MERITS A RECHARGEABLE HEAT BATTERY
www.merits.eu

RC4GleisdorfSolar 9/6/2016

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PROBLEM STATEMENT

- Solar energy suffices & highest potential for sustainable future, but imbalance in supply and demand of heat
- Thermal energy storage is the solution enabling widespread and integrated use of Renewable Energy Systems

	Utilization 2005 [EJ]	Technical potential [EJ/yr]
Biomass	46.3	160 - 270
Geothermal	2.3	810 - 1545
Hydro	11.7	50 - 60
Solar	0.5	**62,000 - 280,000**
Wind	1.3	1250 - 2250
Ocean	-	3240 - 10,500

Towards a sustainable world and energy efficient built environment

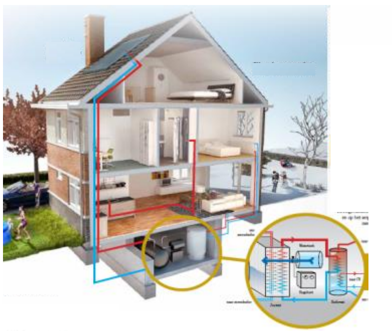
20 % reduction of CO_2 emission by 2020 and 85 % by 2050

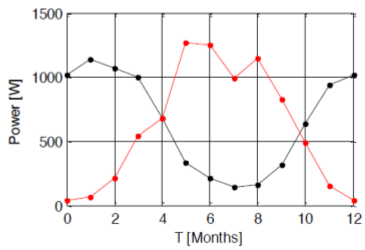
Heat storage as indispensable enabler

[RHC2013]

MERITS PROJECT USE CASE – SEASONAL STORAGE OF SOLAR ENERGY

- Total roof collector heat suffices for space heating of dwellings
- If excess heat in summer is stored for later use in winter
- E.g. 10GJ storage → ~10m^3 system → ~1GJ/m^3 guideline





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BIGGEST CHALLENGES FOR THERMAL STORAGE

- **Cost effectiveness:** economically feasible on the long term

- **Energy density:** achieving an acceptable size

→ MERITS demonstration targets precicely these issues!

Click here for the latest MERITS promotional video (April 2016)

STORAGE PRINCIPLE OF MERITS

- For MERITS, **Na_2S** as thermochemical storage material (TCM).
- Na_2S: cheap hygroscopic salt, reversible reaction:

$$Na_2S \cdot 5H_2O + heat \leftrightarrow Na_2S \cdot \tfrac{1}{2}H_2O + 4\tfrac{1}{2}H_2O$$

- Material Storage Density → **2.9 GJ/m³** (given reaction)
- Storage is in principle **loss free!**

[de Boer 2003]

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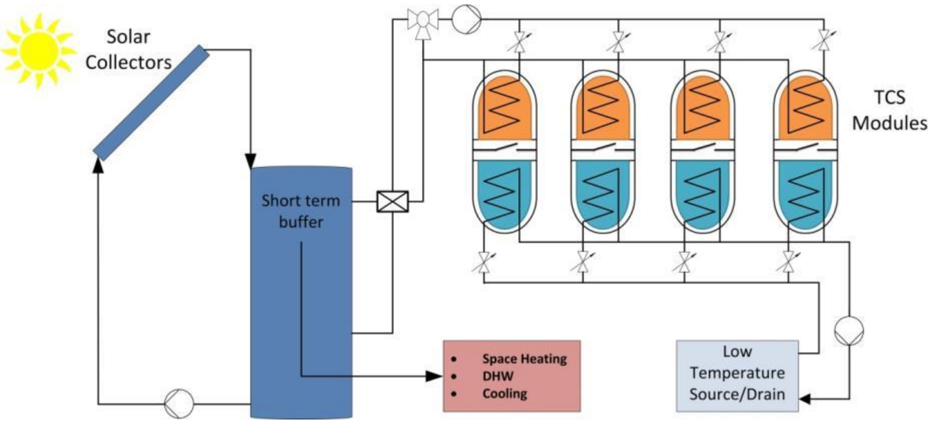
MERITS SYSTEM & COMPONENTS



[de Jong 2015]

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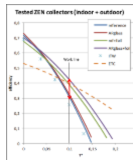
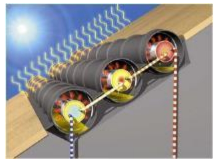
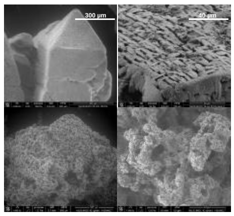
MERITS: AREAS OF RESEARCH





- Renewable Energy Supply: Solar collectors + integration of storage



- Energy storage: Enhanced materials, reactor + components

- Energy delivery: System integration and control strategies

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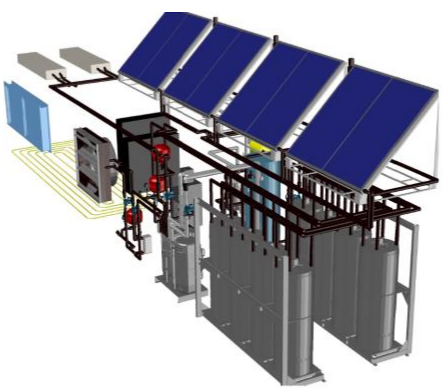
MERITS FIELD TEST DEMONSTRATOR



- Complete storage system and building simulation compartment in a 45ft container
- System demonstrated in Lleida (without TCS)
- Demonstration in Warsaw on-going (with TCS)

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THERMO-CHEMICAL HEAT BATTERIES

Motor operated valve reactor side

Motor operated valve E/C side

Motor operated Internal valve

Pressure sensor and manual operated valve

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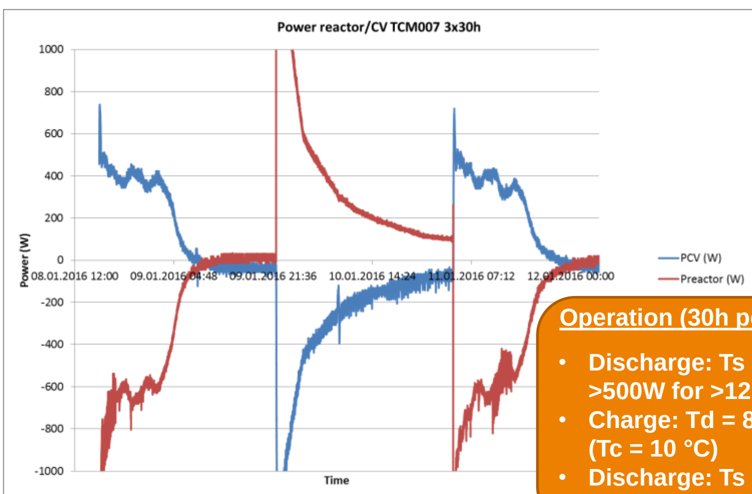
MODULE CHARACTERISATION - POWER



Operation (30h per half-cycle):

- **Discharge: Ts = 52 °C @ >500W for >12h (Te = 10 °C)**
- **Charge: Td = 80 °C for 30h (Tc = 10 °C)**
- **Discharge: Ts = 52 °C @ >500W for >12h (Te = 10 °C)**

MODULE CHARACTERISATION – ENERGY

Conclusions:

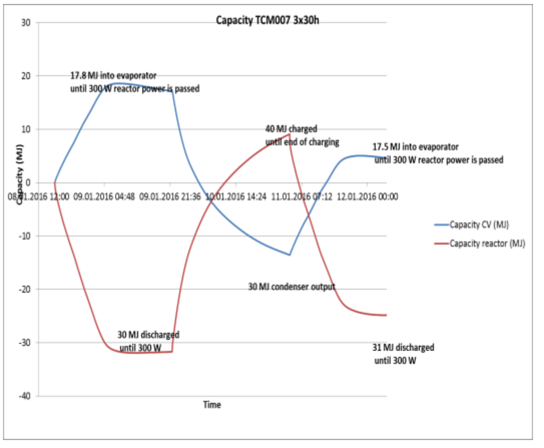
- **~30 MJ of energy discharged**
- 8.9 kg of water evaporated

→ This is consistent with transition between 5 to 2 hydrate with enthalpy of (de-) hydration of about 3400 kJ/kg.

- Volume per module: 326 liter (including insulation)

→ **Q/V ≈ 0.1 GJ/m³**

- For transition between 0,5 and 5 hydrate **Q/V ≈ 0.18 GJ/m³**, which is better than hot water tank



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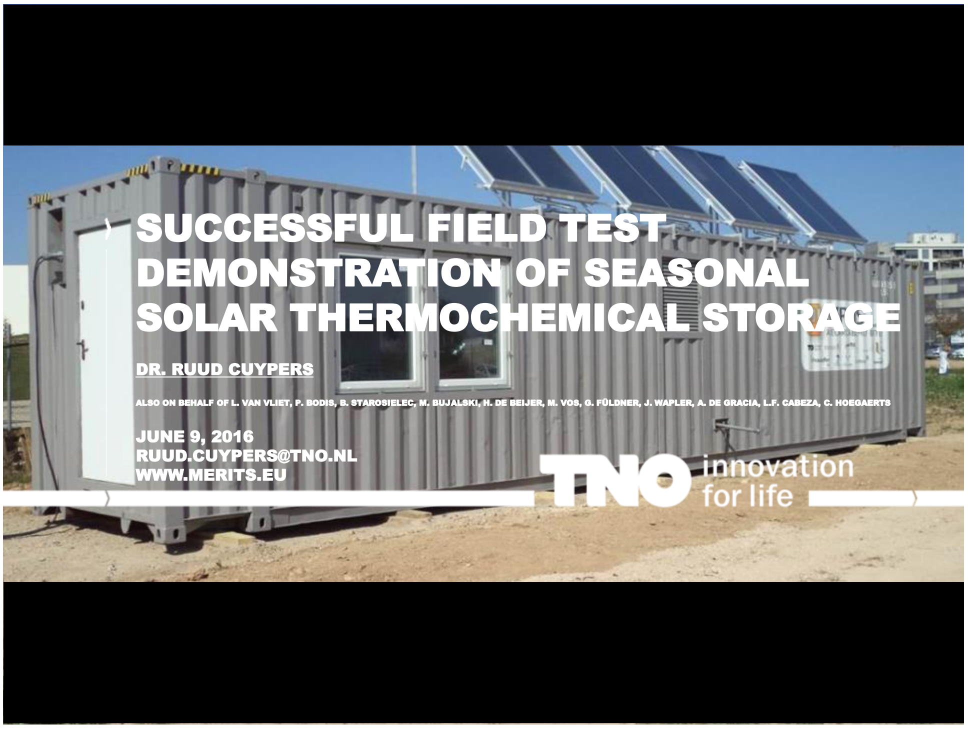
CONCLUSIONS & OUTLOOK

- Compact long-term storage system for seasonal applications demonstrated successfully
- Demonstrated storage density ~100 MJ/m³ (~28 kWh/m³) (module level; Td: 80; Te: 10; Tc:10; Ts:52 °C) using $Na_2S.xH_2O$
- First time: TCS application using solar collector temperatures for charging, with storage densities in order of sensible storage, without thermal losses
- Future outlook
  - Short term: 170-200 MJ/m³ achievable
  - 4 years from now: ~600 MJ/m³ (CREATE)[a]
  - Long term: up to 1000MJ/m³ after complete system redesign[b]

[a: www.createproject.eu; b: de Jong 2015]


SUCCESSFUL FIELD TEST DEMONSTRATION OF SEASONAL SOLAR THERMOCHEMICAL STORAGE
DR. RUUD CUYPERS
ALSO ON BEHALF OF L. VAN VLIET, P. BODIS, B. STAROSIELEC, M. BUJALSKI, H. DE BEIJER, M. VOS, G. FÜLDNER, J. WAPLER, A. DE GRACIA, L.F. CABEZA, C. HOEGAERTS
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