Environmental *Change* Institute

Electrification of heating: the role of heat pumps

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The conventional wisdom on decarbonising the economy

1. Decarbonise electricity
2. Electrify transport
3. Electrify heating

Job done

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Outline of presentation

1. Heat pumps & residential heating
2. Expected role in the UK
3. Challenges at different scales
4. Global model and results
5. Conclusions

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The Context – residential space heating and heat pumps

In the UK 19% of final energy is used for residential heating, EU average is 17.5% and USA 9%.

Heat pumps are the leading technology for efficiently using electricity for residential and commercial space heating

Present in less than 1% of EU households – Austria 2%, Sweden 8%

Annual UK sales of 21,000 heat pumps

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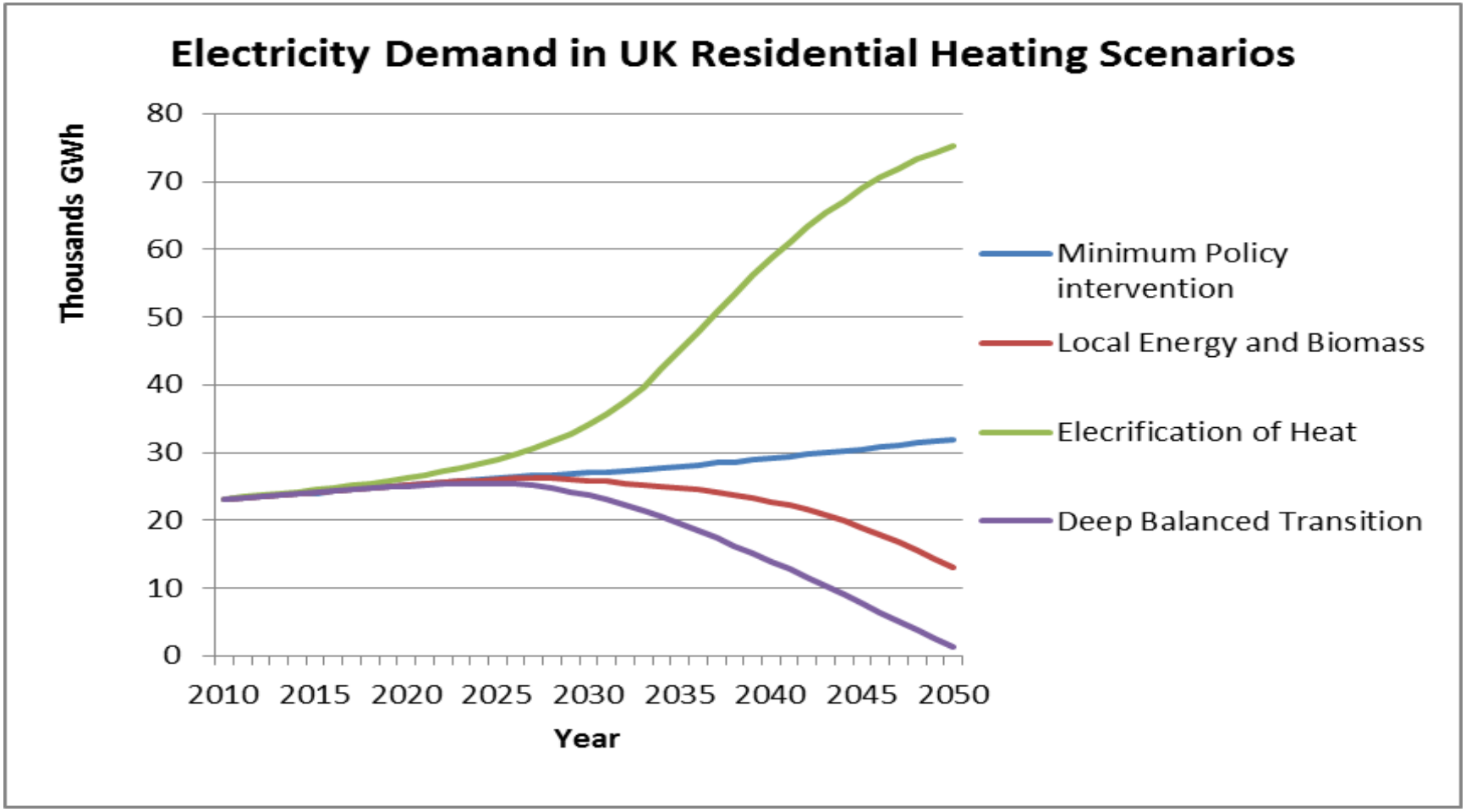
Scenarios for UK electricity use in heating



From Eyre and Baruah, 2014

Expected role of heat pumps in the UK

We have analysed a variety of low carbon scenarios – including DECC, Delta-ee, Ekins et al, Ecofys (see paper for more details)

In all most low carbon scenarios, the role of heat pumps in residential heating increases substantially.

Two influential scenarios – CCC and DECC – have moved towards a mix of low carbon heat options including district heating and bioenergy.

CCC now projects 4 million residential heat pumps by 2030. For UK policy-makers, heat pumps are still expected to be the dominant technology in low carbon heating….

But there are major challenges

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Challenges at different scales

Scale	Challenge
Household	High capital costs and high priced fuel Hot water tank required Ideally a well insulated house and low temperature heat distribution system ASHP technology is least efficient at times of highest demand May need three-phase electricity supply
Local area	Location of ASHPs is difficult in more dense urban areas GSHPs need available land Local increases in electricity demand which may require network reinforcement.
National Supply chain	Lack of supply chain and expertise to design, install and commission heat pumps (EST, 2010, 2013)
National electricity system	Increase of average and peak electricity demand, which must be supplied by low carbon electricity

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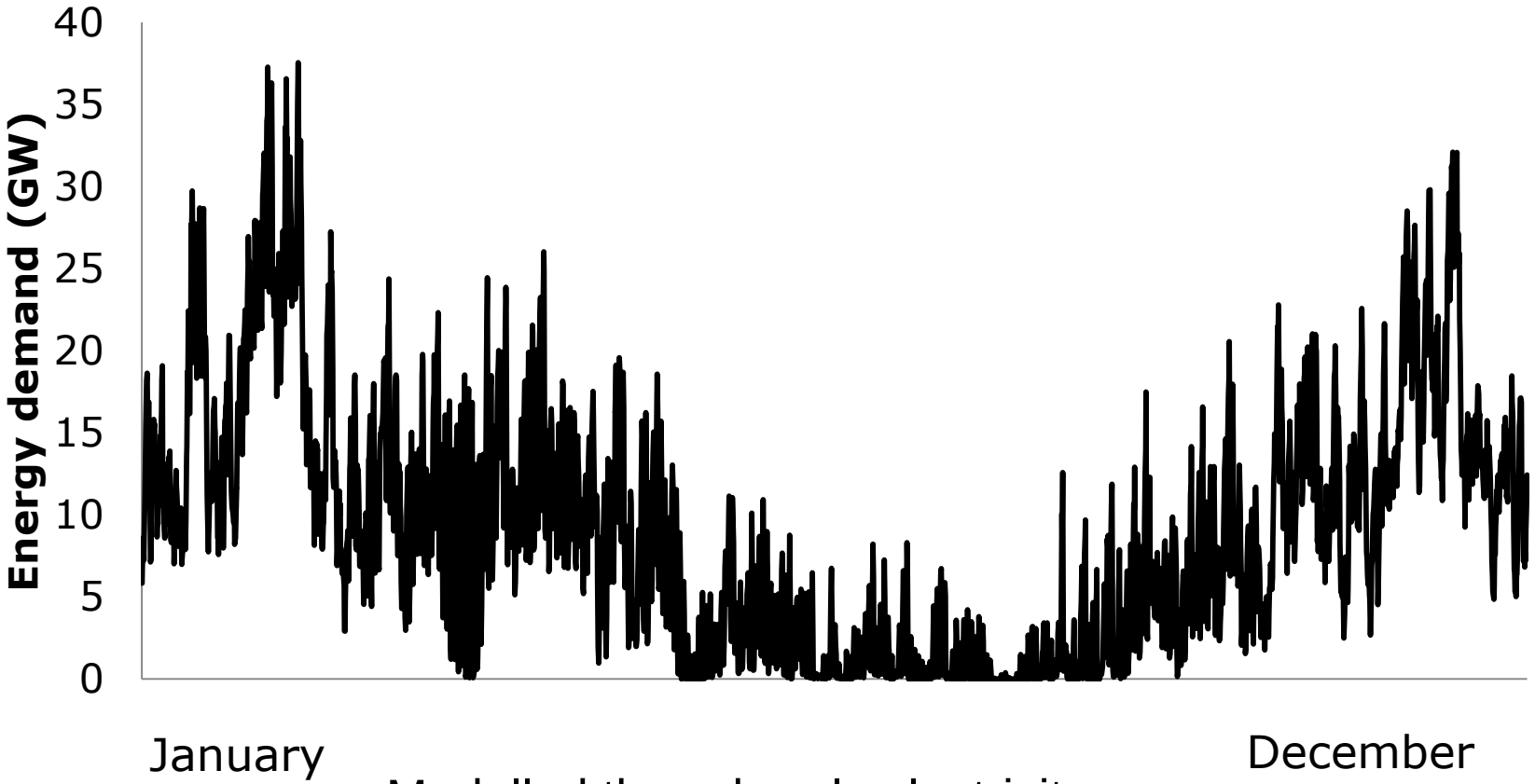
Implications for UK electricity demand



Modelled three-hourly electricity demand due to electrification of residential heating with heat pumps, UK, 2012

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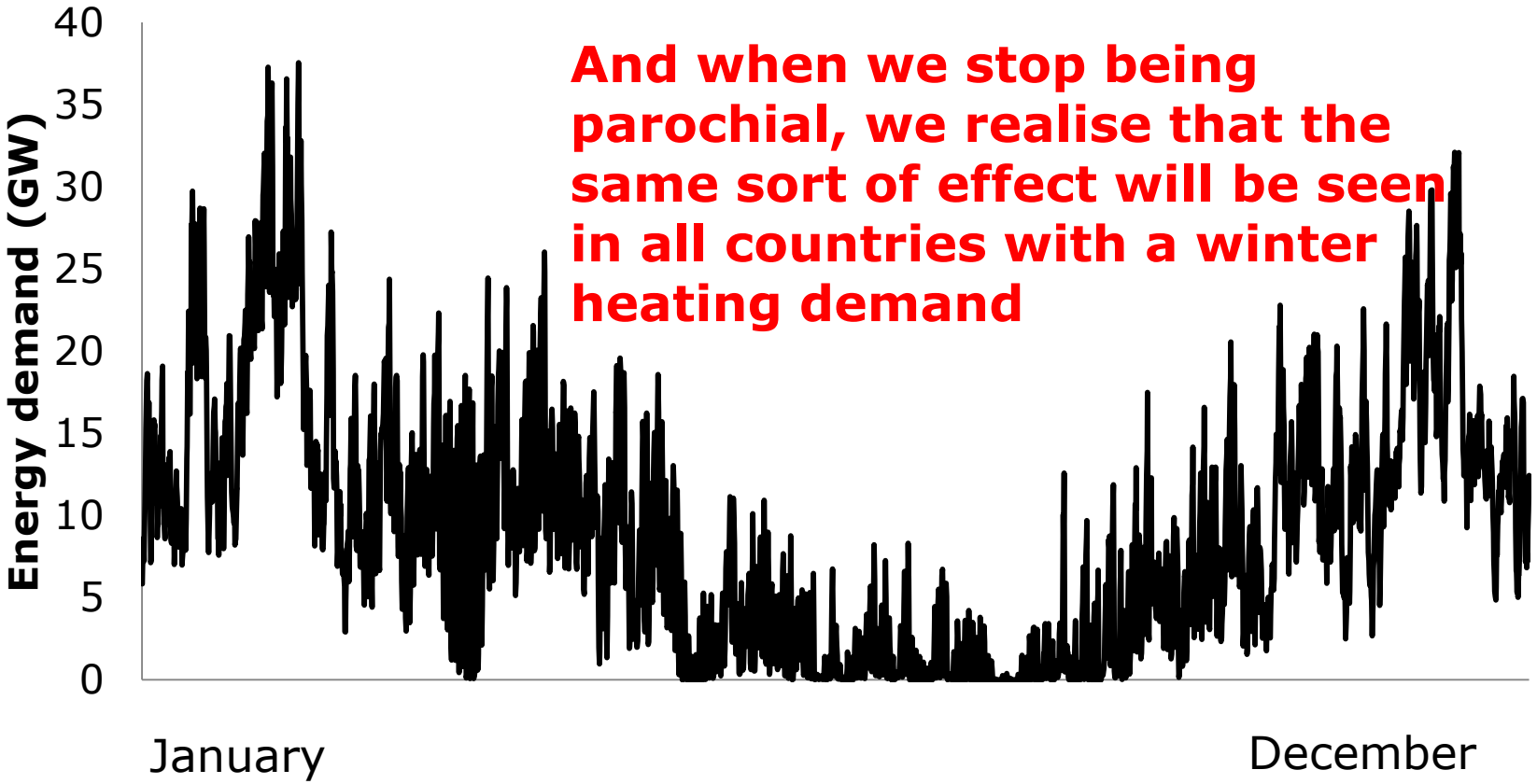
Implications for UK electricity demand



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Global model – purpose

- To calculate residential heating energy ‘need’ in each country of the world
- To calculate electricity demand (annual and peak) per country with all residential heat from heat pumps
- To look at how the peak:average ratio would change with global interconnection

This model combines global population and degree day datasets. It is described in more detail in the paper.

It is well suited to looking at peak demand, due to the 3-hourly time resolution used.

Global model results– residential heating 'need'*

Country	% of global space heating need	Cumulative %
China	39.2	39.2
Russian Federation	9.8	48.9
United States	6.6	55.5
Germany	3.1	58.6
Japan	2.9	61.5
India	2.8	64.3
Pakistan	2.1	66.4
Ukraine	2.1	68.5
United Kingdom	1.8	70.3
Iran	1.7	72.0

* 'Need' is defined as heat required at current UK space, comfort and efficiency standards

Modelled annual and peak electricity demand for residential space heating

	UK	China	World - no interconnection	World - with interconnection
Mean electricity demand (GW)	9.1	232	582	582
Peak electricity demand (GW)	37.6	1172	3353	2325
Peak electricity for 95% of heating demand (GW)	24.2	793	2029	1774
Ratio Peak: Mean	4.1	5.0	5.7	4.0

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Conclusions

- Electrification of heating is expected to be an important contributor to mitigation of climate change, with low-carbon electricity replacing direct us of fossil fuels.
- However, mass adoption of heat pumps will increase peak electricity demand, adding to existing winter peaks
- The high costs of increased peak capacity could delay or prevent electrification

Key research questions:

1. Does this “peak demand issue” constrain the fraction of residential heating demand that can be electrified?
2. What are the alternatives? And how viable are they?

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