The Value(s) of Thermal Storage
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The challenge of heat decarbonisation

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 vs gas – 2 x energy, 7 x swing

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
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

- 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

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

Coevolutionary framework for energy storage pathways [2]

Infrastructure Extended Business Model Canvas (Foxon et al., 2015) [3]
Thermal storage applications 1 – Heat battery through phase-change materials

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

- 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
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

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
Thank you for listening

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