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HUNGARIAN
BATTERY DAYS

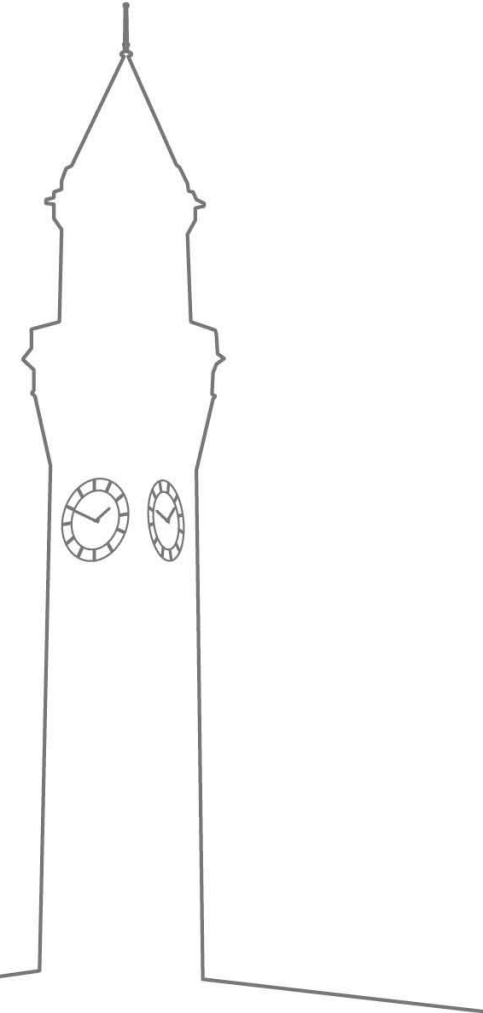
Innovation Pathways in Electrified Thermal Energy Storage

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Consumer friendly flexible energy use

8 March 2024

Ofgem and Innovate UK launch the fourth round of the Strategic Innovation Fund (SIF) with the announcement of priority challenges.

Greater heat flexibility

Challenge areas in scope include:

- flexibility solutions to reduce peak electricity demand from heat decarbonisation

This includes technologies and supporting commercial and market models to help decouple electricity consumption from the grid and heat supplied to consumers during periods of system stress.

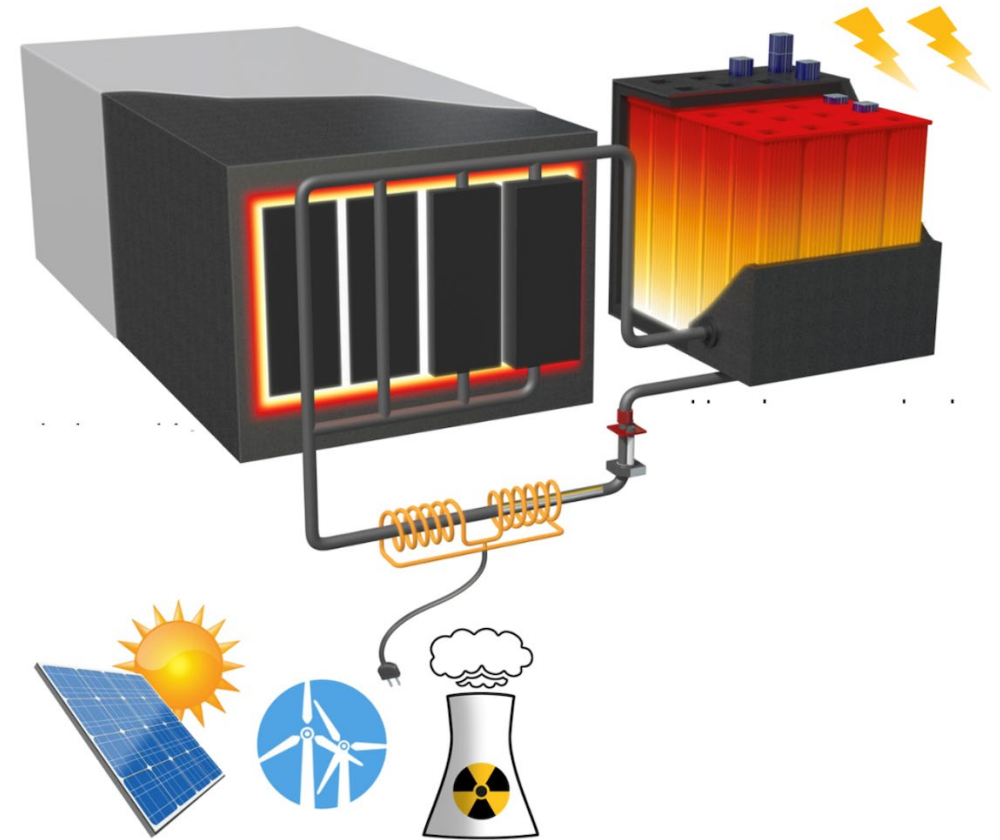


Transform electricity consumption approach for heating and cooling



Energy conversion

direct/indirect electrical heating



Energy conversion and Storage

Electrified thermal energy storage

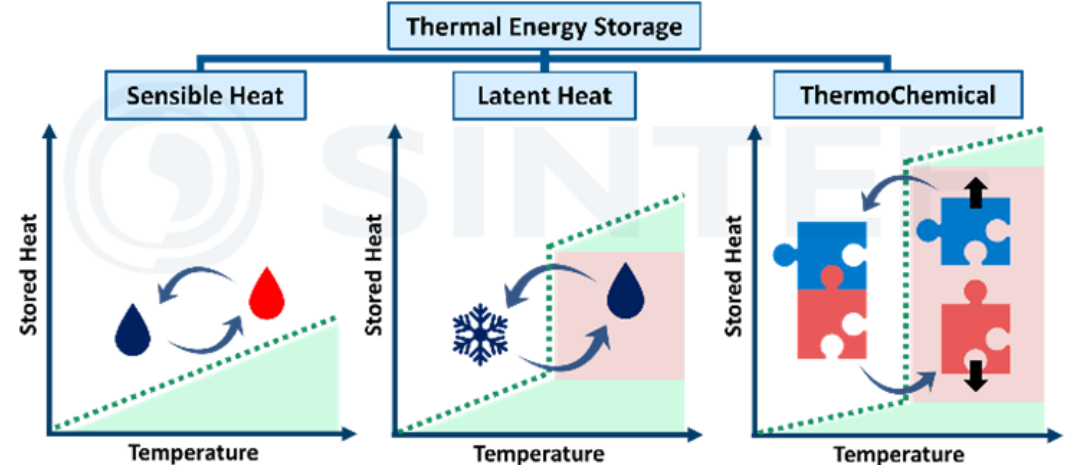
Electrified Thermal Energy Storage (ETES)

Electrical heating methods

- Indirect resistance heating
- Direct resistance (Ohmic) heating
- Infrared heating
- Arc heating
- Electron beam heating
- Induction heating
- Dielectric (microwave) heating
- Dielectric (radio frequency) heating
- ...

Thermal Energy Storage methods

- Sensible Heat Storage (SHS)
- Latent Heat Storage (LHS)
- Thermochemical Energy Storage (TCS)



Commercial Electrified Thermal Energy Storage technologies

e-Boiler

Resistive Heating



Liquid Sensible Heat Storage



e-Brick

Resistive Heating



Solid Sensible Heat Storage



e-PCM

Resistive Heating



Latent Heat Storage



Direct participation in grid balancing

Delivering decarbonisation with zero capex and zero risk



225 assets
developed, funded
and run by AMP



82MW
of operating biomass
assets



30MW
of biomass assets in
build (biomass
+eboiler)



38k+
tonnes of carbon
saved by our
customers each year

AMP + eboilers: charging ahead for a sustainable future

Our electricity network is facing significant challenges. It struggles to store and transmit excess renewable energy, often reaching its limits, particularly at the B6 line. This bottleneck results in 'energy constraint payments' — an expensive cost UK consumers shoulder when wind farms are shut down due to power distribution limitations.

AMP and Simpsons Malt, two businesses committed to change, are putting their heads together for a ground-breaking project — one that's set to turn the Scotch Whisky industry on its head.

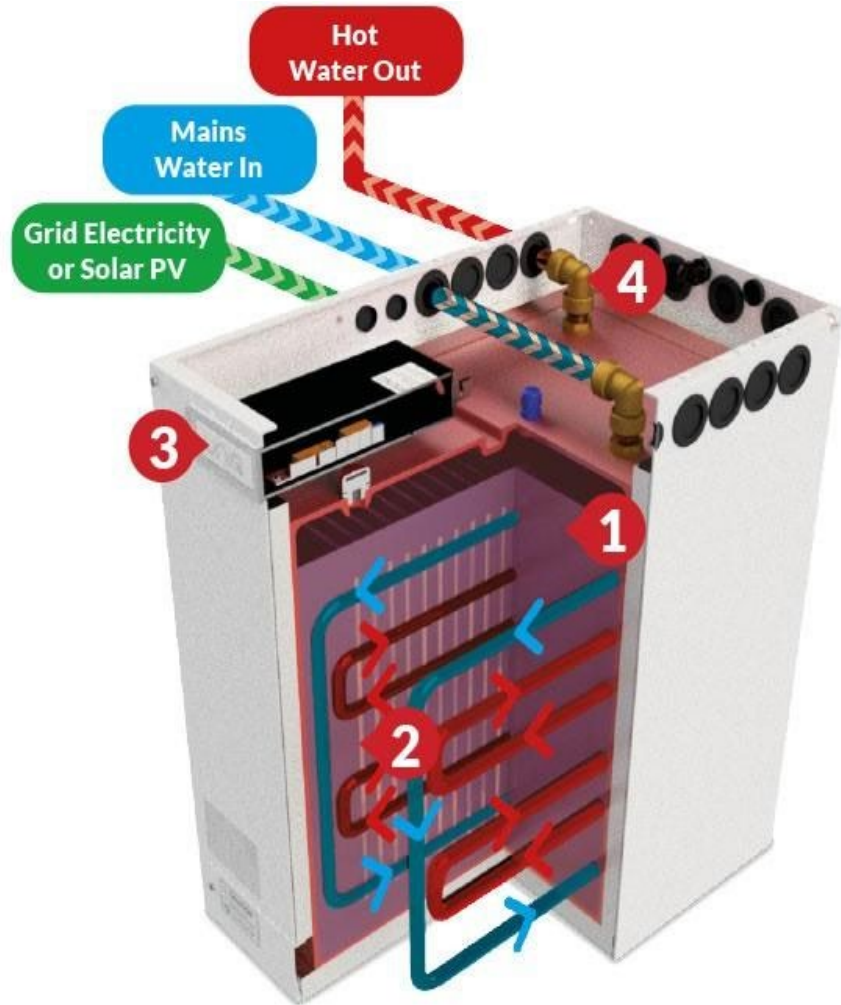
Our project features a low carbon energy centre at the Tweed Valley Maltings site. Housing state of the art electric and biomass boilers, this energy centre has the potential to cut carbon emissions by 25,000 tonnes per year — that's the heating needs of 11,000 homes, sorted. We're bringing a new angle to energy storage, making the most of renewable biomass fuel to ensure a reliable power supply.

Our high-voltage electric boiler is engineered to meet the high heat demands of industry and manufacturing, and not only harnesses excess wind energy — it decarbonises heat from renewable sources.

[Find out more](#)



Indirect participation in grid balancing through electricity tariffs





















Sunamp Hot Water Storage Benefits

- Works with a wide choice of energy sources
- Single and Dual Circuit models work with a wide choice of thermal energy sources
- Simple user interface
- Simple user interface shows heat battery state of charge
- 10-year warranty
- Market-leading 10-year warranty applies to heating element and storage core
- Quick & easy installation
- Quick and easy to install, with high quality brass fit connectors supplied
- Fits anywhere
- Flexibility of orientation with exits on three sides of the product
- High-quality mains pressure showers
- High powered heat exchanger for high quality mains pressure showers
- Stores 4x more energy than water
- Sunamp's patented phase change material formulation – storing 4x more energy than water



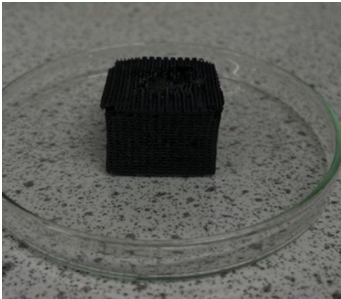
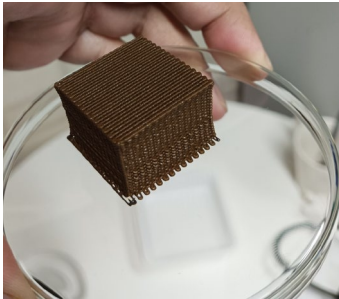
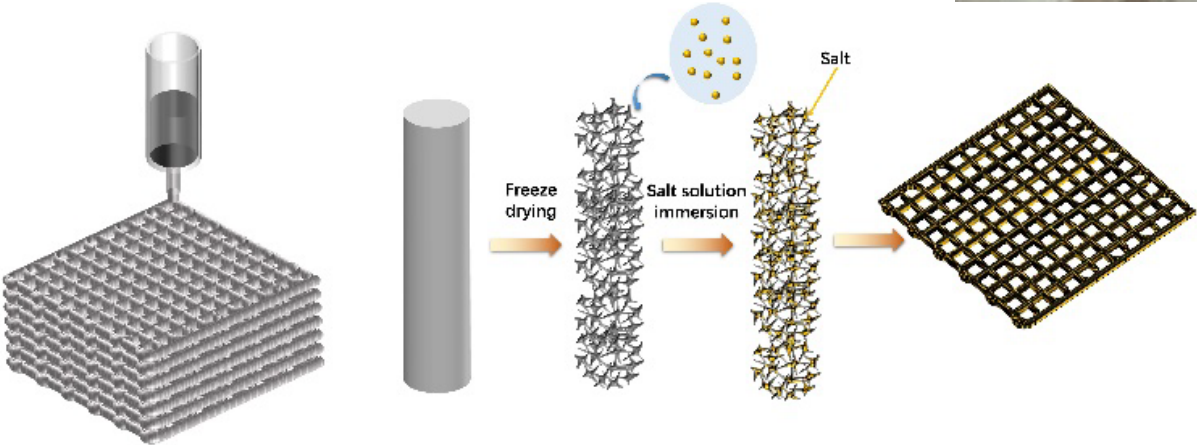
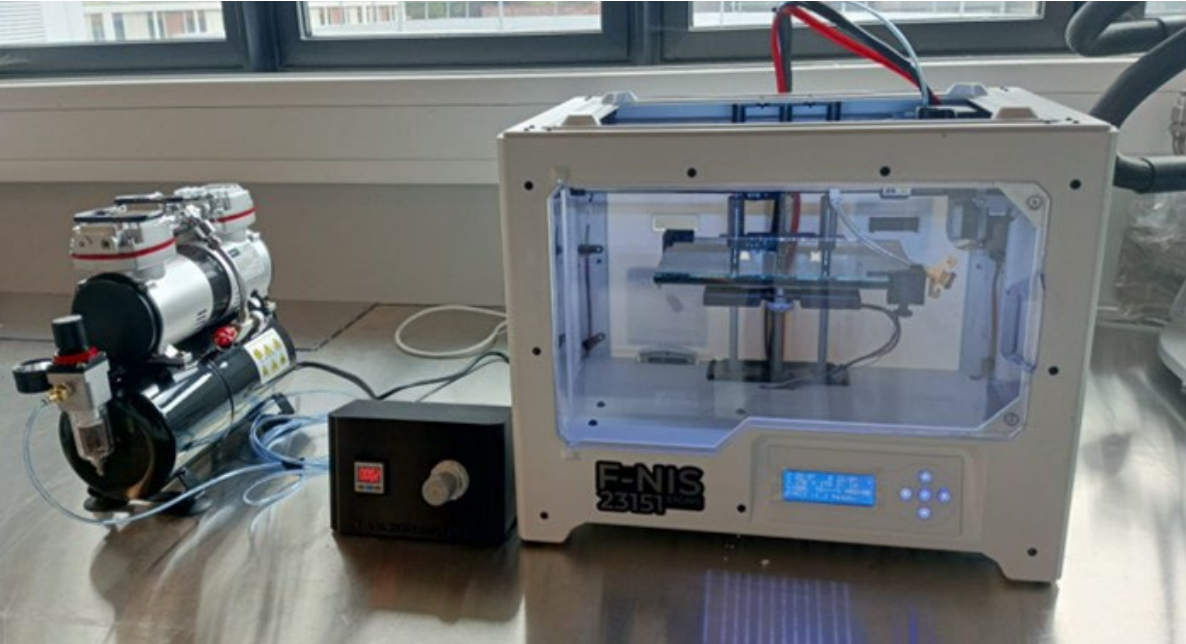
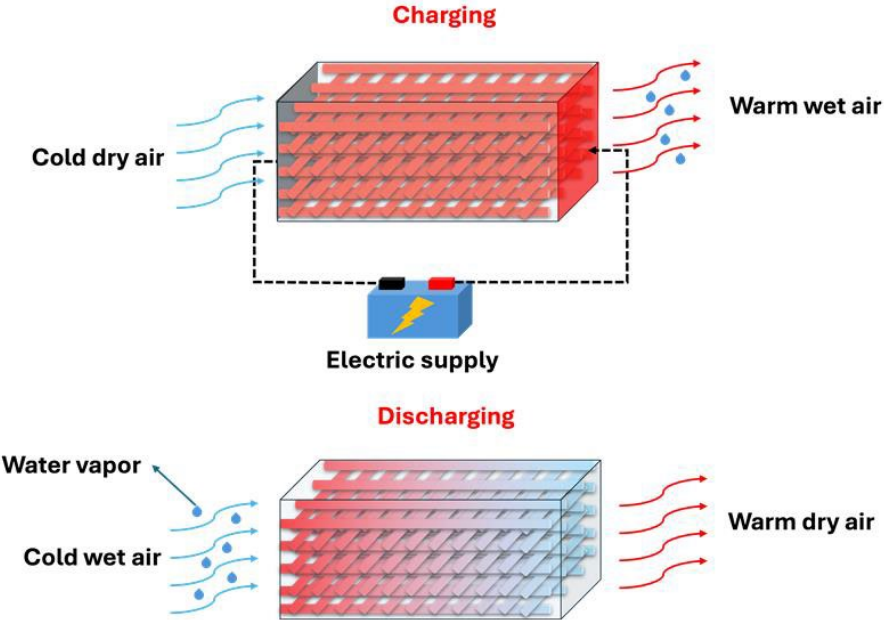
Case 1: Electrothermal store, combining Ohmic heating with TCES

e-Boiler	e-Brick	e-PCM	e-Thermal Bank
Resistive Heating 	Resistive Heating 	Resistive Heating 	Ohmic Heating 
Liquid Sensible Heat Storage	Solid Sensible Heat Storage	Latent Heat Storage	Thermochemical Heat Storage
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UoB aims to be a pioneer in developing new electrified thermal energy storage solutions by combining volumetric electric heating with thermochemical energy storage.

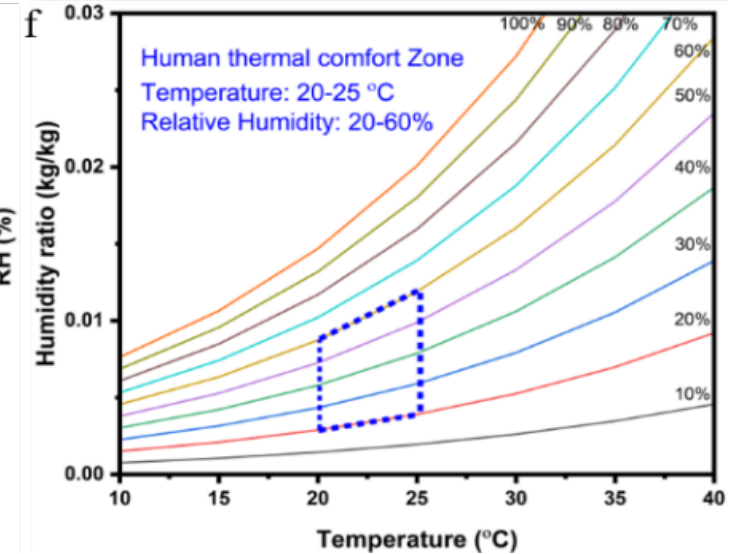
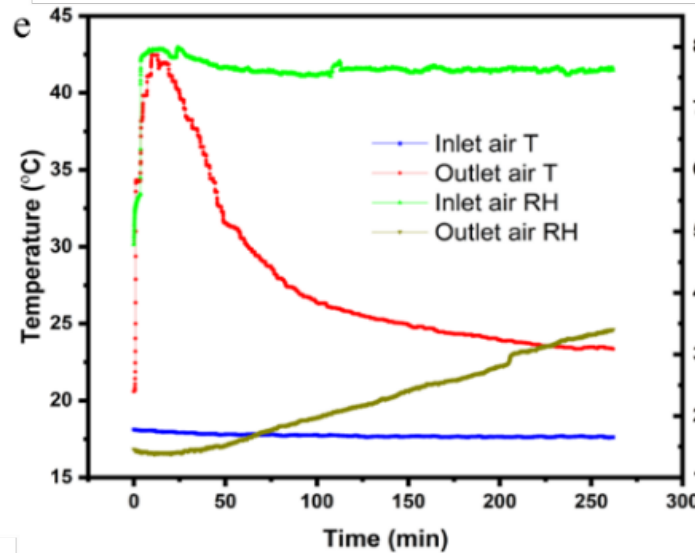
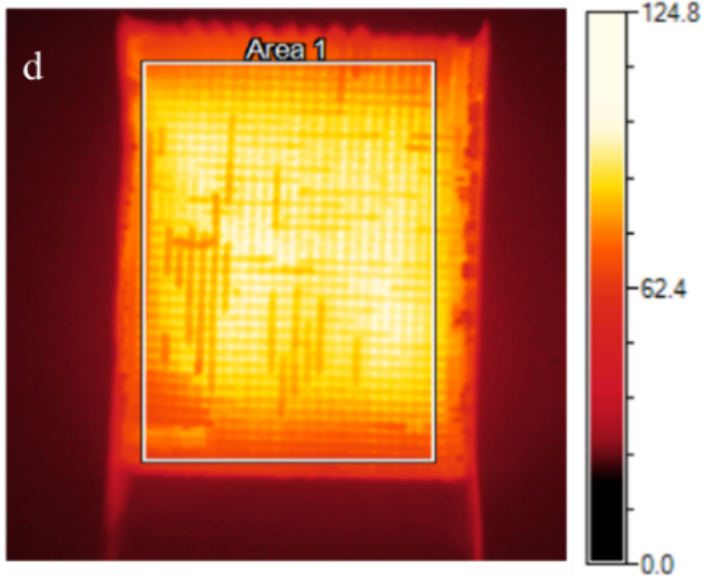
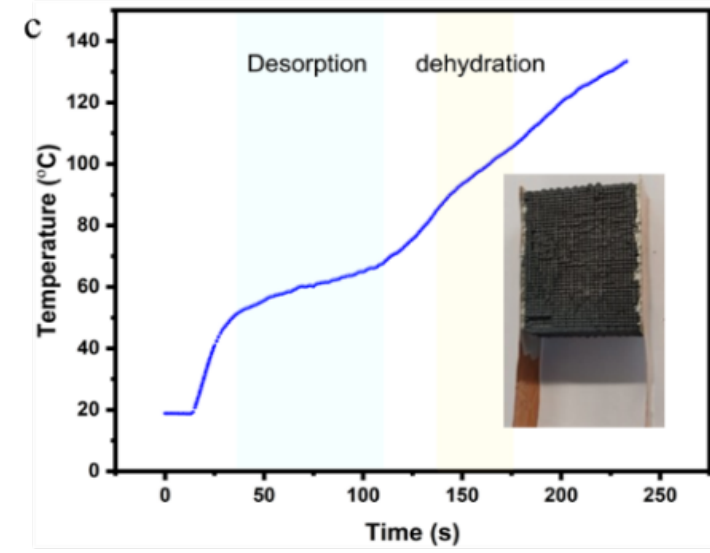
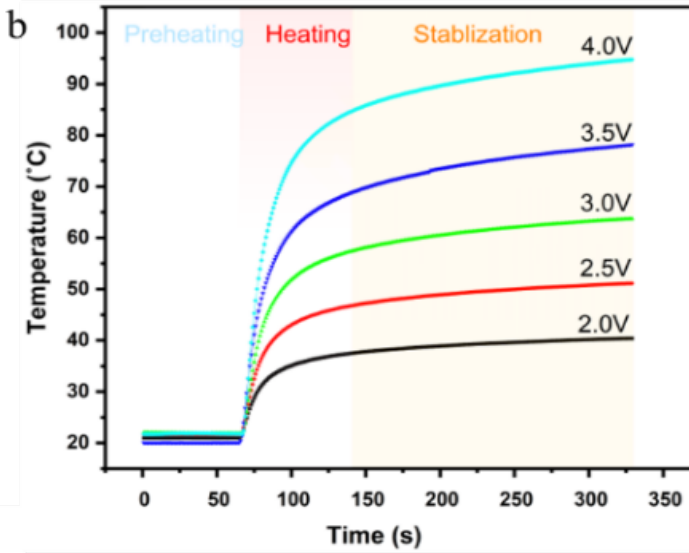
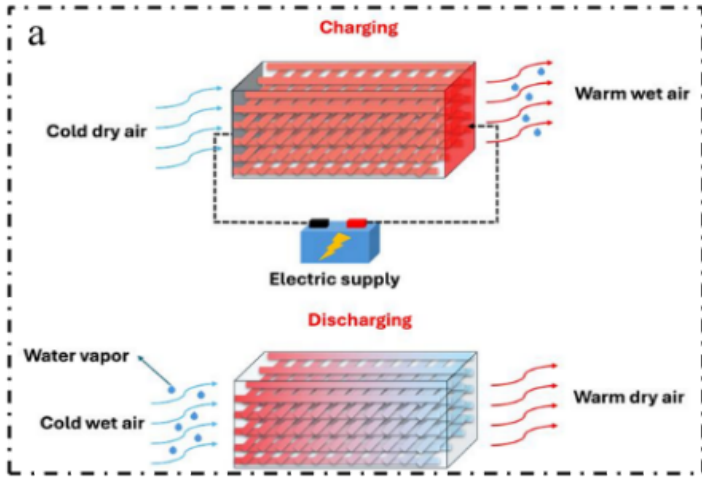


Electrothermal store




Fabrication process of salt-in-GO composite

Charging and discharging performance of the prototype





Case 2: e-Thermal Bank, combining microwave heating with TCES


e-Boiler

Resistive Heating 


Liquid Sensible Heat Storage

 **amp**
CLEAN ENERGY



 **KYOTO**
Heatcube™


 **Rinnai**®


e-Brick


Resistive Heating 


Solid Sensible Heat Storage


 **RONDO**  **tepeo**

 **BRENMILLER**
THERMAL ENERGY STORAGE


 **ELECTRIFIED THERMAL SOLUTIONS**

 **SIEMENS Gamesa**
RENEWABLE ENERGY


 **STEFFES**
Electric Thermal Storage


 **Caldera**


e-PCM

Resistive Heating 


Latent Heat Storage

 **Sunamp**
Heat Batteries™


 **MGA THERMAL**

 **金合能源**
Jinhe Energy

e-Thermal Bank

Microwave Heating 

Thermochemical Heat Storage

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UoB aims to be a pioneer in developing new electrified thermal energy storage solutions by combining volumetric electric heating with thermochemical energy storage.

Advantages of combining microwave heating with TCES

➤ Advantages of TCES

- *Ultra-High Energy Density (3-10X of SHS & LHS), suitable for space-constrained applications*
- *Minimal Energy Loss During Storage, no need for heavy insulation*
- *Chemical heat pump effect, can either amplify heat or raise temperature, and generate cooling*

➤ Advantages of microwave heating

- *Rapid and uniform volumetric heating, ideal to prevent sensitive material degradation*
- *No direct contact with the heating materials*
- *Compatibility with Smart Control Systems for real-time monitoring & optimization*

➤ Advantages of the combination

- *Volumetric heating enhances 'Volumetric reaction' kinetics*
- *Selective heating of the TCES sorbates (polar molecules such as H₂O, NH₃, etc.)*
- *Compact and modular design without large heat exchangers*



The global heating sector is under intense pressure to decarbonize.

Summary

- *In a renewable-dominated and decentralised energy future, ETES has the potential to play a major role in actively supporting grid balancing.*
- *Cost-effectiveness and operational flexibility may take precedence over maximising energy efficiency.*
- *ETES may leverage the chemical heat pump effect, which significantly enhances its efficiency compared to conventional sensible or latent heat-based ETES technologies.*
- *TCES-based ETES offers a significantly higher energy density compared to conventional sensible and latent heat-based ETES technologies.*
- *Microwave heating is a highly scalable and efficient technology, making it an excellent choice for ETES applications.*
- *The e-thermal bank is particularly well-suited for EU residential and commercial applications as it uniquely offers both heating in winter and cooling in summer, a capability that is impossible for existing ETES solutions.*





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Electrified Thermal Energy Storage:

- Converts, stores, and potentially amplifies energy
- Turns intermittent renewables into dispatchable thermal
- Shifts thermal users' electricity consumption pattern from 'when it is needed' to 'when it is available' (demand-driven to supply-driven)



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