UNIVERSITY OF SURREY

# Heat For All

## Economics-informed optimization model for future-equitable-decarbonized-distributed heating systems

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**(plus a long list of co-authors)**

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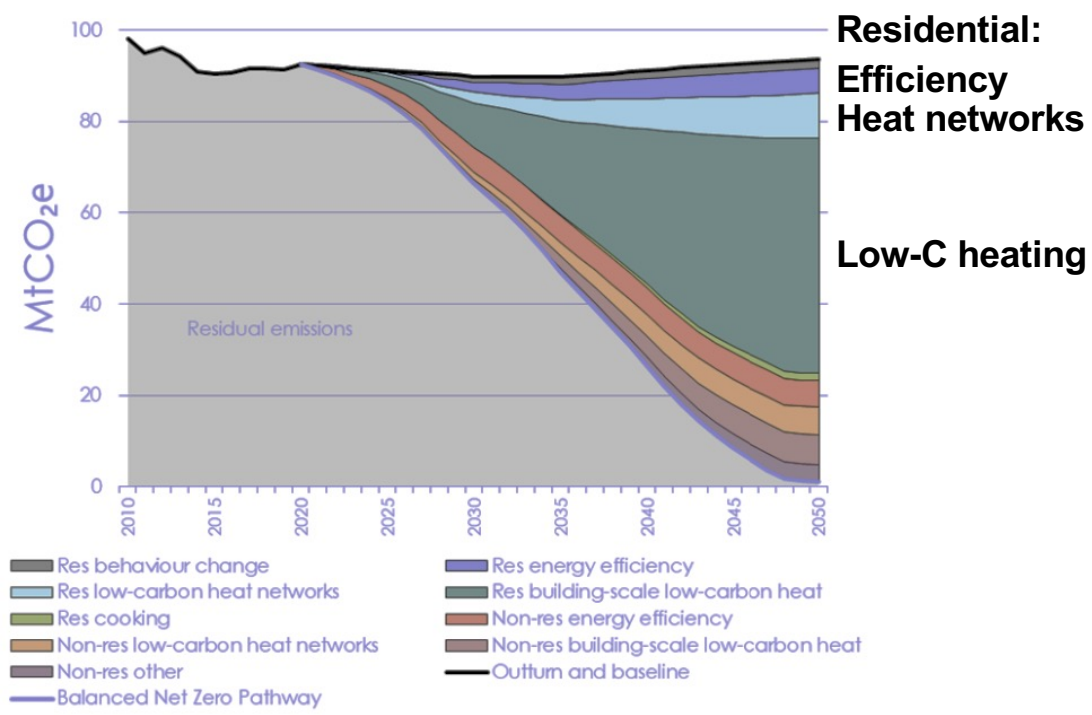
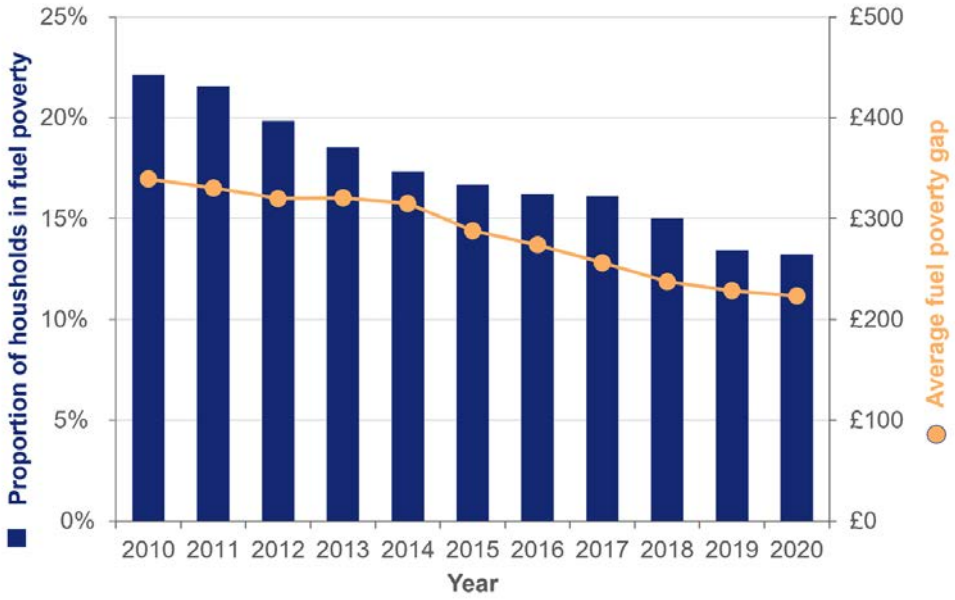
# Fuel poverty and net zero challenges

Role of buildings in UK's path to net zero

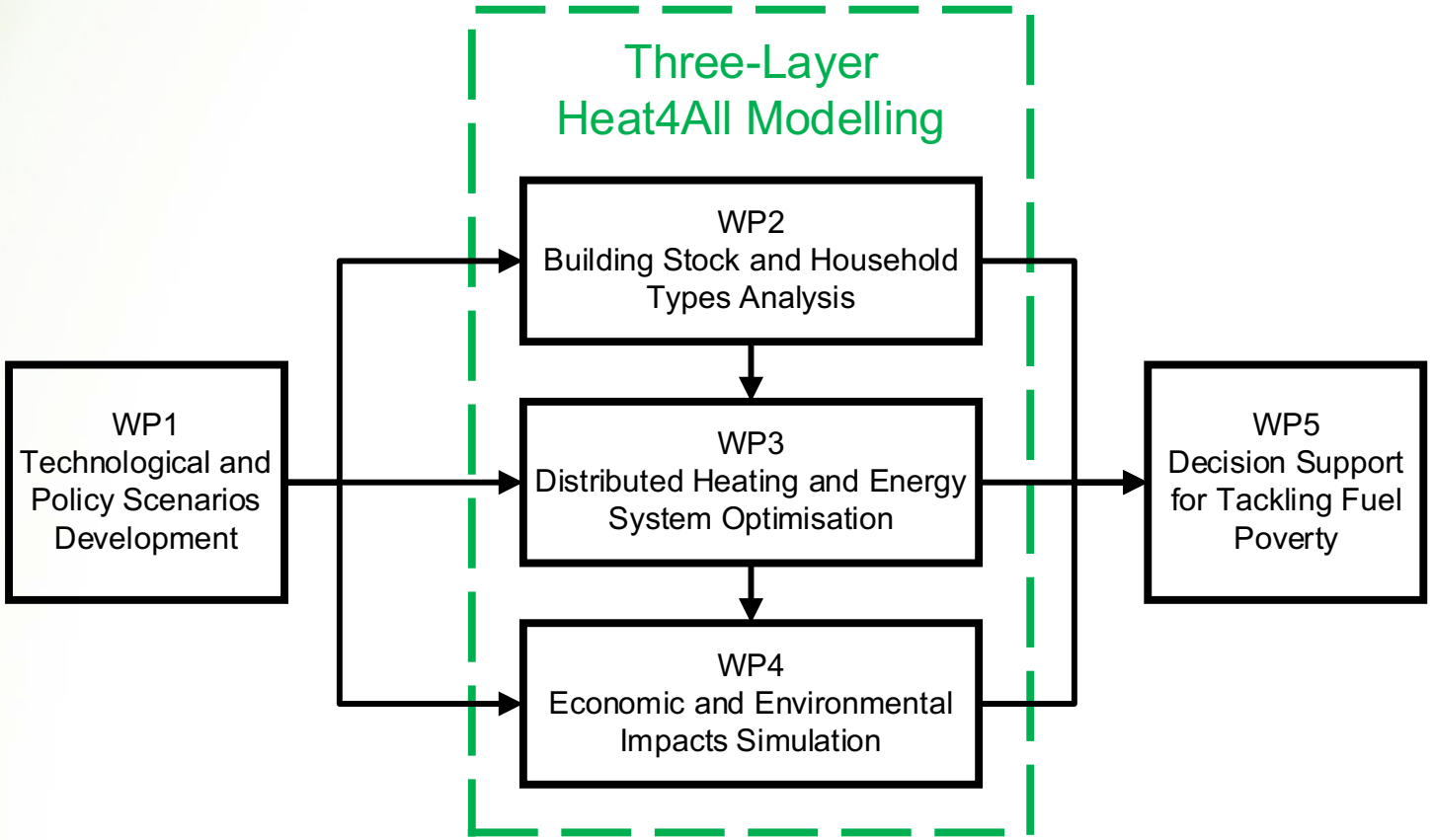



**13.2%** (3.16 million) households in the UK were classified as fuel poor in 2020[1]. Estimated to be >6 million now, rising to >8 million by end 2022[2]




1 Annual fuel poverty statistics report, 2022
2 End Fuel Poverty Coalition, 2022
3 Committee on Climate Change, 2020. *The Sixth Carbon Budget - The UK's path to Net Zero.*

# Project overall




Aim 1:

Establish a systematic analysis framework of heating decarbonisation to minimise fuel poverty

Aim 2:

Perform a case study and propose technological and policy solutions

# Project inputs, outputs and scenarios tested

## Test Case

1. Characteristics of local building stock
2. Demand data
3. Weather data
4. Pricing and tariffs

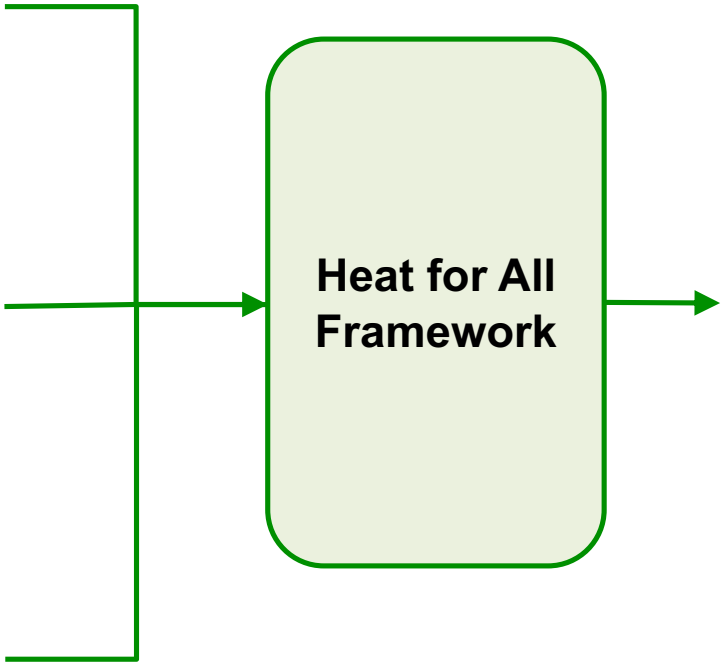
## General Data

1. Technology and equipment-related data
2. Parametric data from other sectors

## Input Scenarios

1. No grants (NG)
2. Business as Usual (BAU) (existing set of UK policy support)
3. Proposed (PRO) (only eligible for D/E/F households)

For different decarbonisation targets




## Outputs

Recommend the best combination of the following, for different housing categories, for reducing fuel poverty while achieving net zero:

- Heating system technologies and their capacities
- Fabric energy efficiency investments
- Most effective policies

Two main housing categories: Energy Performance Certificate rated at A/B/C or D/E/F

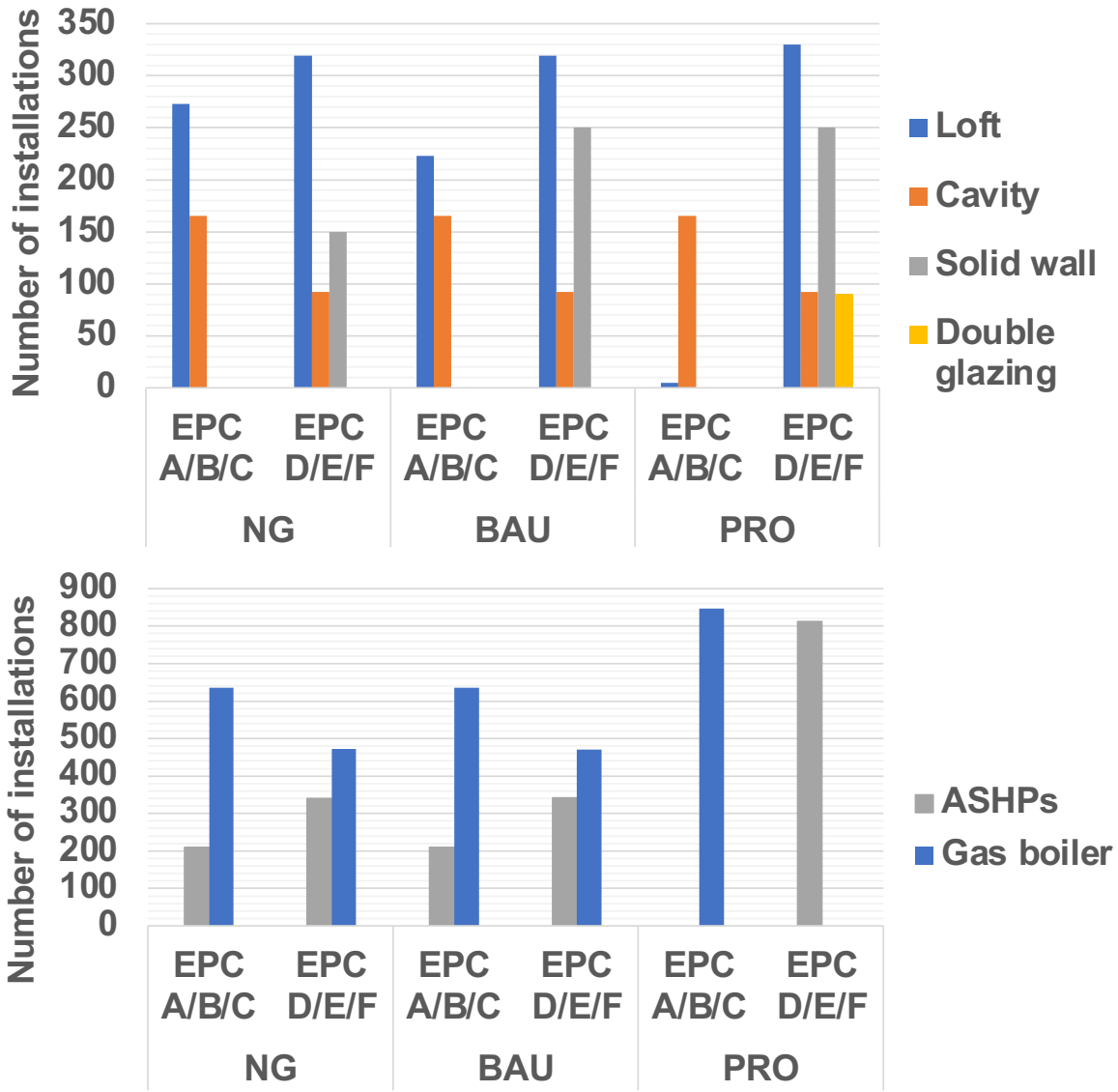
# 61% by 2035: optimising measures to meet decarbonisation objective

**61 %** carbon emission reduction:
2035 target set by Surrey County

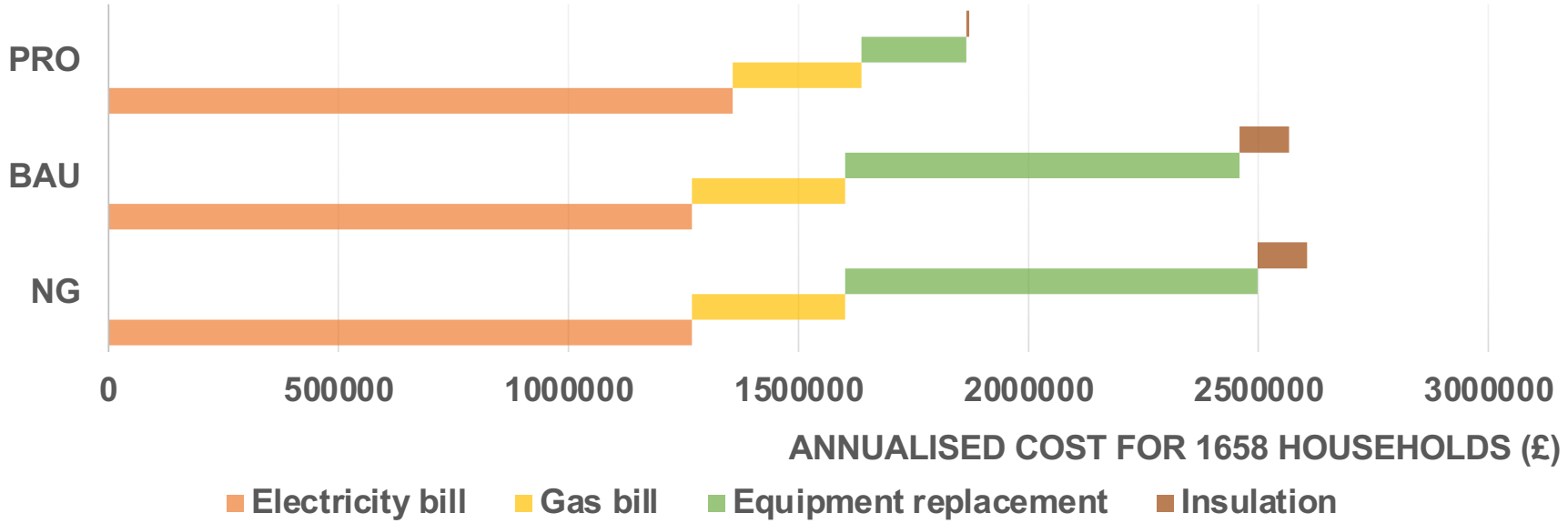
**15** $gCO_2e/kWh$
Projected carbon intensity of grid for 2035

**BAU** scenario
Grants provides capacity for installations of more solid wall insulation.

**PRO** scenario
More grants allows shift of decarbonisation efforts to D/E/F category, benefitting fuel poor.



# 61% by 2035 : cost for households




**PRO** scenario

Has the lowest household cost due to the shift of heating equipment replacement and insulation cost to grants.

**Bills** for gas and grid electricity

are closely related to energy price. With a projected price of 0.4679 £/kWh for gas and 0.1389 £/kWh for grid, energy bills of PRO are higher than BAU and NG.

# Effect of rising Emission Reduction Target

**Installations of measures and technologies as ERT increases from lower to upper limits when GCI is 15 $gCO_2e/kWh$.**

## ‘Fabric first’ approach

All the grants, except for GHG-GJS, employ a ‘fabric first’ approach – implying eligible insulation measures must be installed before ASHPs are funded.

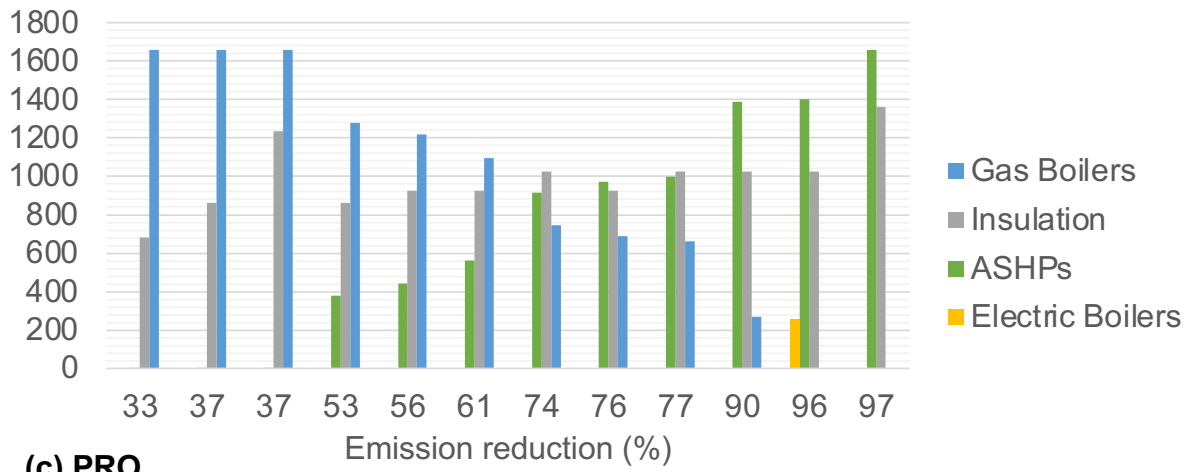
## Trade-off

In all cases, a trade-off can be seen between retrofitting insulation measures and ASHPs.

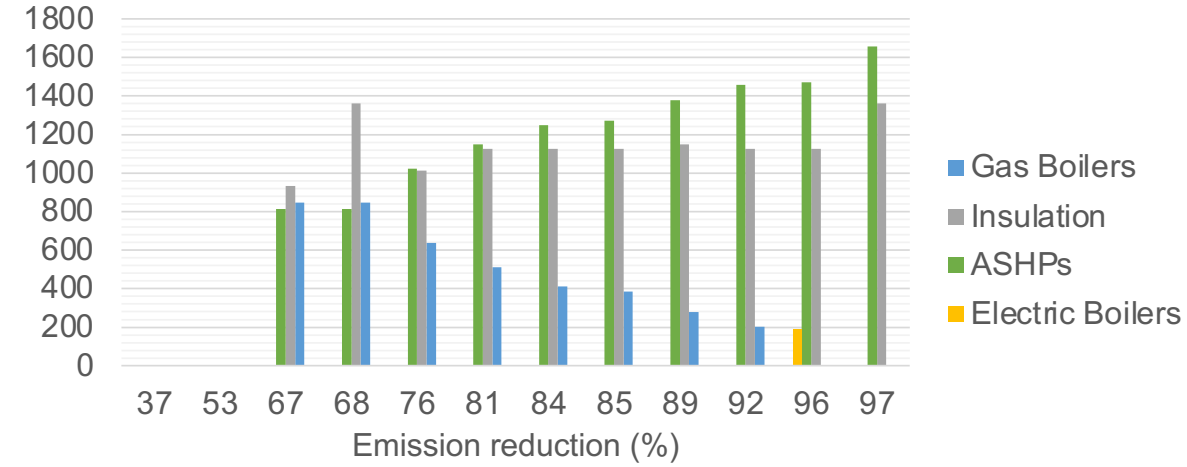
## ASHPs & boilers

Increasing retrofitting of ASHPs and phasing out of boilers.

**(b) BAU**




**(c) PRO**



# Macro economy and environmental impacts

Equipment installation

⇩

Final demand of manufacturing

⇩

Total output

⇩

**Direct GHG emission 1**

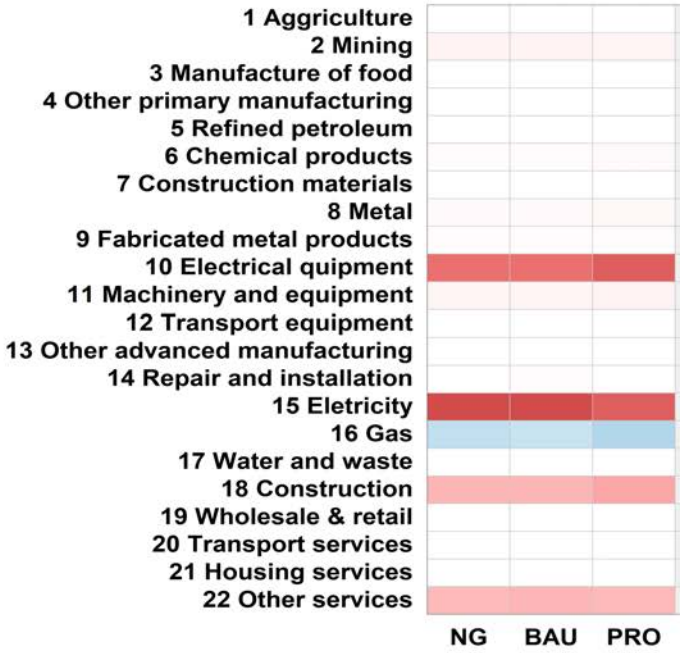
⇩

**Indirect GHG emission**

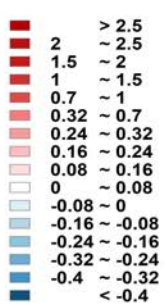
GHG emission of household gas consumption

⇩

**Direct GHG emission 2**




**Changes in total output of industry system by sectors compared with baseline (million £)**

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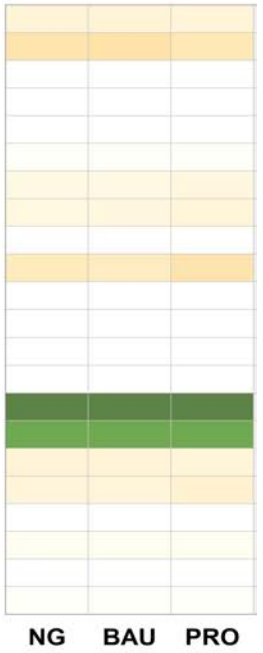
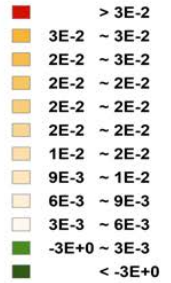
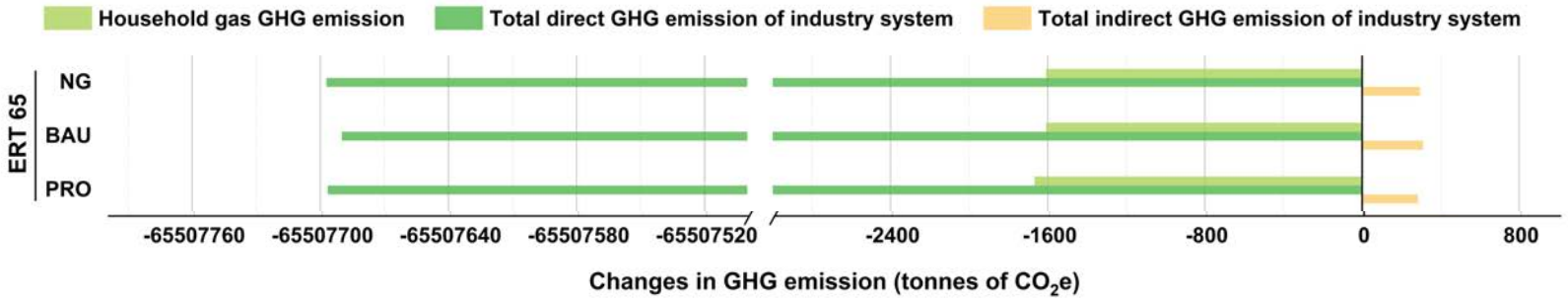



**Changes in direct GHG emission of industry system by sectors compared with baseline ($10^3$ tonnes $CO_2e$)**



# Conclusions & further work

The modelling framework links detailed building stock data to technology and policy choices and on to the supply chain economic outcomes.

There are other integrated models, but often lose the richness of the household level detail, which is necessary to capture impacts such as fuel poverty. So local system modelling seems valuable.

It is early days for this work. Future areas to explore:

- More realistic policy options
- Integrated bottom-up and macro-level optimsation…

And areas perhaps for discussion now:

- Wider co-benefits of fabric efficiency and heating system measures
- The trade-off of requiring fabric-first, with reduced energy use, but perhaps higher cost.

Future
Equitable
Decarbonised
Distributed
Heating system

# THANKS