Stan Shire

Thermal Energy Theme Lead

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University of Warwick
Thermal Energy Technology
Laboratory Facilities and Expertise

Stan Shire

Associate Professor of Sustainable Energy Systems

School of Engineering

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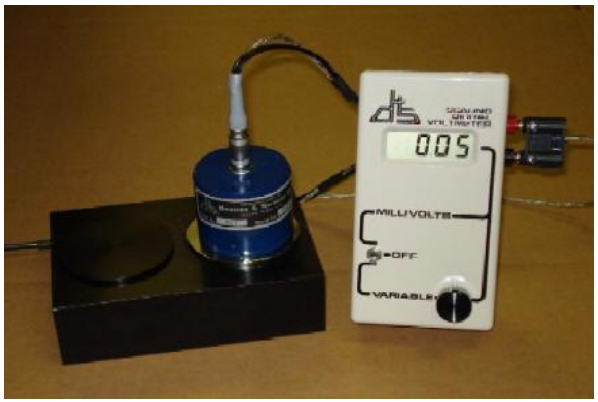
Laboratory Facilities

Solar collector development

- Optical characterisation (transmittance/ reflectance)
- IR Emissivity
- Solar simulators
- Temperature control
- Fluid flow
- Heat transfer



Laboratory Facilities

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Solar systems lab

- Large area solar simulator
- Temperature and flow control
- Heat transfer measurement
- IR imaging
- High power electrical source/sink with rapid data capture for photovoltaics

Laboratory Facilities

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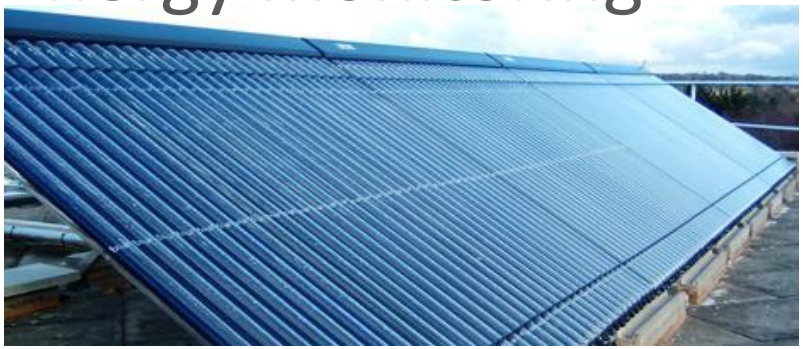
Solar test site

- Weather station
- Radiation monitoring
- Energy monitoring



Laboratory Facilities

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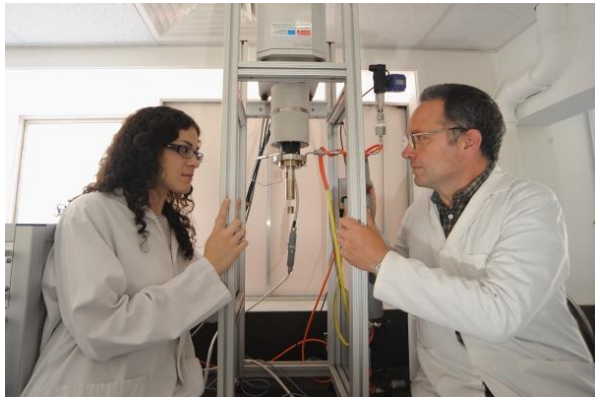
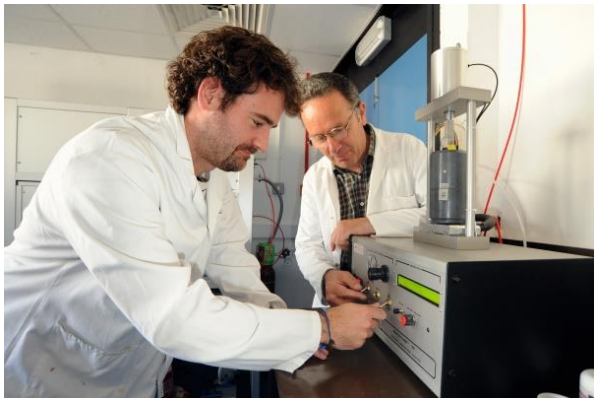
Thermal properties lab

- Material characterisation
- Conductivity
- Specific heat capacity
- Thermal diffusivity
- Adsorbed gas measurement





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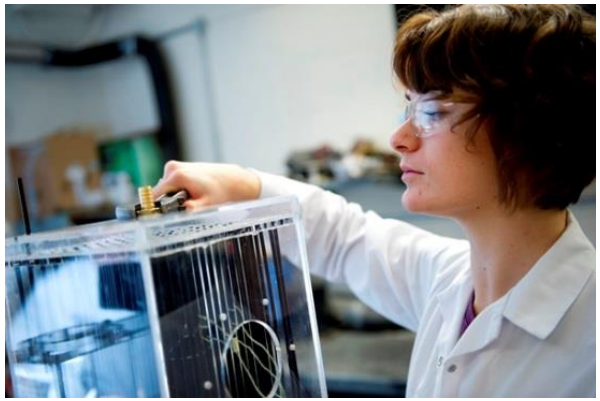
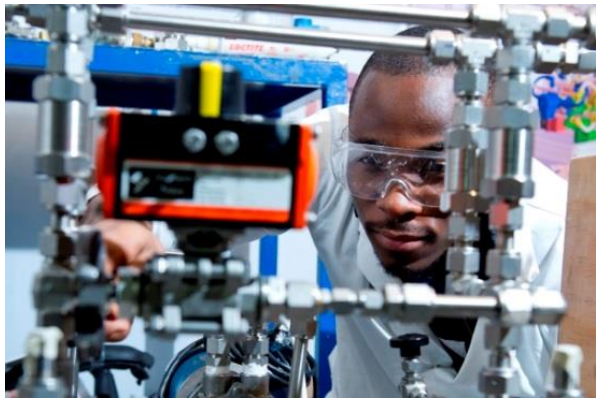
Laboratory Facilities

Thermal devices lab

- Device fabrication, testing and characterisation
- Heat sources & sinks (3kW)
- Highly instrumented
- Reaction kinetics





Laboratory Facilities

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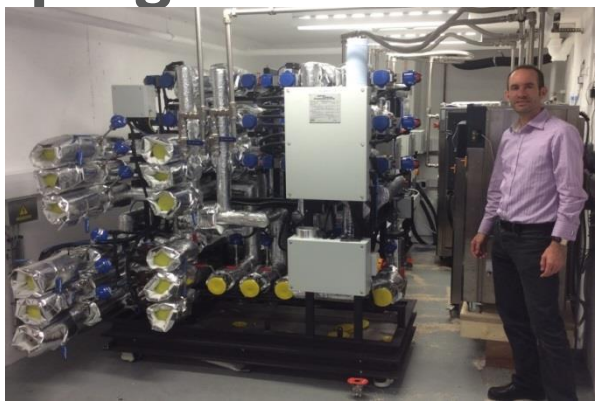
ThermExS lab

The purpose of the facility is to **dramatically reduce the time needed to test new concepts in thermal storage, transformation, heat pumping** etc. by providing a uniquely flexible fully instrumented test rig.



Laboratory Facilities

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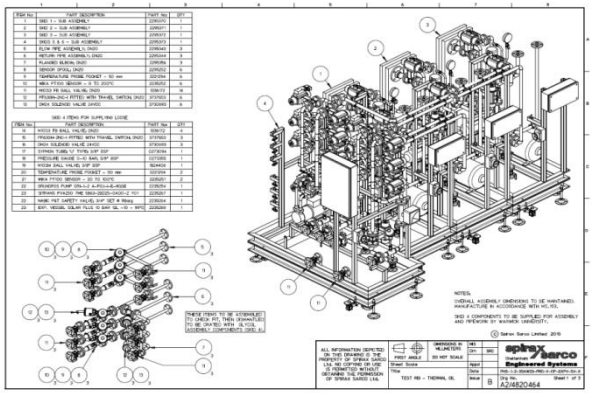
ThermExS lab

- 4 heat sources/sinks (up to 30kW, -20-300°C)
- Switching and controlled pumping to:
  - 4 sorption / chemical reactors
  - 2 ammonia evaporator / condensers
  - 2 steam evaporator / condensers
  - External equipment via pressurised water loop



Laboratory Facilities

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Environmental chambers

- Two independently controlled chambers
- Testing performance of heating systems
- Testing heat emitters
- Temperature control
- Humidity control

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Expertise

We are a small (but growing) research group of mechanical engineers with a background in thermodynamics

- 3 academics
- 4 full time research staff
- Supported by PhD students and technicians

Research Projects

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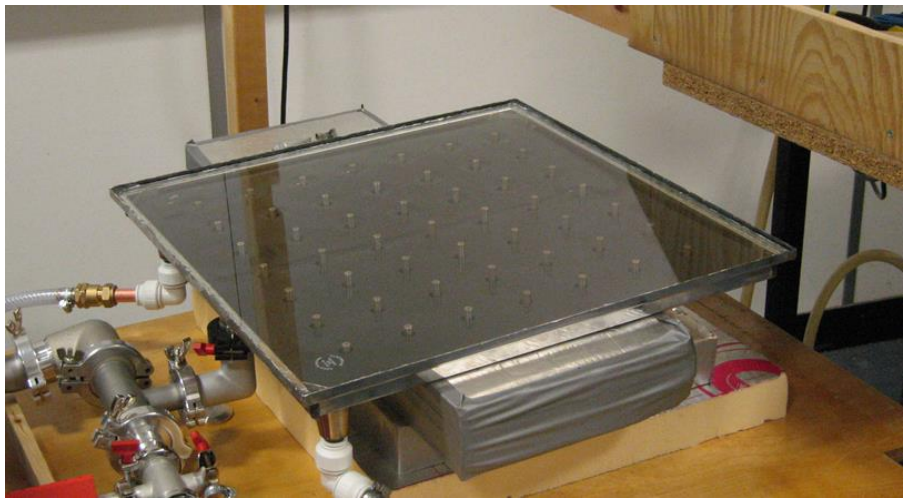
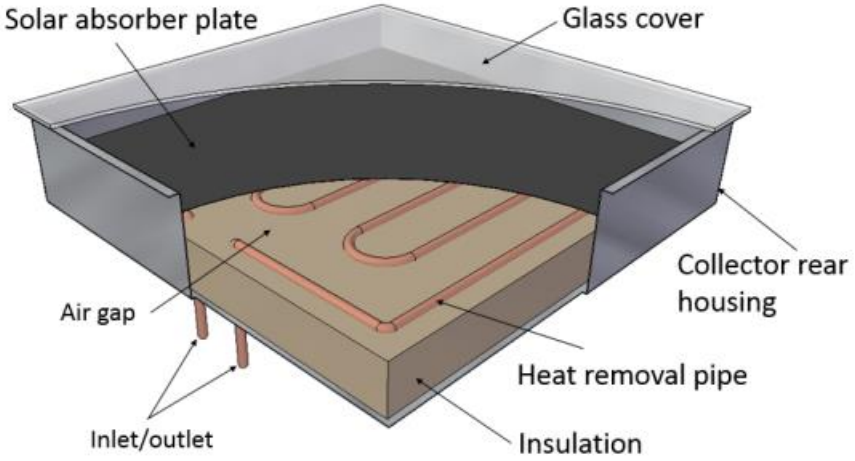
Vacuum flat plate solar thermal collector

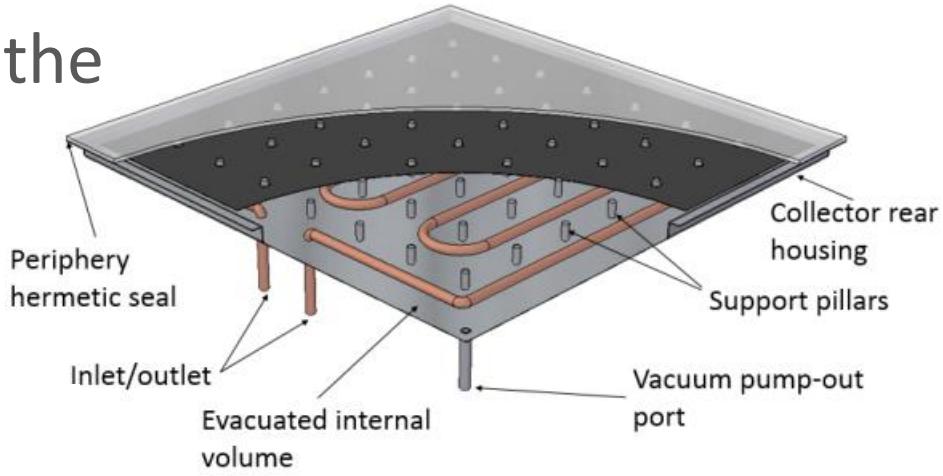
- £1.06M project funded by EPSRC
- Absorber design
- Coating technology
- Enclosure design
- Sealing technology
- Building integration



Research Projects

Absorber fills up more of the installed collector area in comparison to evacuated tube collectors.





Vacuum provides greater insulation in comparison to convectional flat plate collectors.

Research Projects

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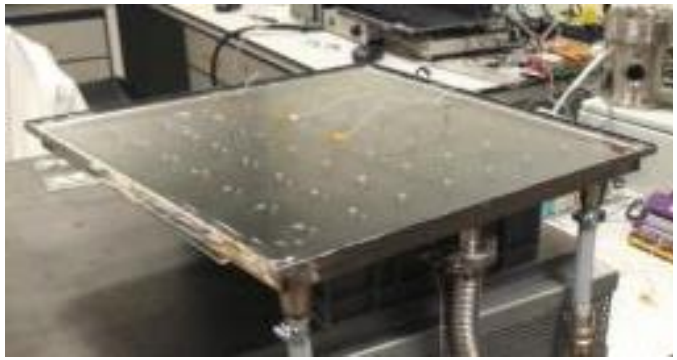
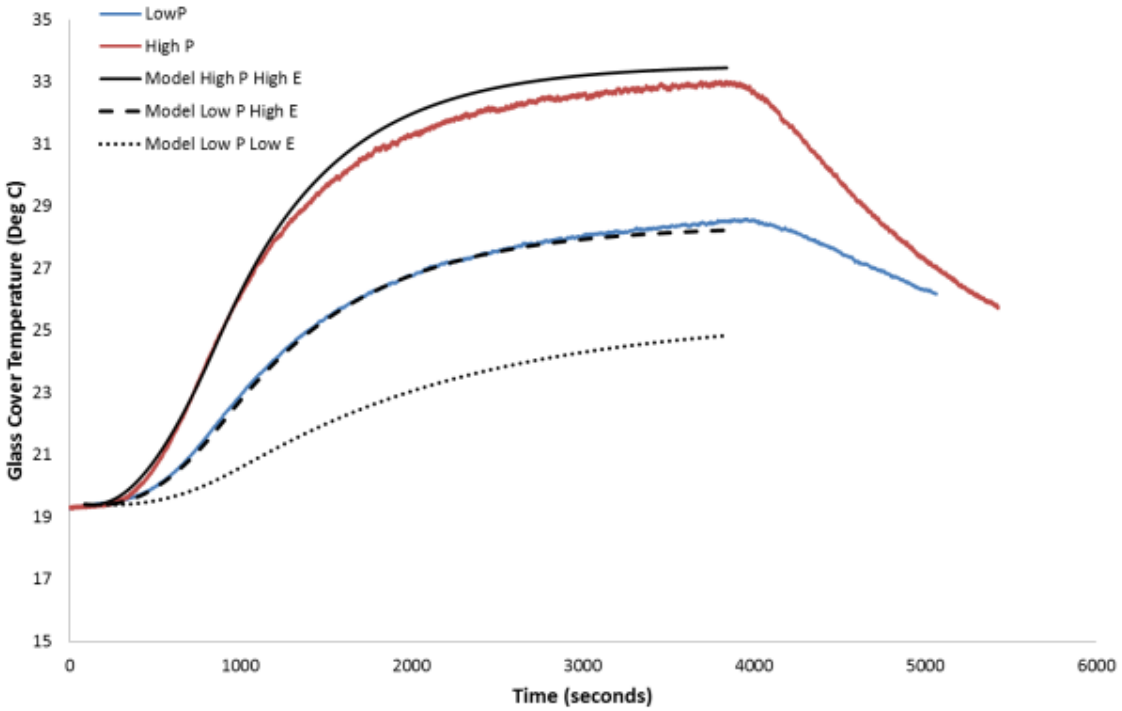
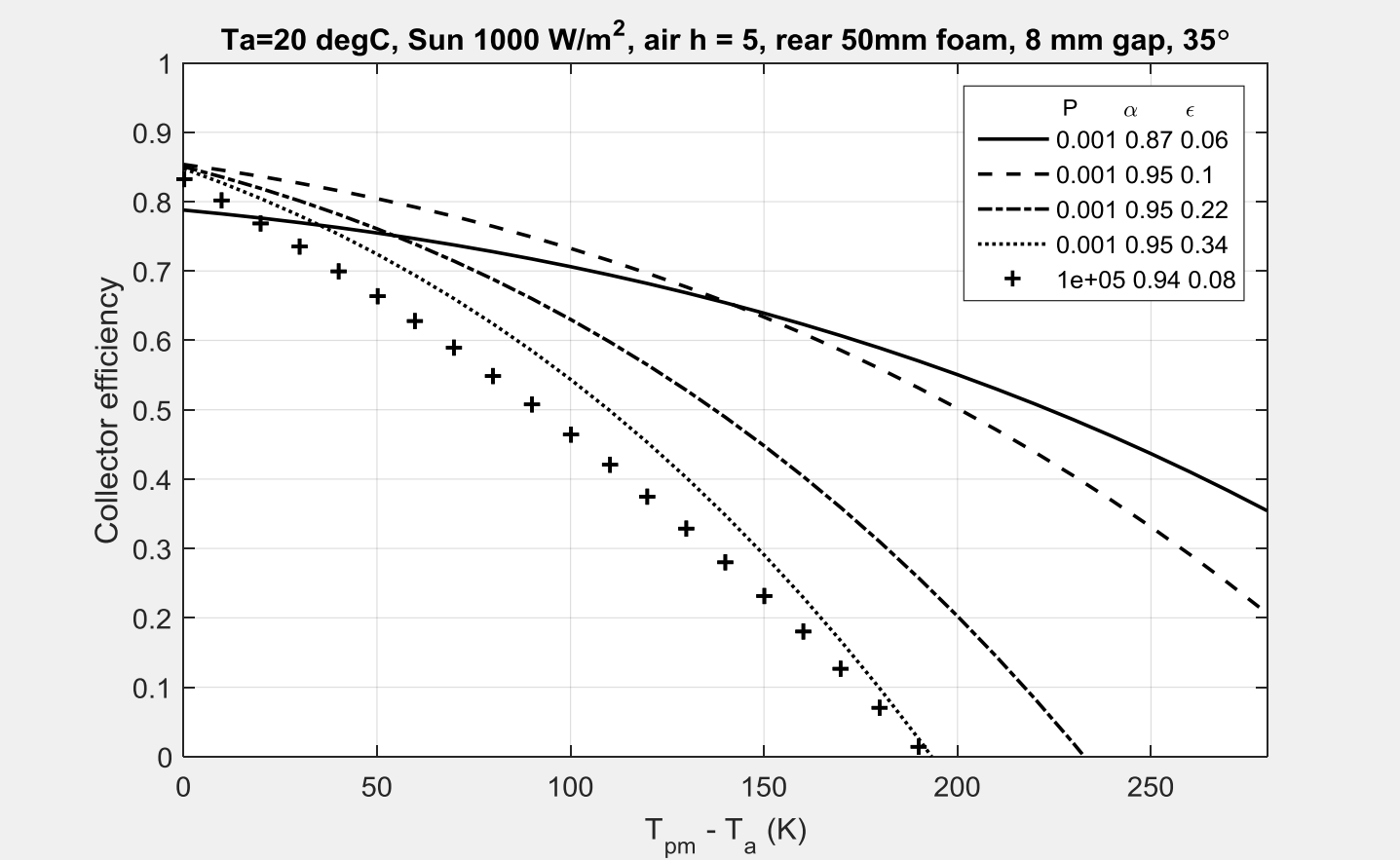
Experimental testing has verified level of insulation attainable





Research Projects



Research Projects

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Industrial Demand Reduction through Innovative Storage Technologies (IDRIST)

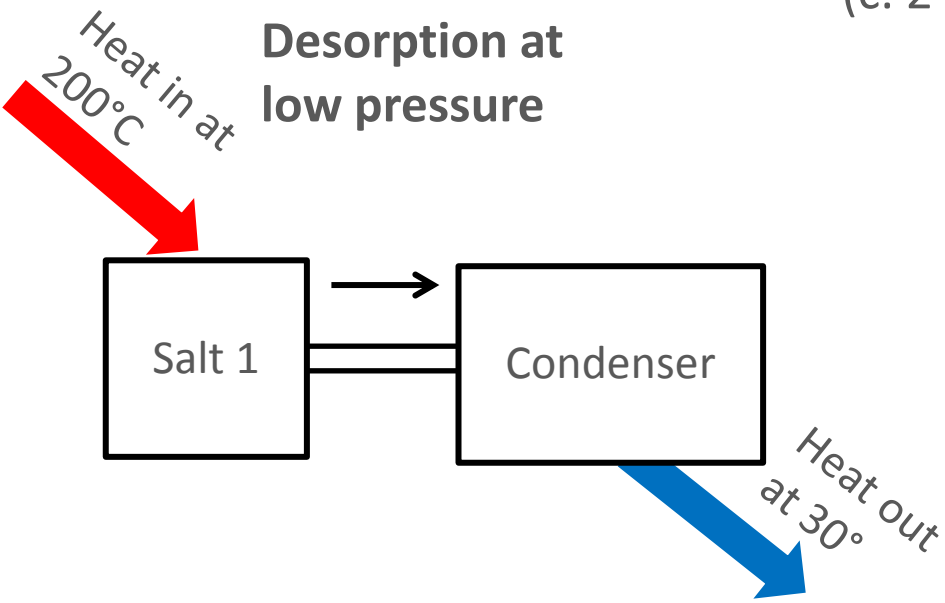
- £750k project funded by EPSRC
- Storage, temperature & vector transformation
- Developing new materials
- Designing HEs for storage
- Building & testing systems
- Modelling & control

Research Projects

1-salt thermal store

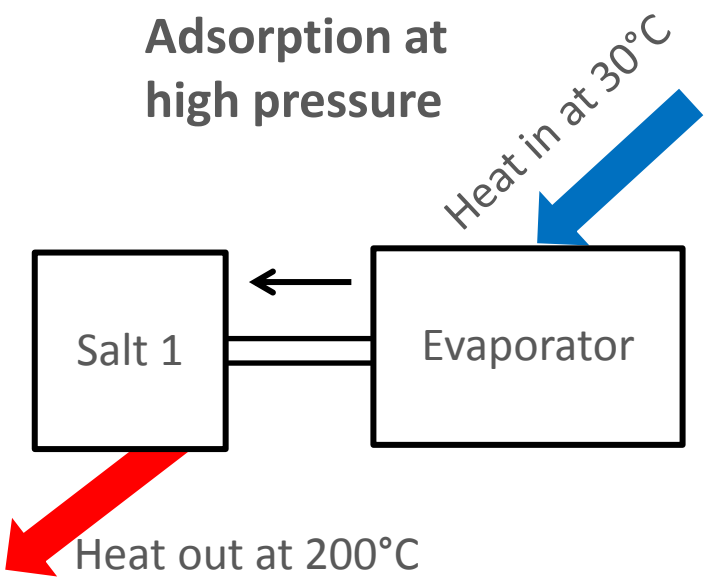
(c. 2 MJ/litre)

Desorption at low pressure



Phase 1: Storage of energy from heat at 200°C

Adsorption at high pressure



Phase 2: Discharge of heat at 200°C

Research Projects

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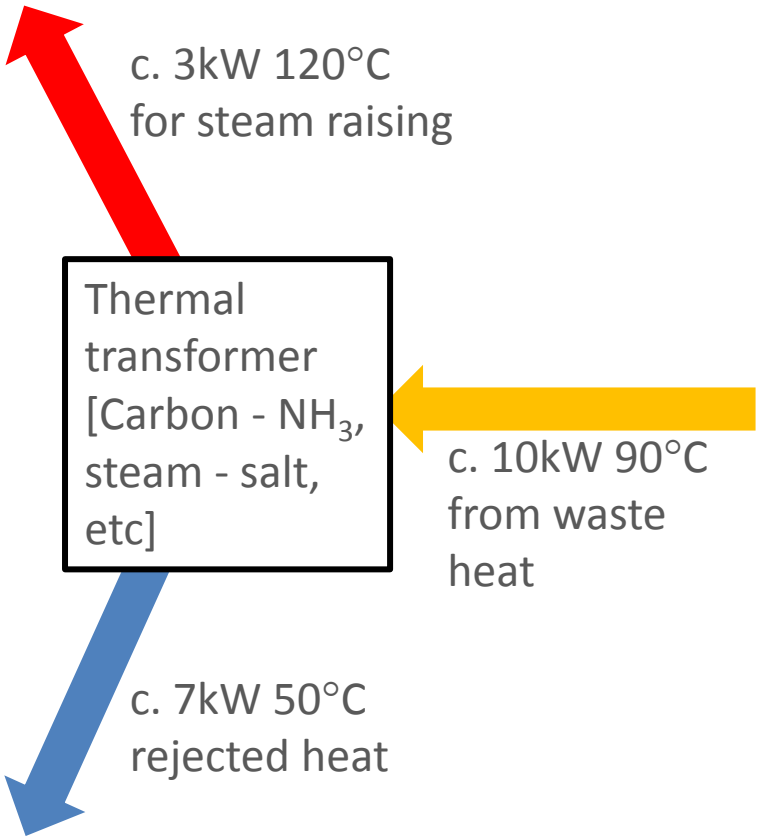
Thermal Transformers

Rationale: Industrial processes commonly reject heat at temperatures (eg.90°C) that cannot be utilised close to their source. A thermal transformer can transform some of this heat to higher useful temperatures, rejecting the remainder to ambient

Challenges: Identifying major processes that would benefit. Identifying physical or chemical reactions best suited to the major needs

Deliverables: Identification of process needs and matching reactions with potentially high efficiency. Construction of laboratory proof of concept to investigate heat and mass transfer limitations

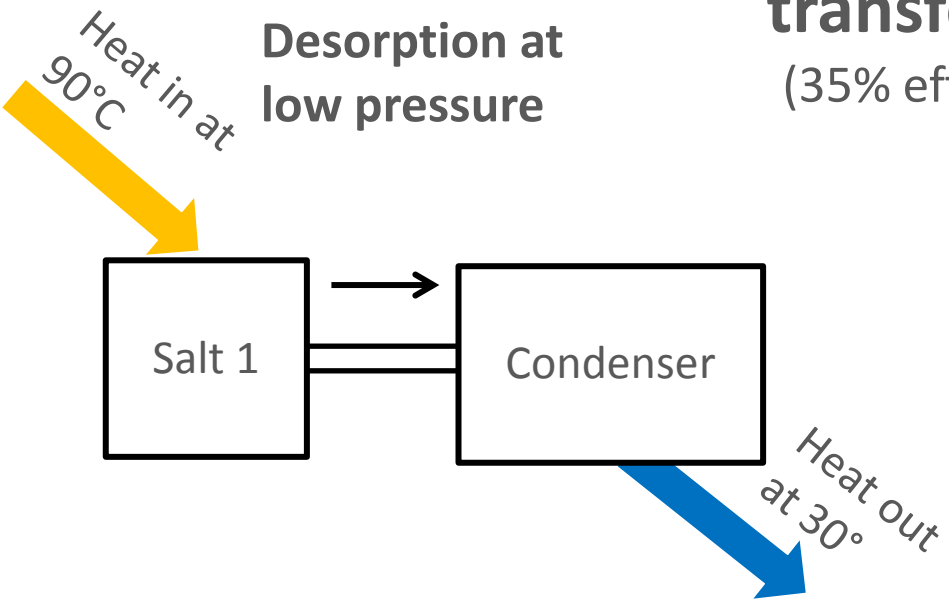


Research Projects

1-salt thermal transformer

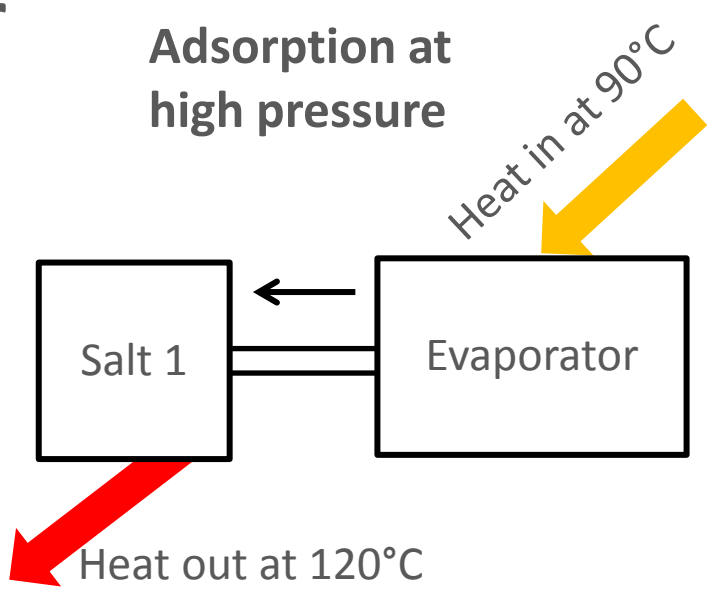
(35% efficient?)

Desorption at low pressure



Phase 1: Storage of energy from heat at 90°C

Adsorption at high pressure



Phase 2: Discharge of heat at 120°C

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Research Projects

Small Smart Sustainable Systems for future Domestic Hot Water (4S-DHW)

- £1.54M project funded by EPSRC
- Low carbon domestic heat
- High temperature electric and gas fired heat pumps
- Compact and efficient storage

Research Projects

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Multiscale Analysis for Facilities for Energy STorage (Manifest)

- £4.99M project funded by EPSRC
- Developing materials for thermal energy storage devices
- Designing & testing devices, validating models
- Determining how devices integrate into systems effectively
- Using data from pilot plants to understand the role of energy storage

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Research Projects

Interdisciplinary centre for Storage, Transformation and Upgrading of Thermal Energy (i-STUTE)

- £6.5M project funded by EPSRC
- Flexible funding to investigate heating and cooling technologies

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Research Projects

Thermal Energy Research Accelerator (T-ERA)

- £20M for the Midlands from InnovateUK
- £1.95M will be used to develop our laboratories and facilities
  - Extend the range of analytical kit, fabrication facilities & connection to district/ ground heat

Industrial Projects

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PCM store optimised for integration with domestic heat pumps

- Modular store constructed from polypropylene sheets with narrow channels carrying water
- Lightweight & chemically resistant plate heat exchanger

British Gas

South Tyneside Homes

spirax sarco

Industrial Projects

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PCM store optimised for integration with domestic heat pumps

- Investigated different thermal energy storage materials and heat exchanger designs
- Allows use of off-peak electricity to generate savings

Industrial Projects

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Heat networks operation controls – a step change for efficiency and waste recovery

- Managing surplus heat
- Storage
- ORC engines
- Predictive controls

HOARE LEA

couchperrywilkes®
engineering change

Industrial Projects

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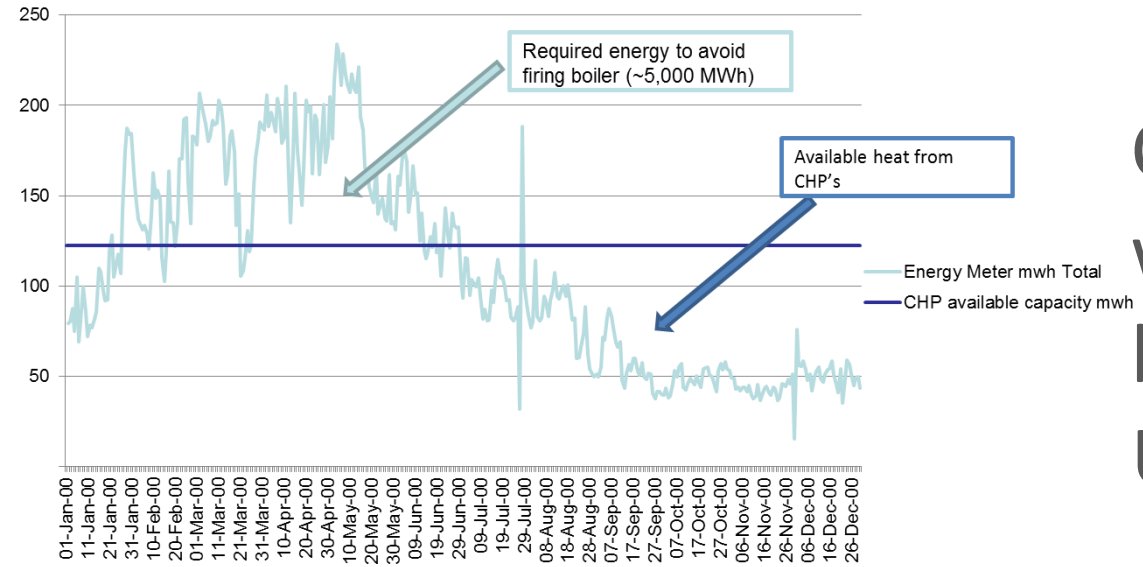
Heat networks operation controls – a step change for efficiency and waste recovery



Control optimisation was found to offer best value for the University system

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Thankyou