EnergyFlex

A flexible approach to local energy modelling

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DAFNI Conference 2022

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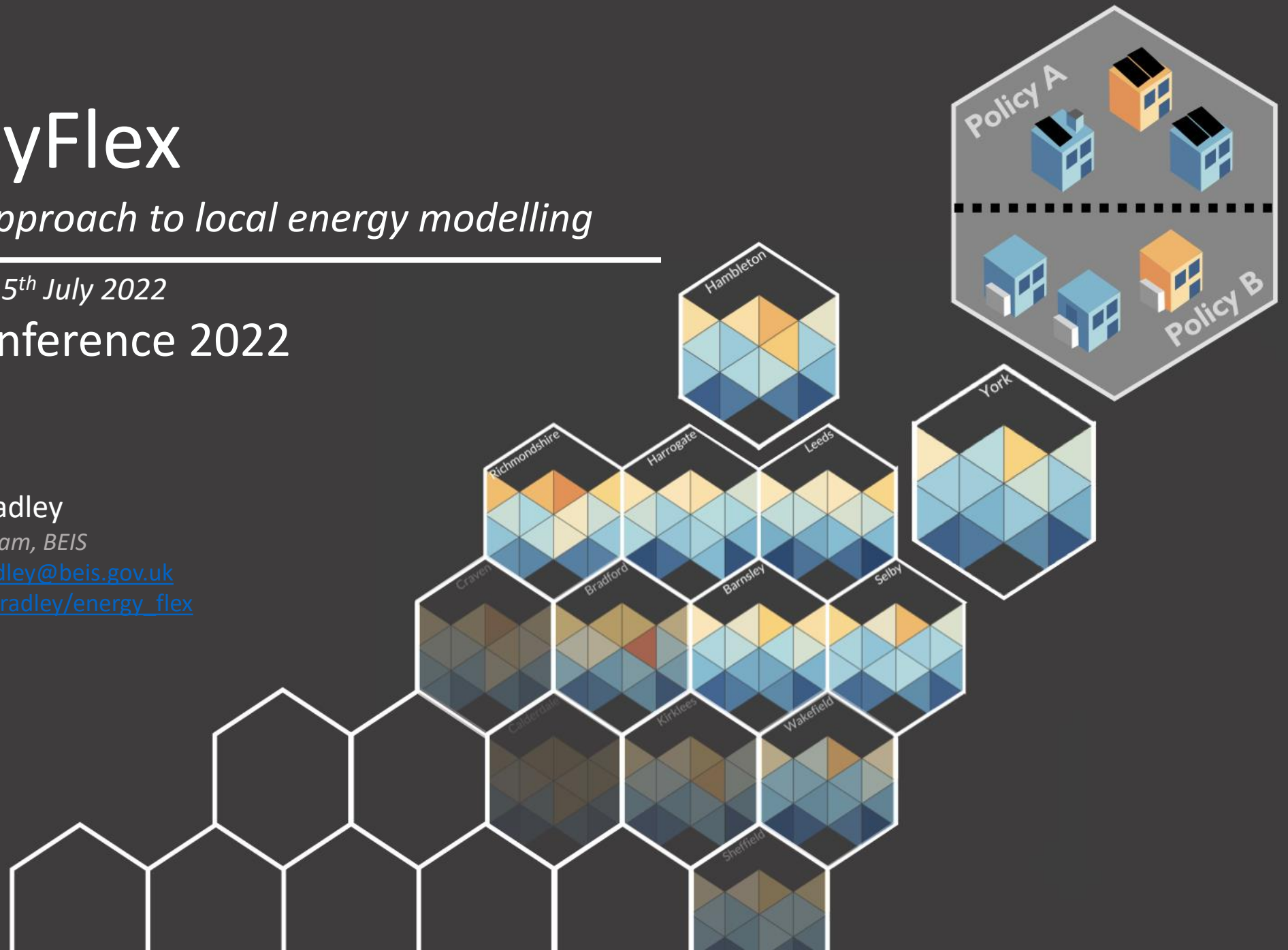
github.com/anetobradley/energy_flex

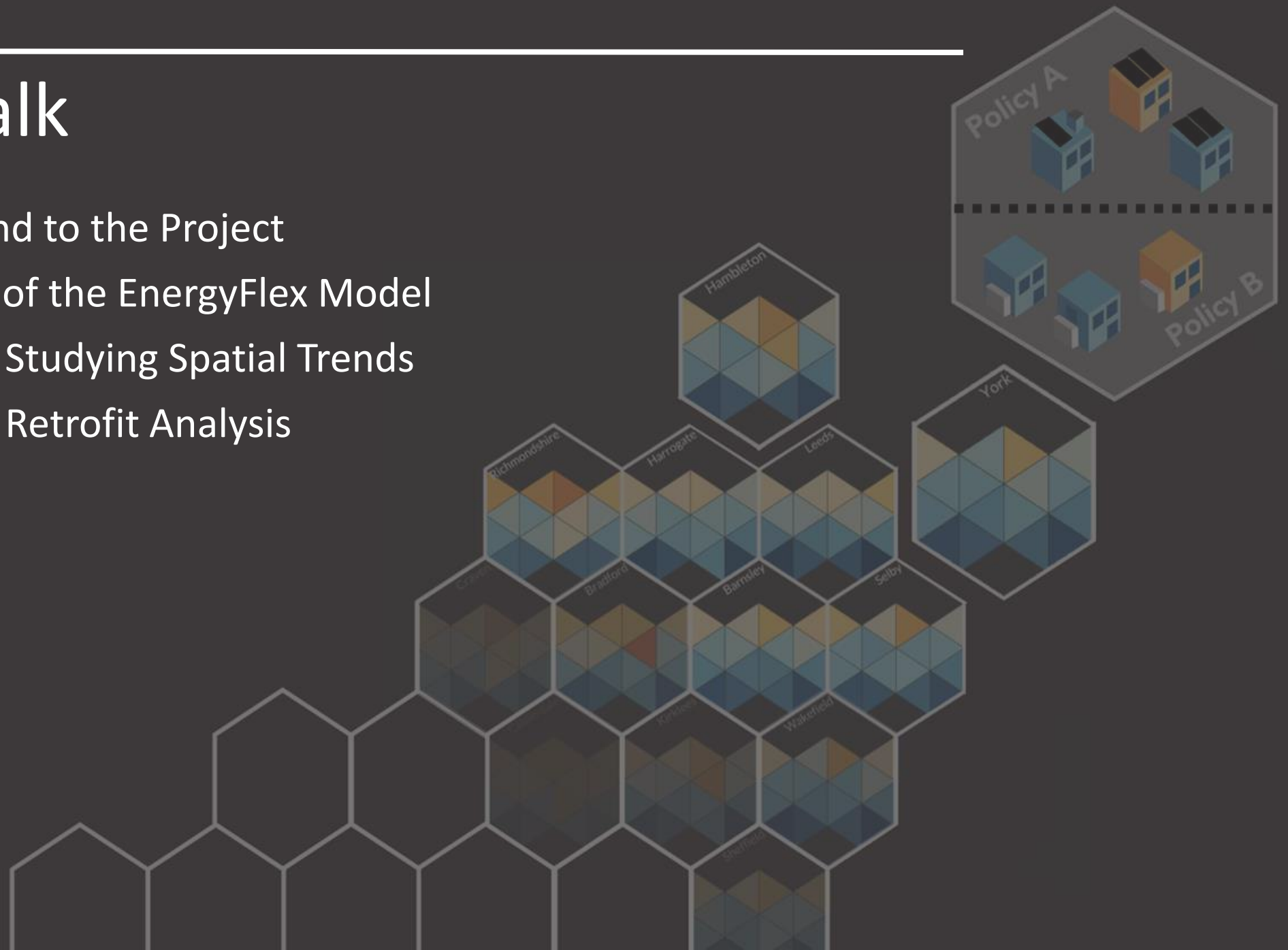
The Alan Turing Institute

UNIVERSITY OF CAMBRIDGE



Today's Talk

- Background to the Project
- Overview of the EnergyFlex Model
- Use Case: Studying Spatial Trends
- Use Case: Retrofit Analysis



Who we are?

UNIVERSITY OF CAMBRIDGE

Ruchi Choudhary

André Neto-Bradley

Department of Engineering

Expertise in Energy modelling, Uncertainty in Decision-making, and socio-economics of energy use

UNIVERSITY OF LEEDS

Nick Malleson

Patricia Ternes

School of Geography

Expertise in Spatial Modelling, Agent Based Modelling and Synthetic Populations

DAFNI

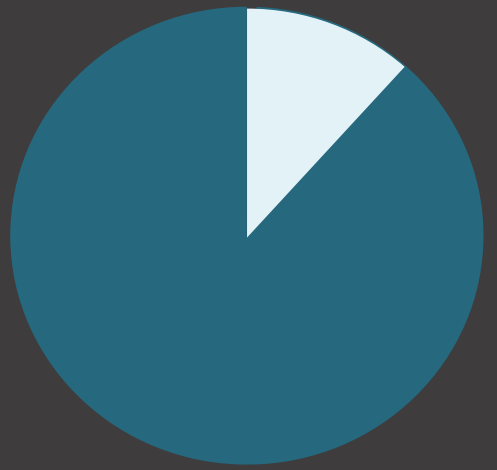
Brian Matthew

Tom Gowland

Motivation

Decarbonising Residential Energy Use

- Decarbonising residential energy demand requires identifying opportunities at a household scale.
- Data at a household scale is often not available, or offers limited information.
- EnergyFlex offers a **microsimulation-based solution** to this.
- We aren't just looking for flexibility in demand but also to support flexible and locally tailored approaches to decarbonisation.



~10% of CO_2 emissions in UK come from residential heating alone

Motivation

Leveraging Public Data to Model Occupancy

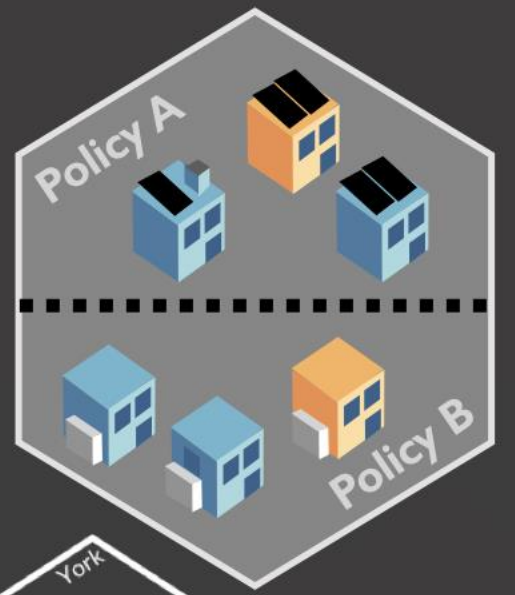
- In energy modelling and building simulation we often rely on one of two things to model occupant behaviour:
  - Assumptions, or…
  - Case study datasets (specialised & usually restricted)
- Both of these have issues.
- Can a microsimulation approach offer a third way on this?

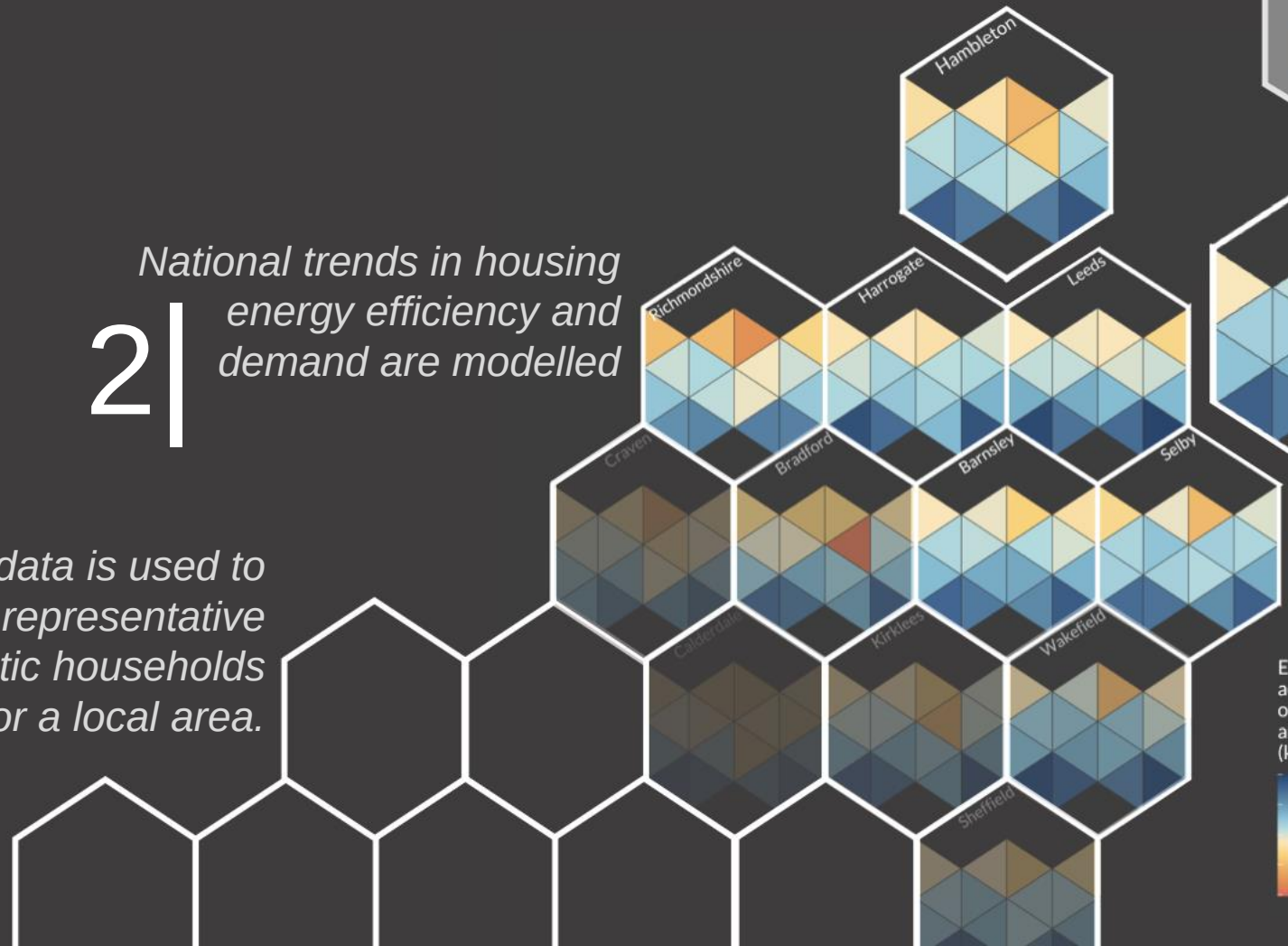
EnergyFlex: An overview

1| *Public data is used to create representative synthetic households for a local area.*

2| *National trends in housing energy efficiency and demand are modelled*

3| *Policies and solutions can be tested on a household by household basis*



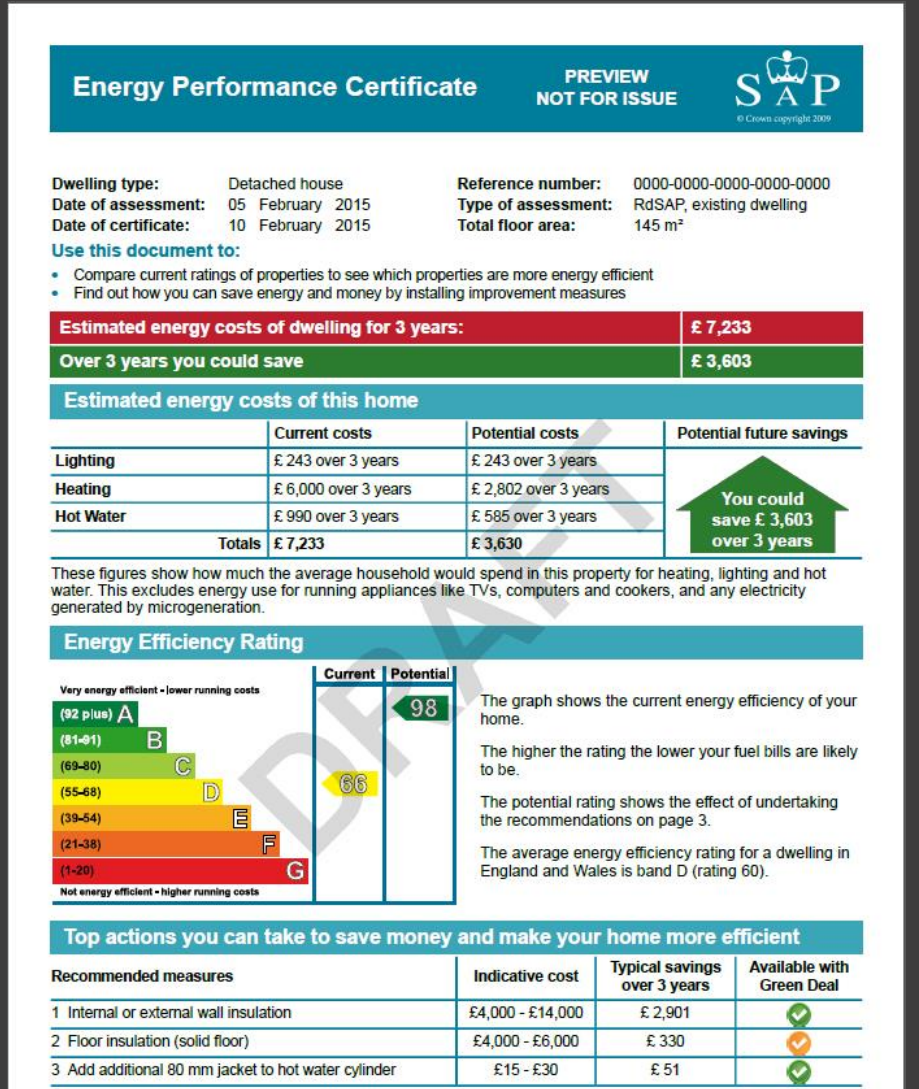


Side note: What about the EPCs?

EPCs are Energy Performance Certificates and they are public records detailing the energy efficiency rating of a property.

While useful, EPCs are not a replacement for a microsimulation approach such as EnergyFlex because:

1) The EPCs are a biased record. They only include homes sold or rented since 2008.
2) EPCs often contain mistakes, approximations or inconsistencies in non-headline values.
3) There is no information on socio-economic context.
4) This data is not anonymous, which raises research ethics questions.



Energy Performance Certificate PREVIEW NOT FOR ISSUE SAP

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Dwelling type:	Detached house	**Reference number:**	0000-0000-0000-0000-0000
Date of assessment:	05 February 2015	**Type of assessment:**	RdSAP, existing dwelling
Date of certificate:	10 February 2015	**Total floor area:**	145 m²

Use this document to:

- Compare current ratings of properties to see which properties are more energy efficient
- Find out how you can save energy and money by installing improvement measures

Estimated energy costs of dwelling for 3 years:	**£ 7,233**
Over 3 years you could save	**£ 3,603**

Estimated energy costs of this home

	Current costs	Potential costs	Potential future savings
Lighting	£ 243 over 3 years	£ 243 over 3 years	You could save £ 3,603 over 3 years
Heating	£ 6,000 over 3 years	£ 2,802 over 3 years	
Hot Water	£ 990 over 3 years	£ 585 over 3 years	
Totals	£ 7,233	£ 3,630	

These figures show how much the average household would spend in this property for heating, lighting and hot water. This excludes energy use for running appliances like TVs, computers and cookers, and any electricity generated by microgeneration.

Energy Efficiency Rating

	Current	Potential
Very energy efficient - lower running costs		
(92 plus) A		
(81-91) B		
(69-80) C		
(55-68) D	66	98
(39-54) E		
(21-38) F		
(1-20) G		
Not energy efficient - higher running costs		

The graph shows the current energy efficiency of your home.

The higher the rating the lower your fuel bills are likely to be.

The potential rating shows the effect of undertaking the recommendations on page 3.

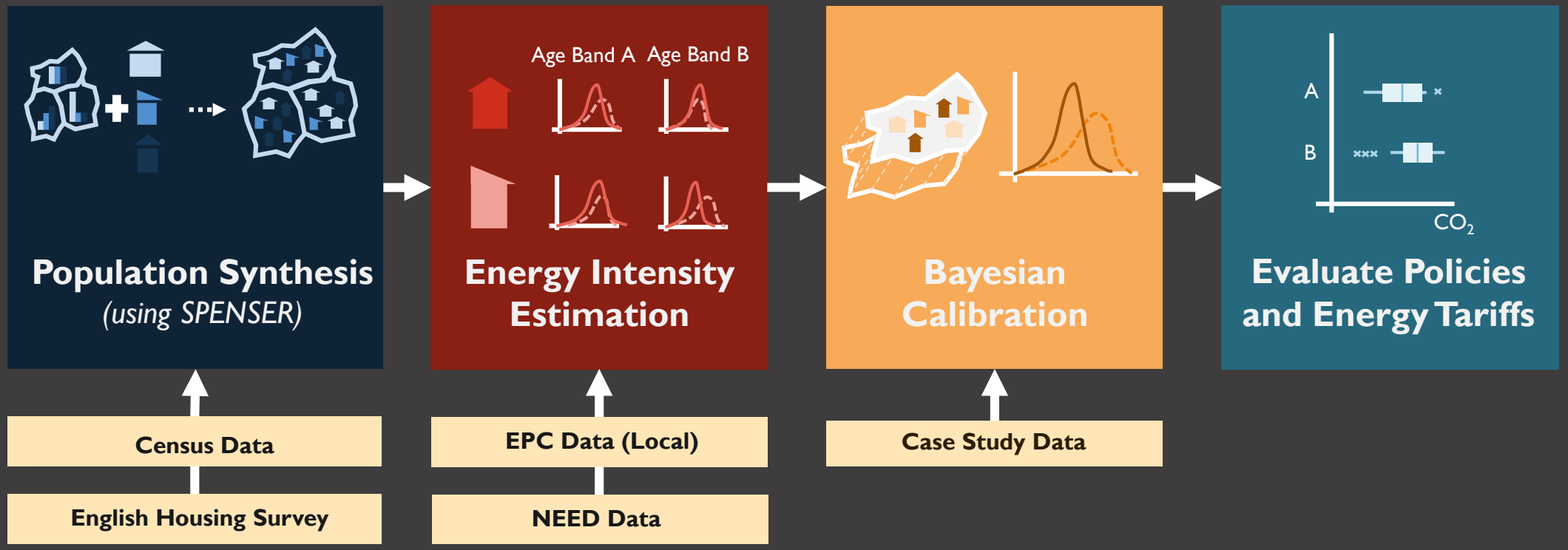
The average energy efficiency rating for a dwelling in England and Wales is band D (rating 60).

Top actions you can take to save money and make your home more efficient

Recommended measures	Indicative cost	Typical savings over 3 years	Available with Green Deal
1 Internal or external wall insulation	£4,000 - £14,000	£ 2,901	
2 Floor insulation (solid floor)	£4,000 - £6,000	£ 330	
3 Add additional 80 mm jacket to hot water cylinder	£15 - £30	£ 51	

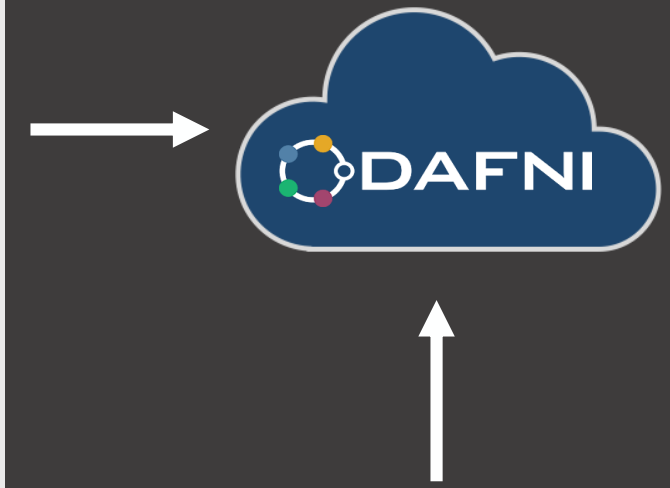
EnergyFlex: Model Structure

Status	Completed	Completed	Testing
DAFNI Version?	*In Progress*	*Yes*	*Pending*



EnergyFlex: Using DAFNI

- Sharing models is challenging and can limit opportunities to pursue meaningful stakeholder engagement.
- DAFNI allows us to package up the model and upload it so anyone can run them in the cloud.
- This has enabled us to more easily respond to engagement from varied stakeholders including housing associations and government.

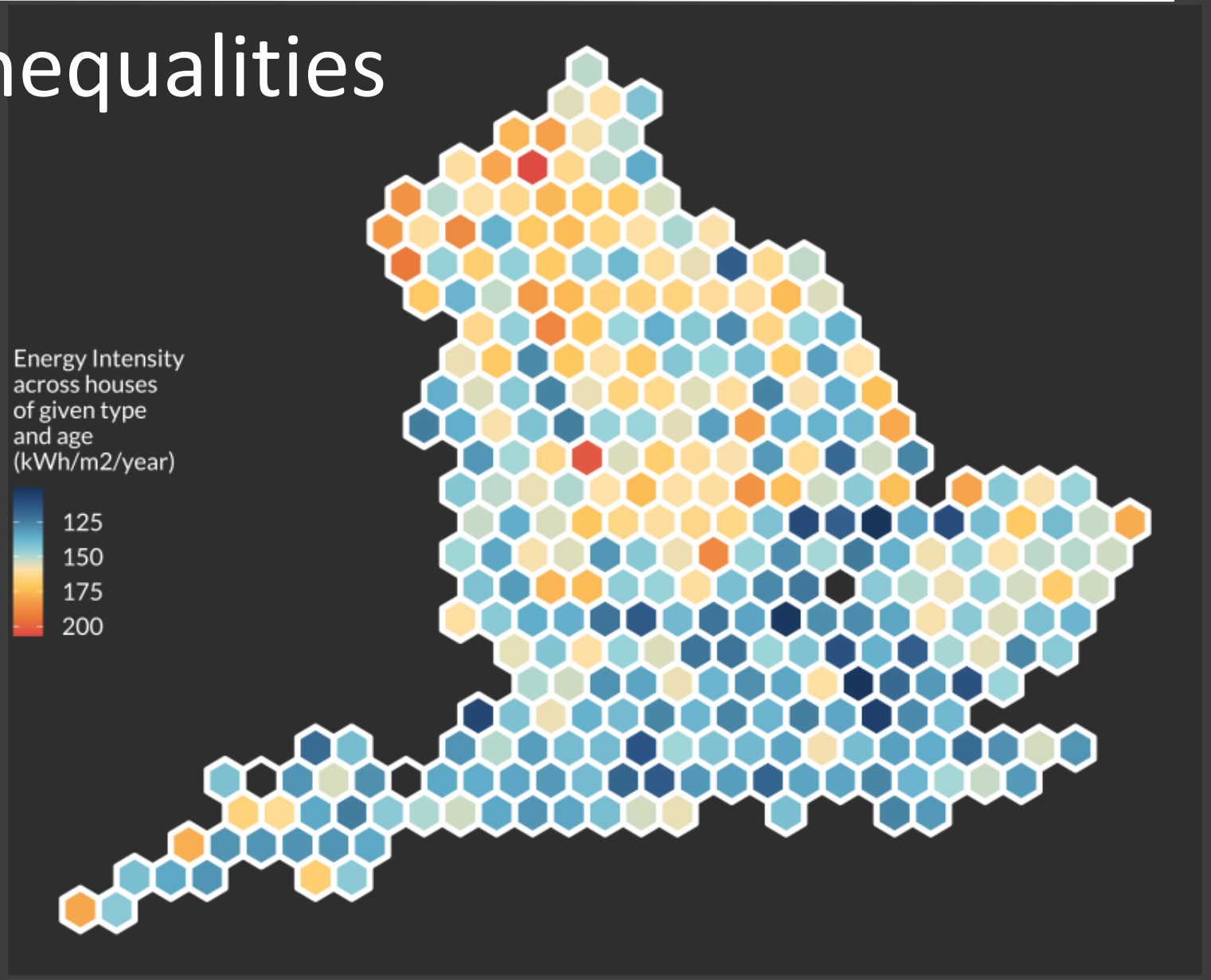


User sets model parameters *(i.e. Local Authority No.)*

Exploring Spatial Inequalities

The model can be used to explore spatial trends in energy efficiency of homes.

We have found that **energy efficiency** of new builds correlates with **house prices** in the area and **incomes,** and has a distinct spatial distribution across the country



*We wrote an article for **The Conversation** about how these regional differences could compound existing socio-economic inequalities.*

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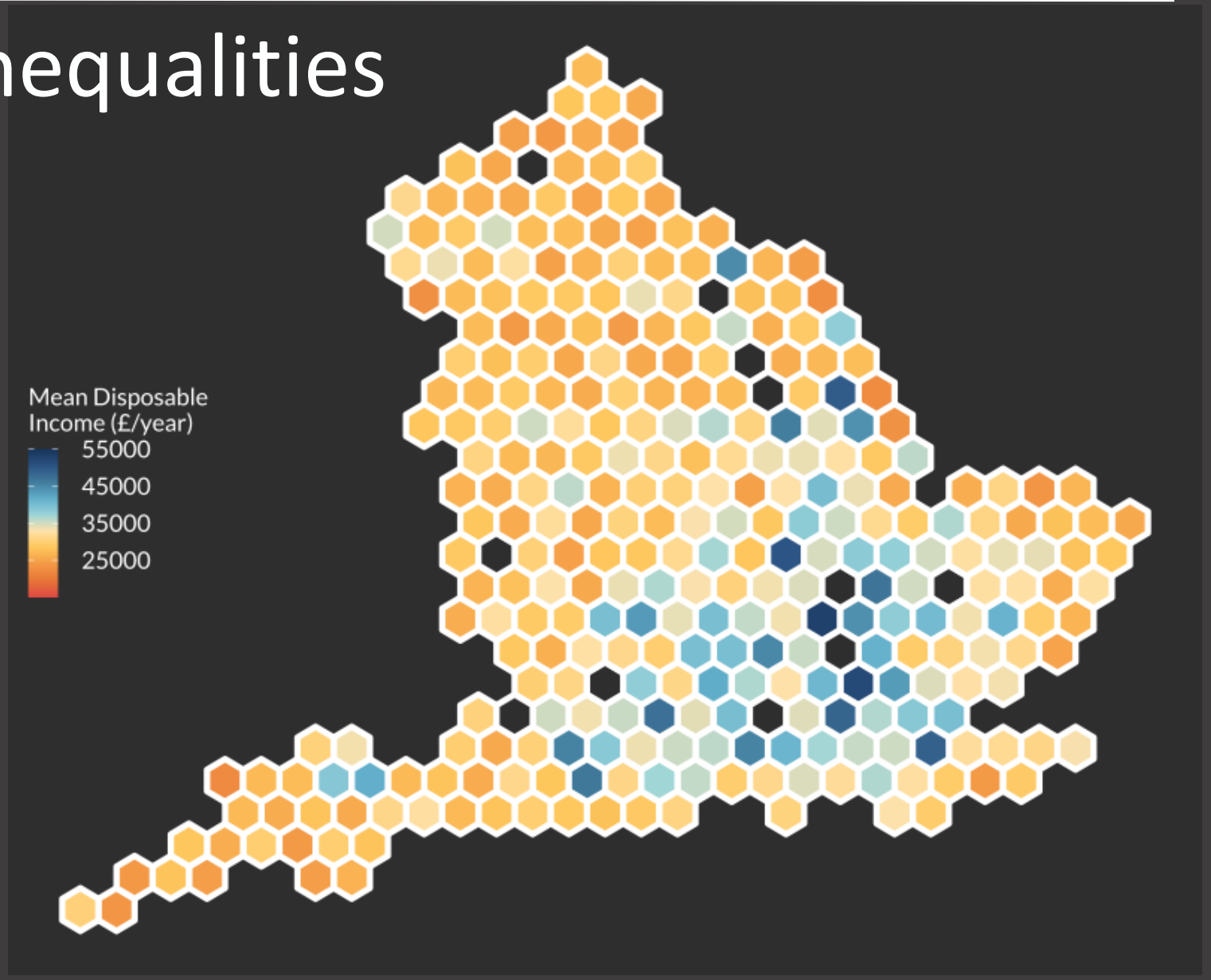
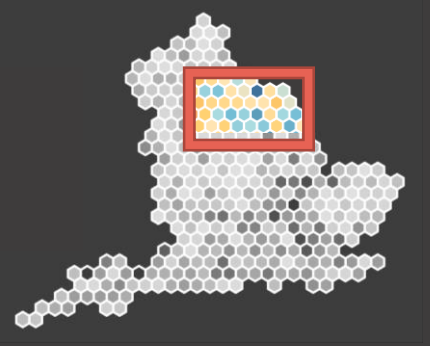


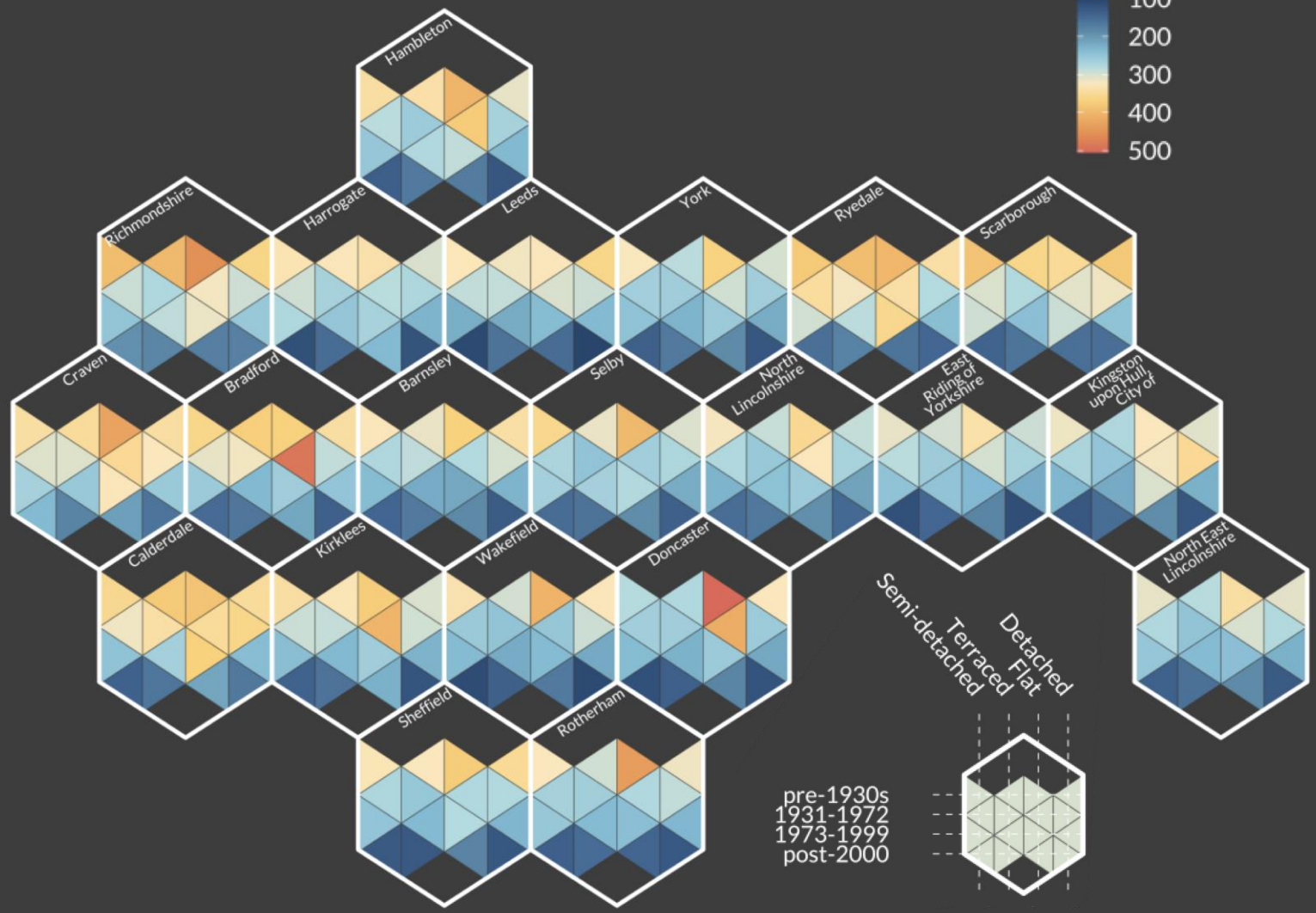
*We wrote an article for **The Conversation** about how these regional differences could compound existing socio-economic inequalities.*

Exploring Spatial Inequalities

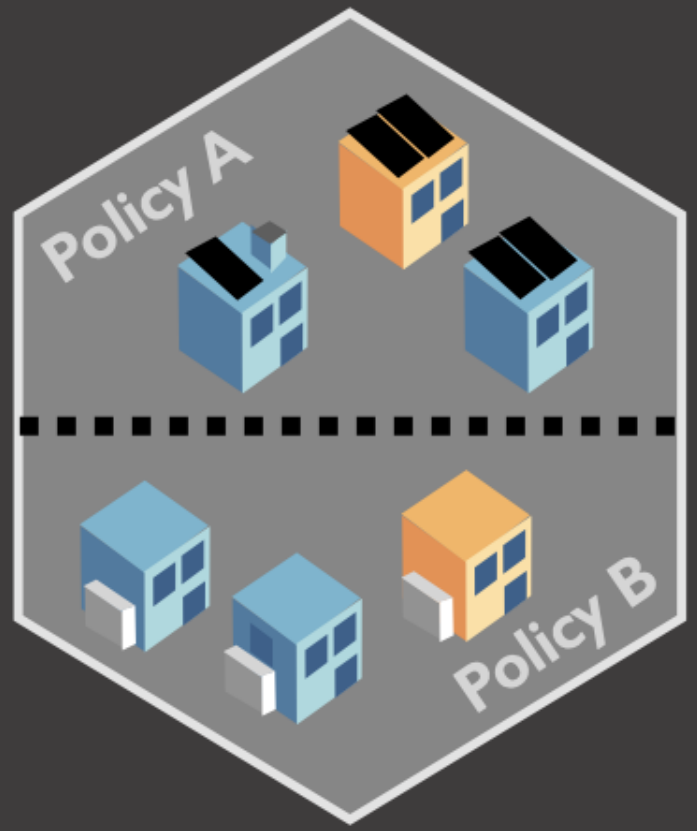
We can also compare trends across different ages and types of housing in a region.

For example older terraced housing and flats in larger cities and affluent areas tend to be more energy efficient than elsewhere, suggesting higher levels of retrofits.

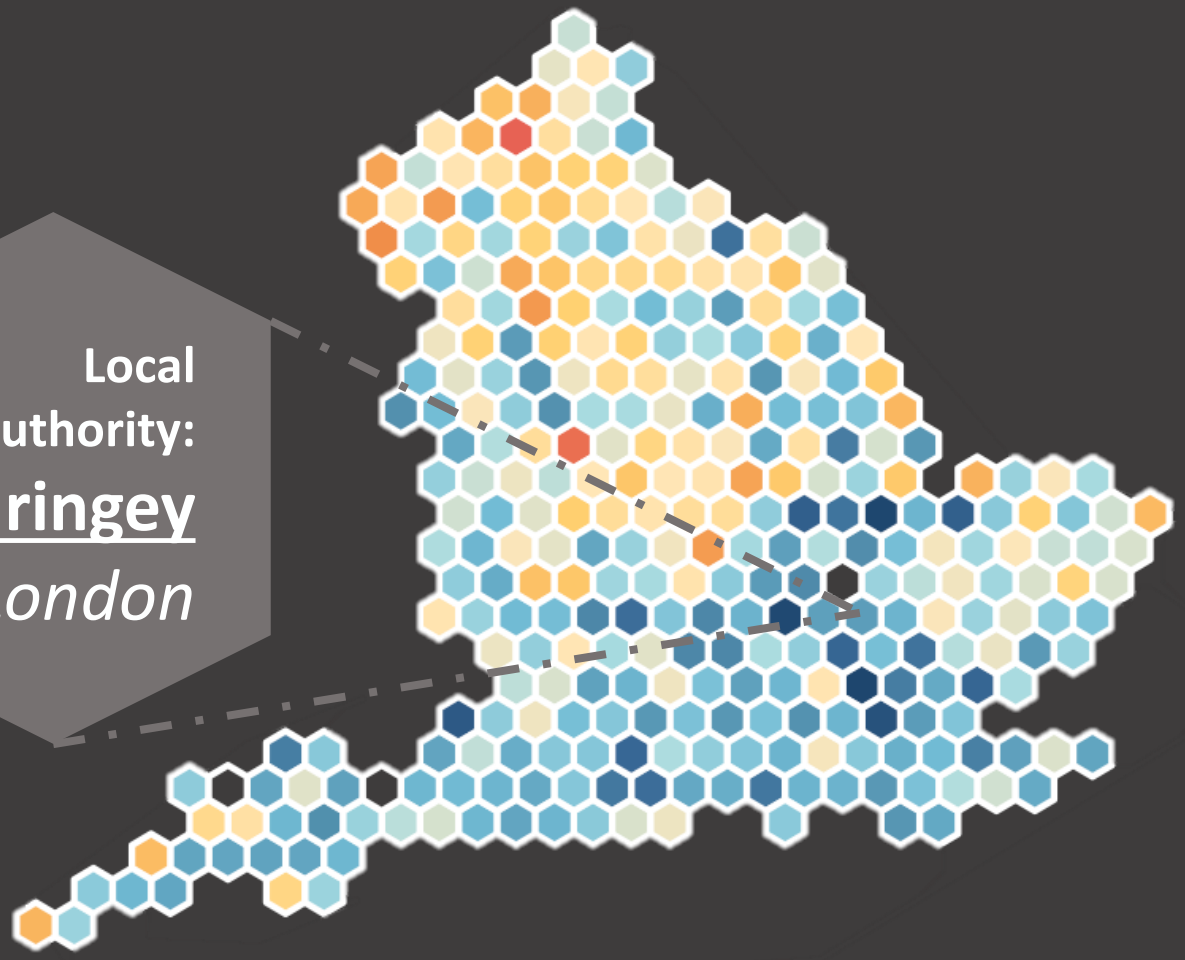




Simulating Retrofit Solutions [DEMO]



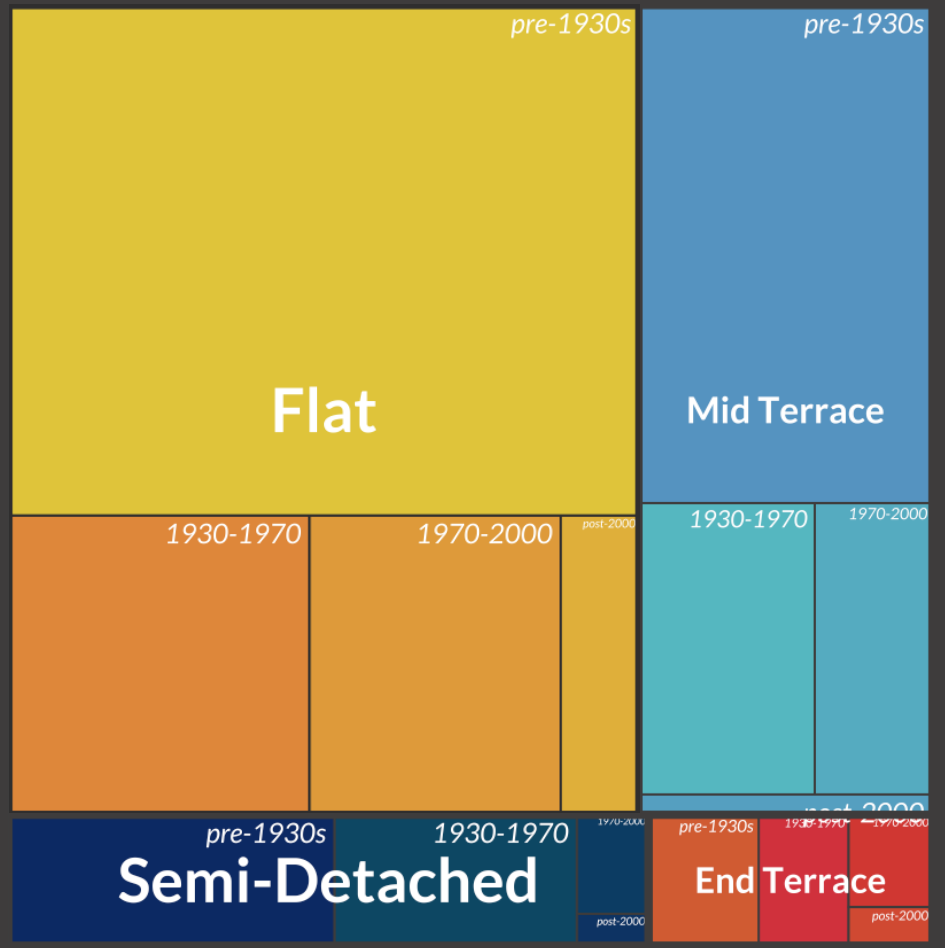
Local Authority:
Haringey
London



Simulating Retrofit Solutions [DEMO]

Local Authority: Haringey, *London*

Housing Stock by
building type
and ***age***



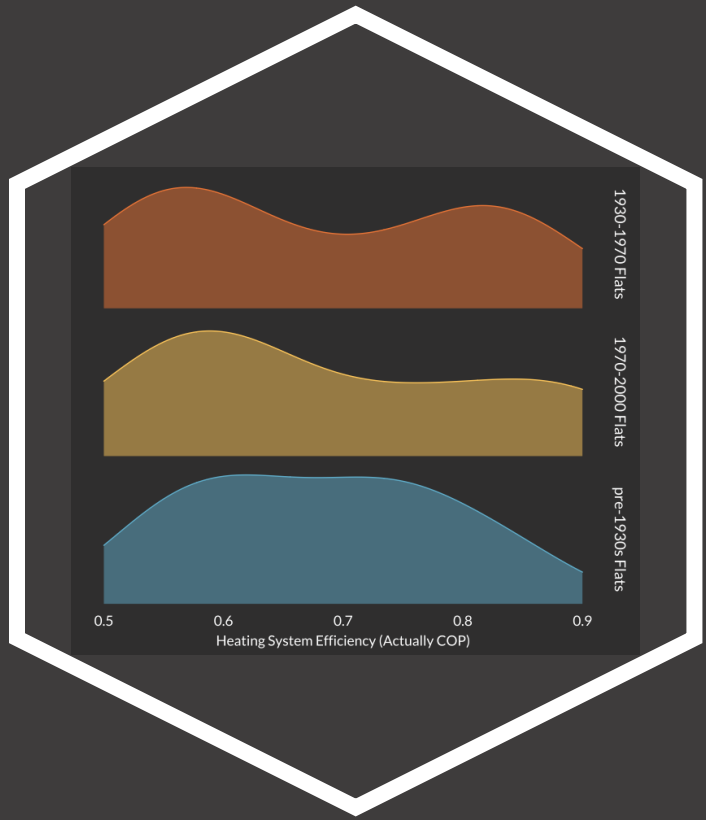
Simulating Retrofit Solutions [DEMO]

Local Authority: **Haringey**, *London*

Dwelling Typology of Interest: *Flats | pre-2000s*

Retrofit Target:
Inefficient Heating Systems

EnergyFlex can model likely energy performance characteristics such as heating system efficiency



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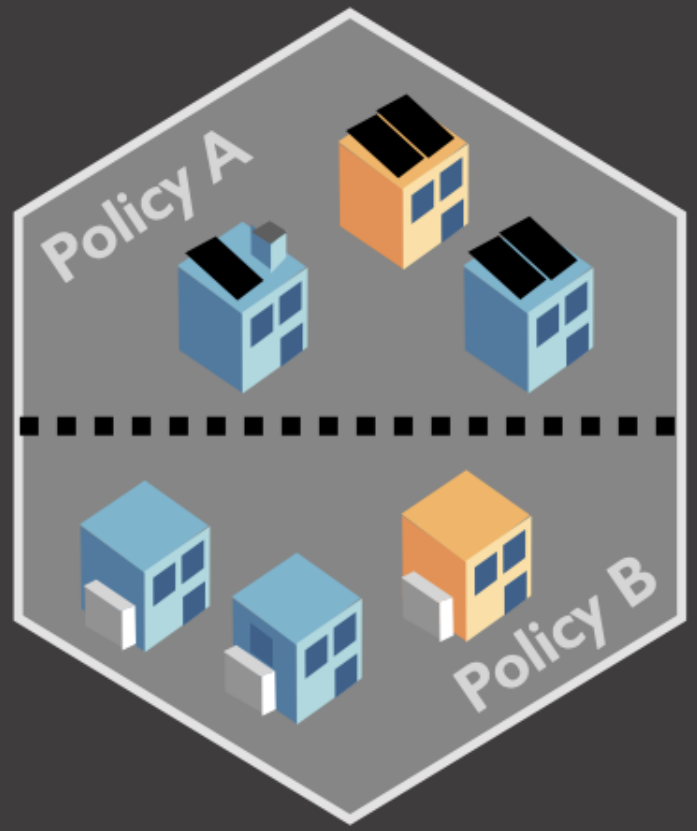
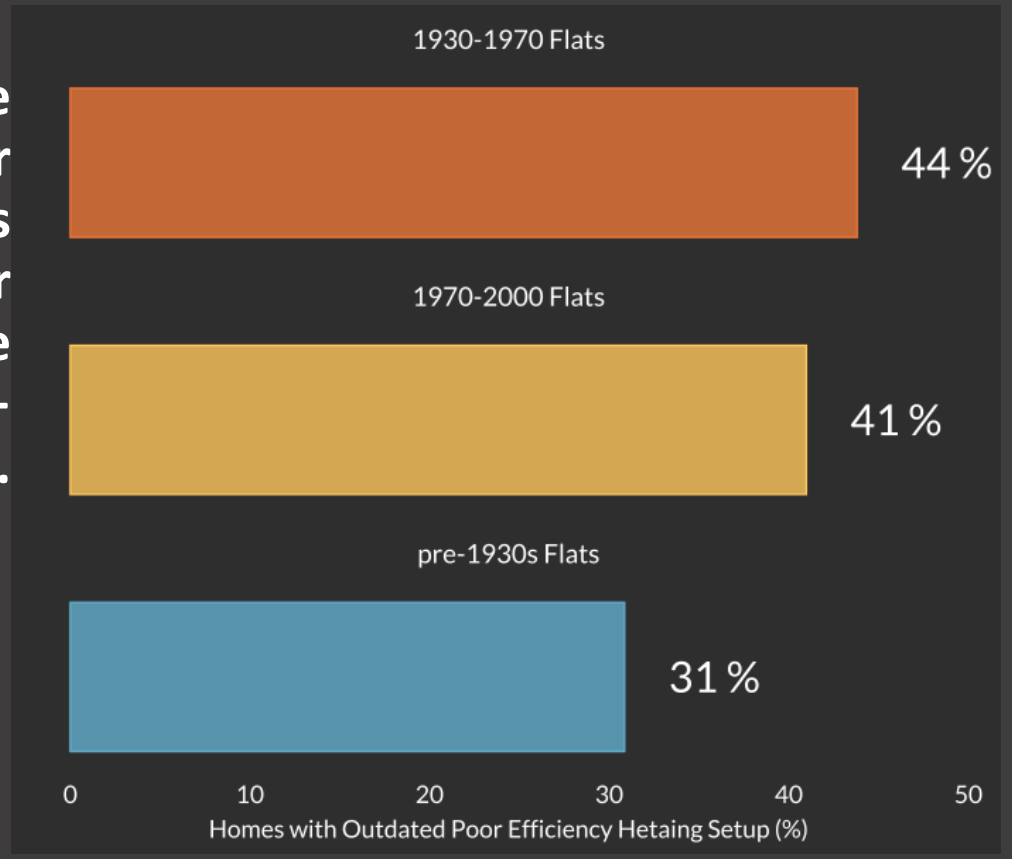


Local Authority: Haringey, *London*

Dwelling Typology of Interest: *Flats | pre-2000s*

Using our model we find that older inefficient boilers (SEDBUK 'E' rated or worse) are more prevalent in 1930—2000 Flats.

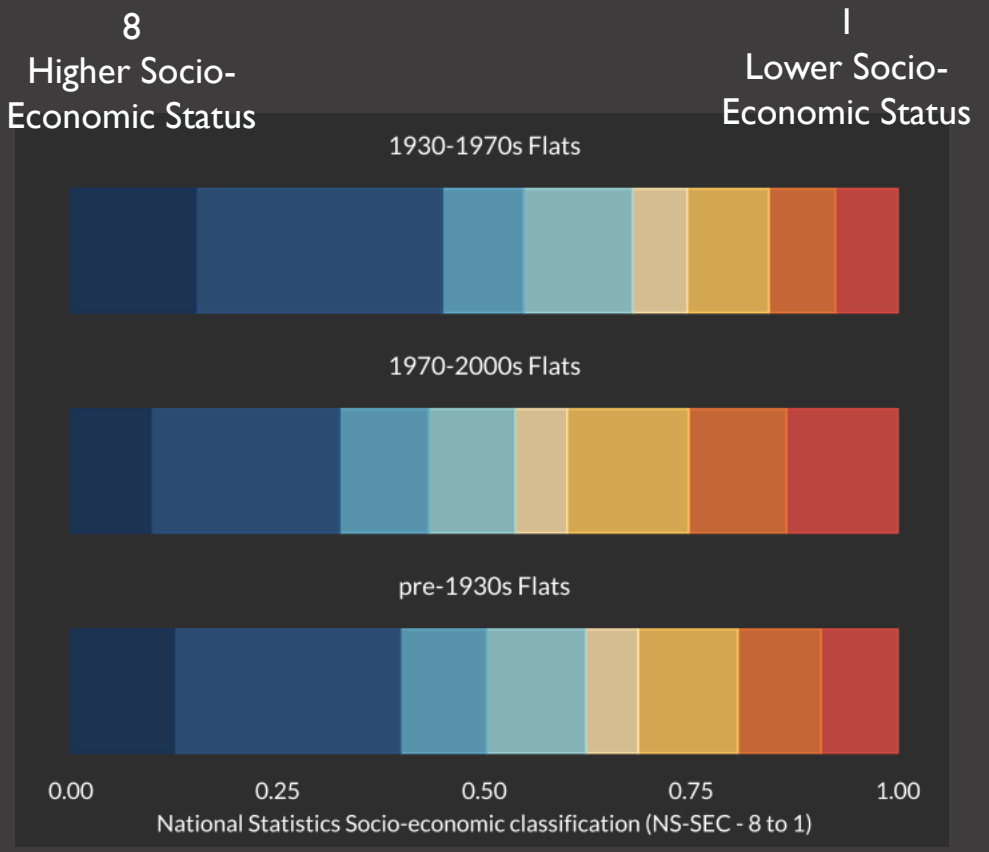


Simulating Retrofit Solutions [DEMO]

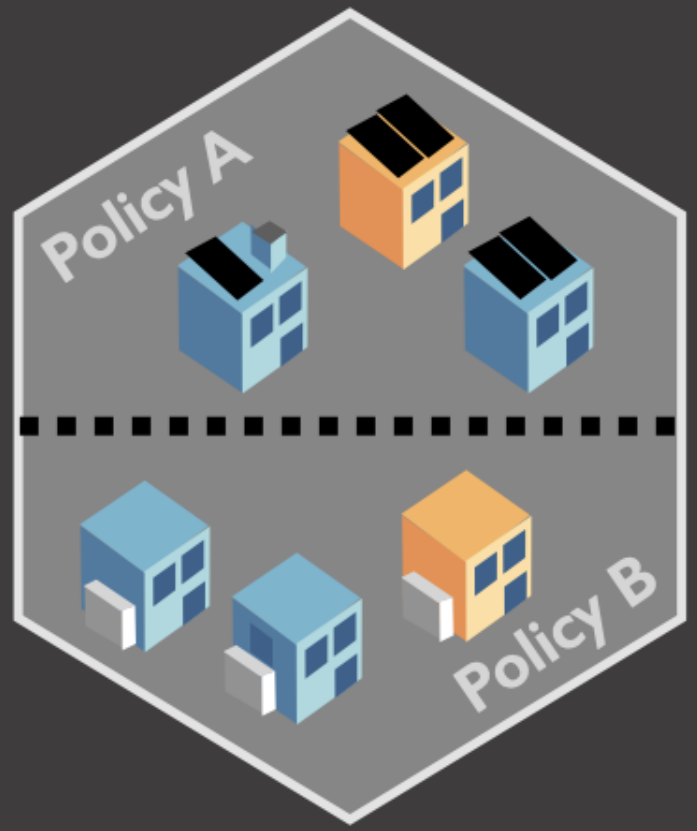
Local Authority: Haringey, *London*

Dwelling Typology of Interest: *Flats | pre-2000s*

Our model also gives us socio-economic context on the households living in these different types of housing



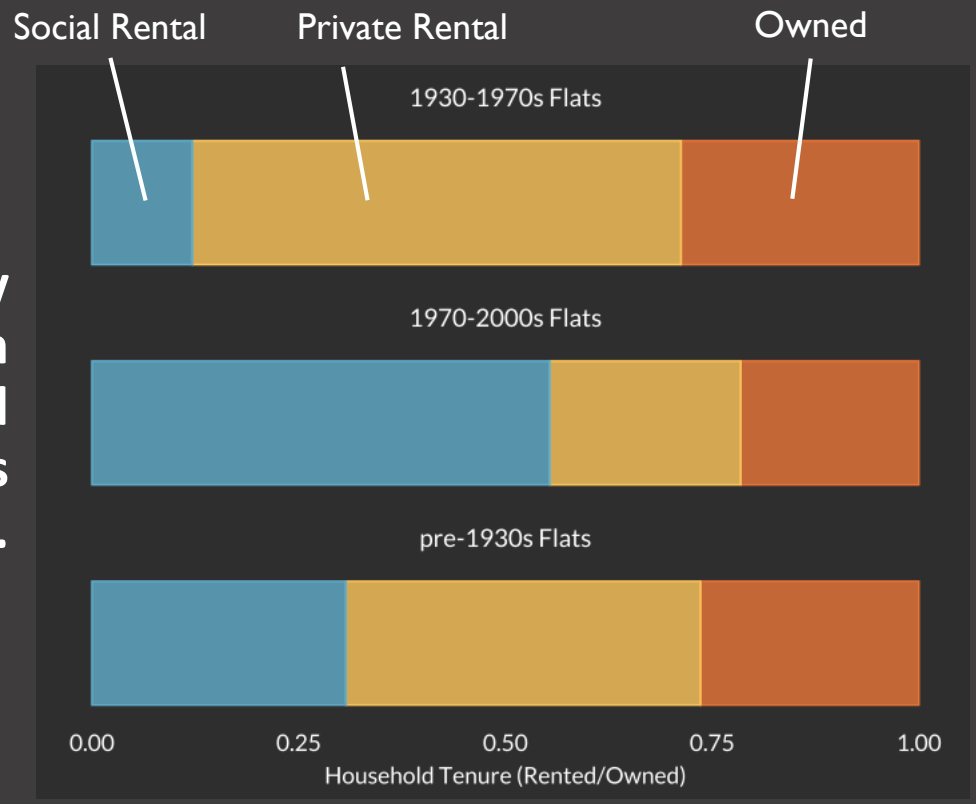
Simulating Retrofit Solutions [DEMO]



Local Authority: Haringey, *London*

Dwelling Typology of Interest: *Flats | pre-2000s*

Knowing who is likely to own households in need of retrofit could help target incentives or polices.



Simulating Retrofit Solutions [DEMO]

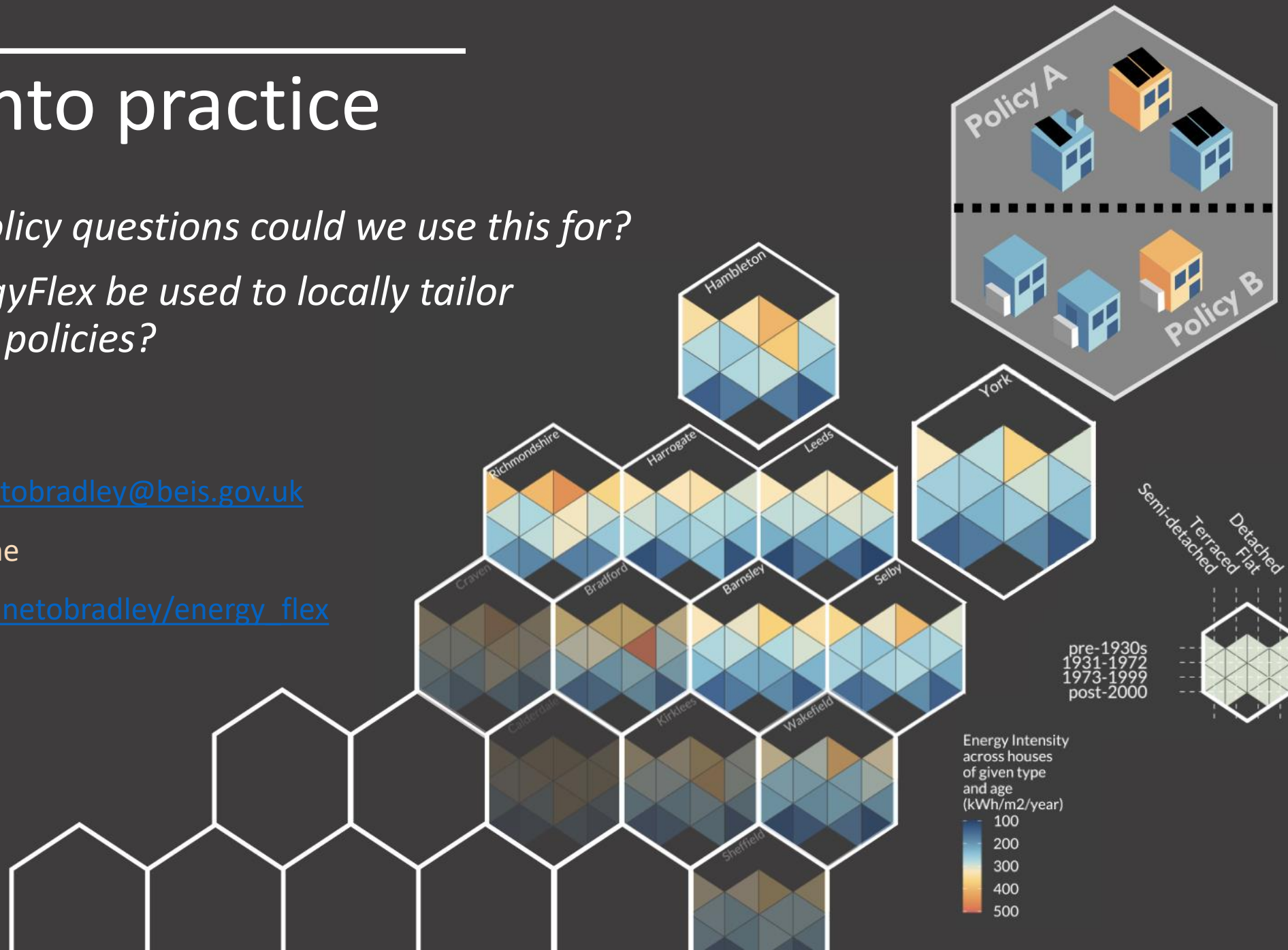
Local Authority: **Haringey**, *London*
Dwelling Typology of Interest: *Flats | pre-2000s*

Solution to consider: *Replace Boilers with Air- Source Heat Pumps*

- ***Greater prevalence of inefficient boilers in 1930-2000s Flats.***
- ***But households in 1970-2000 Flats more likely to need financial support.***
- ***Would need to incentivise private landlords to upgrade heating in 1930-1970s Flats.***

Putting it into practice

- *What sorts of policy questions could we use this for?*
- *How could EnergyFlex be used to locally tailor decarbonisation policies?*



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