

# UCL ENERGY INSTITUTE



Why is data so important for a low carbon future?

Tadj Oreszczyn



# What I will cover

- Why data is so important for a low carbon future?
- An analogy between energy research and health data and research.
- Introduction to the Centre for Energy Epidemiology
- International problem

## The scale of the challenge

- Most developed countries have plans to significantly reduce energy use from the built stock and transport.
- For example, The UK is legally committed to an 80% GHG emissions reduction target for 2050 and to 5-year carbon budgets in the interim. The 2011 UK Carbon Plan states that “**By 2050, all buildings will need to have an emissions footprint close to zero**”
- Globally energy efficiency refurbishment is predicted investments of trillions of dollars.
- If we are to invest this money wisely we need to improve our evidence base.

# Why do we need to make better use of existing data?

1. To **support policy and legislation** in particular in relation to the Climate Change Bill, the Building Regulations and EPBD. In particular test the impact of energy efficient policies.
2. To provide **support to industry to design and install** the most effective energy efficient products in the built environment
3. **To save people money** by improving the installation of energy efficiency measures and money that is currently being wasted because of duplication of effort and data is being collected when it existing data may already provide the answer.
4. To undertake **academic research**
5. To **ground building energy models** (stock and individual) and thereby help provide better agreement between model predictions and reality.

*You can not manage what you can not measure*

# Changes in Energy Building Regulations (Codes) in England and Wales

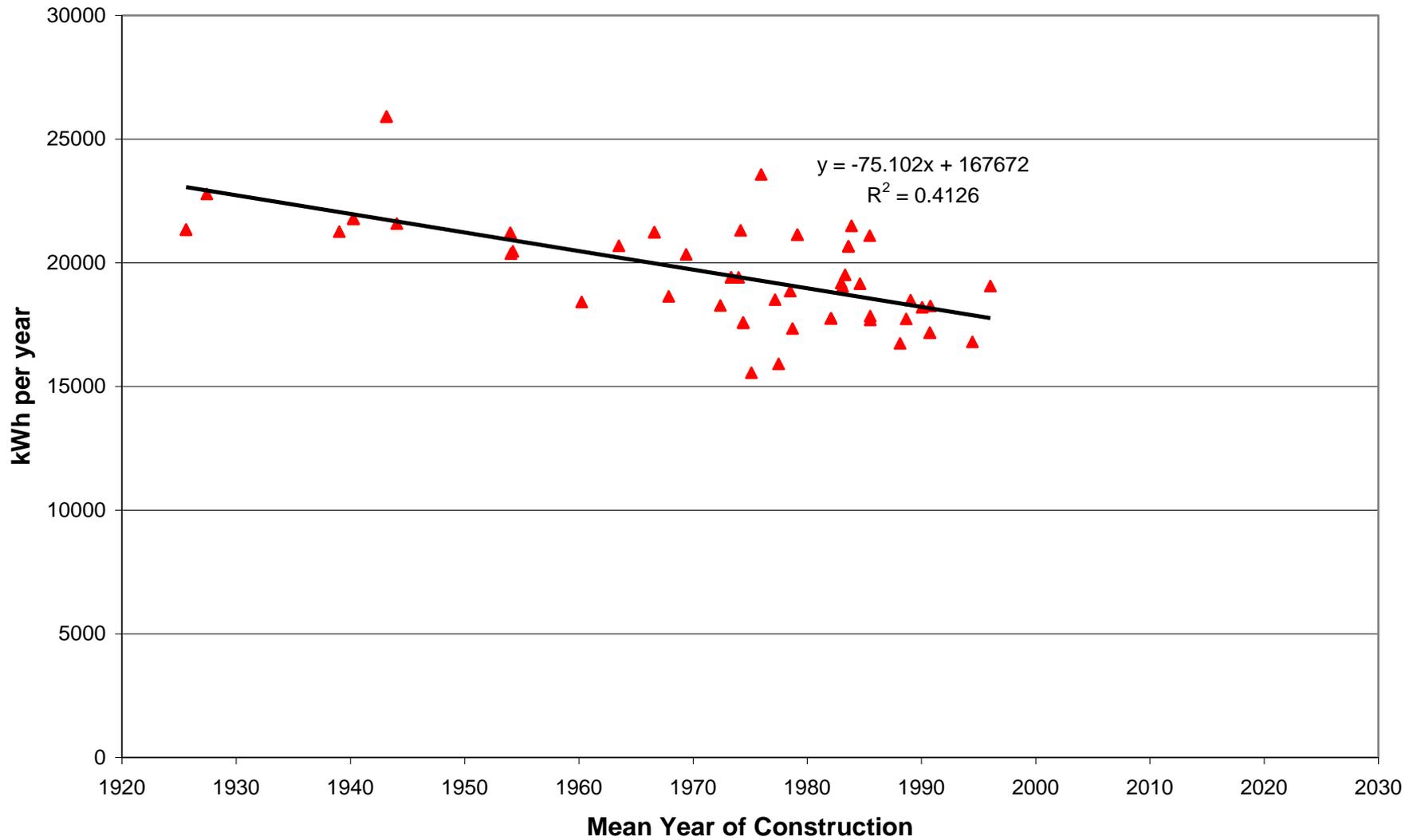
	Roofs	Walls	Floors	Windows, doors and roof lights
1965	1.42	1.70	1.42*	-
1976	0.60	1.00	1.00*	-
1982	0.35	0.60	0.60*	-
1990	0.25	0.45	0.45**	-
1995+	0.25	0.45	0.45**	3.3
2008 (?)	0.16	0.25	0.22	1.3

\*applies to exposed floors only

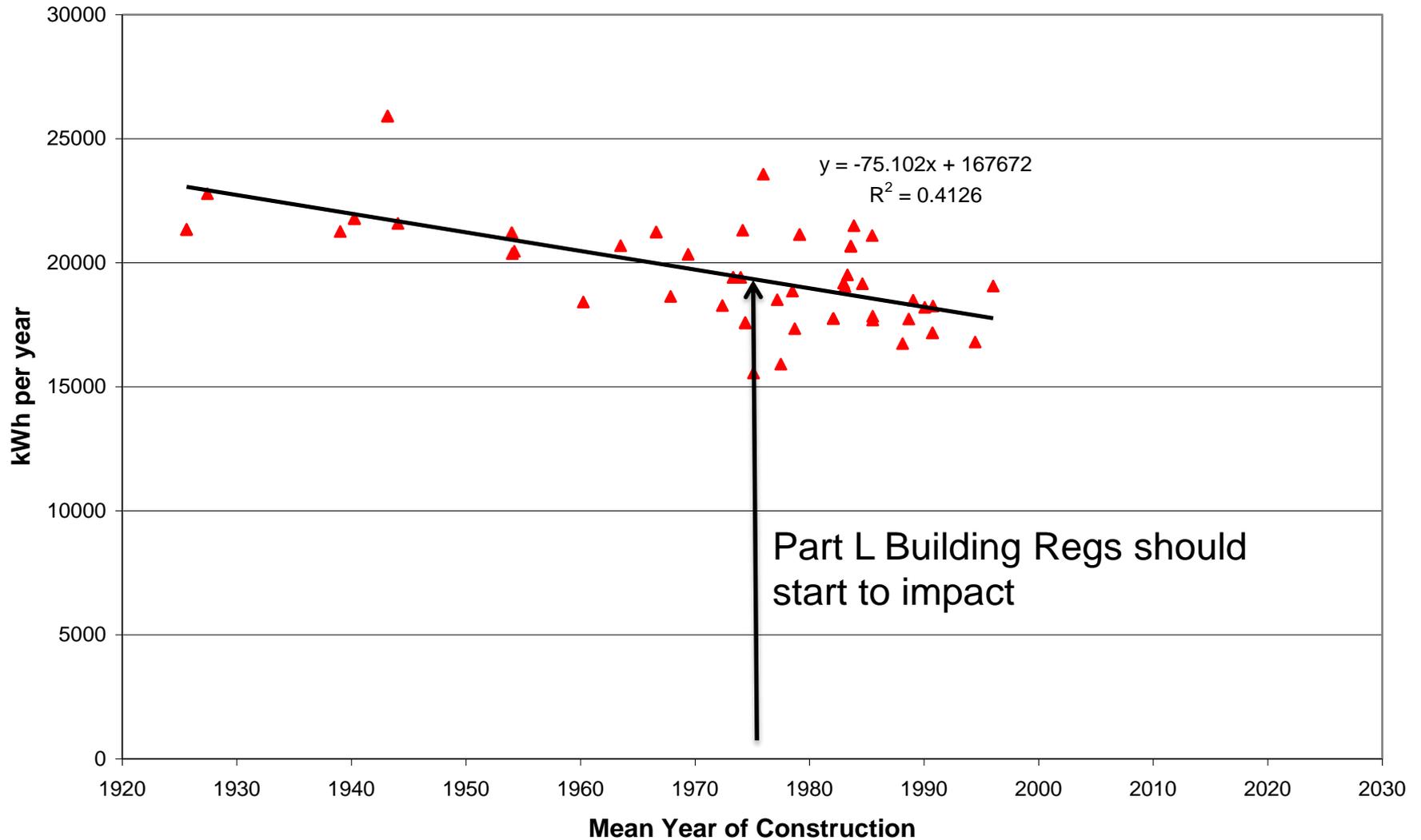
\*\*applies to all floors including those in contact with the ground

+ U-values calculated using proportional area method. Regulations cover material alterations, change of use and lighting efficacy and control

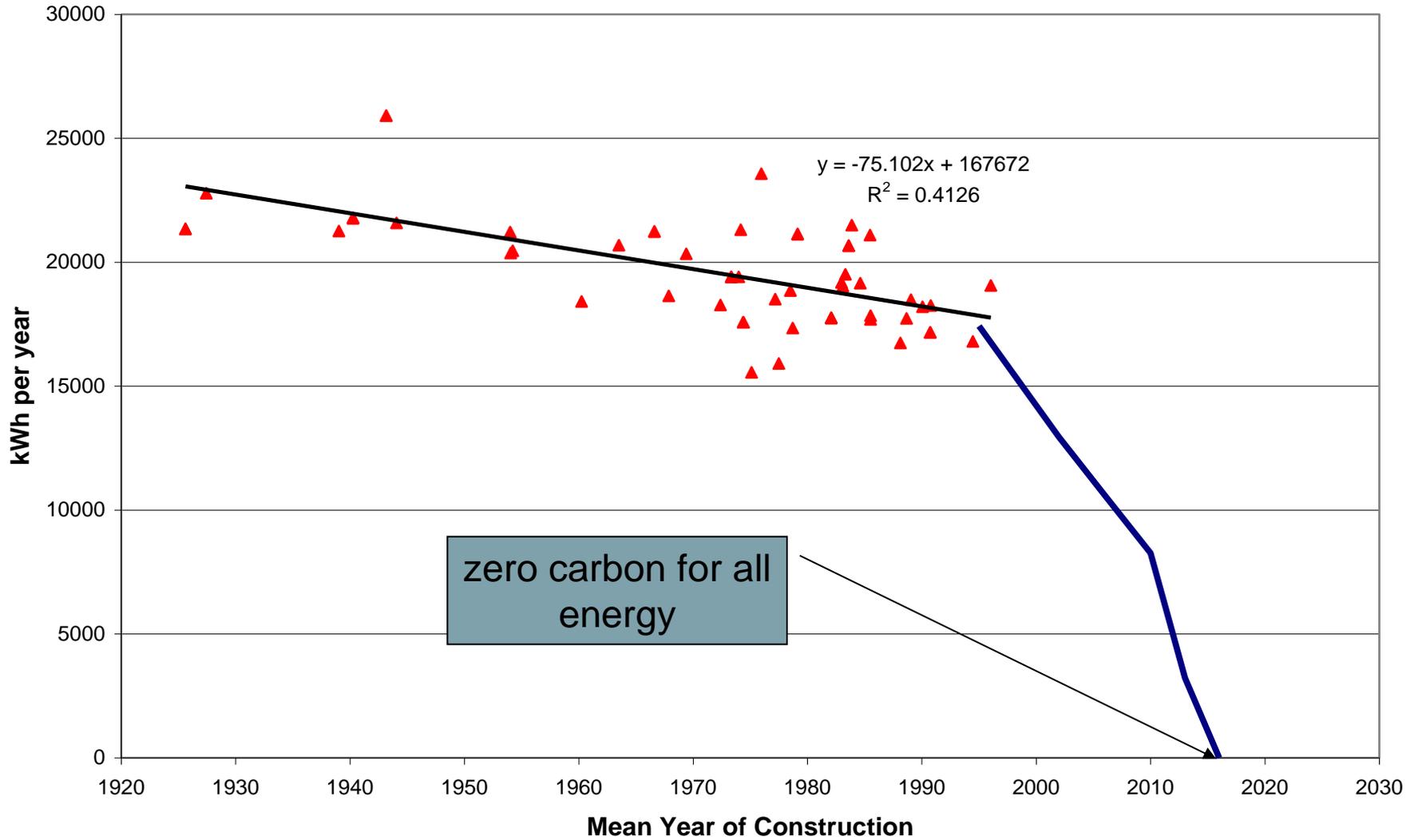
### Postcode Sector Average Dwelling Age vs Average Gas Consumption per Dwelling



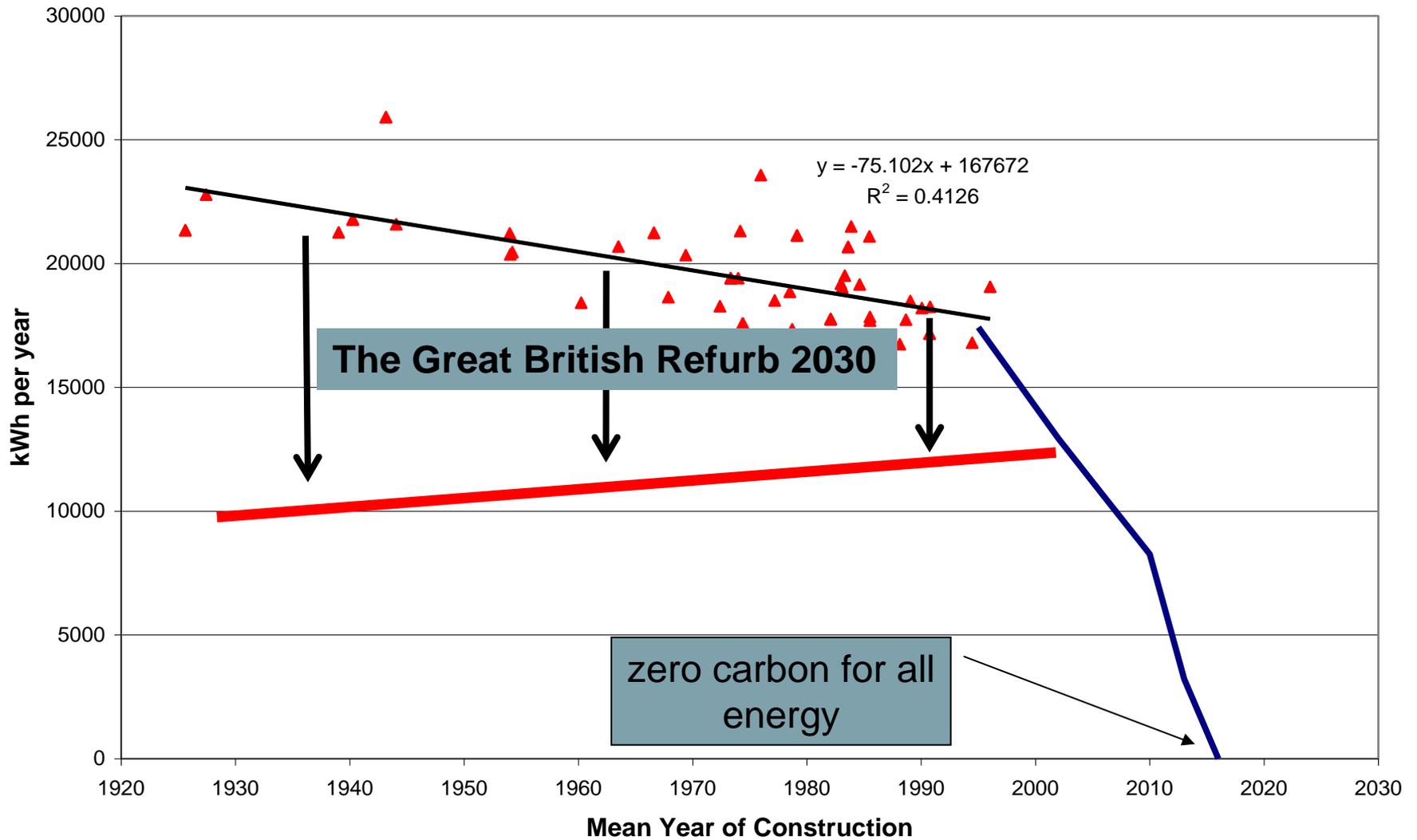
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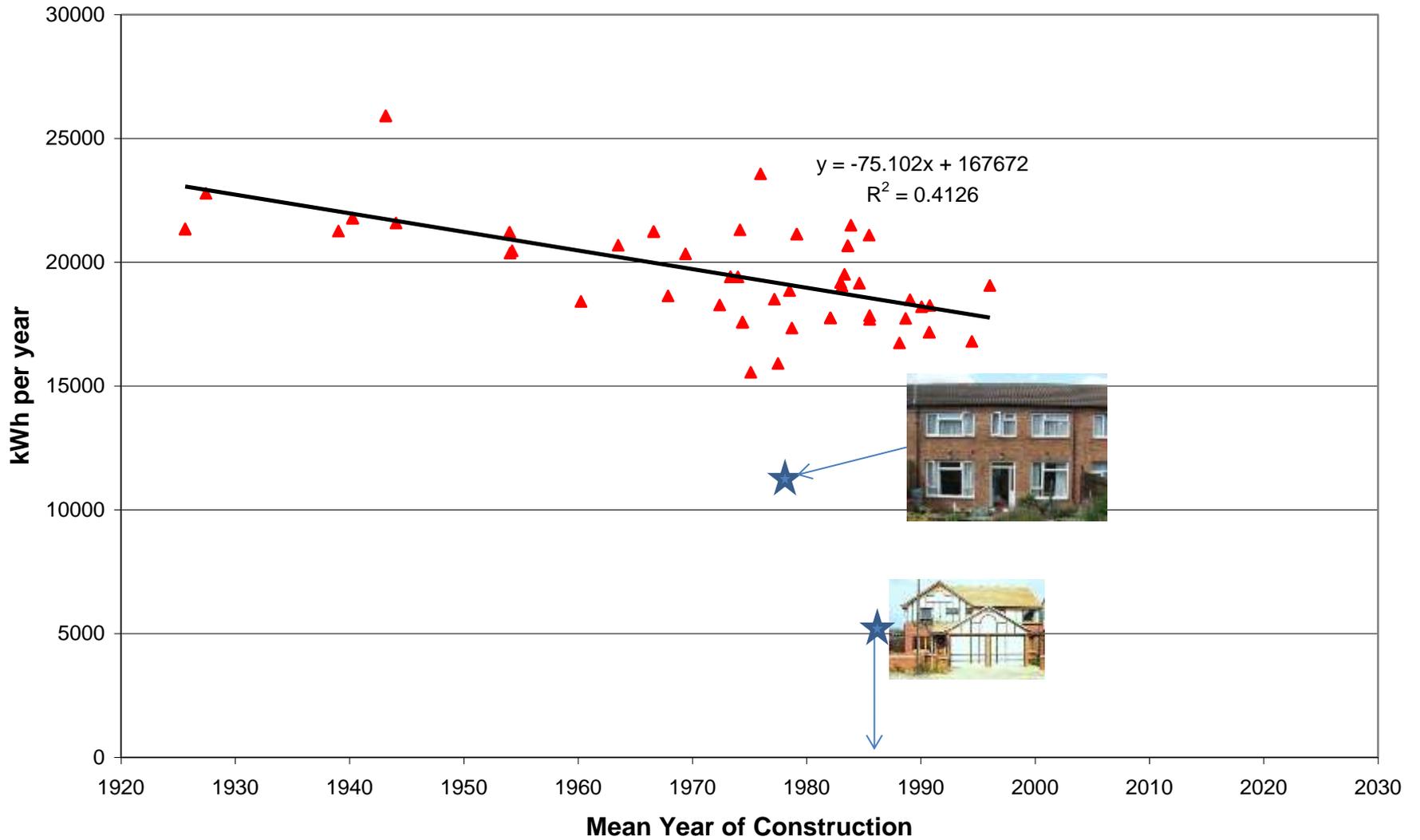
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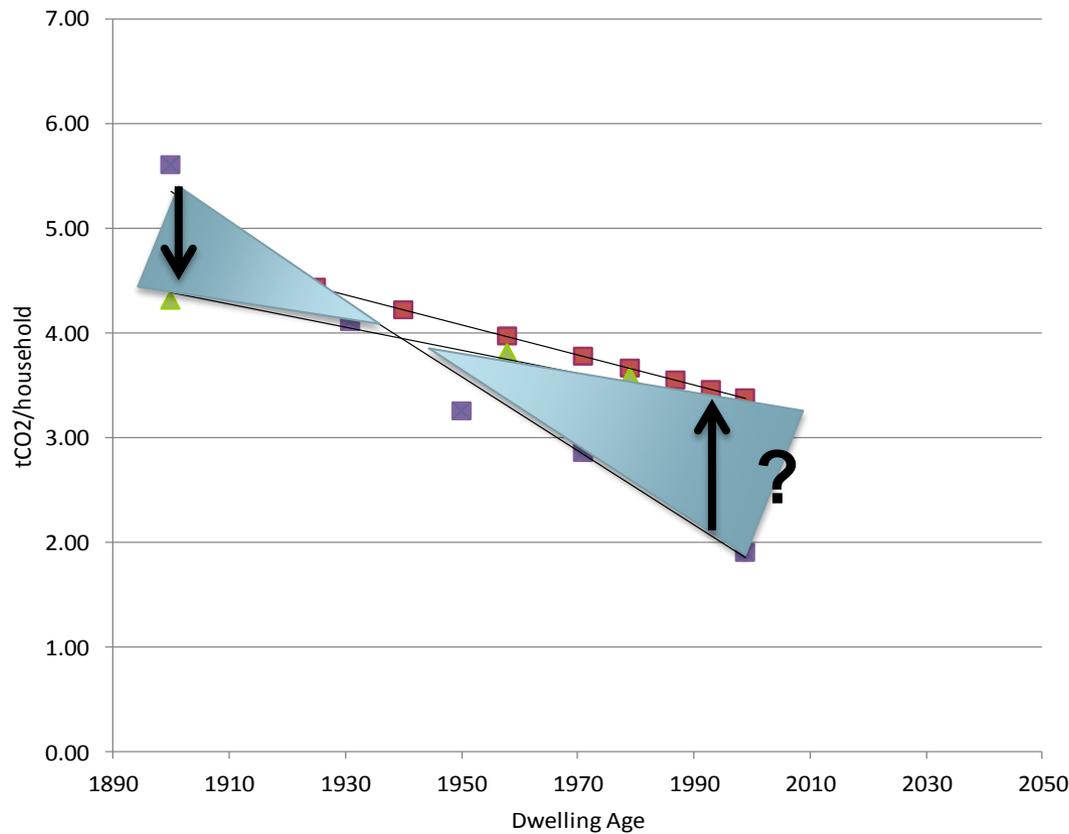


# Postcode Sector Average Dwelling Age vs Average Gas Consumption per Dwelling



# A gap between theory and practice

Mean UK Household tCO<sub>2</sub>\* emissions for gas demand



**HEED Regression:**

**EHCS Regression:**

$$y = -0.011x + 25.375$$

$$R^2 = 0.9583$$

**SAP Regression:**

$$y = -0.0353x + 72.5$$

$$R^2 = 0.9723$$

■ MK

▲ EHCS (2001)

■ SAP Calculated 2007

\* 2008 fuel weighted heating CO<sub>2</sub> emission factor of 0.192 kgCO<sub>2</sub>/kWh

*'In theory,  
theory and practice are the same,  
but in practice,  
they're not'*

Santa Fe Institute in Factor Four

## **Why is theory and practice not the same in this case ?**

1. Applied physics wrongly e.g. party wall
2. Not built/refurbished as modelled/theory
3. Do not understand changes in occupant behaviour including rebound

## Why we depended so much on theory?

- Historic lack of funding and lack of real interest.
- Privatisation of the energy industry (access to data very difficult).
- Perception that if we validated theory 20 years ago we never have to do this again because the construction industry moves so slow.
- Ease of modelling compared to complexity and cost of monitoring.

## What has changed?

- A potential £b industry.
- Government has legislated carbon targets.
- Annualised energy data is now available to government at meter level as is information about energy interventions, building characteristics, etc.
- Monitoring potential much cheaper and easier (e.g. smart meters).
- Government has Open Data policy.

# 'epidemiology'

*e*pi = upon

*demo*s = people

*ology* = logic, study

Term hijacked by the medics!

**John Snow founding father of epidemiology discovered that Cholera spread via a water pump in Soho (1849 to 1854). Worked at University College**

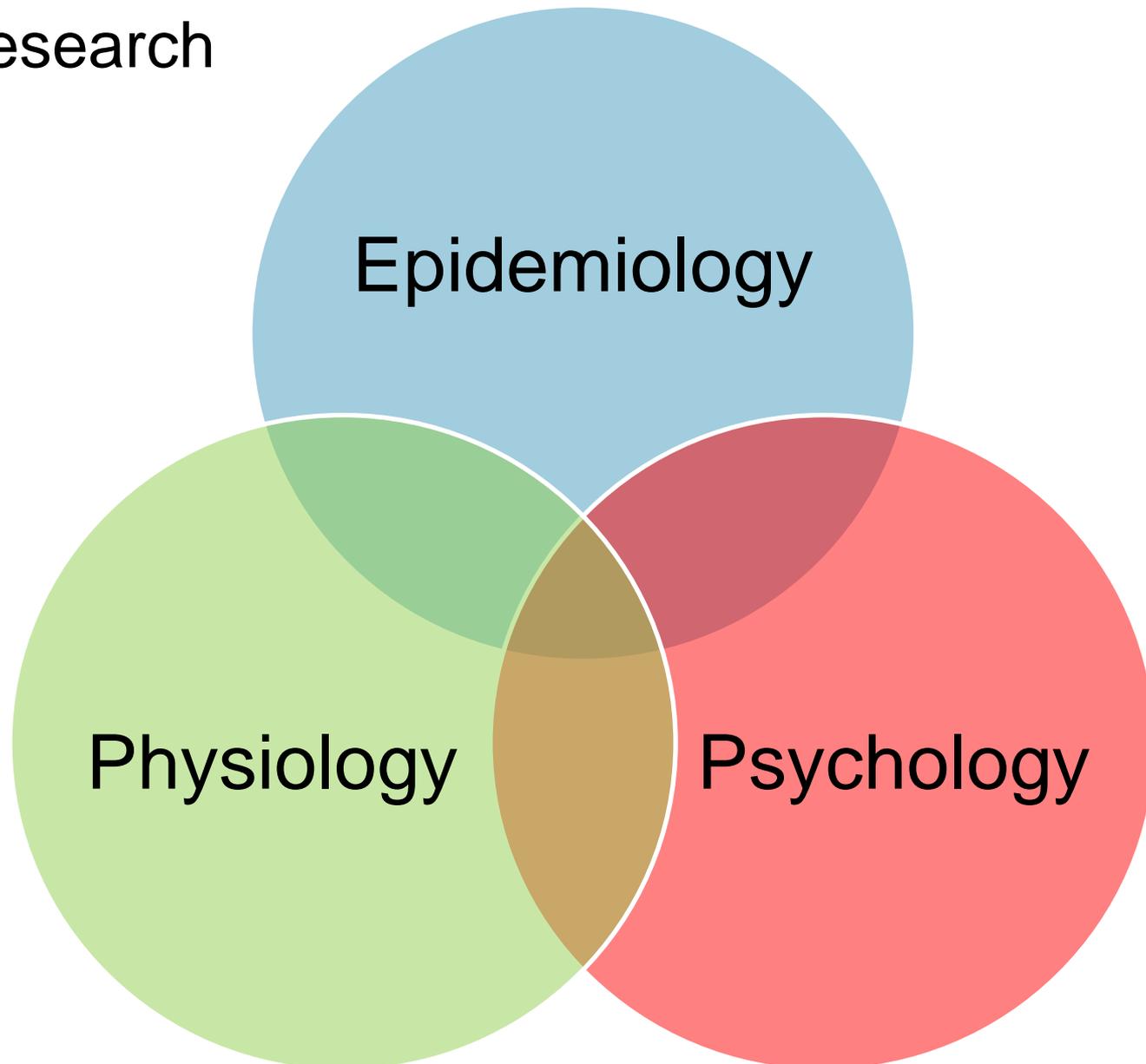


Published in *The Builder*, 1855:

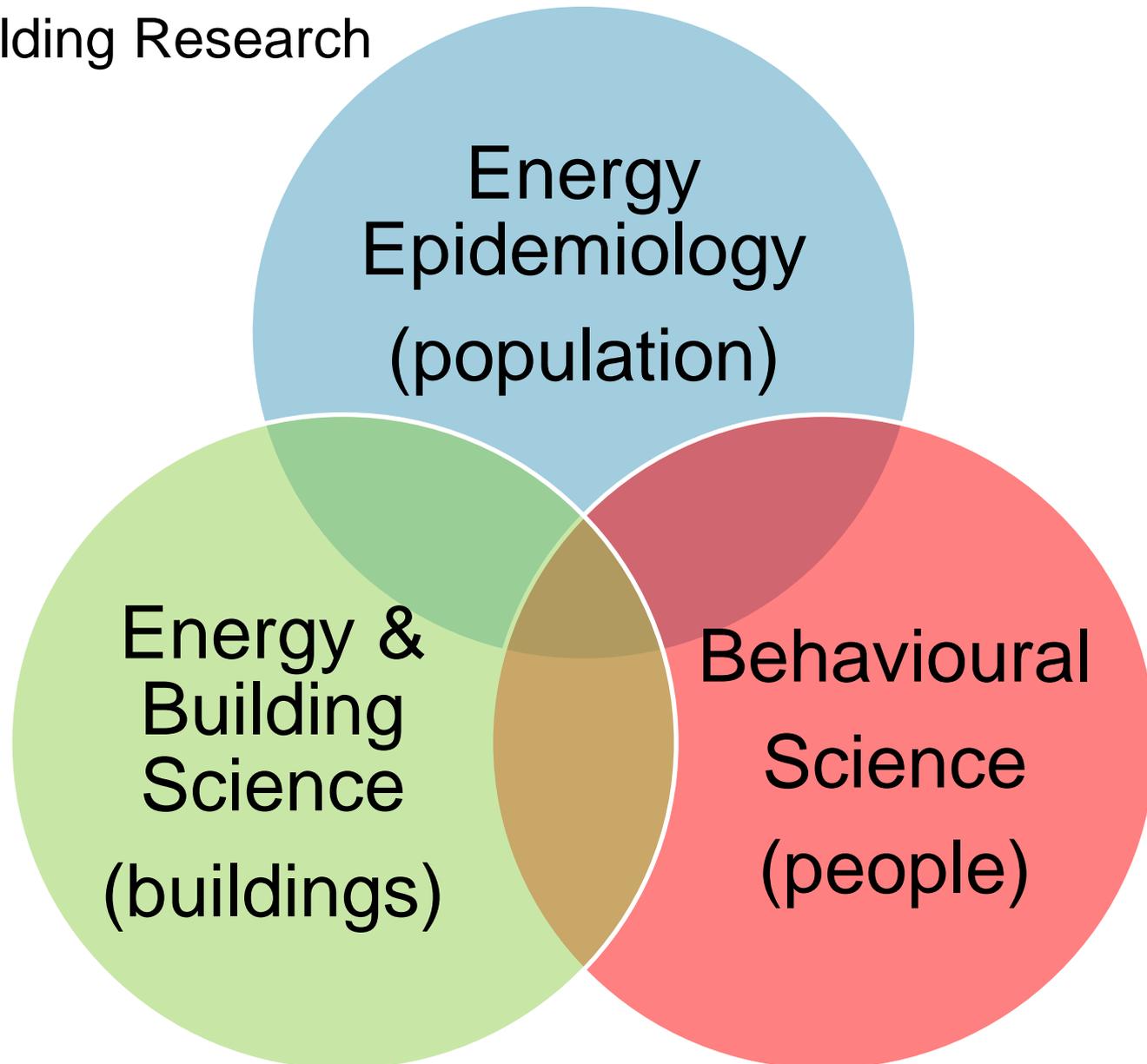
*an Illustrated Weekly Magazine for the Architect, Engineer, Archeologist, Constructor, Sanitary-Reformer and Art-Lover.* London. 15

Now titled: *Building* ([building.co.uk](http://building.co.uk))

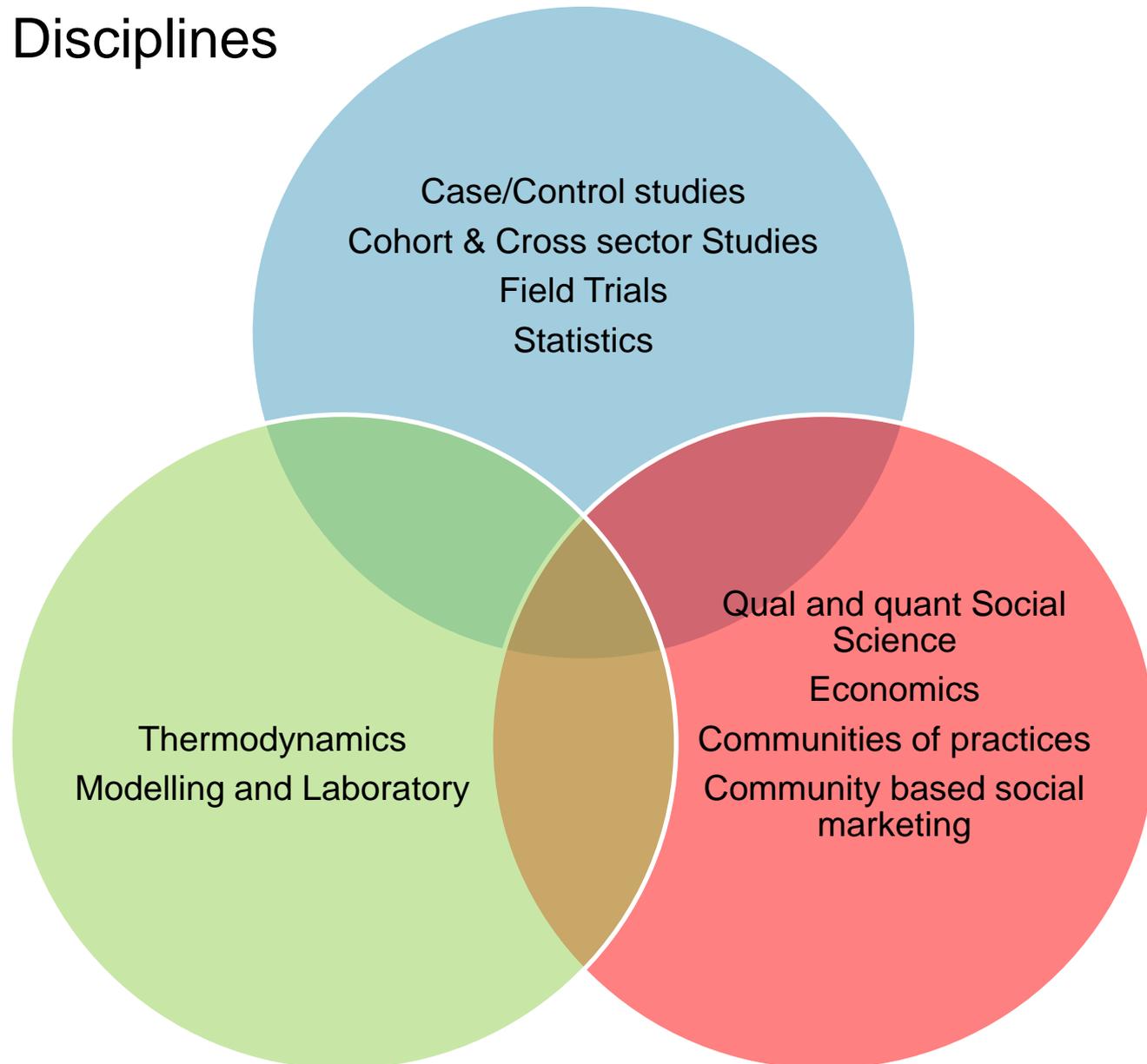
# Health Research



# Energy & Building Research



# Methods and Disciplines



# Energy Epidemiology: the study of energy demand in a population

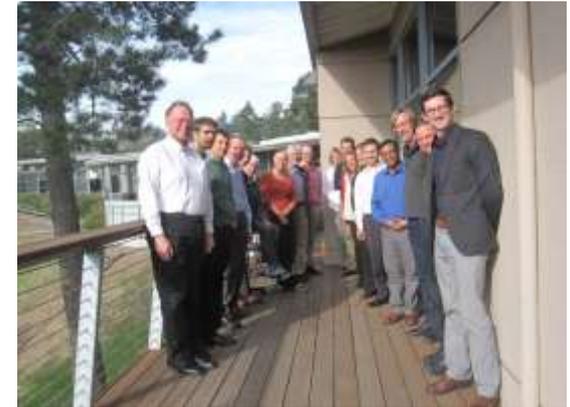
the systematic study of the distributions and patterns of energy use and their causes or influences in populations. It use statistical association to impose top-down, constraints on bottom-up thermodynamics. It deals with the whole energy system rather than its sub-systems, focuses on outcomes such as reduced delivered energy or carbon emissions rather than intermediate performance indicators. It is interdisciplinary, facilitating and illuminating enquiry from the perspectives of economics and social science as well as thermodynamics. It will support the developments of technologies, changes in behaviour and policies and is action-oriented.



## The RCUK Centre for Energy Epidemiology (CEE) will:

- undertake primary data collection;
- advise on data collection;
- provide secure and ethical curation of a wealth of administrative, commercial and research data;
- link, develop and use innovative research methods;
- support a structured research programme on energy demand intended to achieve a major reduction in UK carbon emissions
- provide the secretariat for a new international network

# International Energy Epidemiology Network Workshop, 15-16 November, LBNL, Berkeley, CA, USA



Environmental Energy Technologies Division

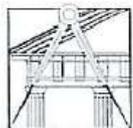


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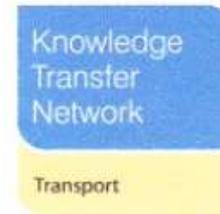
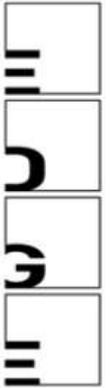
- support UK academics, policymakers and industry to research energy demand, by providing a cost effective, secure and ethical **bureau service** for building and transport data. It will work closely with the new cross government Energy Efficiency Deployment Office (EEDO) of DECC, the Energy Saving Trust (EST), UK Energy Research Centre (UKERC) and the new Open Data Institute (ODI) to marshal and maximise the value of existing and very large future sources of energy-related data (“big data”), ensuring the greatest impact for evidence-based energy demand research.

# Opportunities to build on access to data in other sectors

- Dept. of **Health** National Information Governance Board (who provide access to health data without written consent provided the research case is strong enough) “The NIGB also advises on the use of powers under Section 251 of the NHS Act 2006 to permit the duty of confidentiality to be set aside, where other legal routes are not available”
- **Credit** Reference agency is a company that collects information from various sources and provides consumer credit information on individuals
  - your name, date of birth, address and previous addresses.
  - whether or not you are on the electoral roll, any county court judgements against you and whether you have been declared bankrupt.
  - information from banks and building societies, car loan firms and mobile phone companies.
  - That data includes credit applications lenders you have dealt with, credit limits you have and whether you have made payments correctly and on time.
  - It will also show details of credit card balances and repayments and sometimes bank account balances

# THANK YOU

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Department for *Transport*

The **USABLE BUILDINGS TRUST**  
[www.usablebuildings.co.uk](http://www.usablebuildings.co.uk)



# Eco-homes doubled our energy bills

## Residents rocked by £1,600 charge after six months

By Chris Brooke

THEY were described as the 'homes of the future', with an eco-friendly design that would keep bills low.

The 45 super-insulated houses, built with £5.6million of public money, were even held up as a 'model' of environmentally-friendly construction.

But 18 months after the social housing complex in Bradford was completed, residents have complained of bills that are double what is normal and faulty equipment that was supposed to save them money.

Council bosses admit there is a 'serious' problem with energy use at the Pavilion Gardens site and promised to reimburse residents for excessive bills, blaming the original builder.

Resident Danny Hall, 37, a redundant sales adviser, his wife Jacqueline, 26, and their three children have had problems 'from day one'.



Mr Hall: Problems from day one

warm air, solar panels, and rainwater-harvesting systems to cut water bills. Twelve of the homes, supposedly built to the highest standards for sustainability, are heated by a communal biomass boiler.

Sunny Tandy, 33, a tenant who lives with wife Rachel, 31, and their two young children, said it was proving an expensive disaster.

He said: "We thought it was going to be our dream house. They are lovely houses on a nice street, but they are not what we expected them to be in terms of power-saving and being cheap to run."

"We moved in here to be a family, but it's just tearing us apart because the big bills are making us argue all the time. There are people in the street who already want to move out because it's just too expensive."

Mr Tandy said his electricity bills averaged £160 a quarter since December 2011.

The highest was £949 and he has had to borrow to cover the charges.

A spokesman for Bradford Council said: "We appreciate that it is a serious problem and we are working with residents, the building contractor, the energy company and our managing agents to find a solution."

### 'It's just too expensive'

"The houses were supposedly the most energy efficient in Bradford," he said.

"We weren't really told what expected bills would be but with solar panels, heat exhaust and all this fancy stuff you would expect it to be considerably lower than what we used to pay."

Instead the family received a £1,600 bill after six months.

Energy bills were almost double what they paid at their previous home, he said.

When the family moved in, there was no water in the toilets because the water recycling system had not been activated.

When it was turned on, water poured through the light fittings.

The houses are equipped with an eco-heat exhaust pump that recycles



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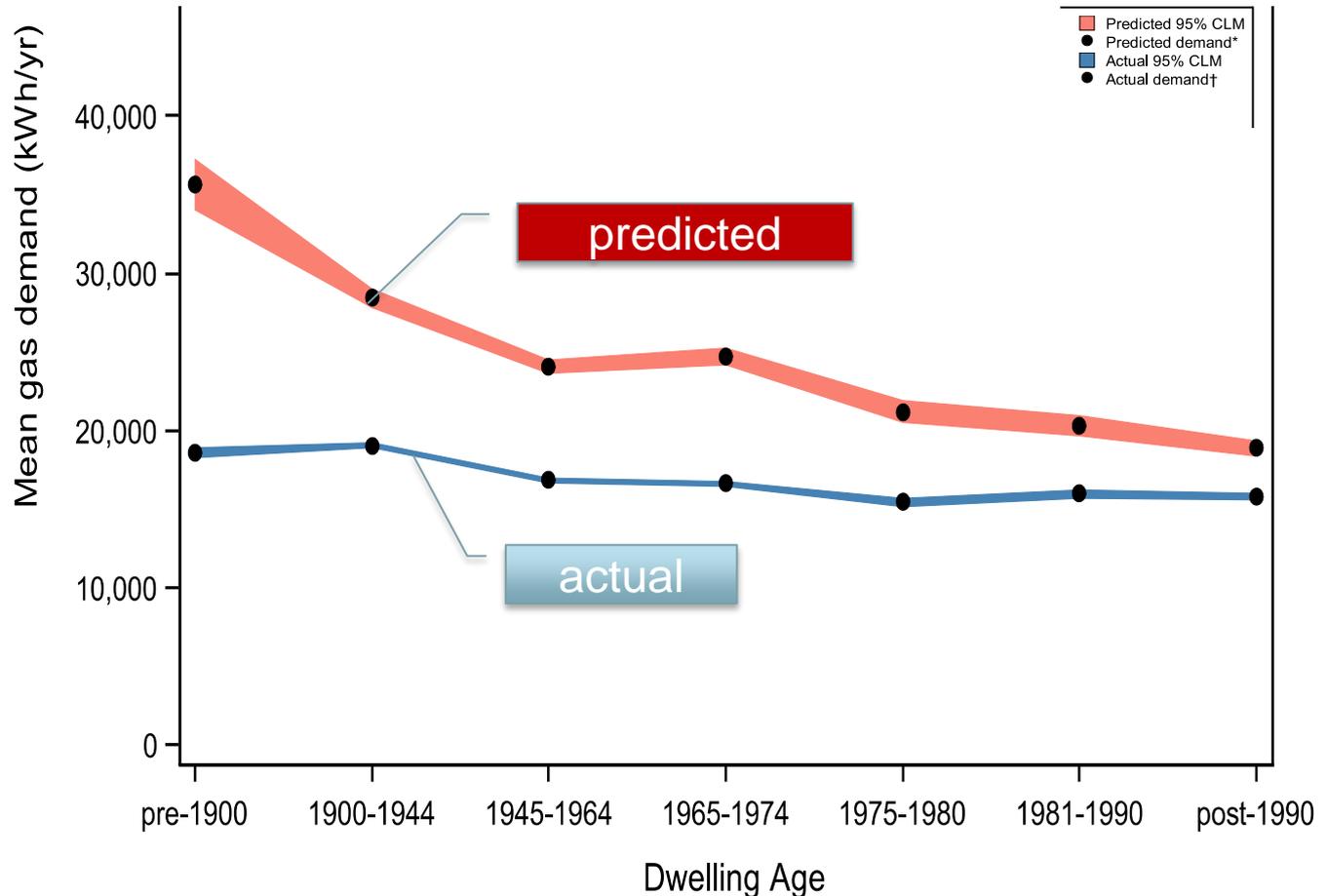
### Electricity bill

<b>Before this bill = £672.64</b>		<b>Energy Tracker</b>	
Balance on last bill - 01 Sep 2012	£647.04	How much do I use every day?	
Your payments - Thanks	£175.00 CR	Electricity	
£20.00 CR on 05 Sep 12	£20.00 CR on 18 Sep 12	11.3 kWh currently	
£25.00 CR on 04 Oct 12	£25.00 CR on 12 Oct 12	10.5 kWh last year	
£25.00 CR on 16 Nov 12	£25.00 CR on 24 Nov 12		
<b>On this bill = £221.55</b>		<b>Notice board</b>	
Electricity charges - see back for info	£217.53		
Discount	£6.53 CR		
VAT at 5% on £217.00	£10.95		
<b>Please pay now</b>	<b>£894.19</b>		
To continue to get a 7% prompt payment discount off your bill, please pay by 15 Dec 12.			

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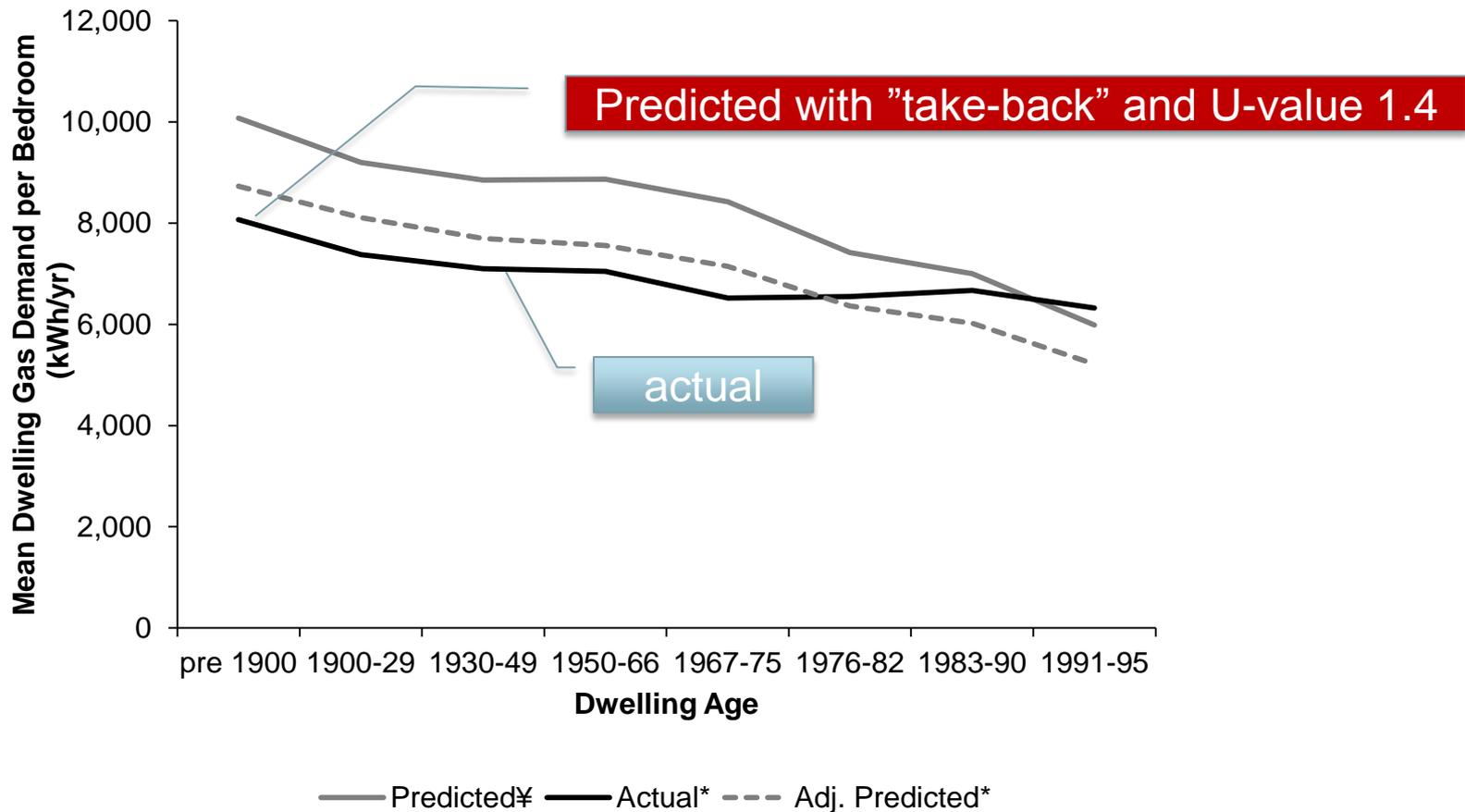
Daily Mail 6<sup>th</sup> February 2013

Predicted British residential gas heating demand using representative sample of dwellings in 2007 and actual annual gas demand from meter readings in 2007 for a representative British sample (N=50,000).

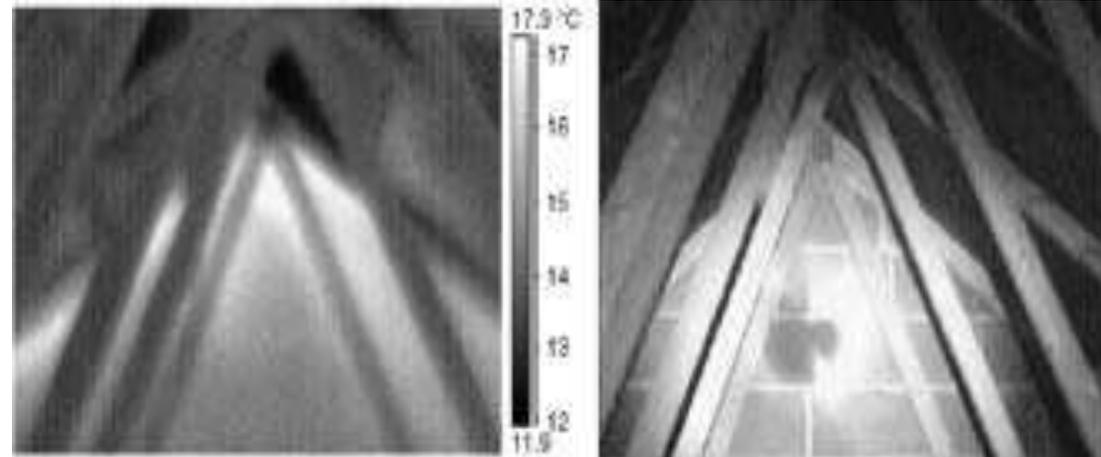


\*Representative sample of British dwellings with predicted 2007 gas primary space and water heating N=13,000

†Representative sample of British dwellings with actual 2007 gas meter readings N=50,000



Note: \*Actual demand is drawn from randomly selected 10% representative sample from HEED linked to gas consumption (N=374,616); ‡Predicted demand is drawn from EHS 2008 SAP with solid wall u=1.4; †Predicted demand is adjusted using predicted/actual fuel vs fuel expenditure/income intensity curve algorithm.



Stamford Brook – thermal envelope defects – convective bypasses (Lowe et al 2007)

# Not refurbished as modelled/theory

20% cavity wall missing in insulation (n = 85)

13% loft area missing in insulation (n = 85)

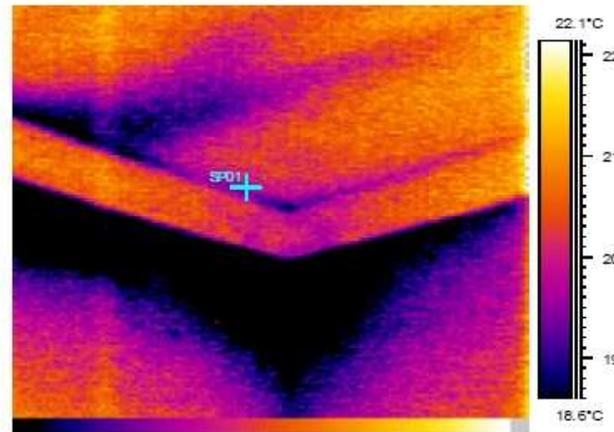
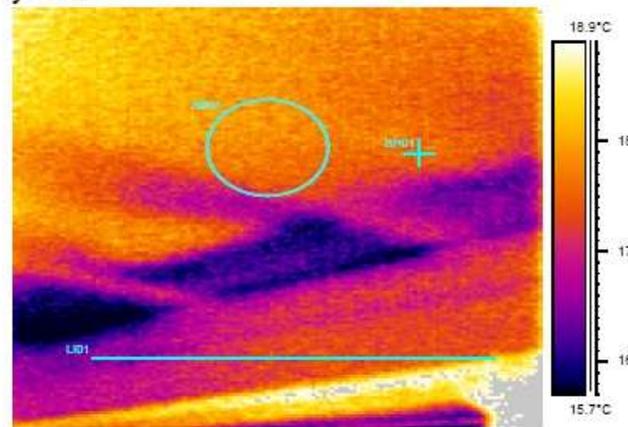


Figure x : Infrared thermography images showing missing cavity wall insulation along the top of the cavity wall



Figures 3: Missing loft insulation along the ceiling edge