The Value(s) of Thermal Storage

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The challenge of heat decarbonisation

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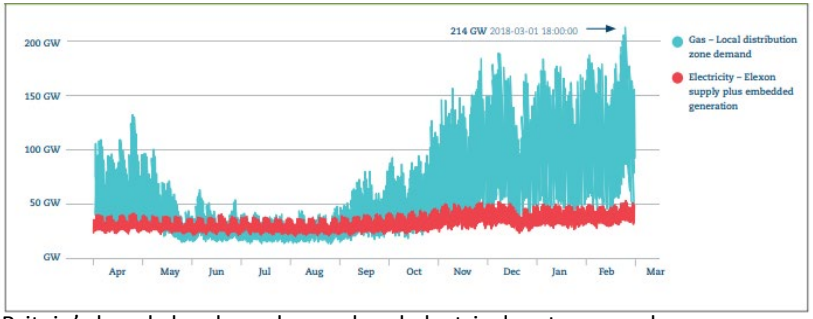
Global

- Heat accounts for over 50% final energy consumption, 1/3 of carbon emissions, cooling currently at 2% but expected to increase dramatically

UK

- Highly centralized infrastructure and policy-making, liberalised market economy.
- Municipal authorities expected to support carbon reduction targets with little local control
- Ubiquity of natural gas, supplying 85% of domestic customers, 81% of heat
- Electricity v gas – 2 x energy, 7 x swing



Britain's hourly local gas demand and electrical system supply, 2nd April 2017 - 6th March 2018 [1]

Focus

- Urban-scale responses in relation to thermal storage and district-level energy
- Whether adding the flexibility from thermal storage to electric heating represents optimal pathway to heat decarbonisation

The challenge of heat decarbonisation

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Thermal storage – can help decarbonise both heat and electricity system

- Capture heat that would otherwise be wasted
- Reduce size of plant and use of peaking (with associated carbon emissions)
- Seasonal storage can help mitigate winter peak (or summer peak cooling)
- When combined with electricity generation, allows electricity generation at times when there is no demand for heat, without resorting to heat rejection

When combined with electric heating

- Help balance electricity supply
- Enables additional renewable energy capacity
- Reduce network reinforcement costs

Methodological approach

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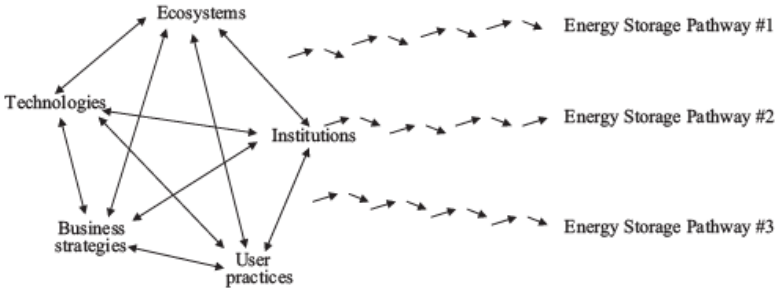
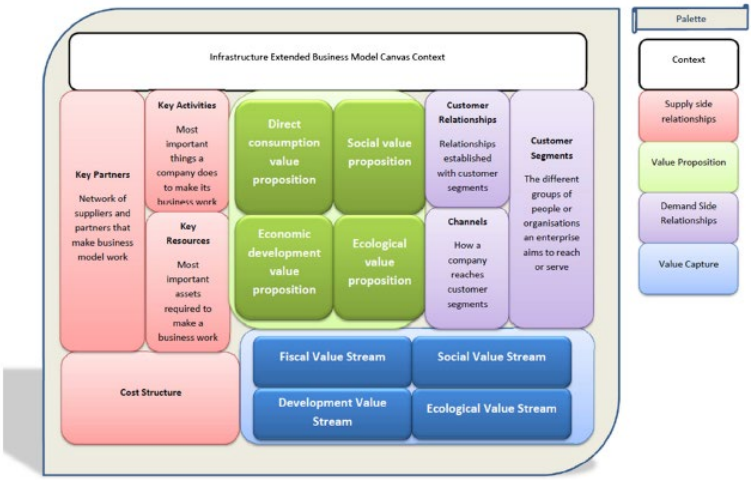
- Sociotechnical perspective – thermal storage as a technology within (complex) system
- Interacting elements in the system affect each other to co-evolve
- Thermal storage likely to have characteristics of *local* infrastructure
- Infrastructure investment decisions likely to be sub-optimal if made on the basis of simple financial gains



Coevolutionary framework for energy storage pathways [2]

Research involved:

- Data gathering and documentary analysis of 33 UK projects to extract themes of value capture



Infrastructure Extended Business Model Canvas (Foxon et al., 2015) [3]

Thermal storage applications 1 – Heat battery through phase-change materials

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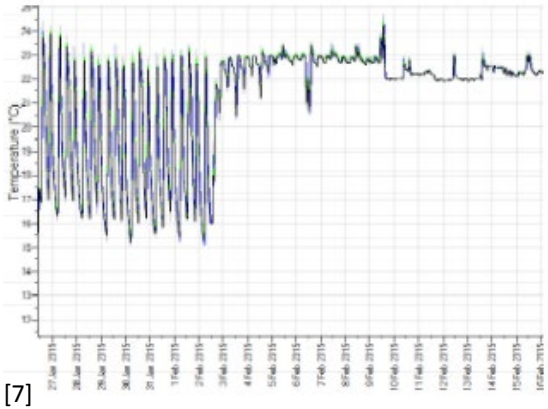
[4]

[5]


[6]

EastHeat: Edinburgh and Surrounding Towns Heat Energy Action through Thermal-Storage

- 625 dwellings fitted with phase-change heat battery (Sodium acetate trihydrate), 404 linked to PV. Consortium of two social housing providers and local R&D firm, Sunamp
- Majority grant funding from Scottish Government/ERDF funded through CARES Local Energy Challenge Fund
- Focus on reducing energy costs and fuel poverty, demonstrate local energy economy approach linking energy generation to energy use
- Technology chosen to maximise solar PV self-consumption, make use of lower night-time tariffs
- Delivered 40-60% reductions in heating bills and significant improvement in comfort



[7]

Thermal storage applications 2 – Local authority-led district energy with thermal storage

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[8]

Gateshead Energy Company

[9]

Leeds PIPES

[10]

Bunhill Heat & Power

- Local authority owned, large scale district heat networks with tank-based thermal storage (8 of 33 case studies)
- Thermal storage (with CHP) to capture heat generated when grid electricity prices high but heat demand is low and (without CHP) to operate at peak efficiency
- Business model: municipal ESCo (Gateshead EC – assets remain with council), council direct control (Islington and Leeds PIPES)
- Non-traditional values:
  - Change in focus away from carbon reduction and towards economic development and social objectives

Thermal storage applications 3 – Geo-exchange and heat sharing

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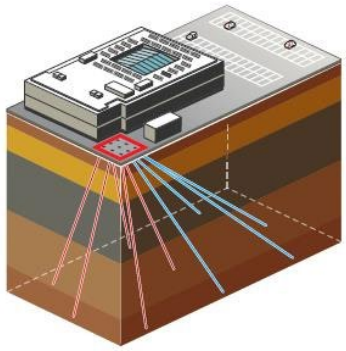
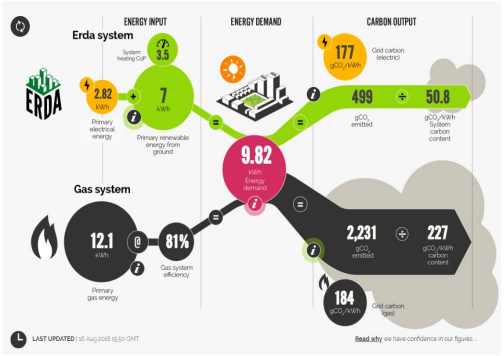


[11]

Ground-coupled thermal storage with ground source heat pumps

[12]

Borehole field following completion of drilling



[13]

ERDA Energy published low carbon heat supply

- 4 ground storage, 4 aquifer, 2 mine water (conceptual)
- Potential to integrate wide array of customers/types
- ESCo model meets heat requirement at low carbon
- Currently limited non-traditional values reflecting commercial models but potential to provide excess heat/cold to other customer segments
- Evidence of innovative business models, inc revenue stacking, demand-side response to avoid peak loads on grid and earn income through aggregation
- Single customer deployment at present but potential for replication at larger scale

Conclusions

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Findings

- A wide range of technologies and business models employed in the UK seeking a broad range of non-traditional values
- Important role for local actors, especially municipal authorities, importance of devolved powers – with evidence of temporal values shift
- All large-scale projects involved district heating and were set up by local authorities – impact on future development potential
- Innovative business models having an impact on deployment

Future work:

- Geo-exchange and the potential for greater deployment with support from municipal authorities
- The role of municipal government in supporting the urban energy transition for heat
- Decision support processes for energy planning at the local authority level

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Thank you for listening

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