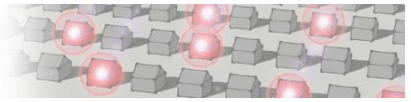
UKERC

FITS-LCD
Fabric-Integrated Thermal Storage in Low Carbon Dwellings



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# 5 problems and 5 solutions in decarbonising domestic heat… and what it means for networks

LCNI 2018 Conference – Views from Academia

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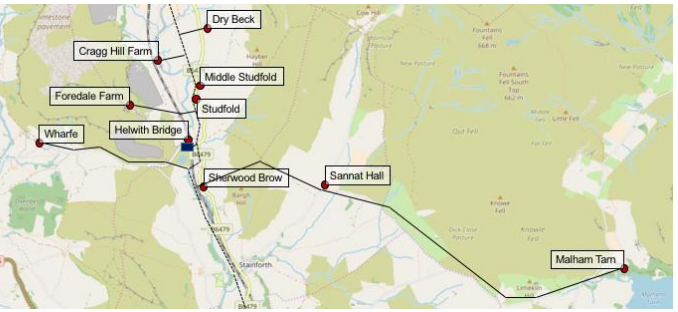
Institute for Energy and Environment, Department of Electronic and Electrical Engineering, University of Strathclyde

# Local Network Modelling

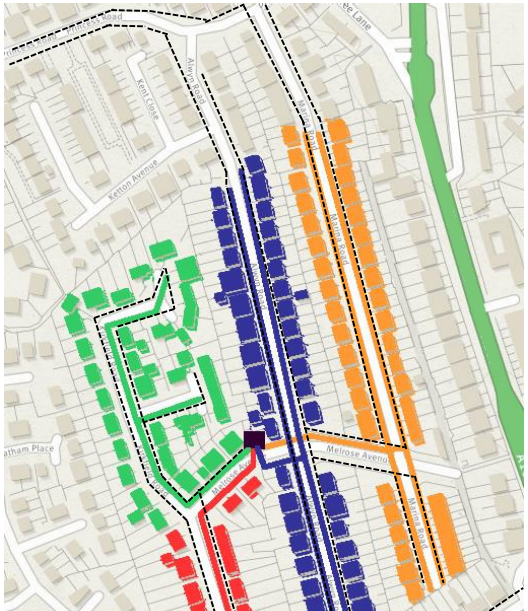
**Rural**

**Disaggregate UK energy system into exemplar archetypes**

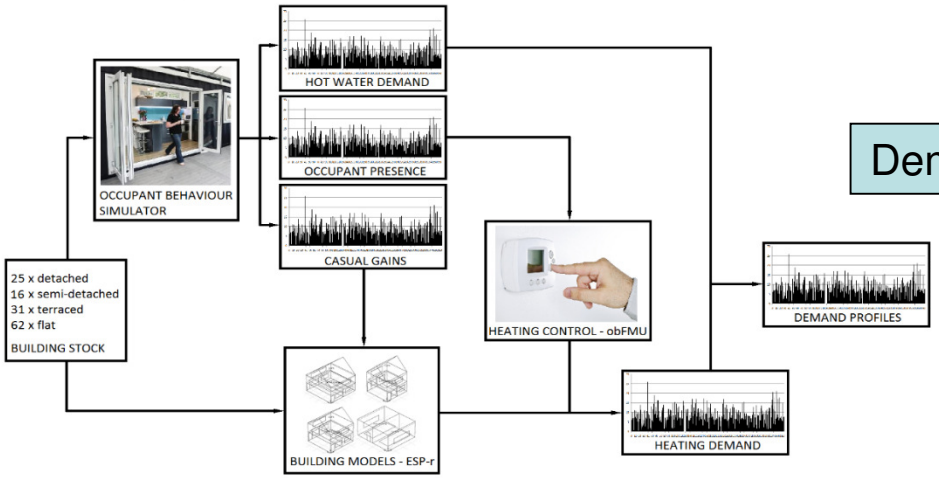
**Urban**



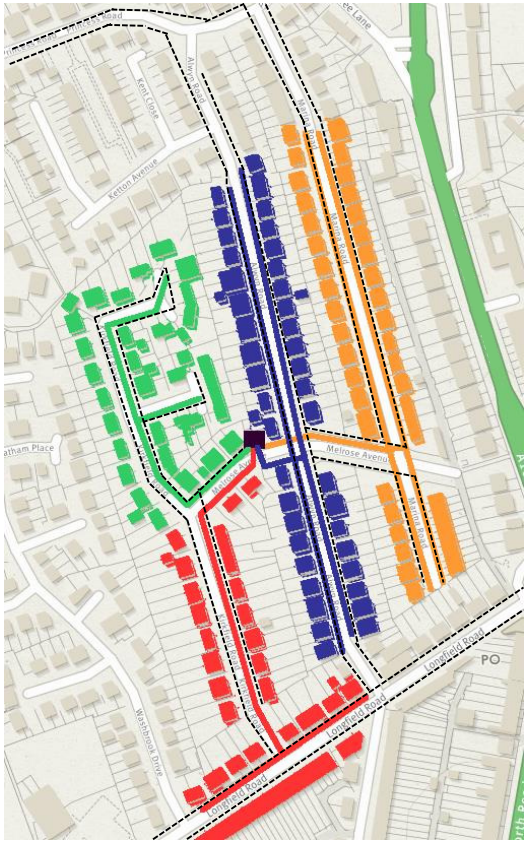

**Suburban**

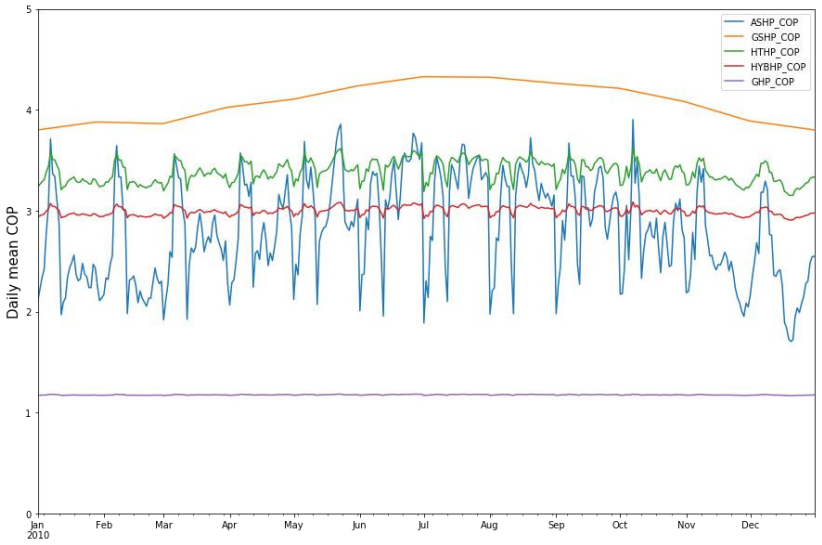


# Demand and technology modelling




Demand






Supply

# Problem 1: Peak heat demand pick-up

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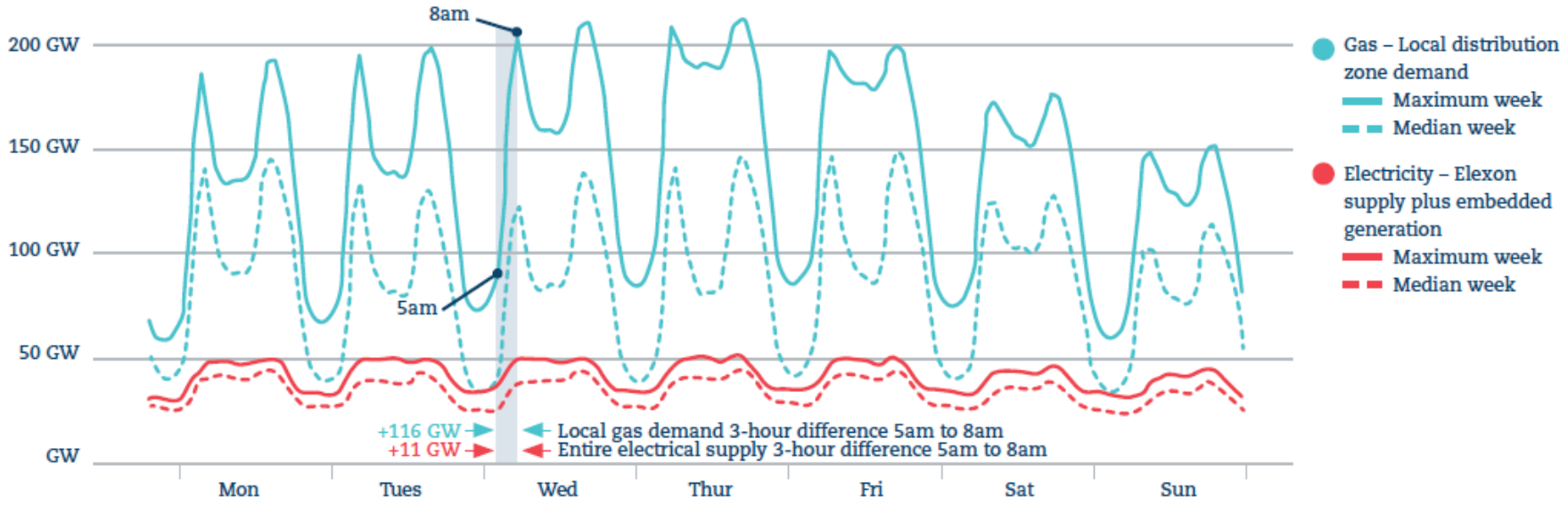
On 1st March 2018 at 6pm:

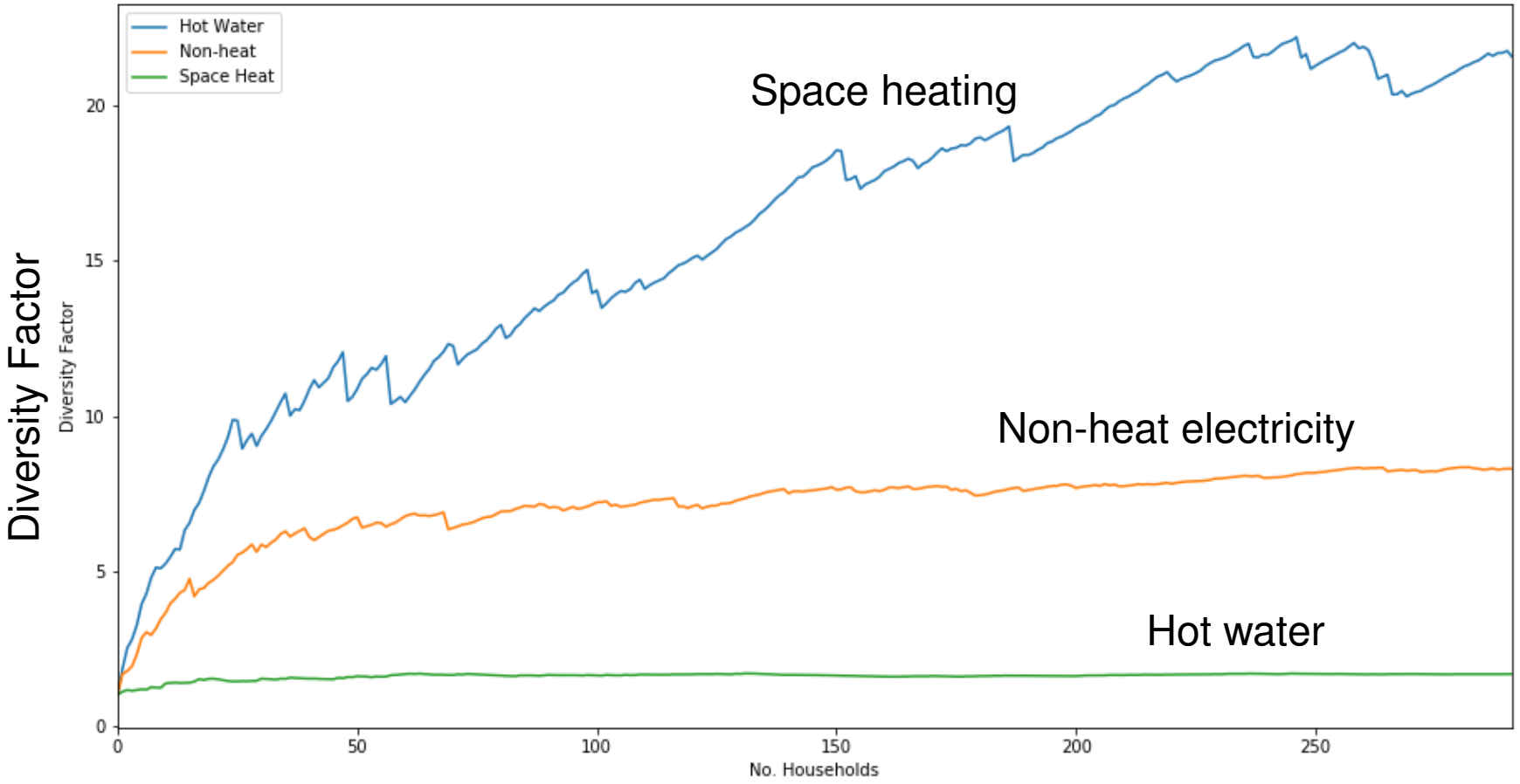
- hourly local gas demand: 214GW
- electrical supply: 53GW




Grant Wilson, University of Birmingham

http://www.ukerc.ac.uk/publications/local-gas-demand-vs-electricity-supply.html

# Problem 2: Heat load does not follow existing diversity patterns




Increasing No. Households →

Hawker G. (2018) Spatial and temporal disaggregation of whole system energy models through exemplar local multi-carrier networks

# Problem 3: Where has all the hot water storage gone?

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- UK domestic new-build properties are shrinking
- Combi boiler installations have ‘freed up’ additional space in many houses which is now being used as living space
- Many new-builds may not have sufficient supportive infrastructure (or space) to retrofit
- BEIS ‘Future Framework For Heat in Buildings’ call for evidence is considering futureproofing for storage in new build requirements

# Problem 4: Working with the system we have

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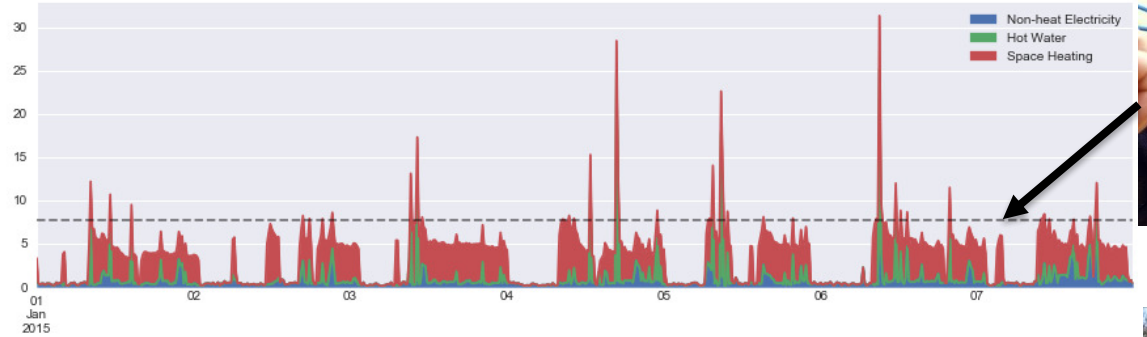
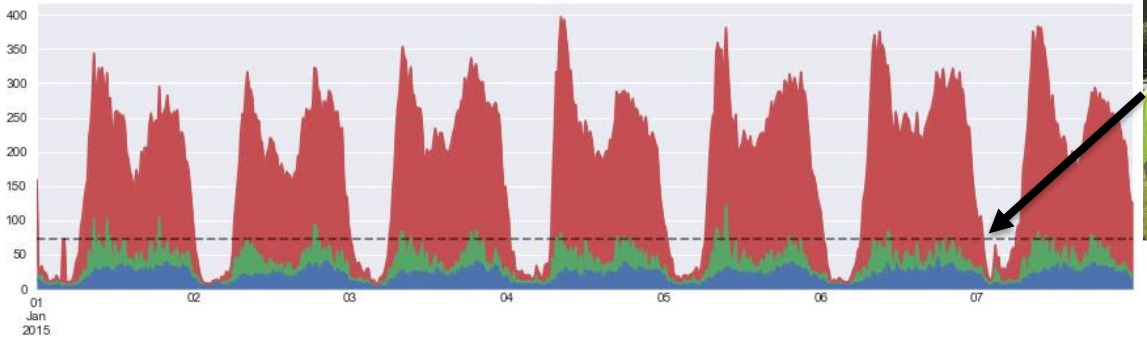
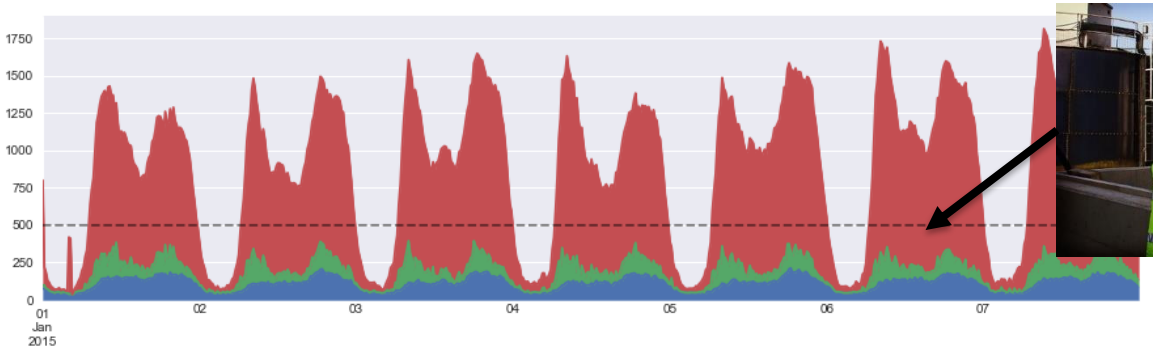
1 house
3 occupants



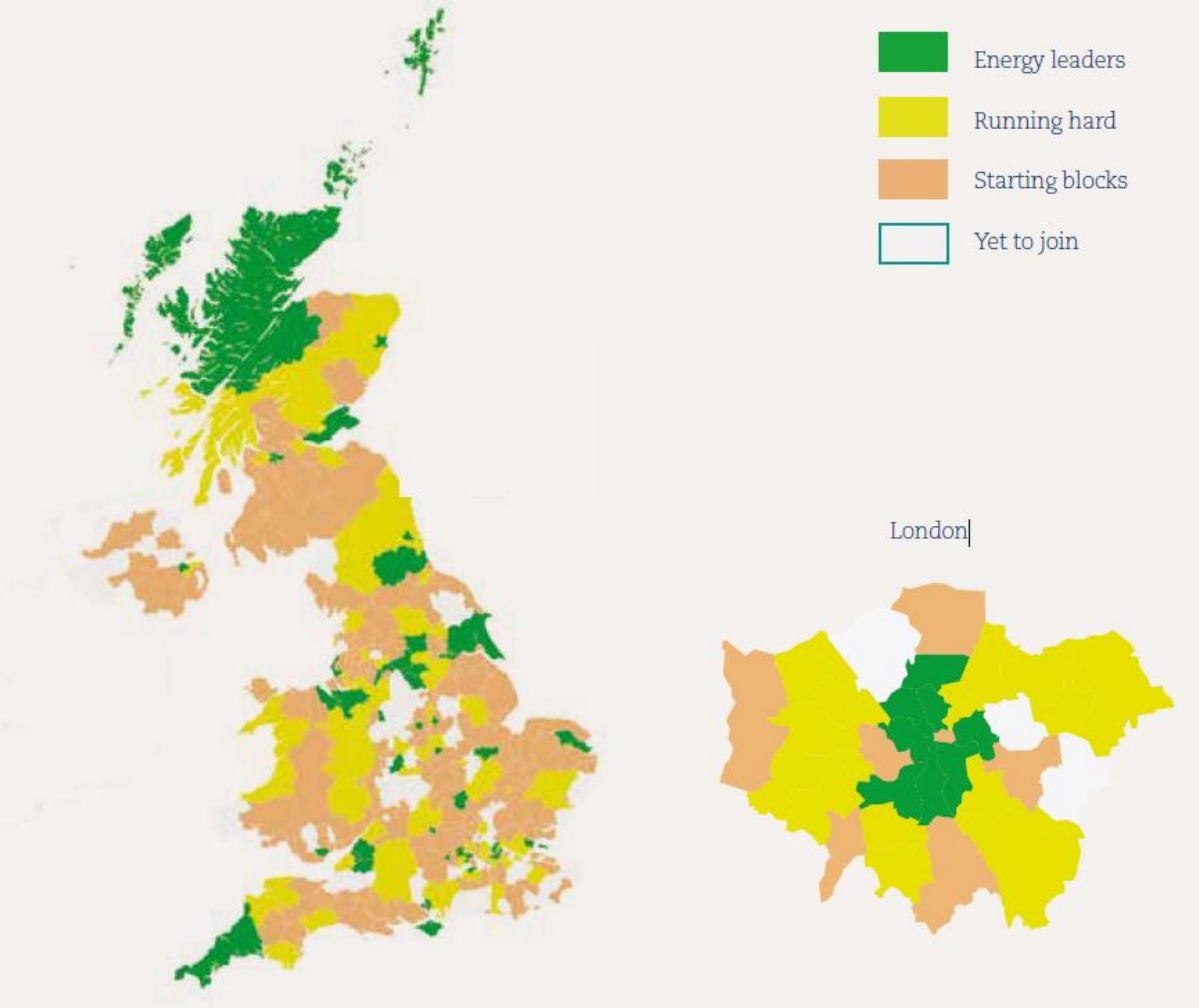

1 LV Feeder
59 houses
162 occupants




1 LV Xformer
292 houses
697 occupants



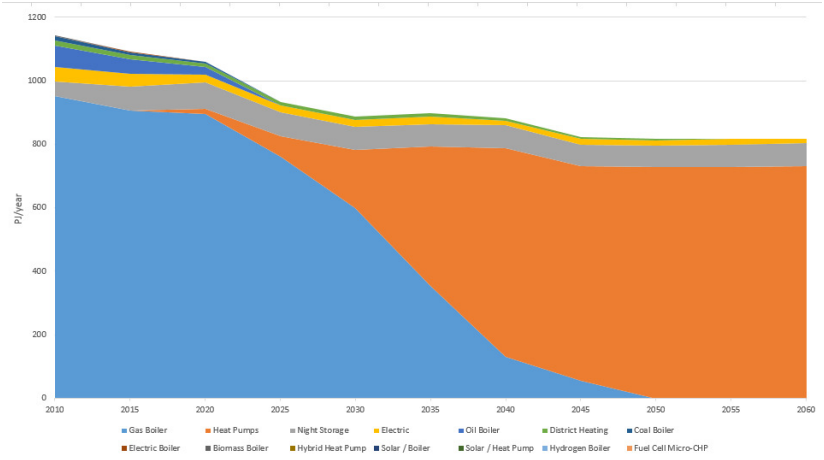

# Problem 5: Coordination is complex




Webb, Tingey and Hawkey (2017), What we know about local authority engagement in UK energy systems, UKERC and ETI

# Solution 1: Recognising spatial heterogeneity

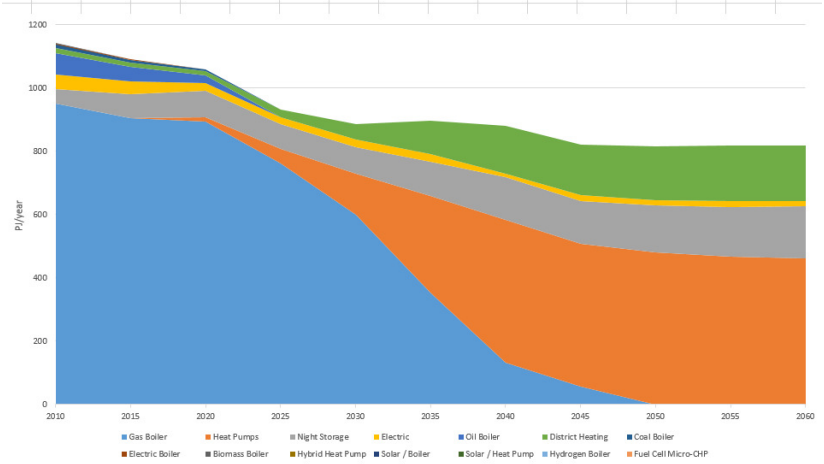
Before spatial disaggregation




Heat pumps are the solution to all of our problems!

The Whole System View

After spatial disaggregation



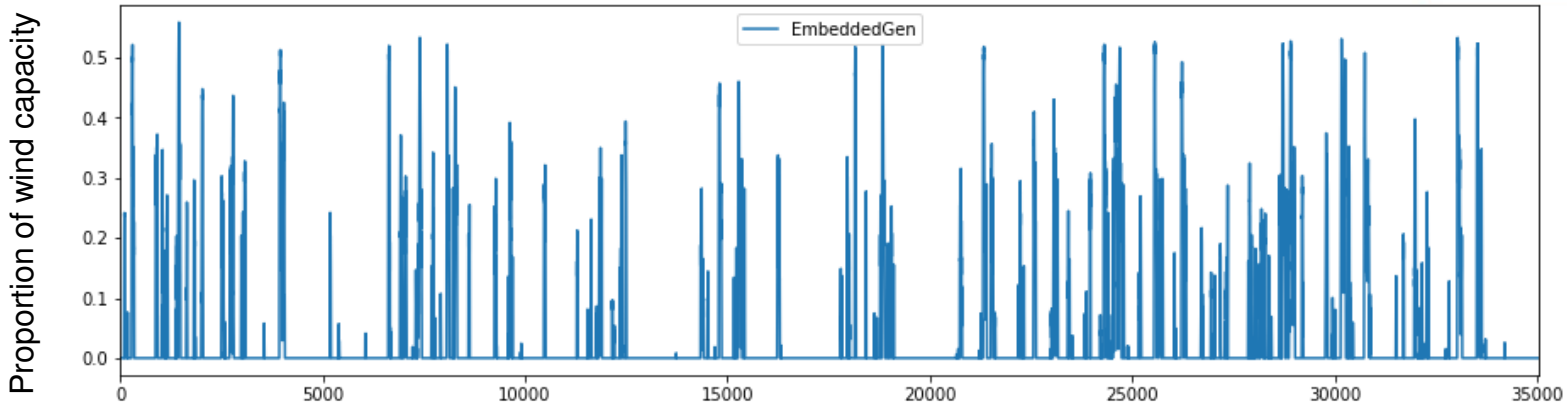

Economic heat network opportunities in densely populated urban areas

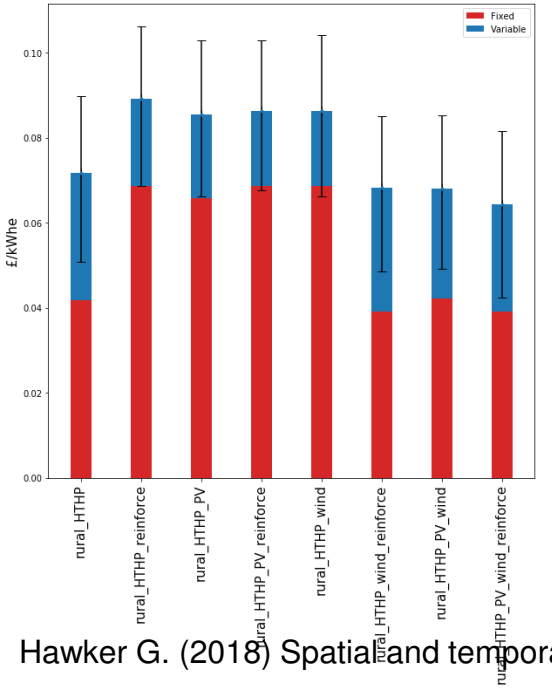
Increased value of heat storage in rural areas

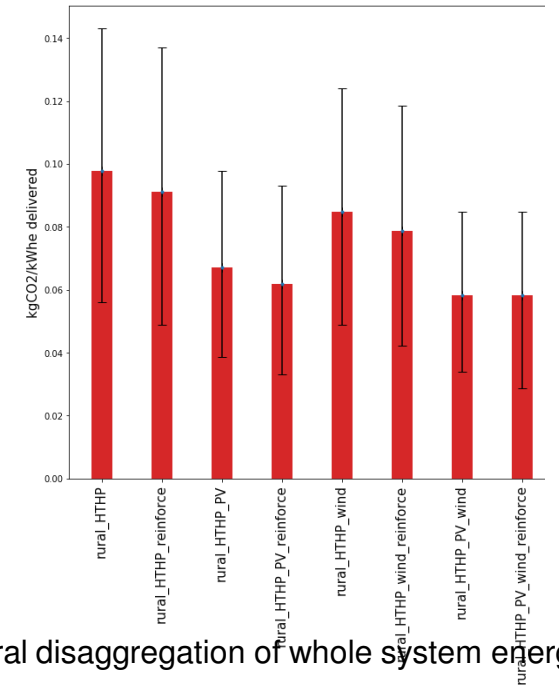
Heat pumps remain as key technology displacing natural gas boilers over time

Hawker G. (2018) Spatial and temporal disaggregation of whole system energy models through exemplar local multi-carrier networks

# Solution 2: Opportunities from curtailed renewables




| End Use Technology | Scenario PV | Wind | Reinforcement | Average Abatement Cost compared to Base Scenario (£/kg$CO_2$) |
|---|---|---|---|---|
| High Temperature Heat Pump | - | Yes | Yes | -0.203 |
| High Temperature Heat Pump | - | - | Yes | -0.195 |
| High Temperature Heat Pump | - | Yes | - | -0.190 |
| High Temperature Heat Pump | - | - | - | -0.183 |
| High Temperature Heat Pump | Yes | - | Yes | -0.091 |
| High Temperature Heat Pump | Yes | Yes | - | -0.086 |
| High Temperature Heat Pump | Yes | Yes | Yes | -0.086 |
| High Temperature Heat Pump | Yes | - | - | -0.077 |
| Ground-to-water Heat Pump | - | - | - | -0.052 |
| Air-air Heat Pump | - | - | - | 0.054 |

**Abatement costs for high temperature heat pump scenarios compared to fuel oil condensing boilers, rural model, central assumptions**

Hawker G. (2018) Spatial and temporal disaggregation of whole system energy models through exemplar local multi-carrier networks

# Solution 3: Heat buffering and thermal storage

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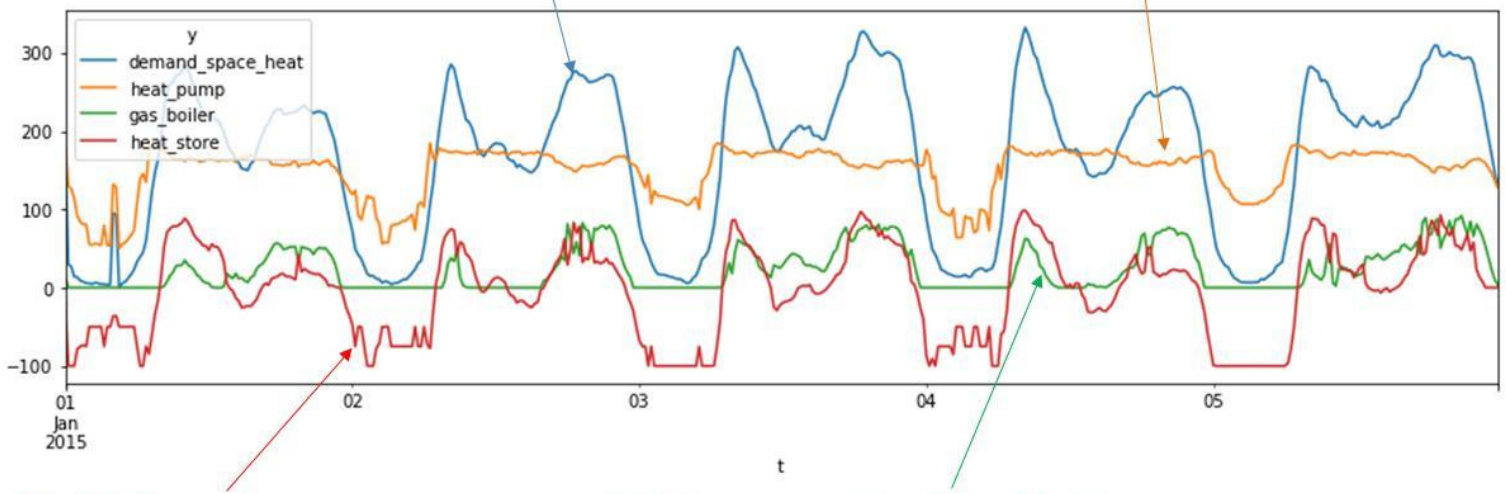
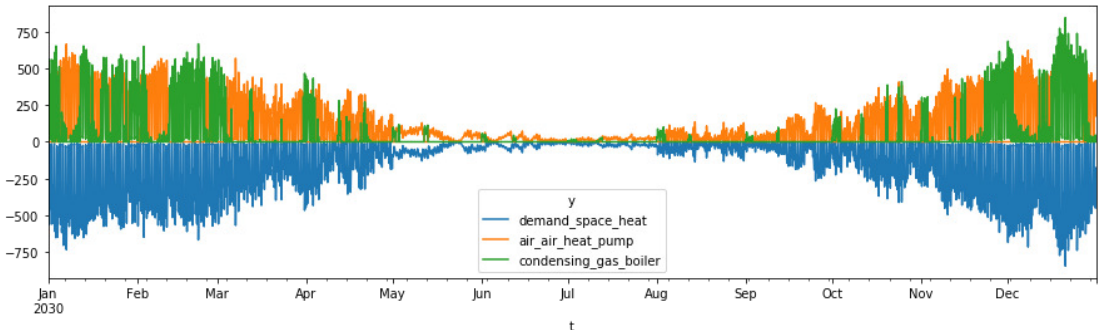
Net space heat demand: building efficiency reduces total energy and provides temporal buffering

Heat pumps utilise decarbonised electricity (local and grid) to limit of network capacity (minus other electrical demand)

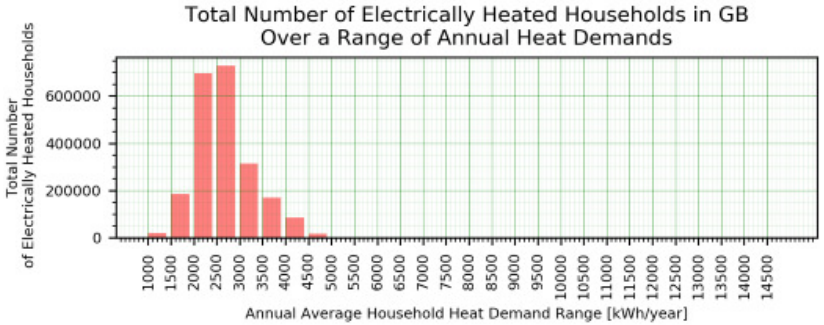


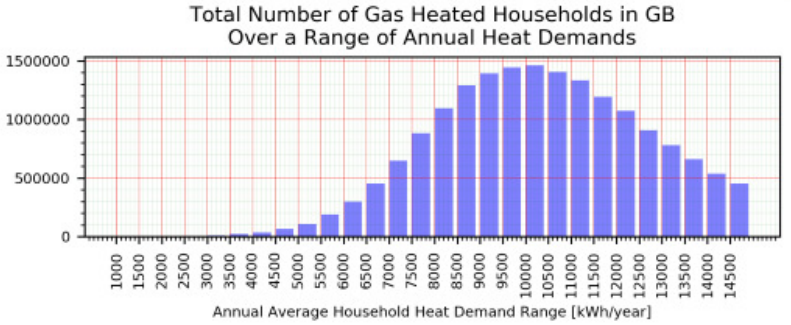

Heat storage increases utilization of heat pump capacity

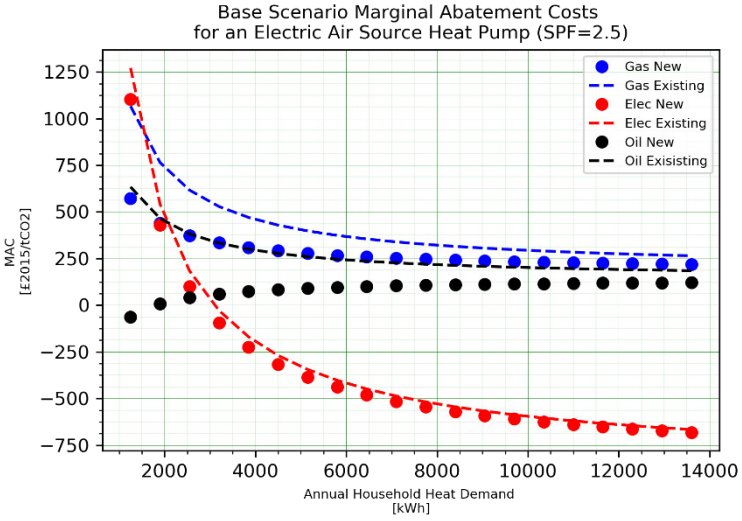
Existing gas network and boilers provide remainder of space heating



# Solution 4: Targeting the right technologies at the right people



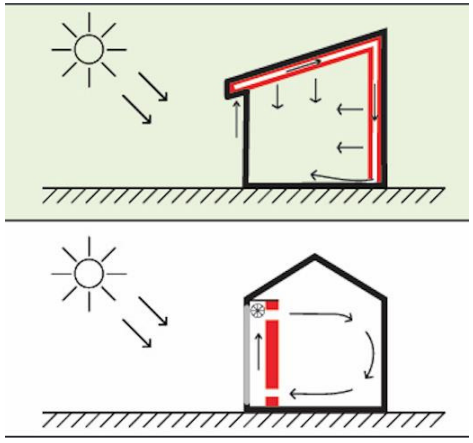



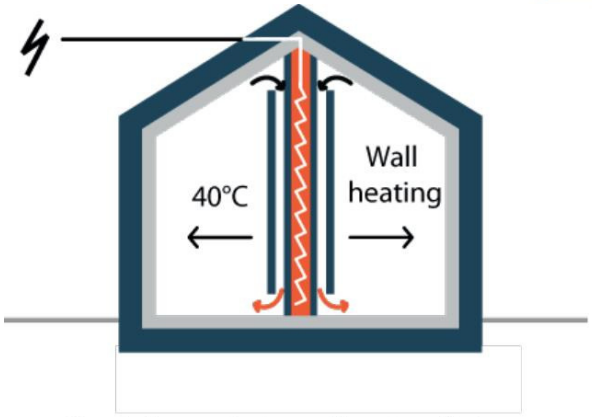

*Sources: [1] England, Northern Ireland, Scotland and Wales 2011 Census: Office for National Statistics ; National Records of Scotland ; Northern Ireland Statistics and Research Agency (2017): 2011 Census aggregate data. UK Data Service (Edition: February 2017). DOI: http://dx.doi.org/10.5257/census/aggregate-2011-2; [2] UK GOV, Sub-national electricity and gas consumption data 2015*

*University of Strathclyde IPPI blog October 2018* - **Reducing emissions from heating our homes – does one size fit all?**

https://www.strath.ac.uk/research/internationalpublicpolicyinstitute/ourblog/october2018/reducingemissionsfromheatingourhomesdoesonesizefitall/

# Solution 5: Recognising the link between buildings and networks



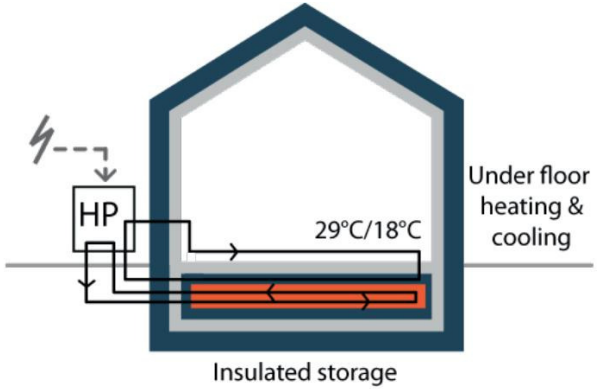


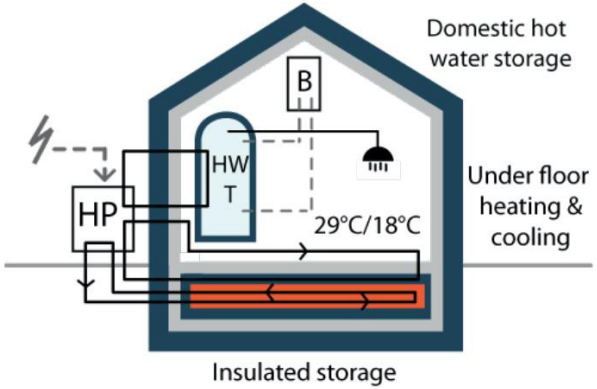
Semi-decoupled ventilated wall storage

***Solid Storage heated and cooled with heat pump***

Solid storage with water as the heat distribution fluid

Other locations:
Exterior walls and under staircases




Marinho de Castro, M.M. et al., (2018). A Taxonomy of Fabric Integrated Thermal Energy Storage: A review of storage types and building locations. Future Cities and Environment. 4(1), p.5. DOI: http://doi.org/10.5334/fce.6

# So what?

- Building standards and efficiency have direct and significant impacts on network requirements, not only in terms of aggregate demand
- An individualist approach to heat provision creates significant overcapacity
- Heat solutions which do not entirely displace incumbent technologies may imply overcapacity of both end-use technologies and network
- The UK is a highly spatially heterogeneous system with a broad variety of extant technologies and use cases, and great care should be taken in extrapolating from case studies
- The least-cost and least-emissions pathways (both for the system and consumer) are subject to high uncertainty due to the wide range of future technology cost estimates and fuel carbon intensities