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The impact of future heat demand pathways on the economics of low carbon heating systems

BIEE – 9th Academic Conference 2012

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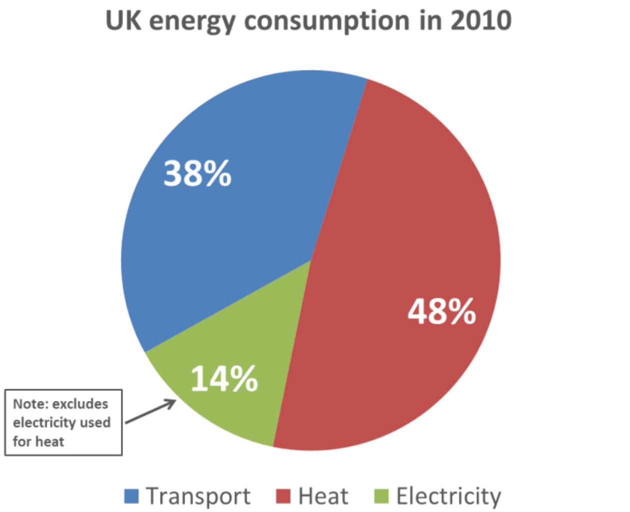
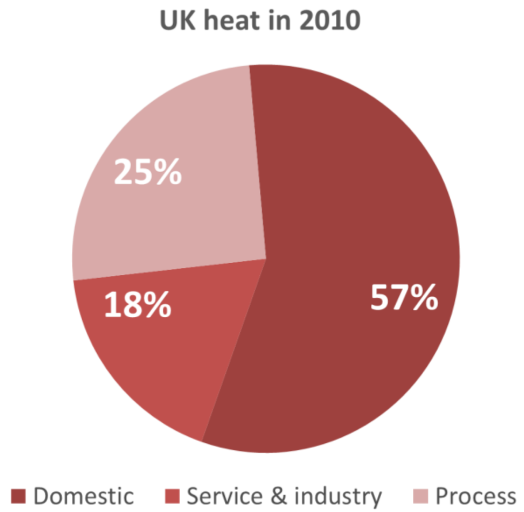
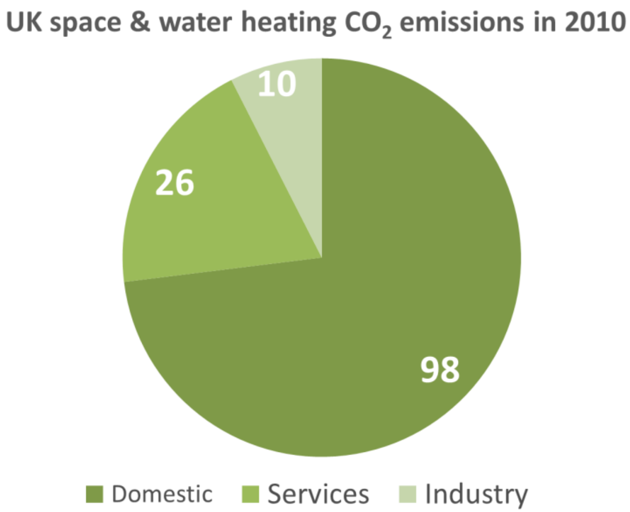
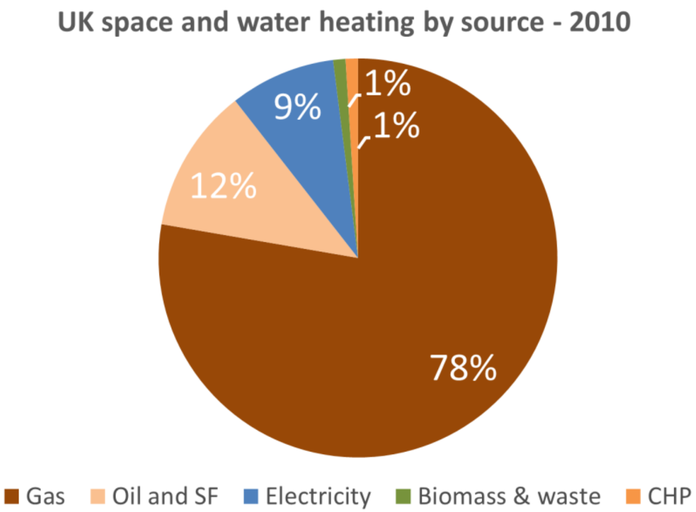
Heat in 2010


UK energy consumption in 2010
38%
48%
14%
Note: excludes electricity used for heat
Transport
Heat
Electricity


UK heat in 2010
25%
57%
18%
Domestic
Service & industry
Process


UK space & water heating CO_2 emissions in 2010
10
26
98
Domestic
Services
Industry


UK space and water heating by source - 2010
1%
9%
1%
12%
78%
Gas
Oil and SF
Electricity
Biomass & waste
CHP

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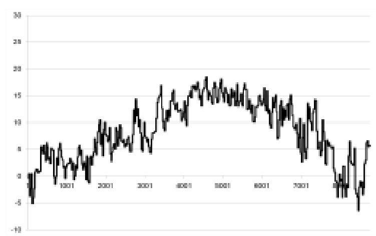
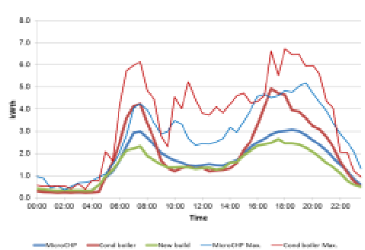
Heat demand model

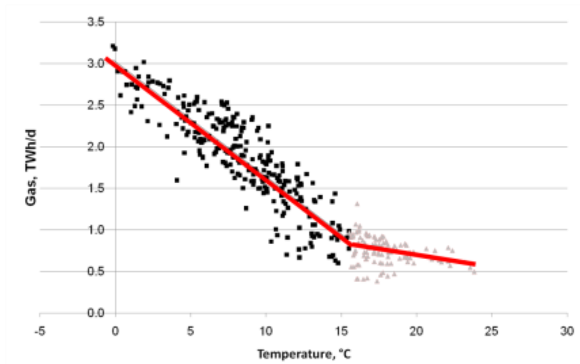
Temperature scenario



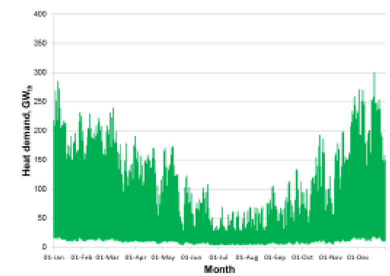
"Typical" day thermal demand



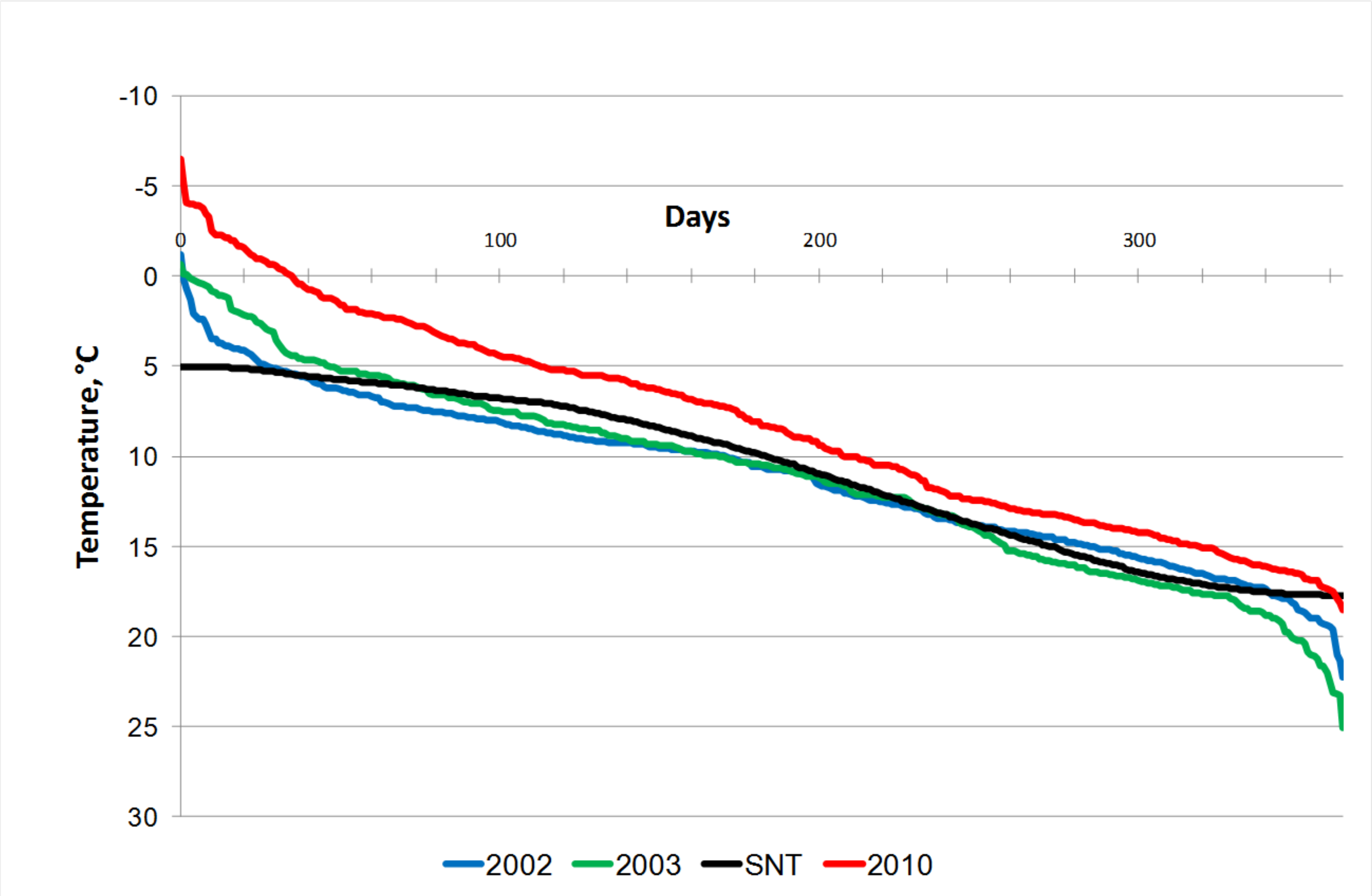
Heat demand model



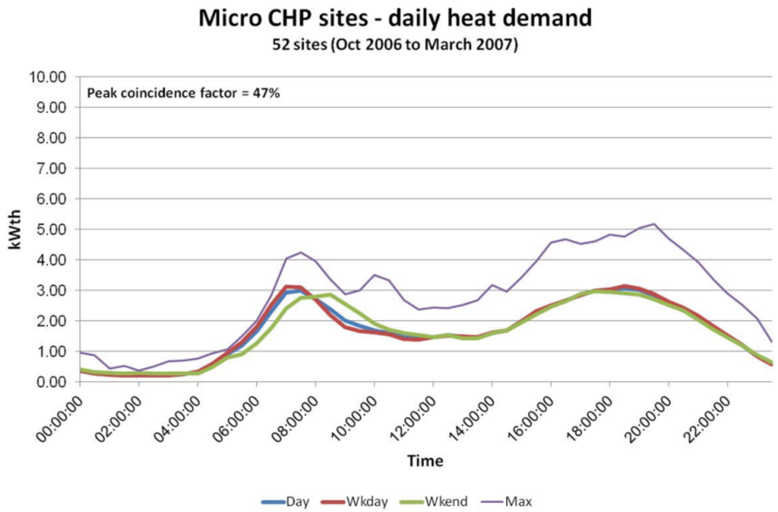
Half hourly annual heat demand

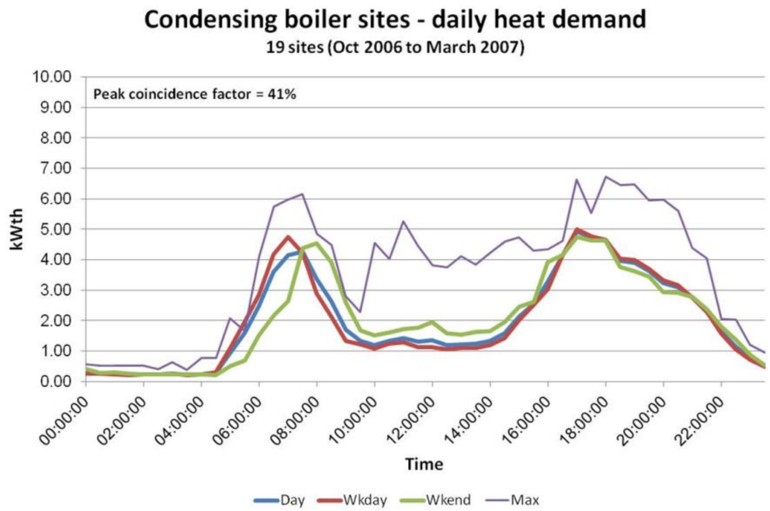


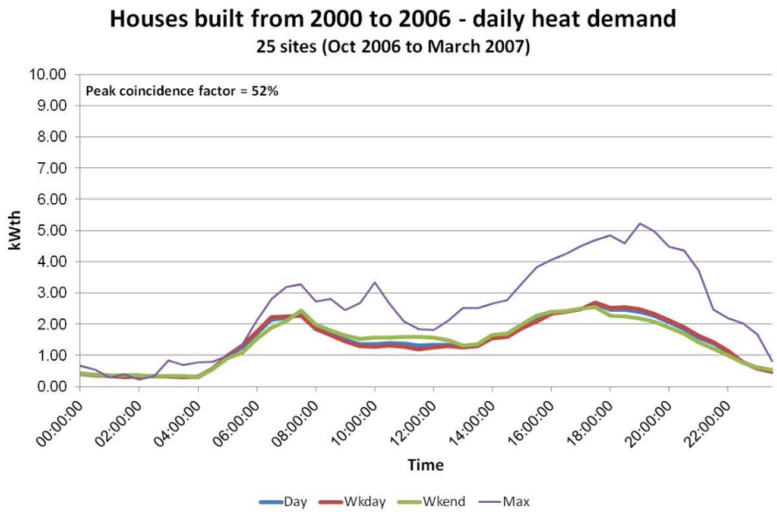
UK daily temperature annual duration curves



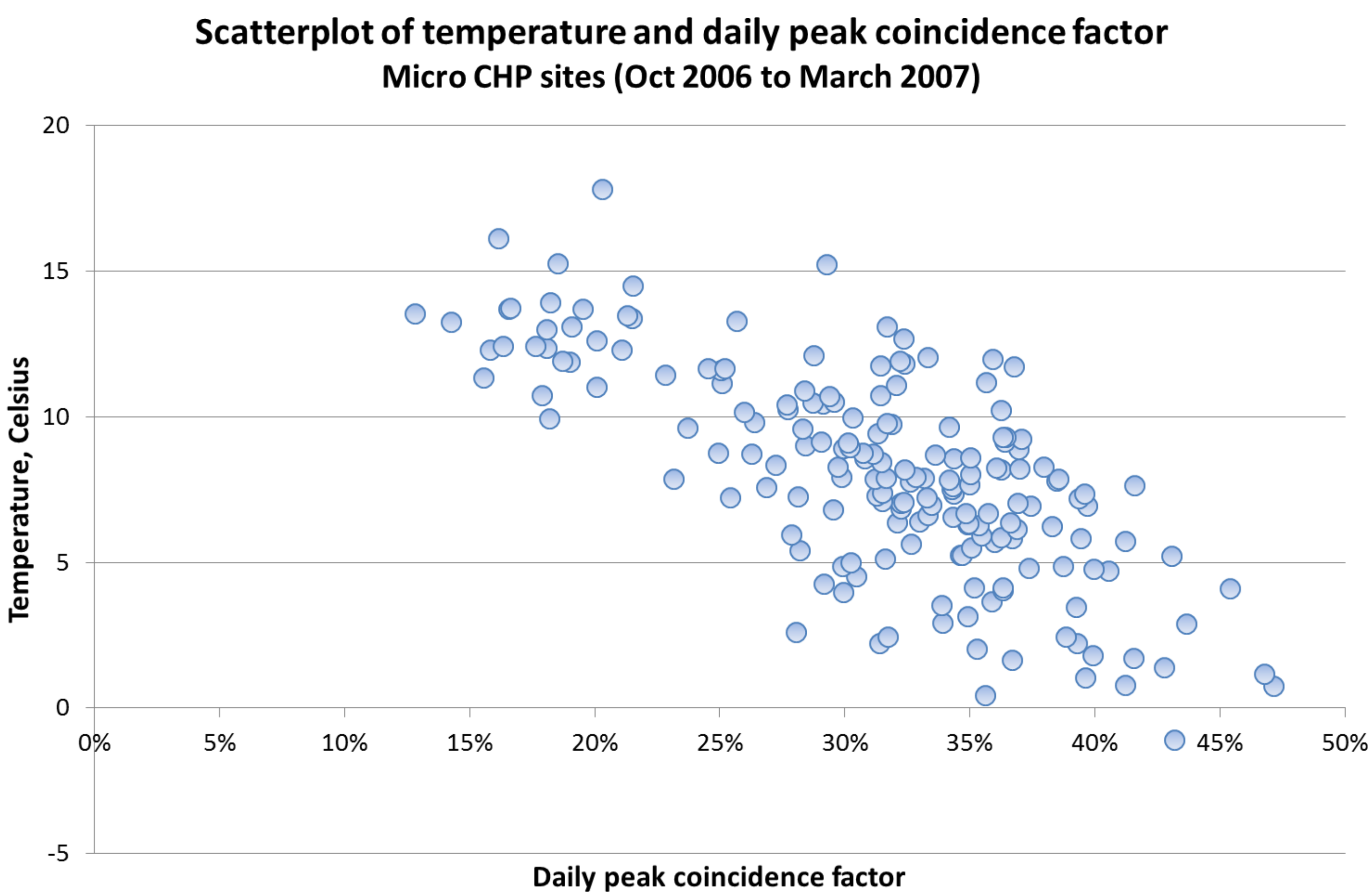
Heat demand profiles



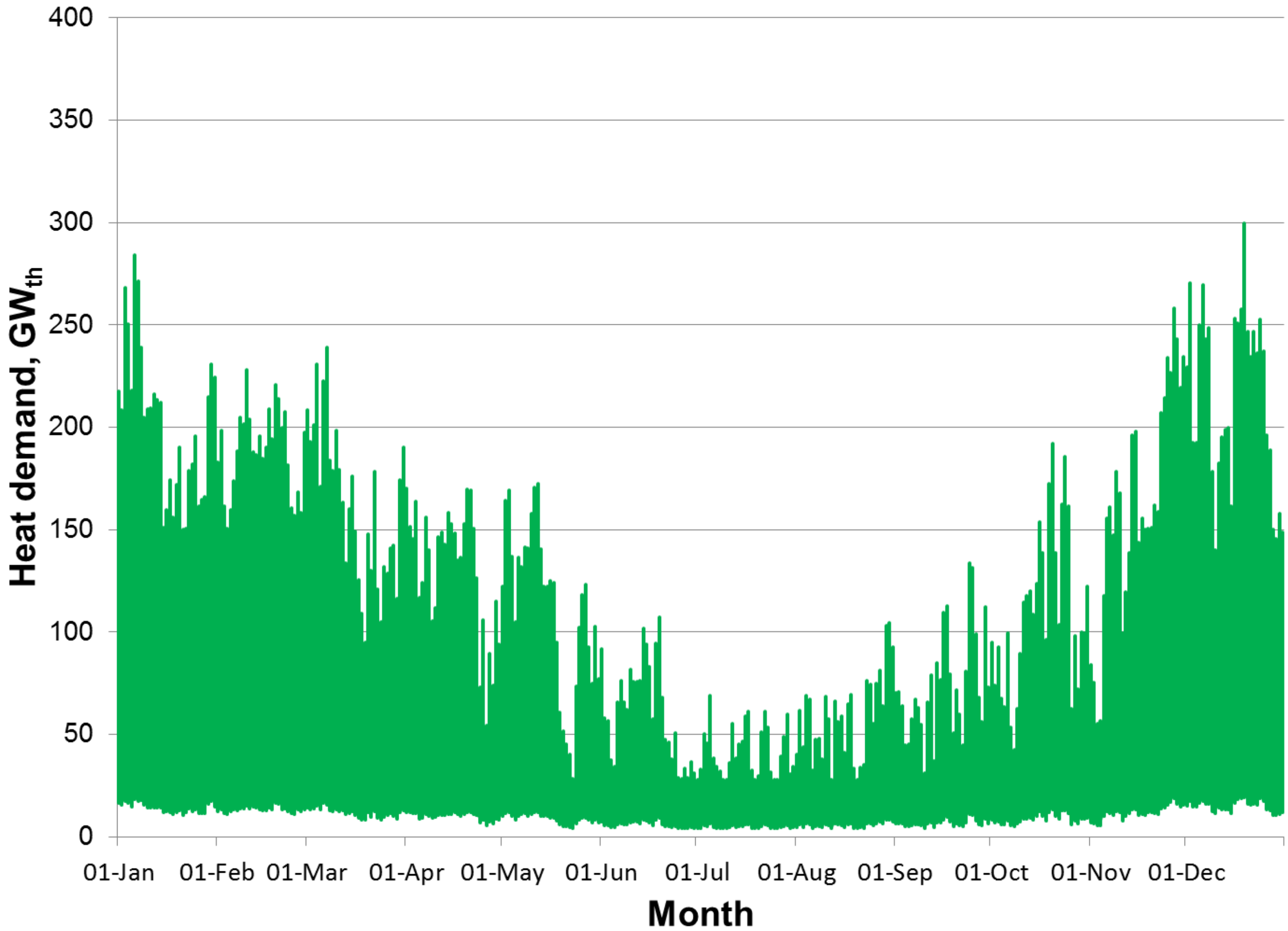




Peak coincidence factor & temperature scatter plot



UK half hourly heat demand 2010



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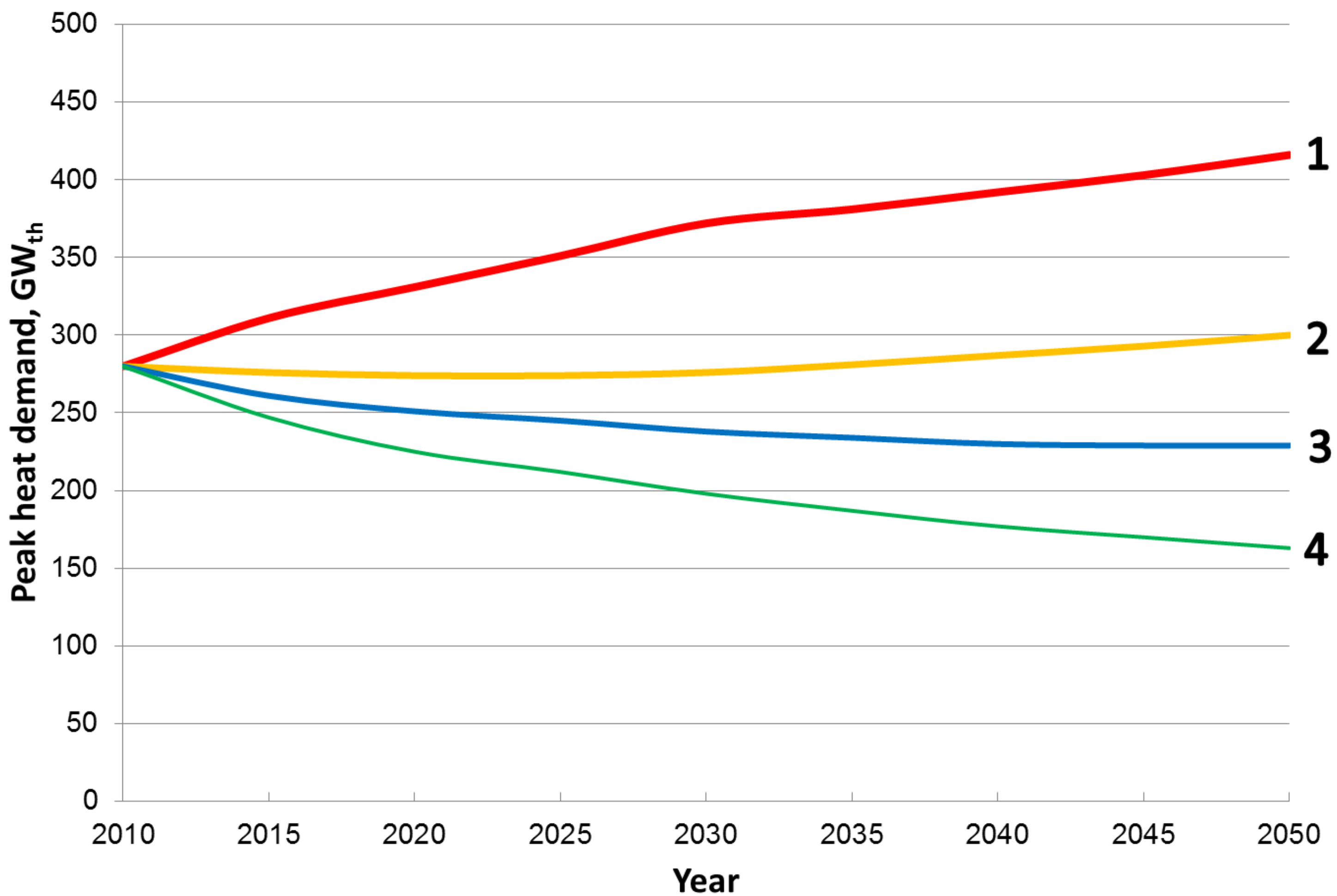
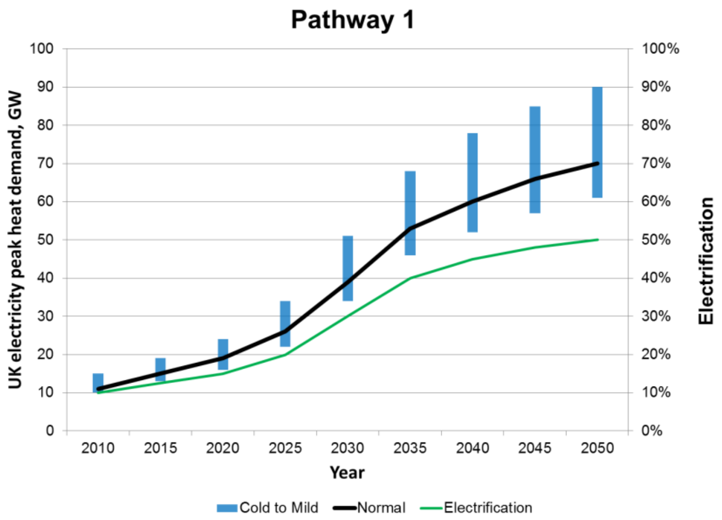
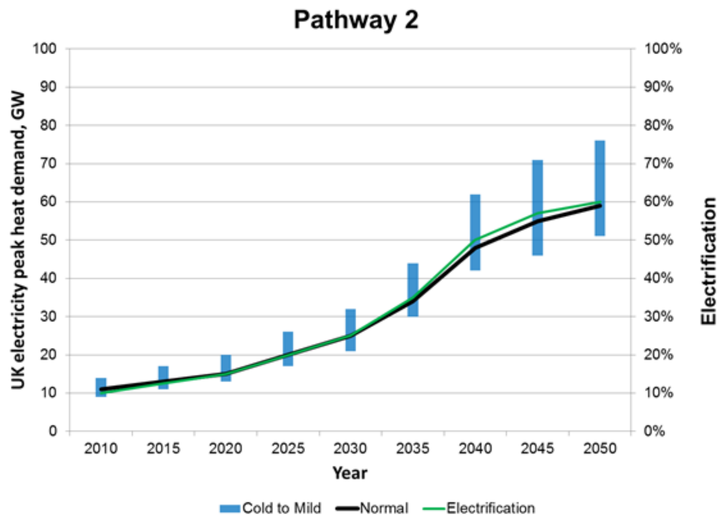
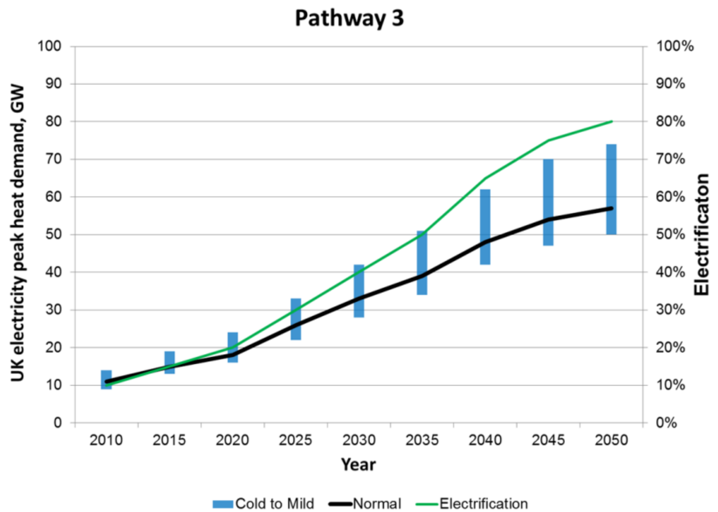
2050 Pathways UK peak heat demand

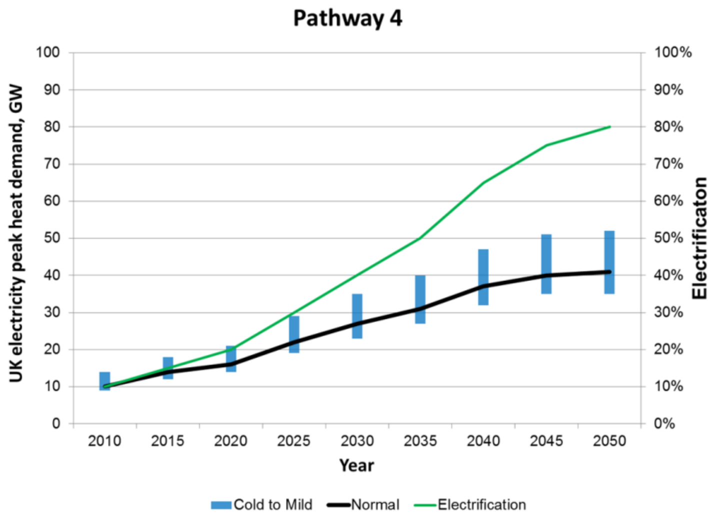


UK electricity peak demand
(Consumer premises)









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Conclusions
Heat demand model

- Model can be used to investigate the impact of different heat and electricity demand pathways.
- Some caution needs to be exercised as:
  - Half hourly profile based on a limited number of sites for a single winter
  - Micro-CHP may have similar heat output to an ASHP there are many other differences
- Peak coincident factor is affected by temperature so it is likely that it will be higher for colder weather conditions thereby increasing peak demand.
- Model assumes heat pump is sized for maximum demand. Under very cold conditions supplementary heating may be required increasing peak demand.
- Heating does offer opportunities for demand side participation which could reduce peak demand.
- Finally the results illustrate the increase in electricity demand sensitivity to changes in temperature.

Heat economics

- Two scenarios developed to explore the impact of residential heat demand on the economics of heating systems.
- The first is a transition scenario to 2030 and the second is a full decarbonisation scenario to 2050.
- The focus of the analysis is to identify the asset requirements and the associated cost differences.
- As a consequence investments and other costs which are common to the case studies are not included.
- The analysis may be described as “high level” with a number of simplifying assumptions but from which further more comprehensive analyses can subsequently be performed.
- Parameters are expressed on a per household basis with results presented in levelised terms, i.e. £/household/a.

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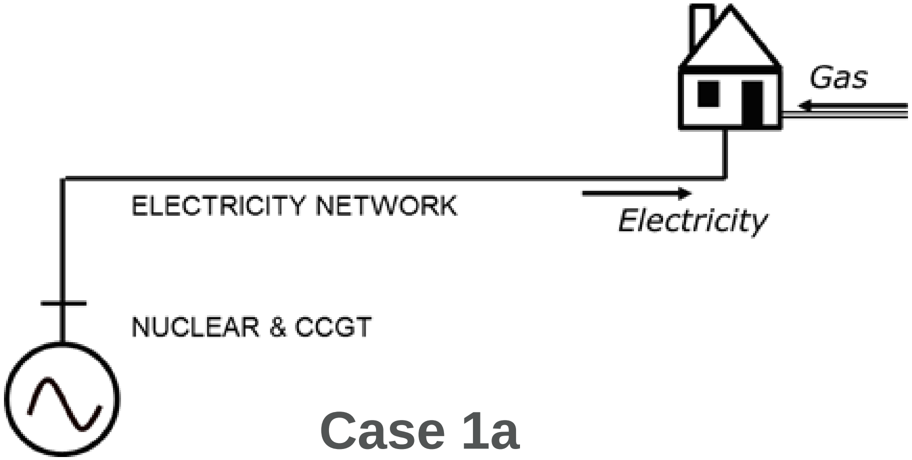
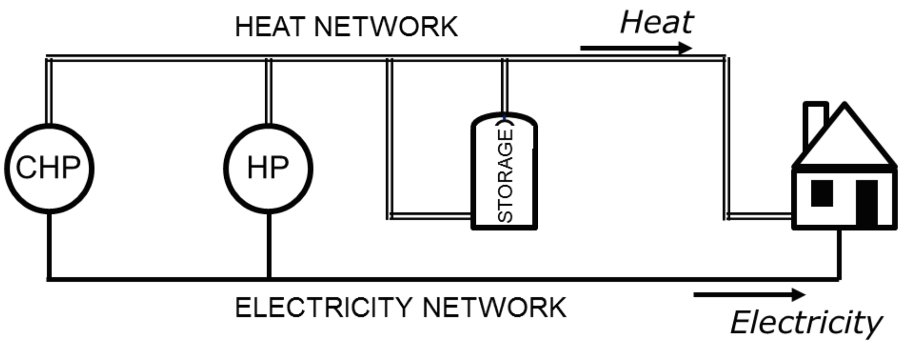
2030 Transition scenario

- This assumes that the focus is on decarbonising electricity and improving building energy efficiency.
  - Case 1a, assumes power plant investment is nuclear and CCGT with operation constrained such that overall CO_2 <100 g/kWh.
  - Case 1b, assumes power plant investment is gas based CHP CCGT connected to a district heat network and which includes thermal storage and network connected heat pumps to meet heat demand.



Case 1a



Case 1b

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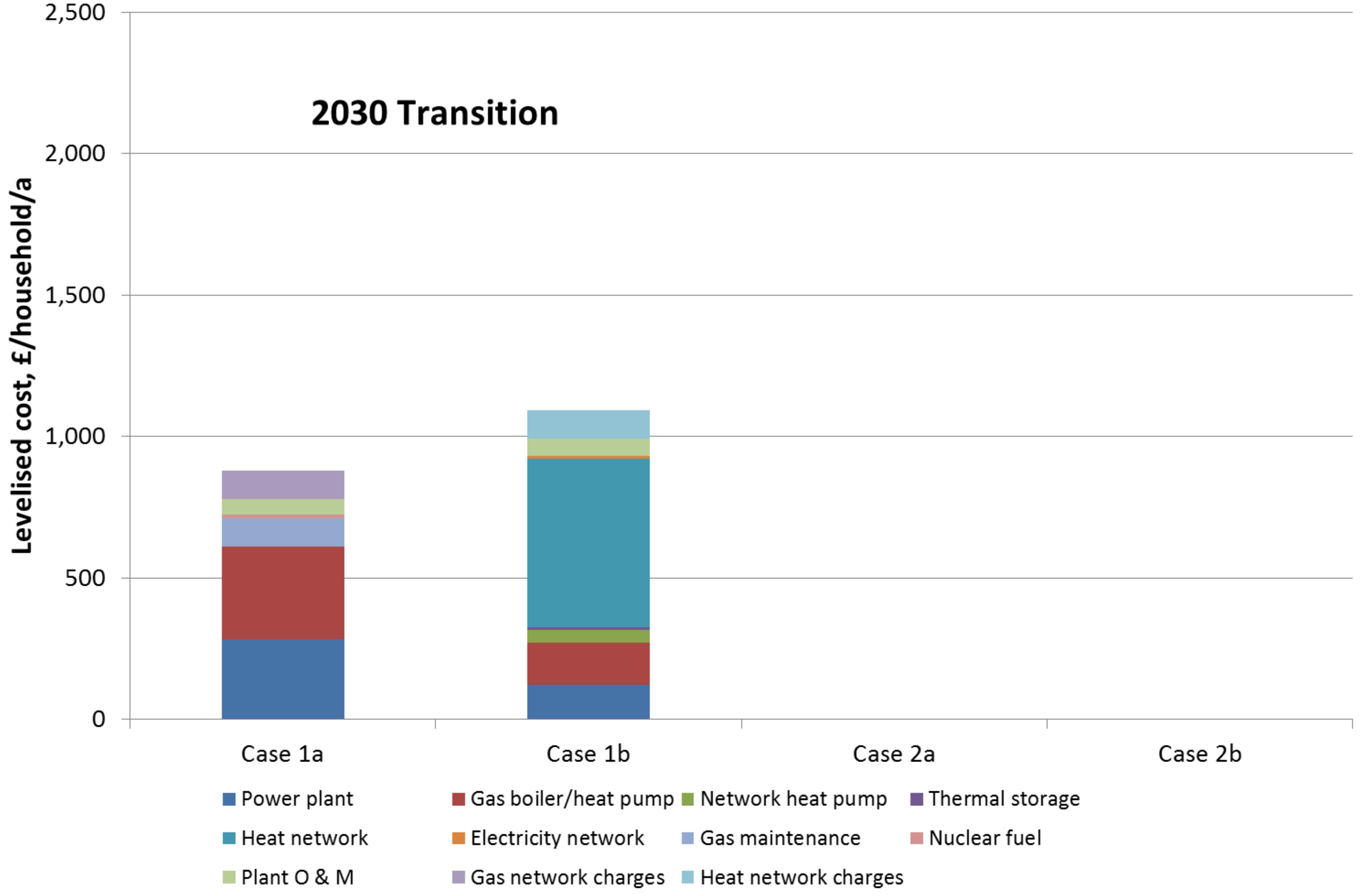
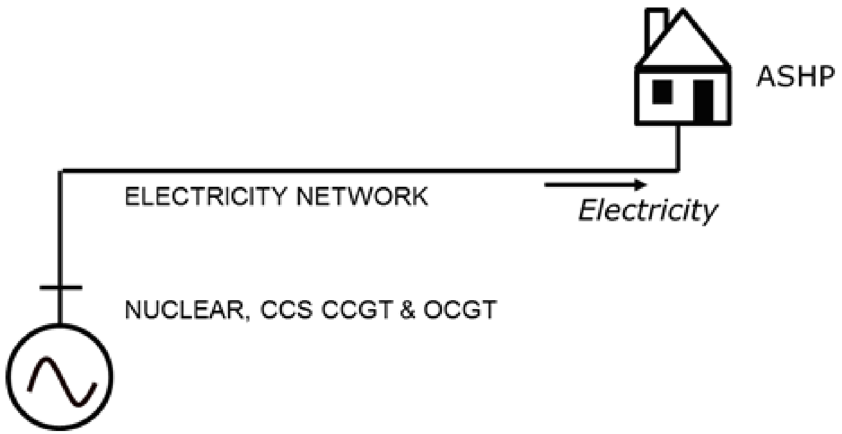
2030 Transition scenario

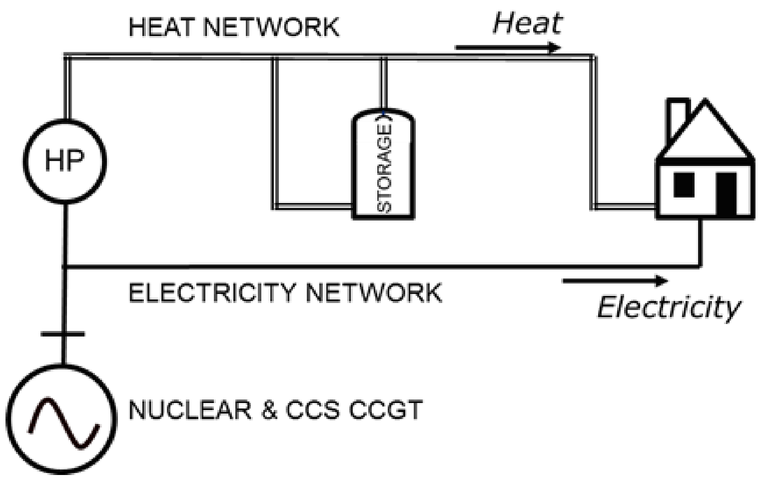


2050 Target Met scenario

- This scenario develops the 2030 Transition Scenario to 2050 with the full decarbonisation of both electricity and heat to meet the 2050 targets.
  - Case 2a, assumes the large-scale rollout of household ASHPs with further nuclear, CCS CCGT and OCGT.
  - Case 2b, assumes the replacement of gas CHP CCGT with nuclear and CCS CCGT. Heat demand continues to be met by the heat network which is now exclusively supplied by network heat pumps.



Case 2a



Case 2b

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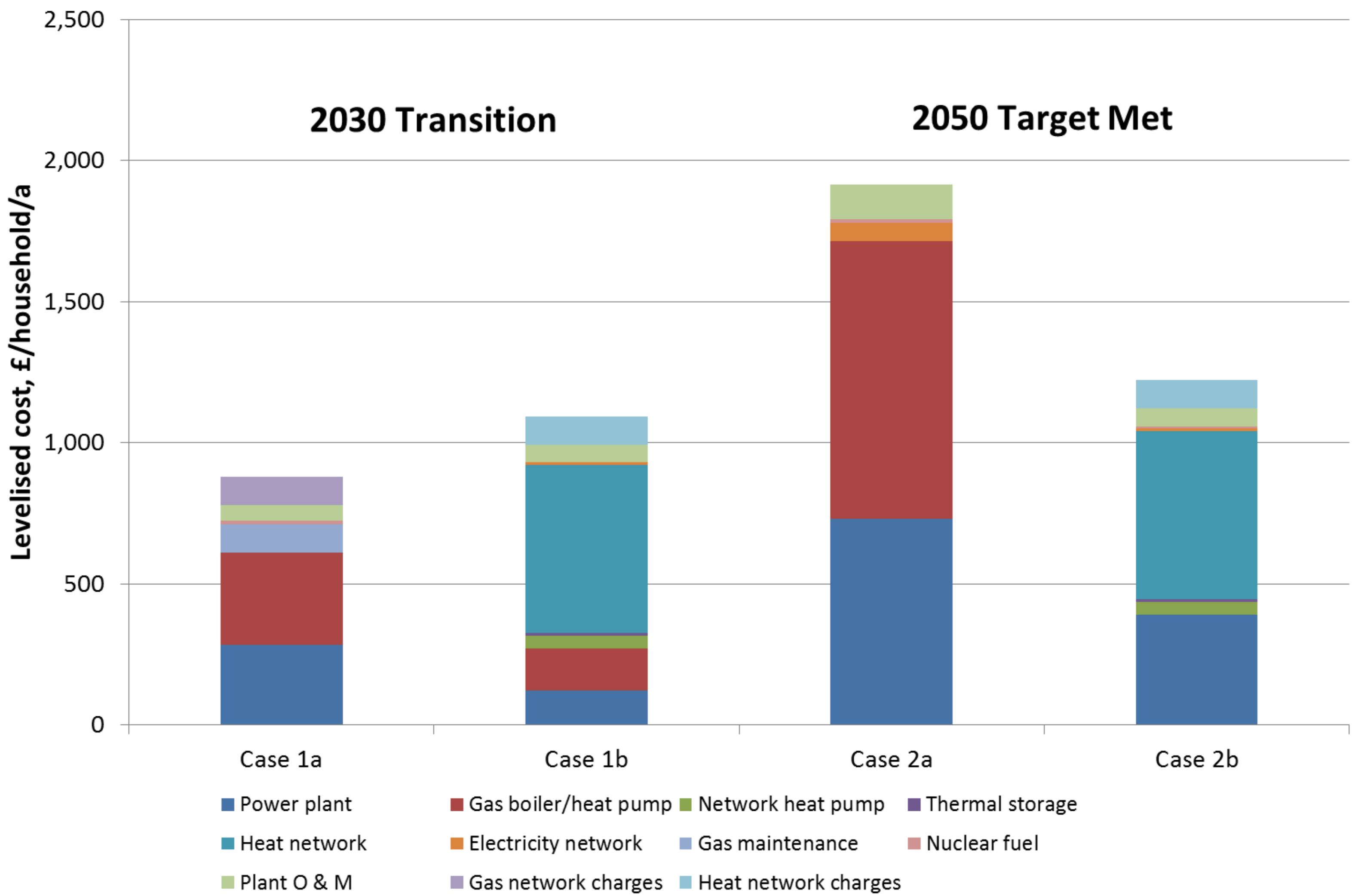
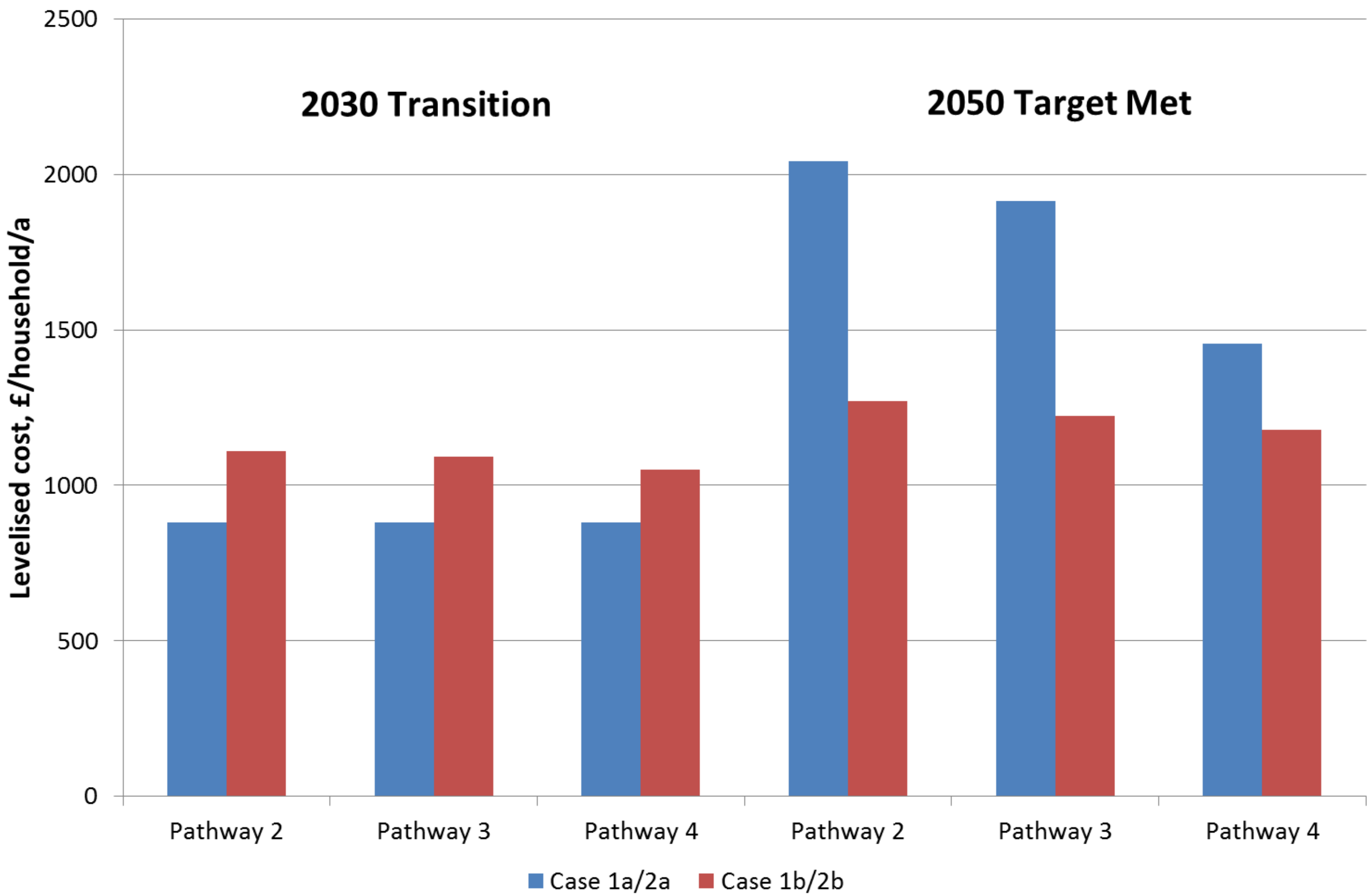
2050 Target Met scenario



Impact of heat pathways on costs



Conclusions
Heat economics

- District heating has higher levelised costs for all the pathways examined up to 2030. This is mainly due to the cost of the heat network.
- Gas consumption and hence CO_2 emissions are similar for both cases in this scenario. This is because district heating includes a network heat pump which recovers renewable heat offsetting the gas consumed by the CHP plant.
- As heat is fully decarbonised to 2050 district heating has lower costs for all the pathways examined. This is mainly due to the cost of the household ASHP appliances and the additional power plant capacity to meet the demand requirements of the ASHP.
- The impact of the pathways on levelised costs is much less for district heating as heat capacity is provided by low cost thermal storage and high efficiency network heat pumps.

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Acknowledgements

The authors are grateful to the UK Energy Research Centre for funding the work reported in this study.