Modularise Inter-Seasonal Thermochemical Storage (ISTS)

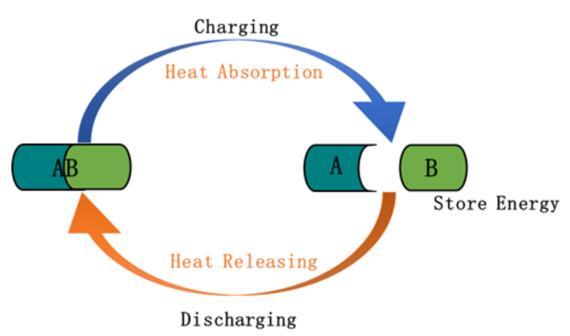
ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

Introduction

Thermal energy storage (TES) plays a key role in supporting UK's future decarbonisation targets for heat and electricity. It is an established concept for:

- Balancing the match in demand and supply for heating or cooling, as well as intermittent production of renewable energy
- Offsetting differences in time and magnitude of heat / cooling production
- Smoothing supply and demand patterns, which constrain or reduce efficiency for low carbon heating

TES can be divided into sensible (SHS), latent (LHS) and thermochemical heat storage (THS). THS refers to the use of reversible chemical reactions to store large quantities of heat in a compact volume.

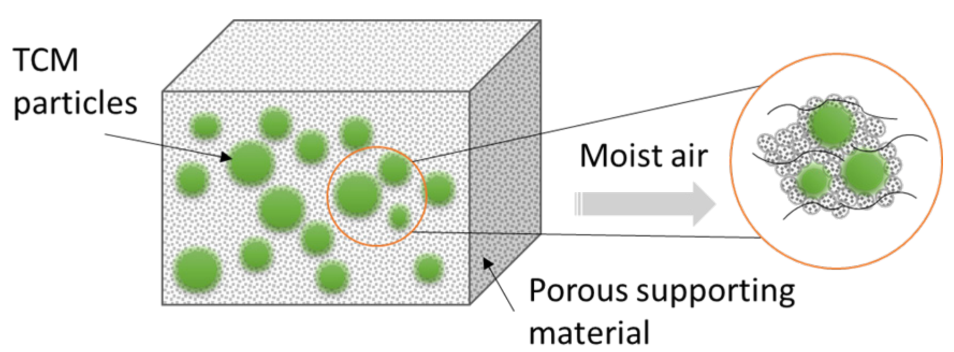


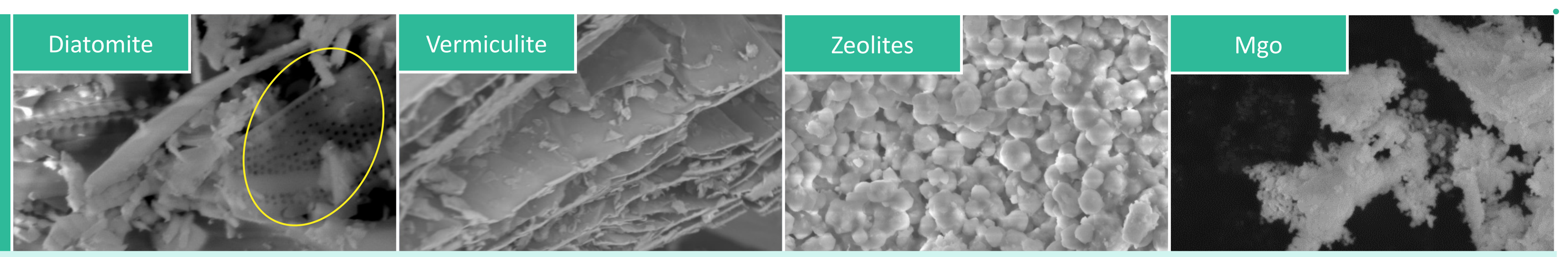
UoB is targeting on developing the Inter-seasonal THS technology, from thermochemical materials formulation, module design and fabrication → device design and construction → system design and integration → demonstration at a 1.5kW/7.5kWh scale.

Thermochemical material modularization, fabrication & Cyclability

Objective: obtain TCM modules with desirable structure and property

Challenges:
- Agglomeration of salt particles
- Poor mass transfer
- Poor heat transfer
- Poor cyclability

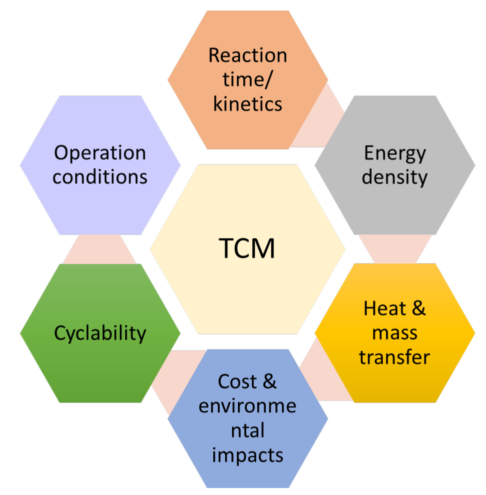


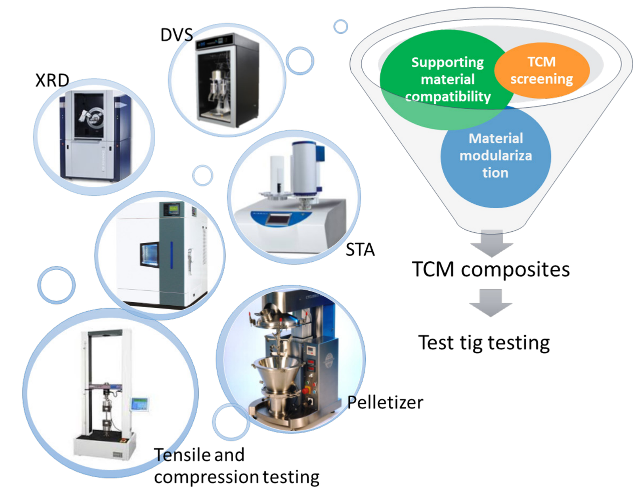


Outcomes:
TCM composite with porous supporting material presents better stability under similar hydration kinetics

Thermochemical material (TCM) screening and formulation

Objective: screen and formulate TCM with desired properties





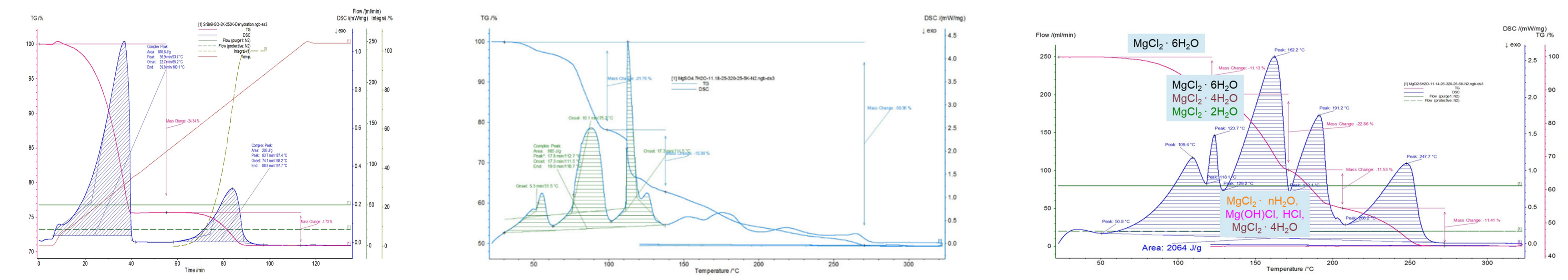
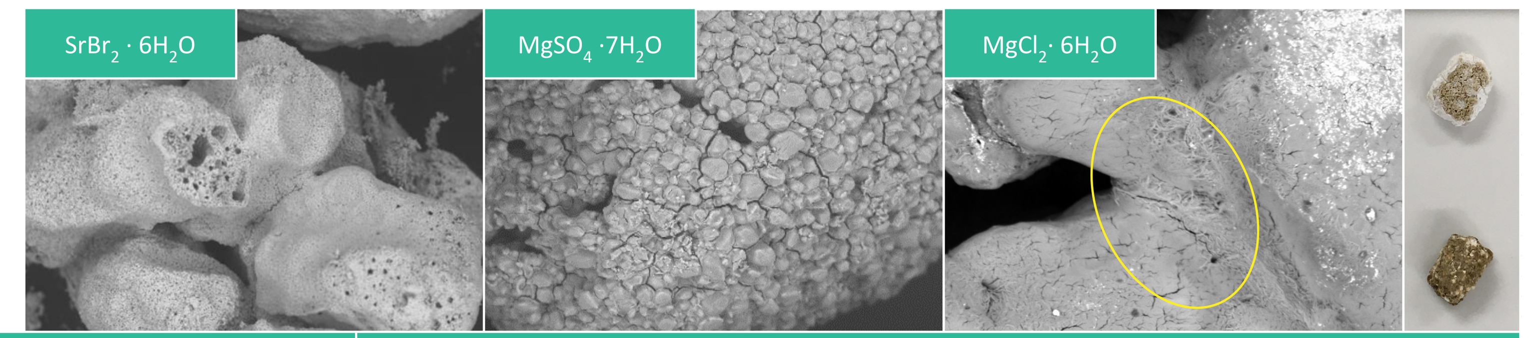
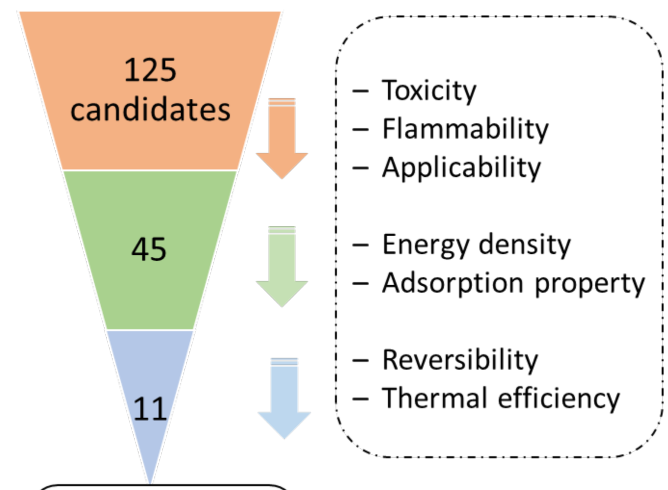
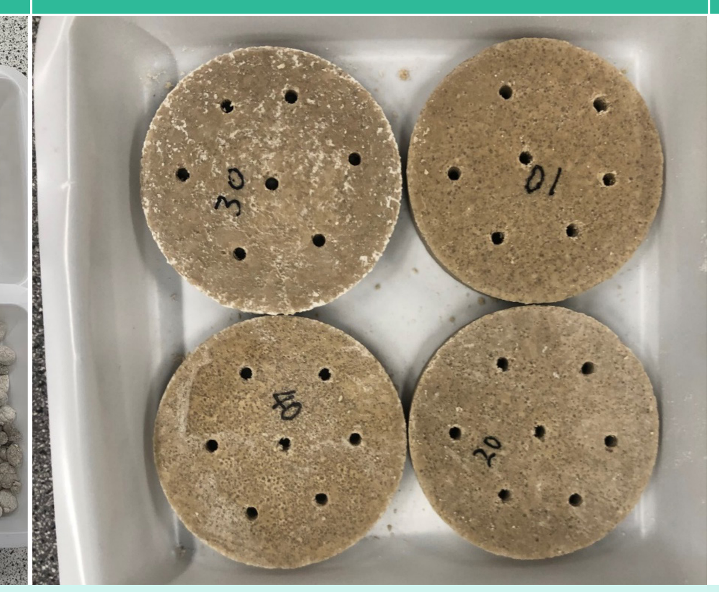
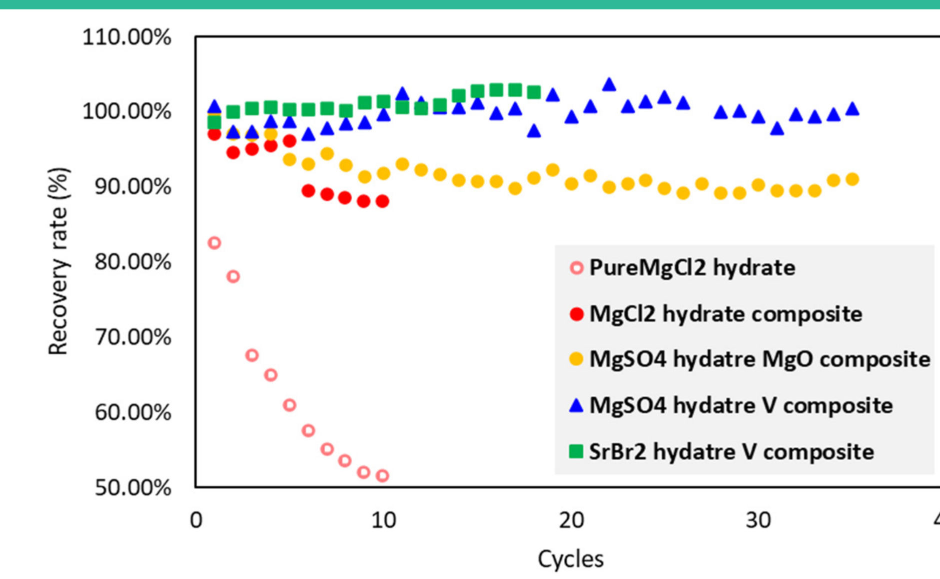


Illustration of TCMs discharging profile and energy release @ the optimal condition & Material morphology after the charging and discharging cycles:





$MgSO_4 \cdot 7H_2O$
$MgCl_2 \cdot 6H_2O$
$SrBr_2 \cdot 6H_2O$

Pelletizer fabricated TCM composites Variables: rpm and time	Pelletizer fabricated TCM composites Variables: rpm and time	TCM thermal cycling stability
		

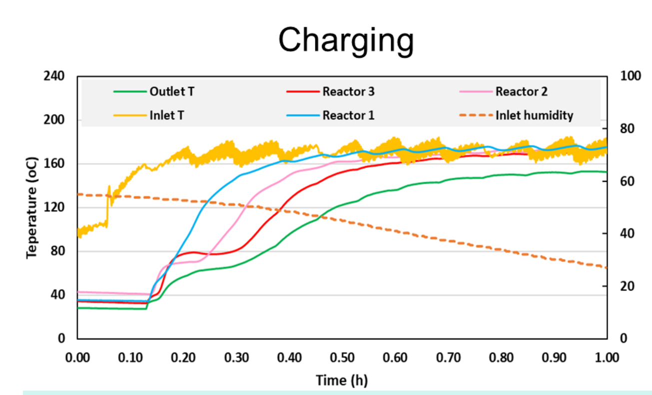
Outcomes:
$MgSO_4 \cdot 7H_2O$ & composite - high energy density (~1000 kJ/kg), good cyclability, developed preferable micro-cracks after thermal cycling; dehydration mechanism;

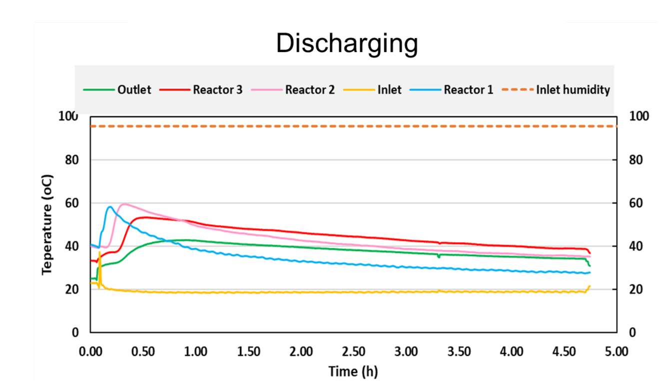
$SrBr_2 \cdot 6H_2O$ - obtained optimum hydration conditions (i.e. temperature and relative humidity, RH); high energy density (~1013 kJ/kg), good cyclability, satisfactory hydration kinetics, favourable micro-channels after thermal cycling;

$MgCl_2 \cdot 6H_2O$ & composite - poor cyclability; hydration process difficult to control, often over-saturated.

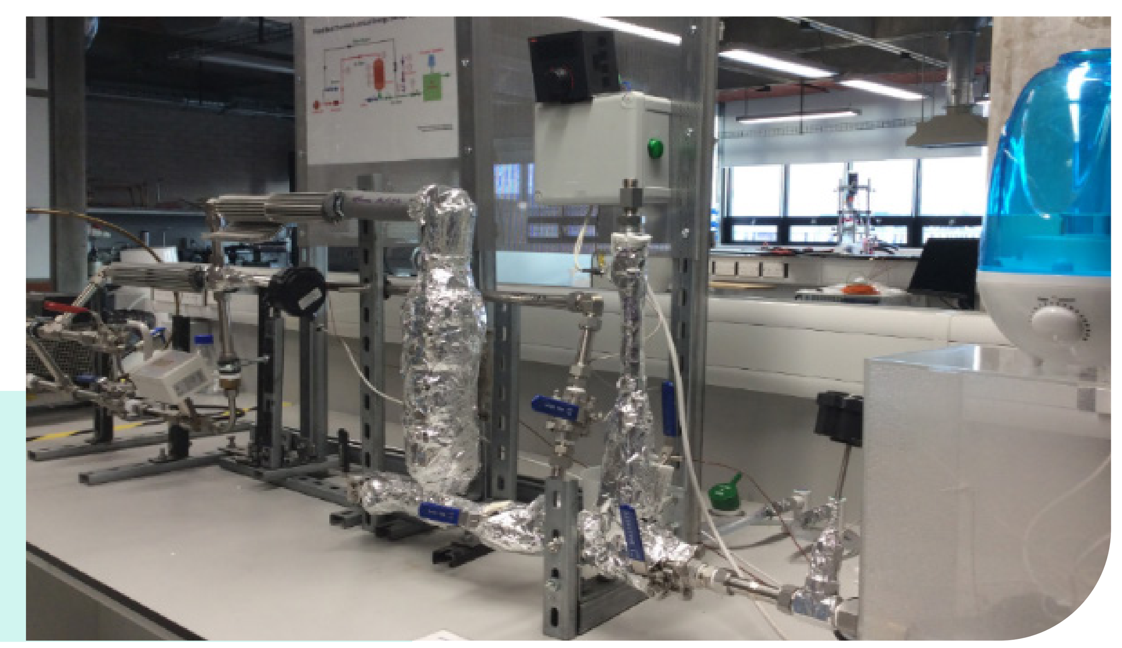
Thermochemical material small lab-scale test rig testing

Objective:
testing material stability, charging and discharging performance





Outcomes:
- During discharging Max. temperature is around 30 degree
- Material no obvious deformation or energy degradation after 5 cycles testing



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