



**Hawker, Graeme and Flower, Jack and Bell, Keith (2019) The possibilities are endless : making sense of local system modelling. In: UKERC Annual Conference 2019, 2019-04-24 - 2019-04-25, St Anne's College. ,**

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# The possibilities are endless: Making sense of Local Energy System Modelling

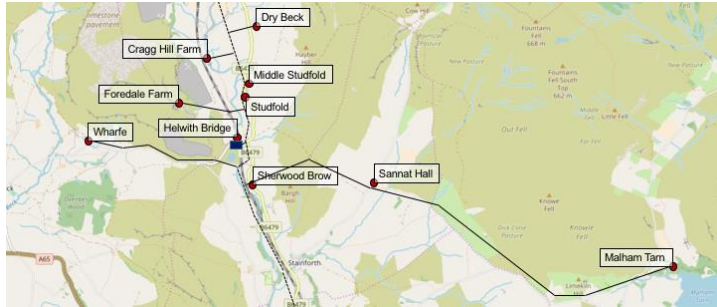
Graeme Hawker, Jack Flower and Keith Bell  
Institute for Energy and Environment, University of  
Strathclyde

# Examining future local archetypes

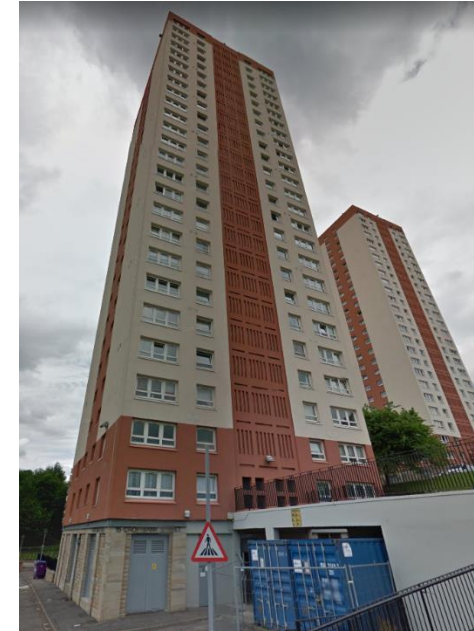
**Rural**

Disaggregate UK energy system into exemplar archetypes

**Urban**



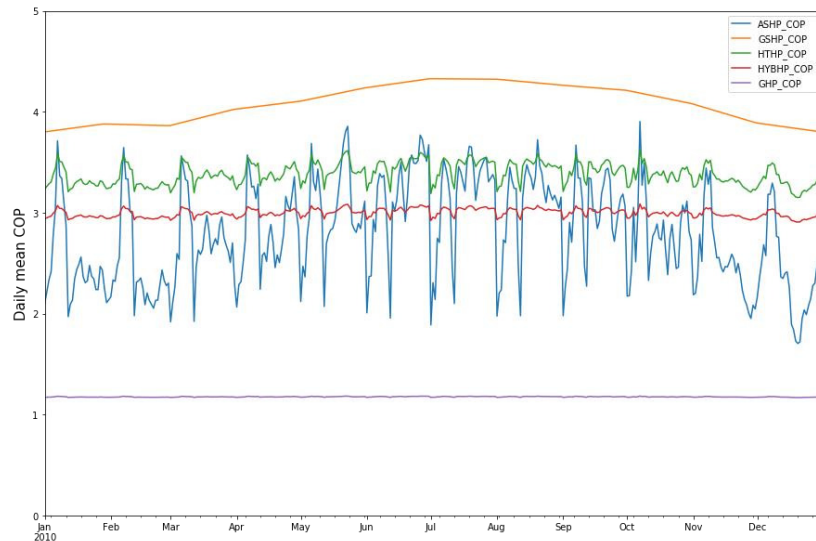
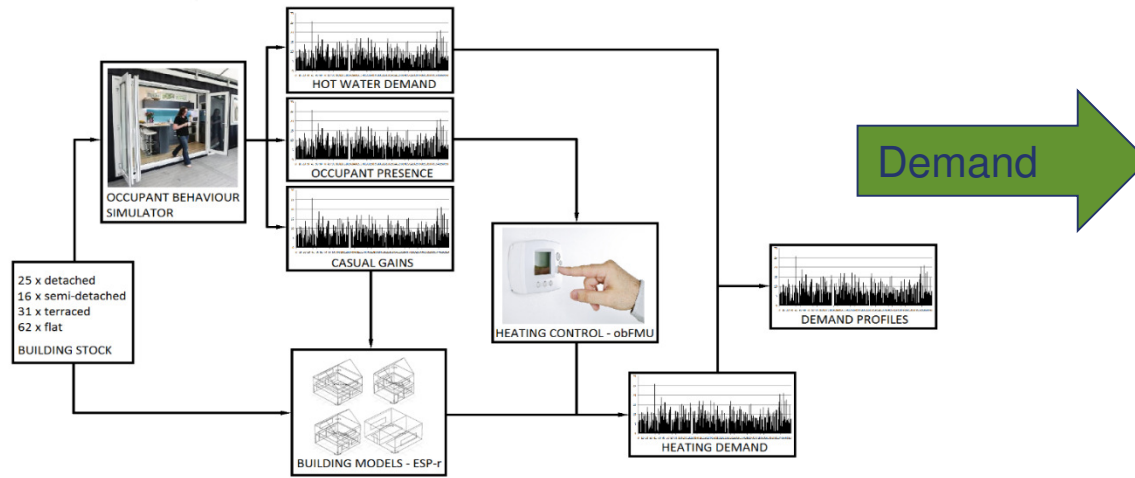
**Suburban**



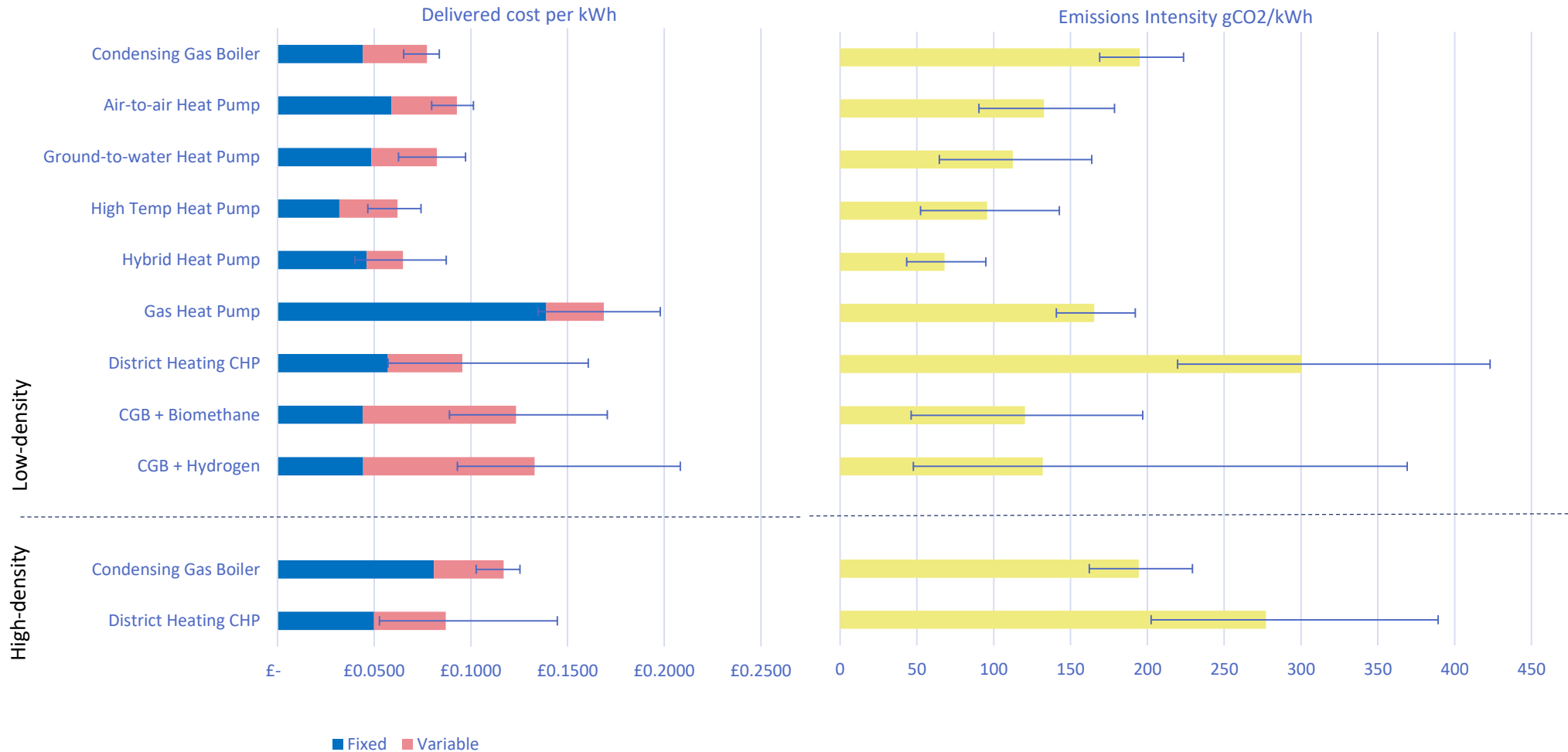
Modelling conducted within UKERC  
Theme 3: “Energy Systems at Multiple Scales”

Sub-theme: “Modelling spatial and temporal diversity”

# Demand and technology modelling



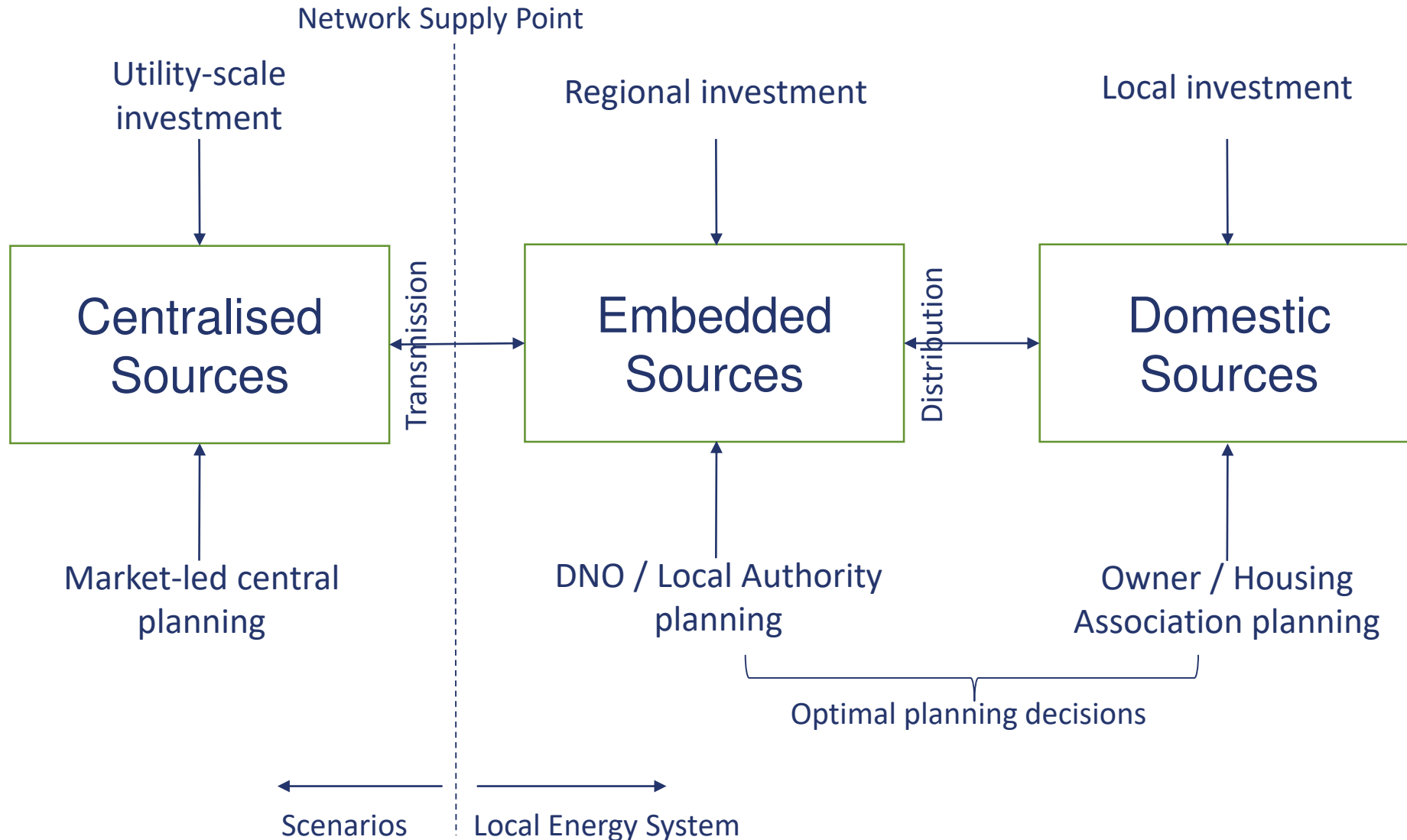
# Evidence for costs and abatement



# The end goal

- Achievable policies and business models which incrementally decarbonise real-world systems at a local scale
- For residential heating:
  - The ability to discern between ‘bridging’ solutions and long-term sustainable options
  - A clear picture of the likely technical performance and efficiency of low-carbon options
  - A breakdown of discrete responsibilities between homeowners/housing associations, local authorities, network owners/operators and national bodies
- A clear route to the ‘first million’ homes with low-carbon heating
  - Least regret? Whose regret?

# Delineating the local system



# Local issues in implementation

- “Technology isn’t the issue – we all know what to do”
- Project ownership
  - Cost of capital, risk allocation, control of assets
  - Public vs private infrastructure – continuum of ownership
- Persuasion and authority
  - Need for anchor customers?
- Uncertain evolution of regional/national-scale systems
- Danger of near-term small-scale efforts undermining the business case for more transformative change



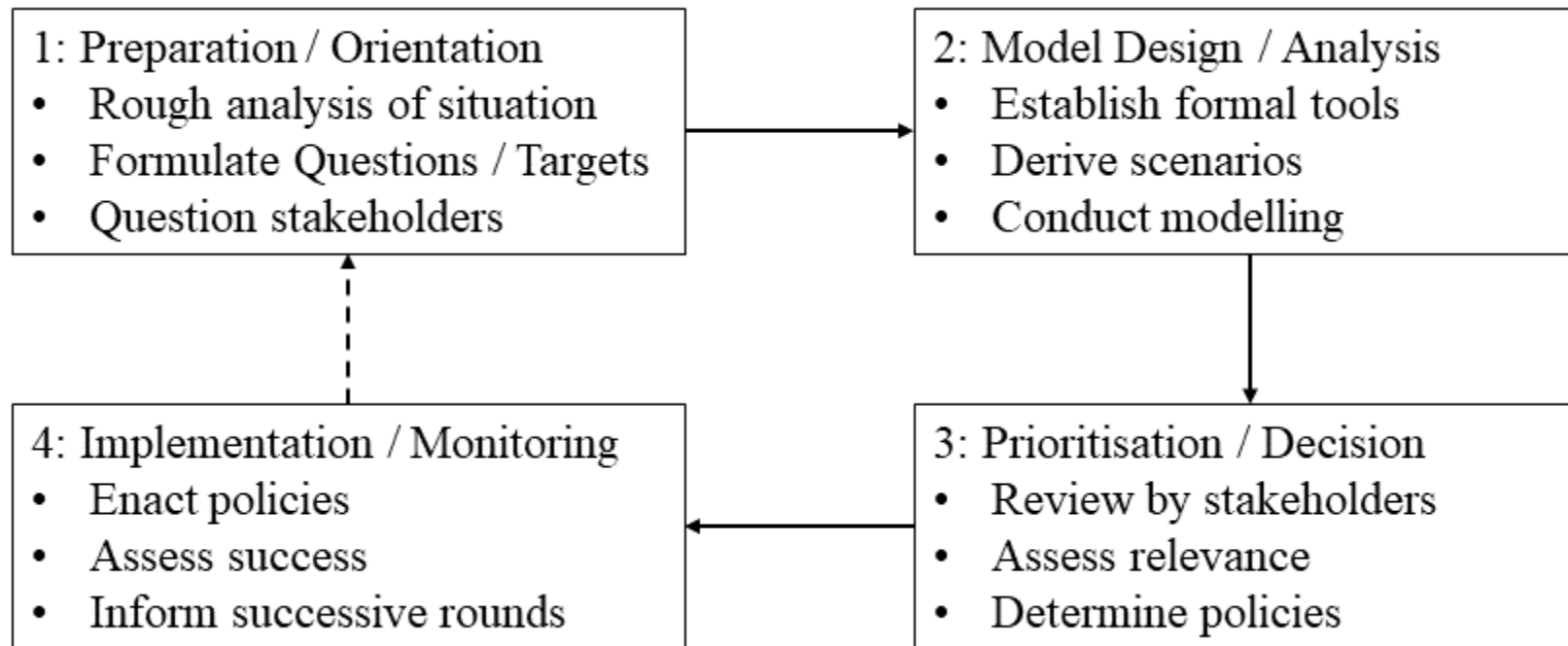
# Optimality?

- The failure of techno-economic models to represent non-technical or economic constraints on technology investments may lead to a recommended trajectory which is not feasible when behavioural and political requirements are considered
- Political will and public acceptance are also limited resources alongside cost
- Least-cost minimisation is perhaps justified only where an overarching economic driver exists or there is an actor who has the global purview to enact policies across that domain

# What makes a model 'useful' to a local actor?

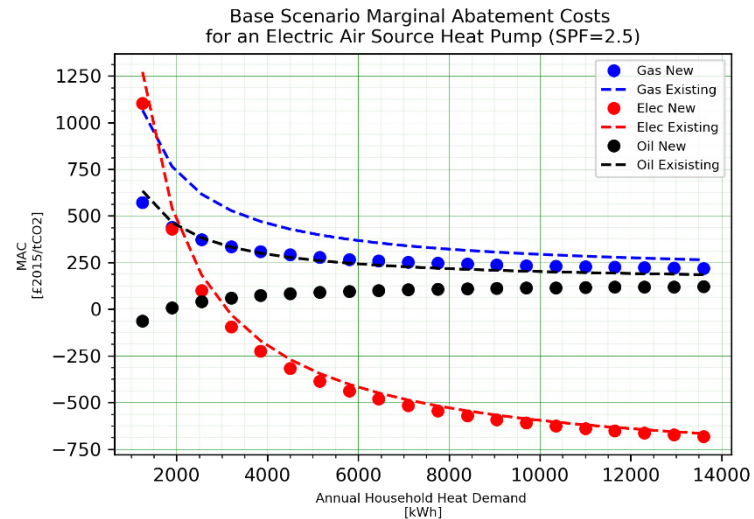
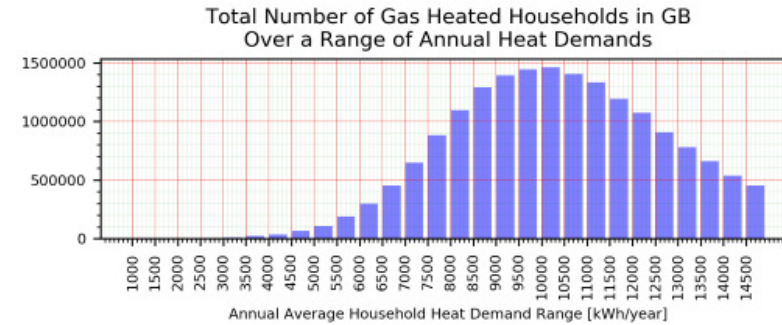
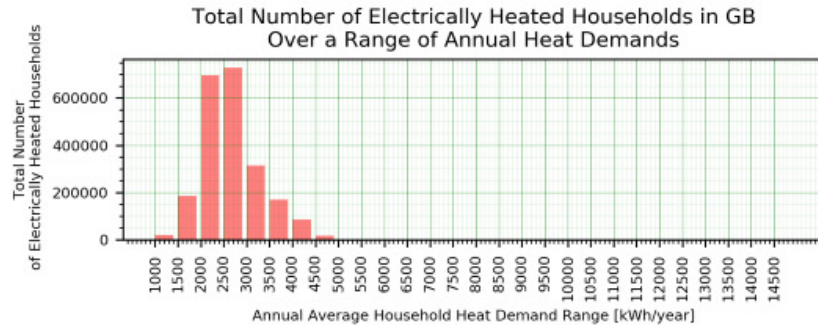
- **Conceptualisation:** Demonstrating (qualitatively or quantitatively) a previously unknown contribution
- **Quantification:** Confirming a hypothesised contribution by a technology, policy or implementation
- **Comparison:** Comparing and/or contrasting different technology/policy/implementation options
- **Contextualisation:** Adding additional detail to previous analyses on how such technologies/policies might be implemented and how they may interact with complex extant systems
- **Certainty:** Reducing the uncertainty (and by extension the risk) associated with one of the above
- **Application:** Illustrating some aspect of the above within a specific real-world context

# Stakeholders in model design



adapted from (Mirakyan & De Guio, 2013)

# Exogenous variables



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?

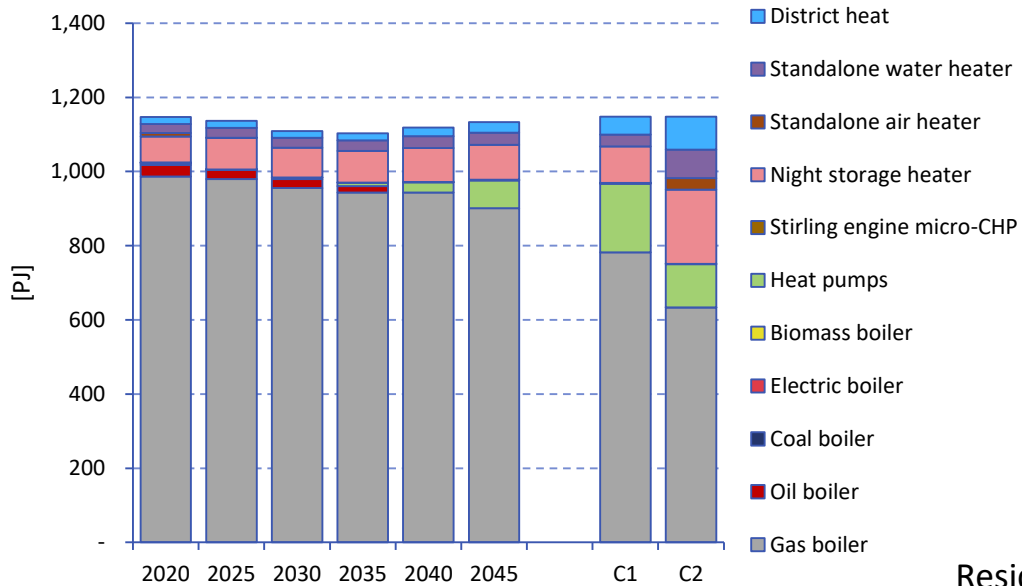
J. Flower, G. Hawker, K. Bell, (2019) Heterogeneity of UK Residential Heat Demand and its Impact on the Value Case for Heat Pumps

# Non-incremental change

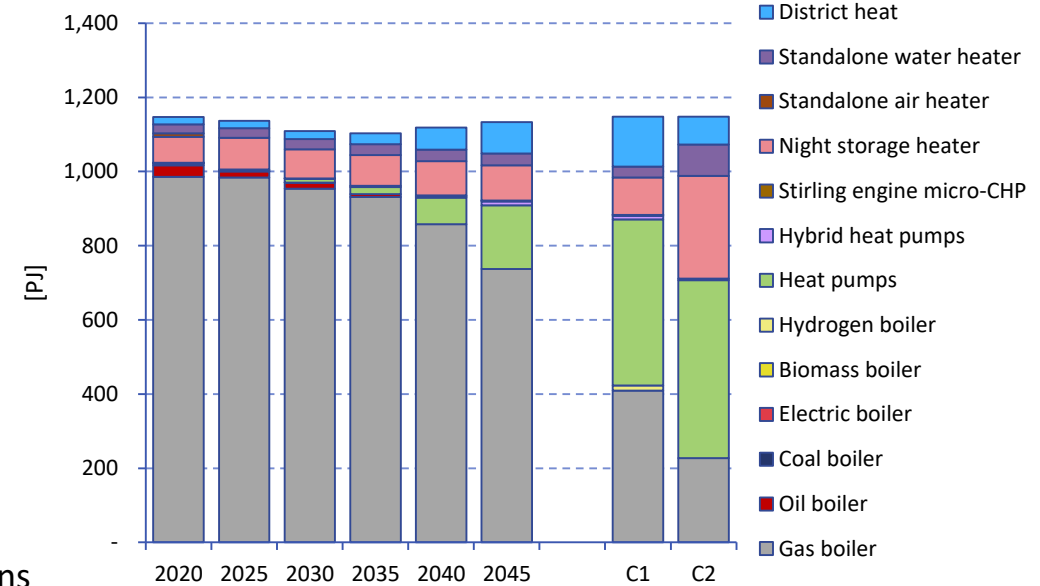
- All trajectories to decarbonisation involve non-incremental change for some actor at some level, e.g.
  - Domestic consumers investing in a change of heating technology
  - CHP and district heating systems requiring critical volume of buy-in
  - Increasing electrical demand requiring infrastructure reinforcement both locally and at higher voltages
  - Natural gas to hydrogen conversion requiring regional switch-over and potential huge costs for transmission
- Local systems have dependencies and impacts on regional and national systems
- The means and responsibilities for coordinating non-incremental change among actors (both local and supply-side) is not clear

# The contribution of local diversity

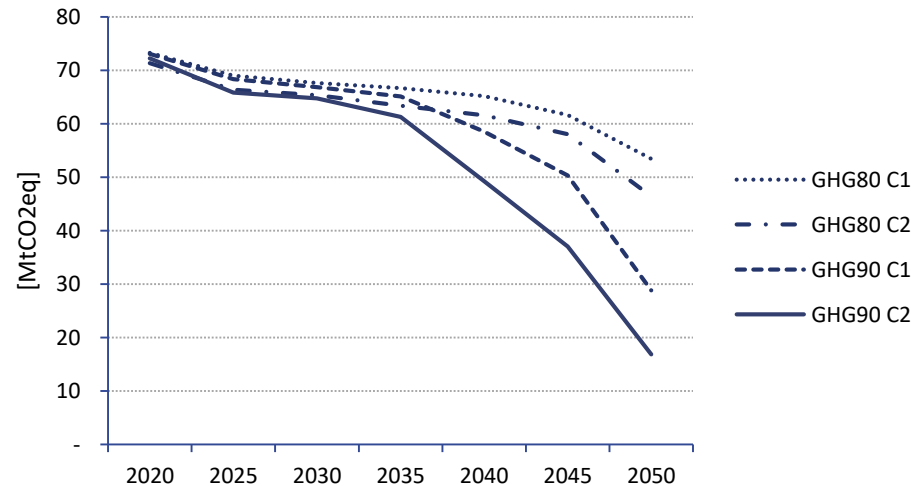
GHG80 alternative case



GHG90 alternative cases



Residential sector emissions



Steps taken to accelerate deployment of unconventional systems lead to their increased contribution to emissions reduction over heat pumps – a role for more varied incentives?

O. Broad, G. Hawker, P. Dodds, (2019) *Decarbonising the UK residential sector: the dependence of national abatement on flexible and local views of the future*