 2: SELF-SUPPORTING URBAN SMART GRID

DEMONSTRATION OF MODULAR TECHNOLOGY IN A TINY HOUSE IN BREDA, NETHERLANDS

- › 2 Loss-free storage modules during storage time
- › Compact storage, high volumetric energy density
- › Complete storage system heating a building with solar energy
- › Energy density on battery module level:
 - › 0.35 GJ/m³ (proven) → equals 5x water storage vessel
 - › 0.50 GJ/m³ (t.b.d. summer 2021)
 - › 0.75 GJ/m³ (expected 2022) → up to 10x water storage!



› HOW CAN THE HEAT BATTERY CONTRIBUTE TO THE RENOVATION WAVE?

COMPACT THERMAL ENERGY STORAGE ENABLES INNOVATIVE RENOVATION CONCEPTS

- › Heat storage enables better use of available energy (E & H)
- › Compact heat batteries fit in renovated buildings
- › Energy concepts can be used that would otherwise not be possible in renovated buildings, e.g.:
 - › PV / heat pump / heat storage combination
 - › Extending heat network range with decentral storage but without increase of network
 - › ...



› NEAR FUTURE

SPINOUT COMPANIES MARKETING COMPACT STORAGE TECHNOLOGIES BASED ON SALT HYDRATES

- › Cellcius – closed loop system (Established 2020)
- › BatterHeat – vacuum system (*under establishment*)

[cellcius]

www.cellcius.com



Store better heat.

› INTERESTED? GET IN TOUCH! CONTACT DETAILS



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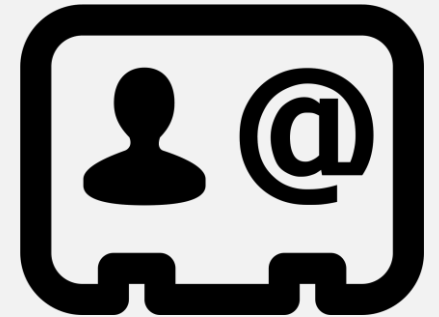
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