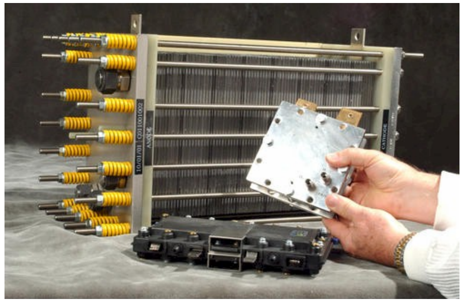
UCL ENERGY INSTITUTE

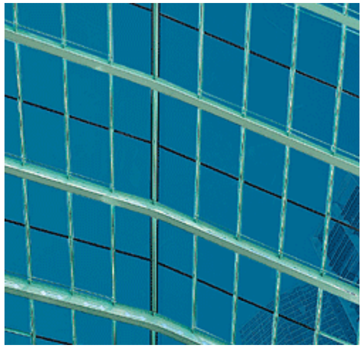
Tadj Oreszczyn

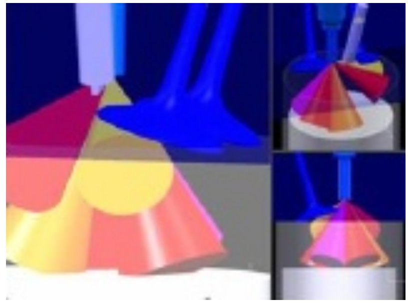
Future Energy Demand and Energy Security

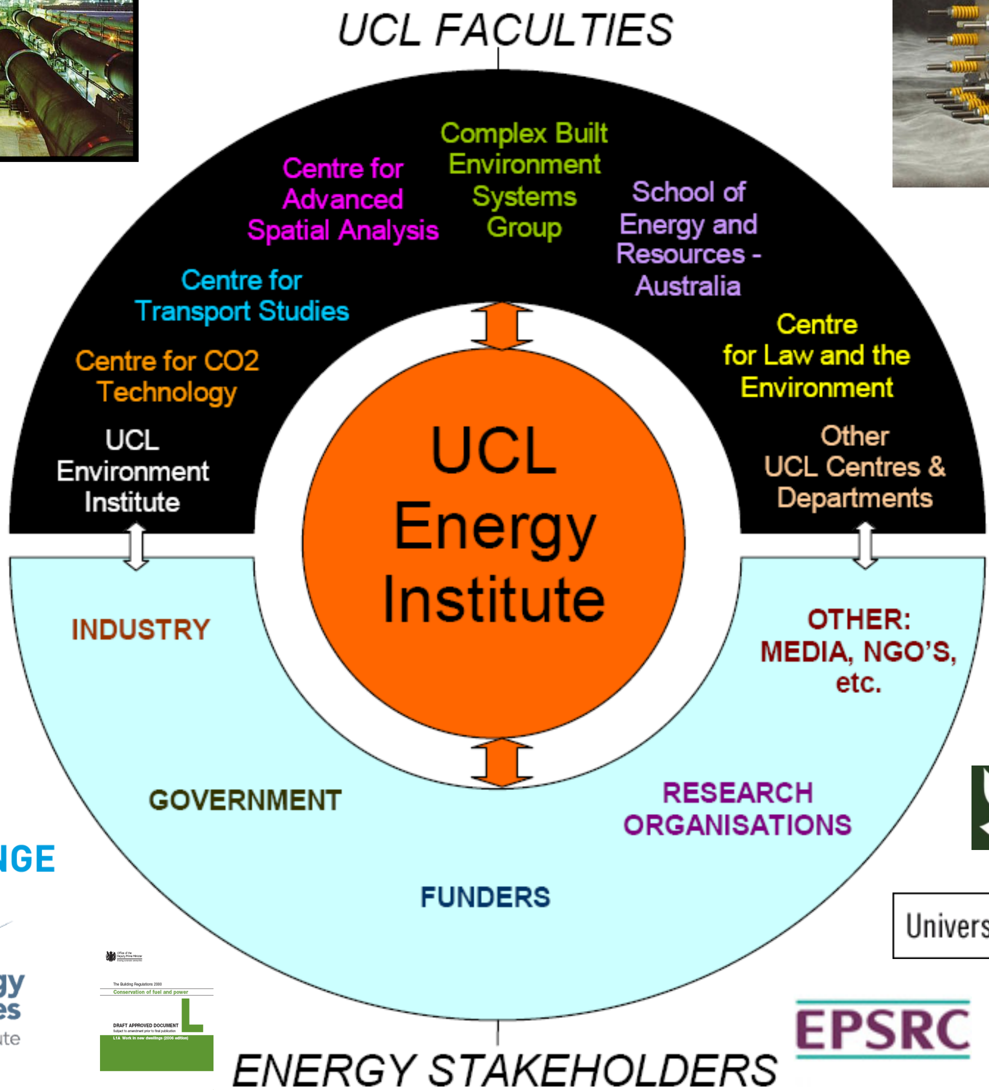
UCL - London's research and teaching powerhouse

- Established over 180 years ago
- First university in England to admit students of any race, class or religion, and the first to welcome women on equal terms with men
- The first in England to teach experimental science, modern European languages, Laws…
- Today - still **providing excellent and relevant research and teaching to the World**









EDF R&D

ARUP

DEPARTMENT OF ENERGY & CLIMATE CHANGE

energy technologies institute

UCL ENERGY INSTITUTE

Global Green Growth Institute

green fiscal commission

University of Wollongong

EPSRC

The Energy Institute has since its launch in June 2009

- Bought together a highly motivated multi-disciplinary team 34 staff and 32 MRes/PhD students
- Attracted a portfolio of nearly £10m of funding, 30% from industry
- Established a vibrant Doctoral Training Programme
- Made important findings which it has presented to government, other academics and stakeholders
- Supported the College Grand Challenges

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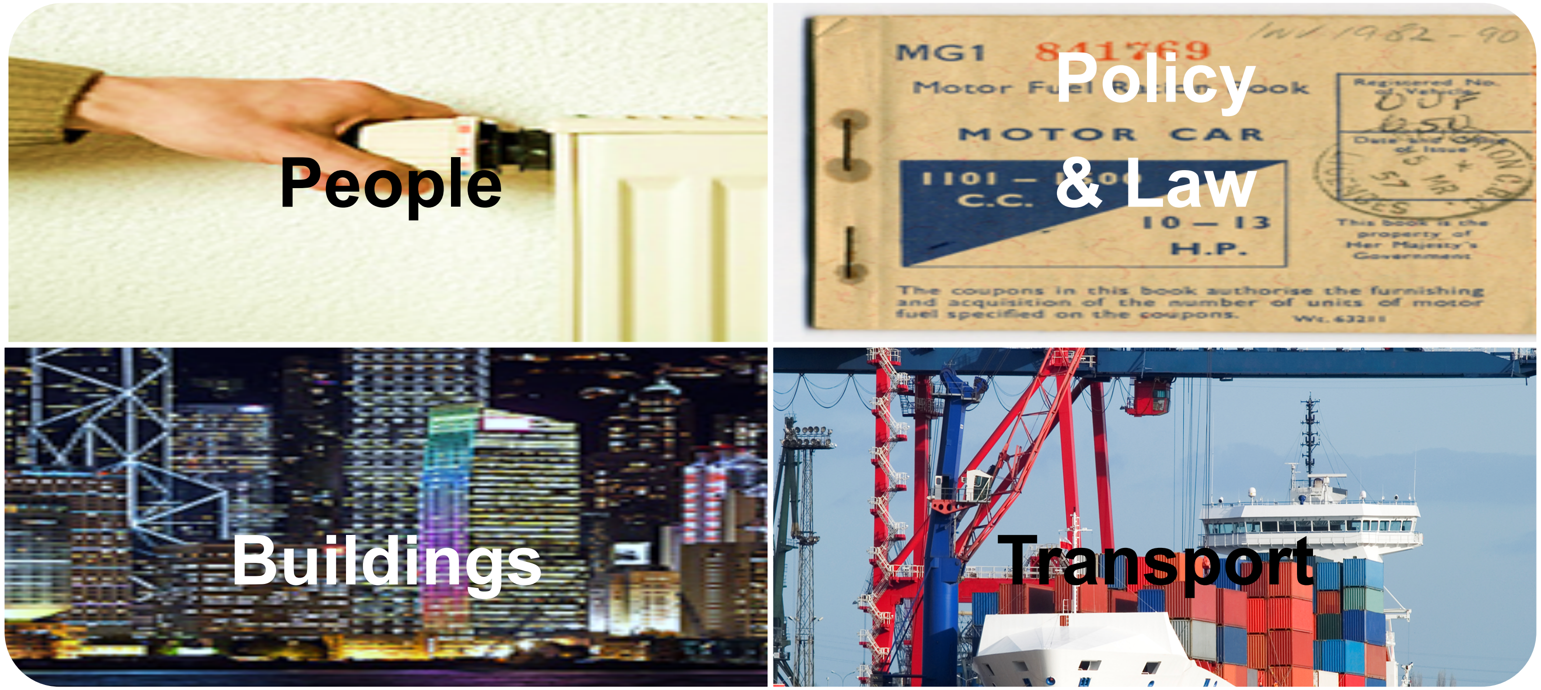
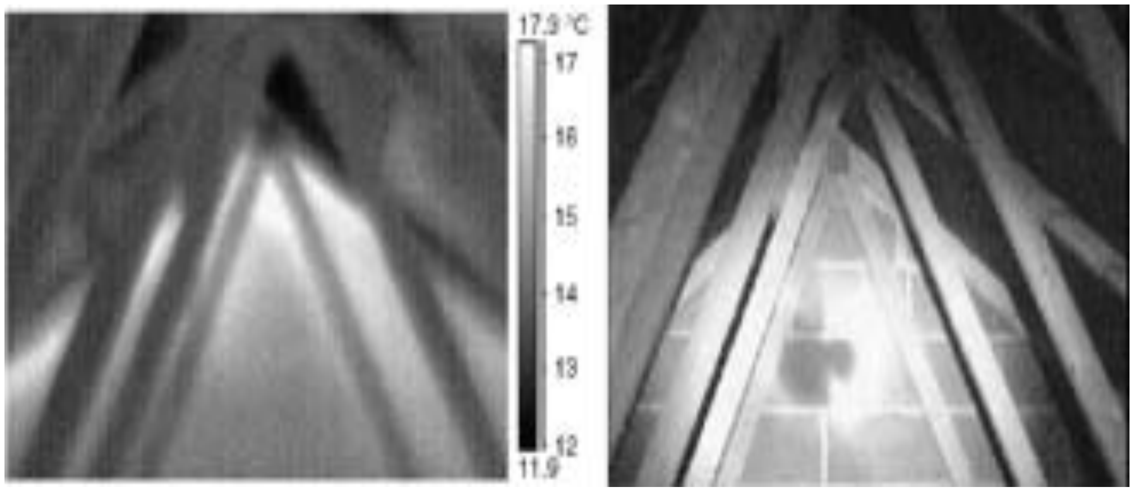
Our Vision: A globally sustainable energy system

Our Aim: To understand and help improve energy systems

Strategic Focus: Demand and Systems

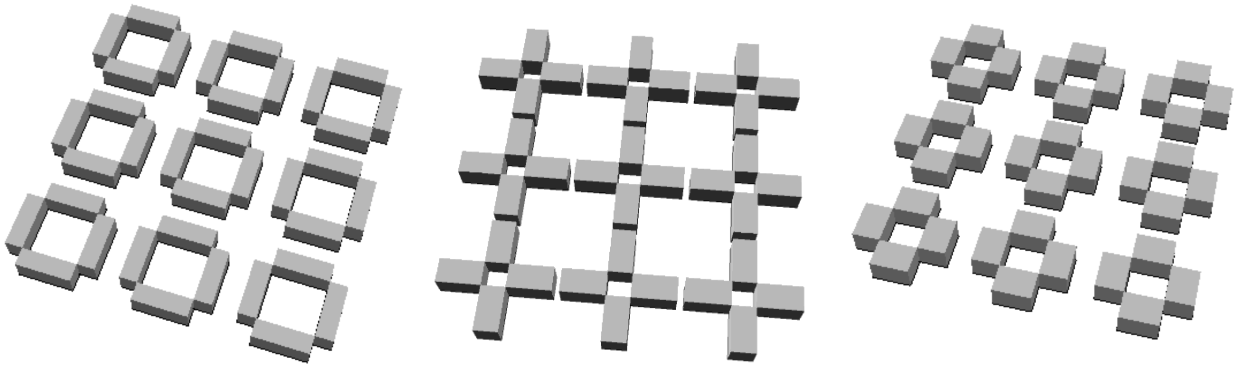


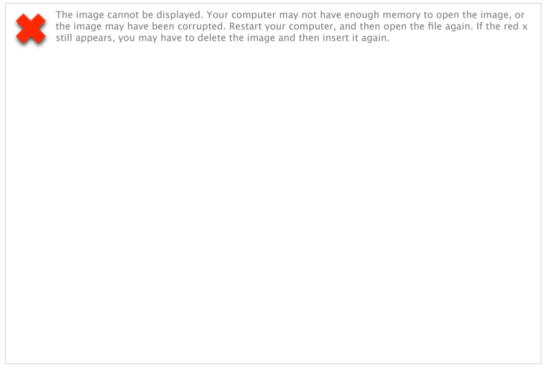
Methods: Multi-disciplinary, observation, data collection, analysis, energy epidemiology, model development and scenarios

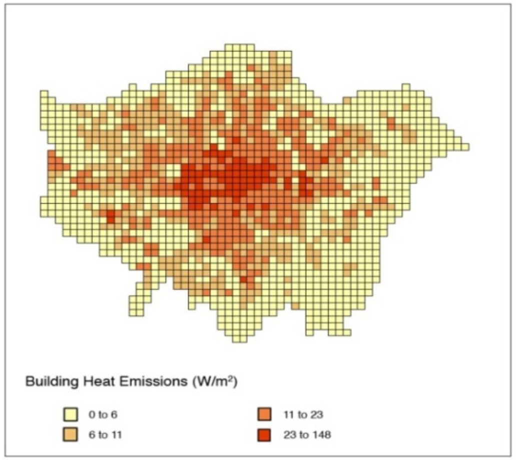


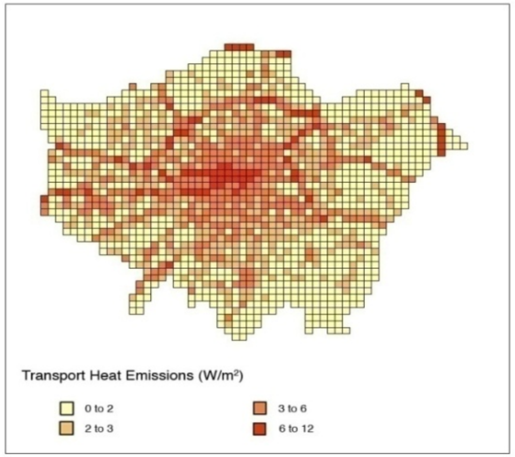
Stamford Brook – thermal envelope defects – convective bypasses
(Lowe et al 2007)

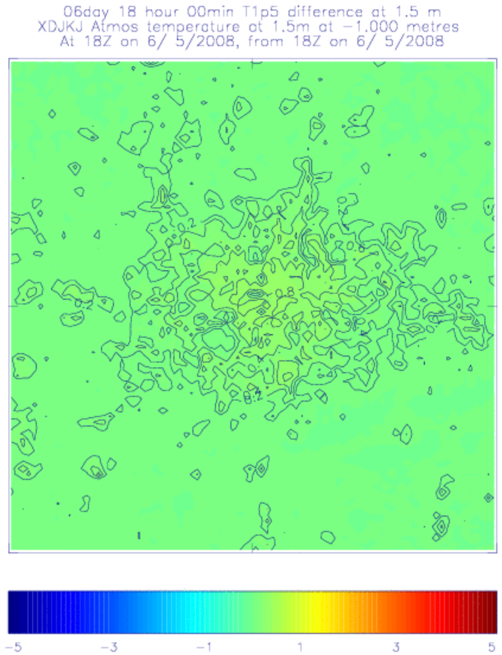
Master-Planning and Urban Heat Island



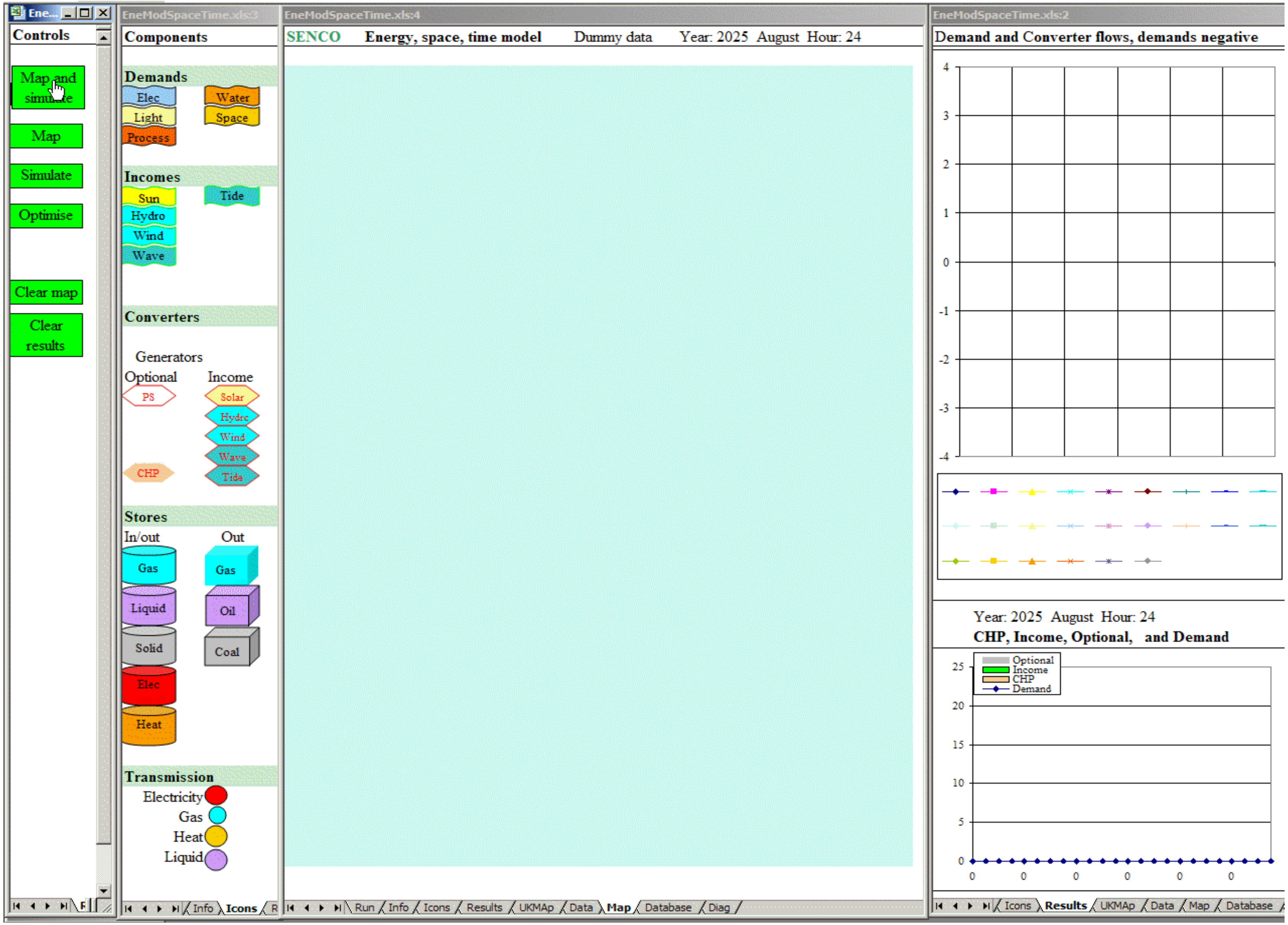




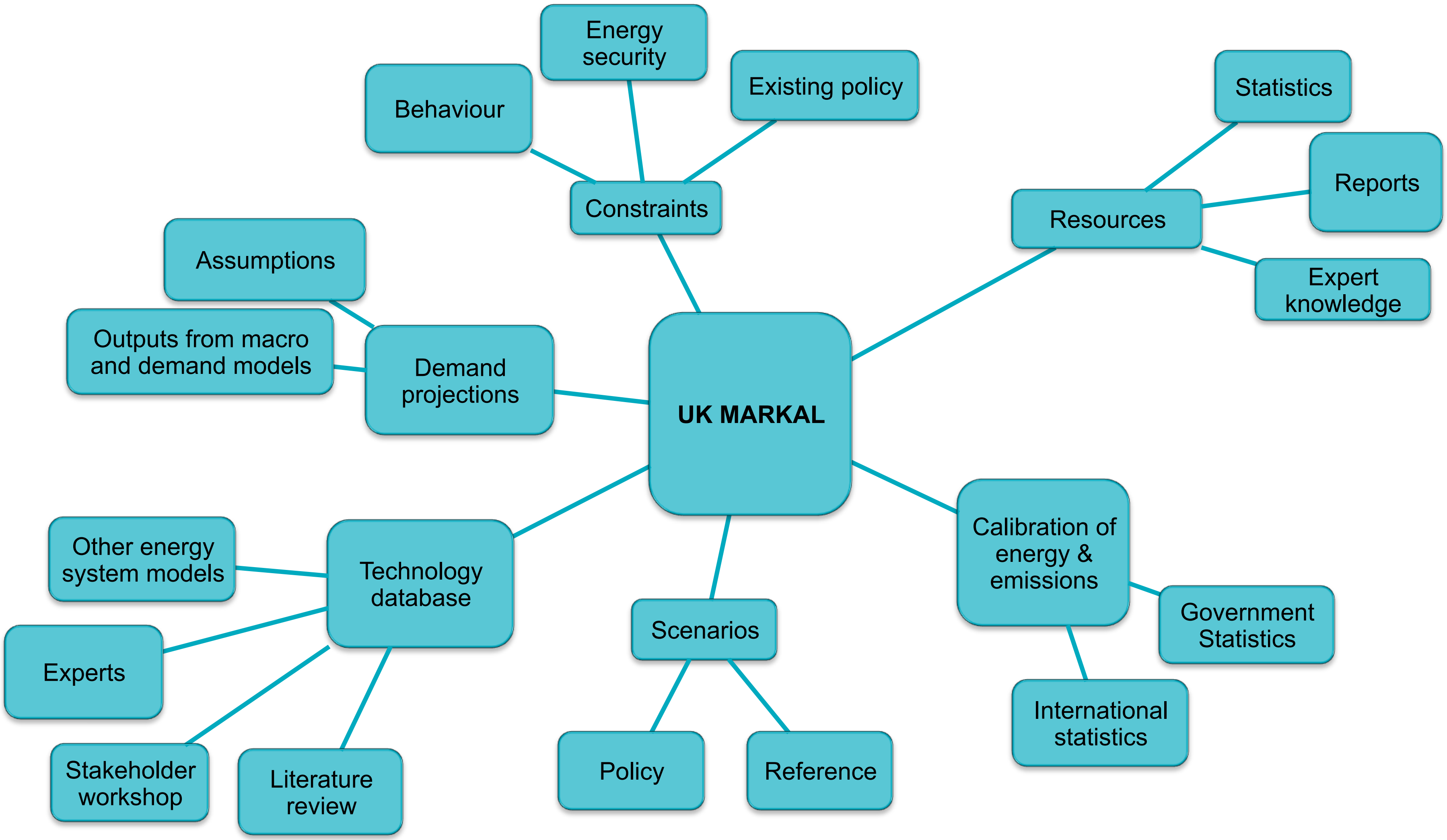




UK energy, space and time illustrated with EST : animated



Data requirements for an energy system model



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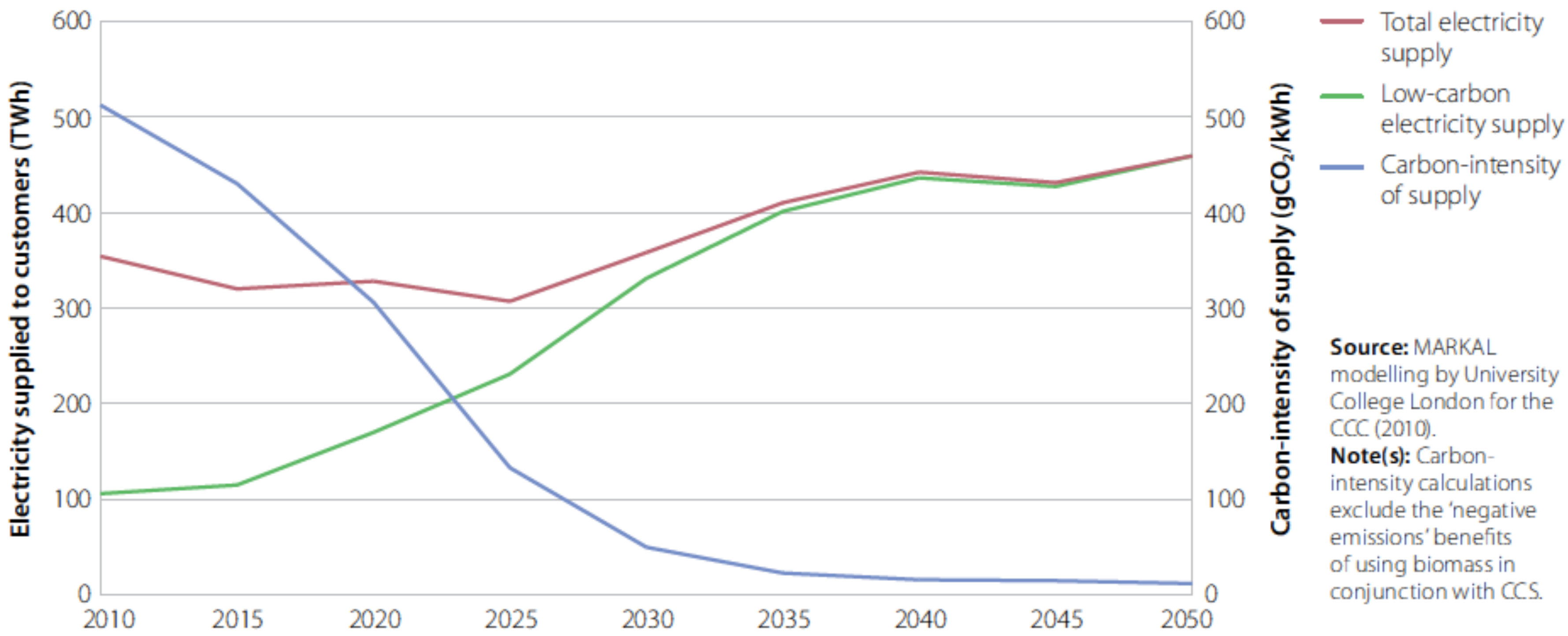
Rapid decarbonisation of electricity supply by 2030

Figure 6.5: MARKAL trajectory for the power sector (2010-2050)



Source: MARKAL modelling by University College London for the CCC (2010).
Note(s): Carbon-intensity calculations exclude the 'negative emissions' benefits of using biomass in conjunction with CCS.

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4th CCC budget

Definition of Resilience

"Resilience is the capacity of an energy system to tolerate disturbance and to continue to deliver affordable energy services to consumers. A resilient energy system can speedily recover from shocks and can provide alternative means of satisfying energy service needs in the event of changed external circumstances."

UKERC ENERGY 2050

Energy Demand in 2025

with respect to a 2000 baseline

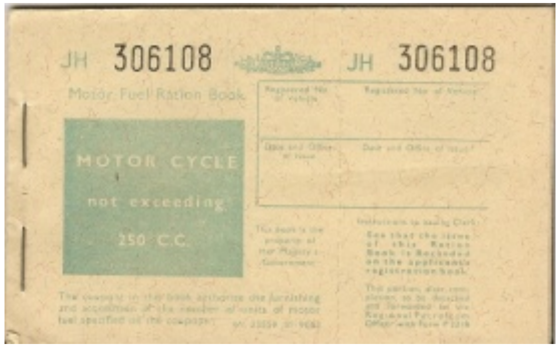
REFERENCE (REF)		RESILIENT (R)	
Primary energy demand:	-7%	Primary energy demand:	-20%
Final energy demand:	+2%	Final energy demand:	-16%
Electricity demand:	+14%	Electricity demand:	+1%
Residential demand:	+5%	Residential demand:	-23%
LOW-CARBON (LC)		**LOW-CARBON RESILIENT (LCR)**	
Primary energy demand:	-13%	Primary energy demand:	-20%
Final energy demand:	-2%	Final energy demand:	-16%
Electricity demand:	+6%	Electricity demand:	-8%
Residential demand:	0%	Residential demand:	-20%

Conclusions

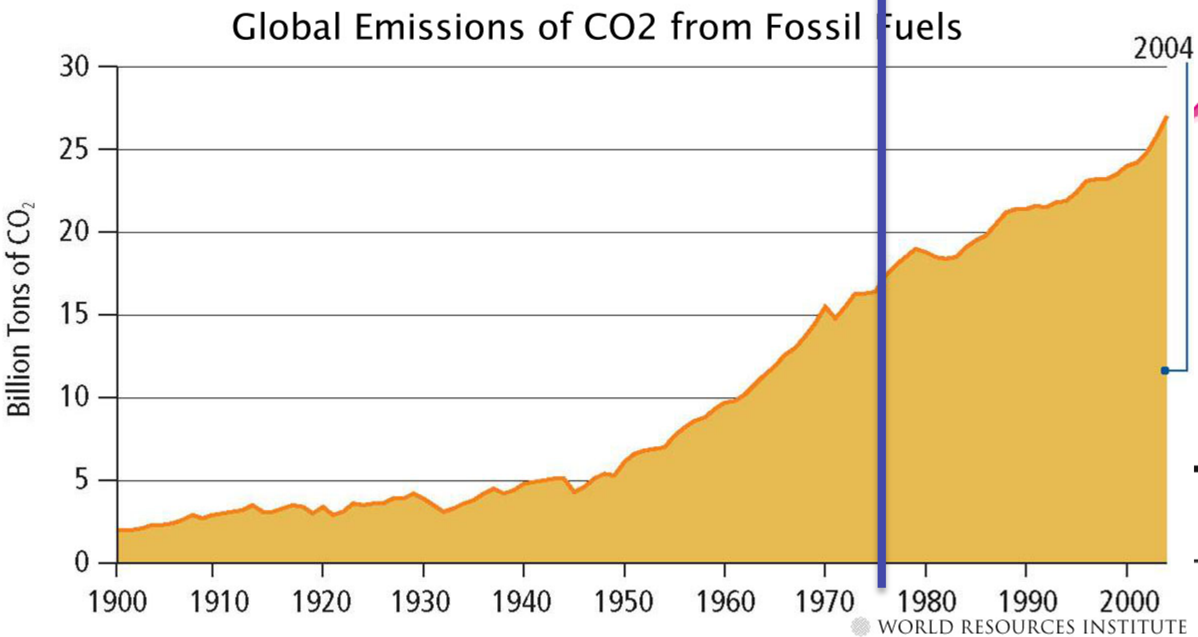
- CO_2 reduction will improve the resilience of the energy system but may not be enough in itself ….. conversely measures aimed solely at enhancing resilience will not achieve current CO_2 reduction targets
- The electricity sector offers some of the cheapest opportunities for improving diversity
- Further investment in gas storage and LNG imports will be needed as domestic supplies decline
- Major gas supply shocks costing several £billions could be mitigated by investing in storage, LNG terminals or further interconnectors
- The market will not drive such investments: "strategic" investment requires a careful evaluation of:
  - certain upfront costs v more uncertain benefits
  - whether policy intervention will discourage market-driven investments.

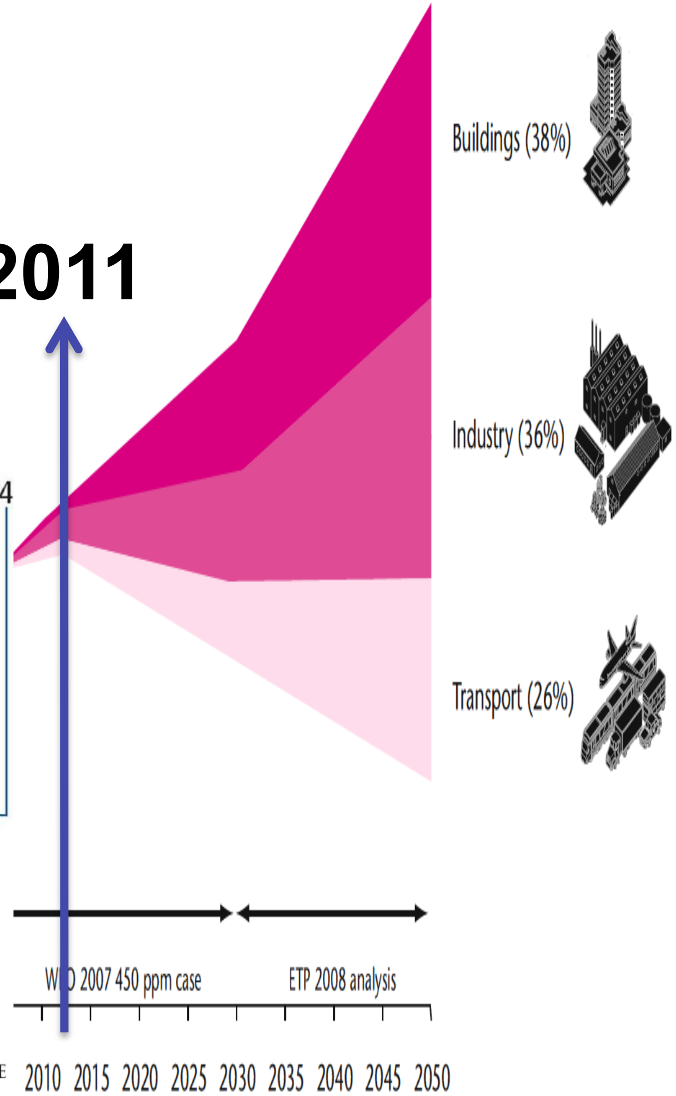
Energy Security: Balancing supply and demand

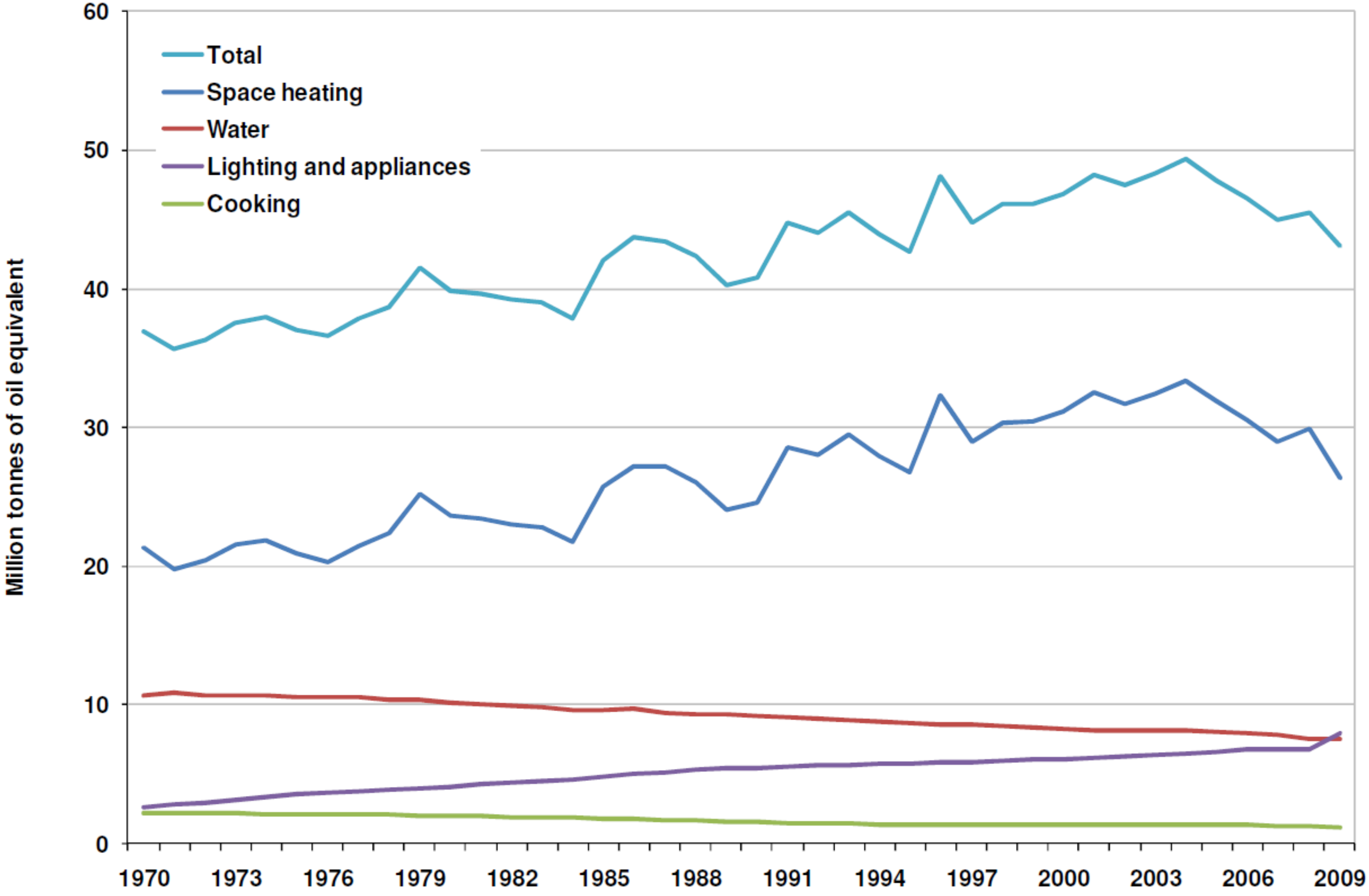
- Long lead times for some supply and demand changes
- Reducing fossil fuel use – reduced storage and hence less capability to balance system.`
- How will demand change and what is the capacity to control – change this?
- We will need to be smarter - thermal storage, demand management


JH 306108
JH 306108
Motor Fuel Ration Book
MOTOR CYCLE
not exceeding
250 C.C.

2011


Global Emissions of CO2 from Fossil Fuels
Billion Tons of CO_2
30
25
20
15
10
5
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2004
WORLD RESOURCES INSTITUTE

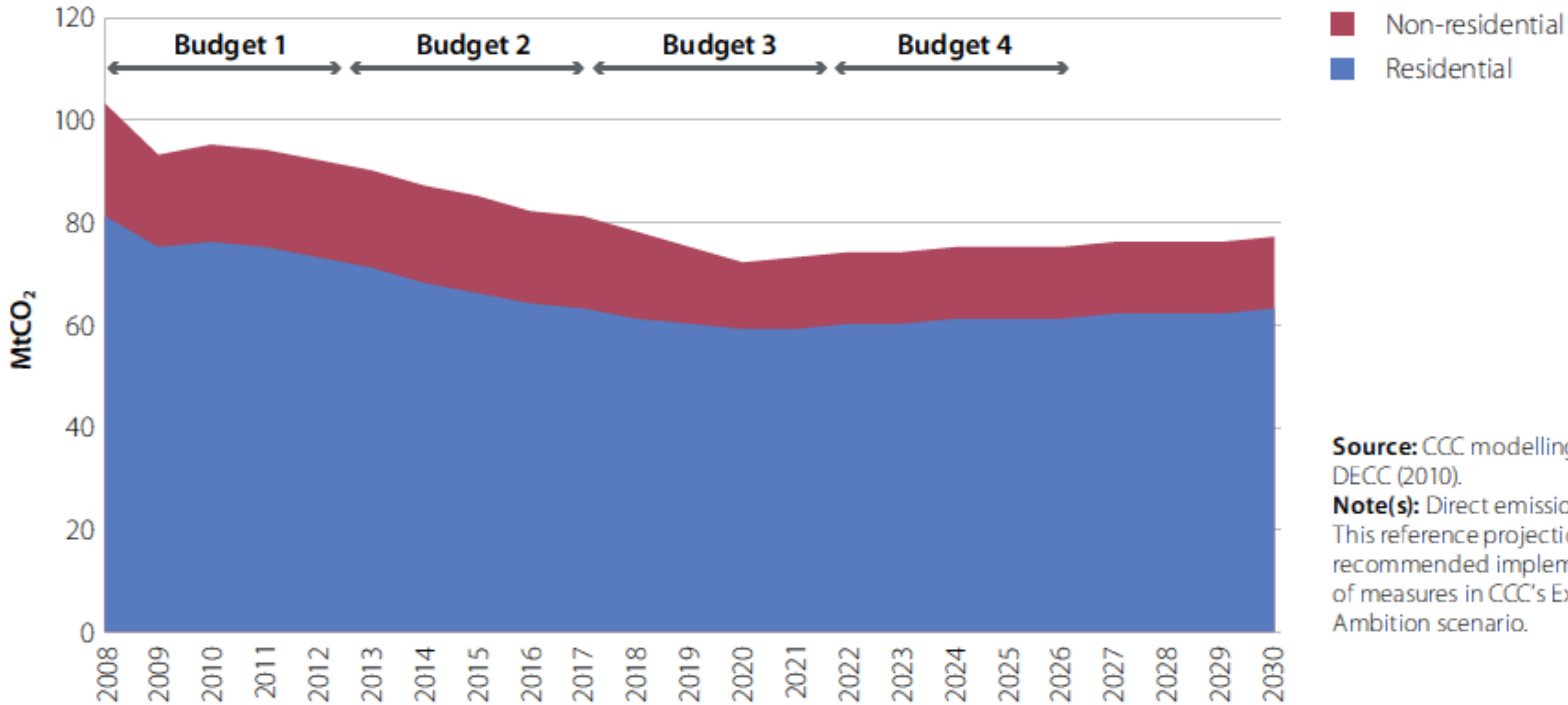

Buildings (38%)
Industry (36%)
Transport (26%)
WEO 2007 450 ppm case
ETP 2008 analysis
2010
2015
2020
2025
2030
2035
2040
2045
2050



Source: DECC, ECUK Table 3.6

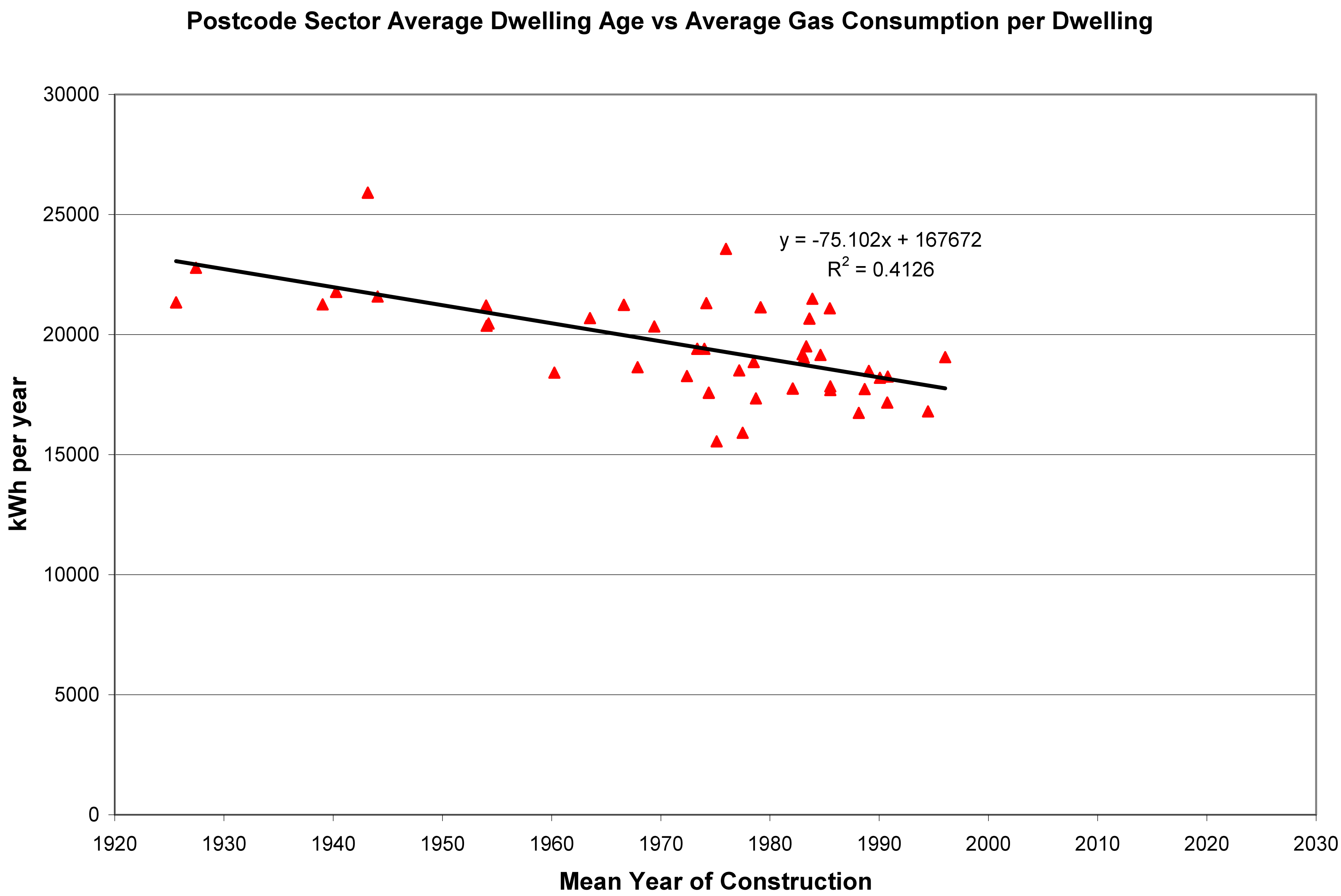
- **Residential buildings.** We assume that new policies successfully address barriers to action and deliver significant energy efficiency improvements in the UK housing stock, including the insulation of 90% of lofts and cavity walls, as well as 2 million solid walls (from a total of nearly 8 million) by 2020. We also assume that 13 million boilers are replaced with new efficient boilers and that substantial increases in appliance efficiency are achieved. In total this could result in a 2020 emissions reduction of 17 $MtCO_2$ in the residential sector.

Figure 5.5: CCC reference projection for buildings (2008-2030)

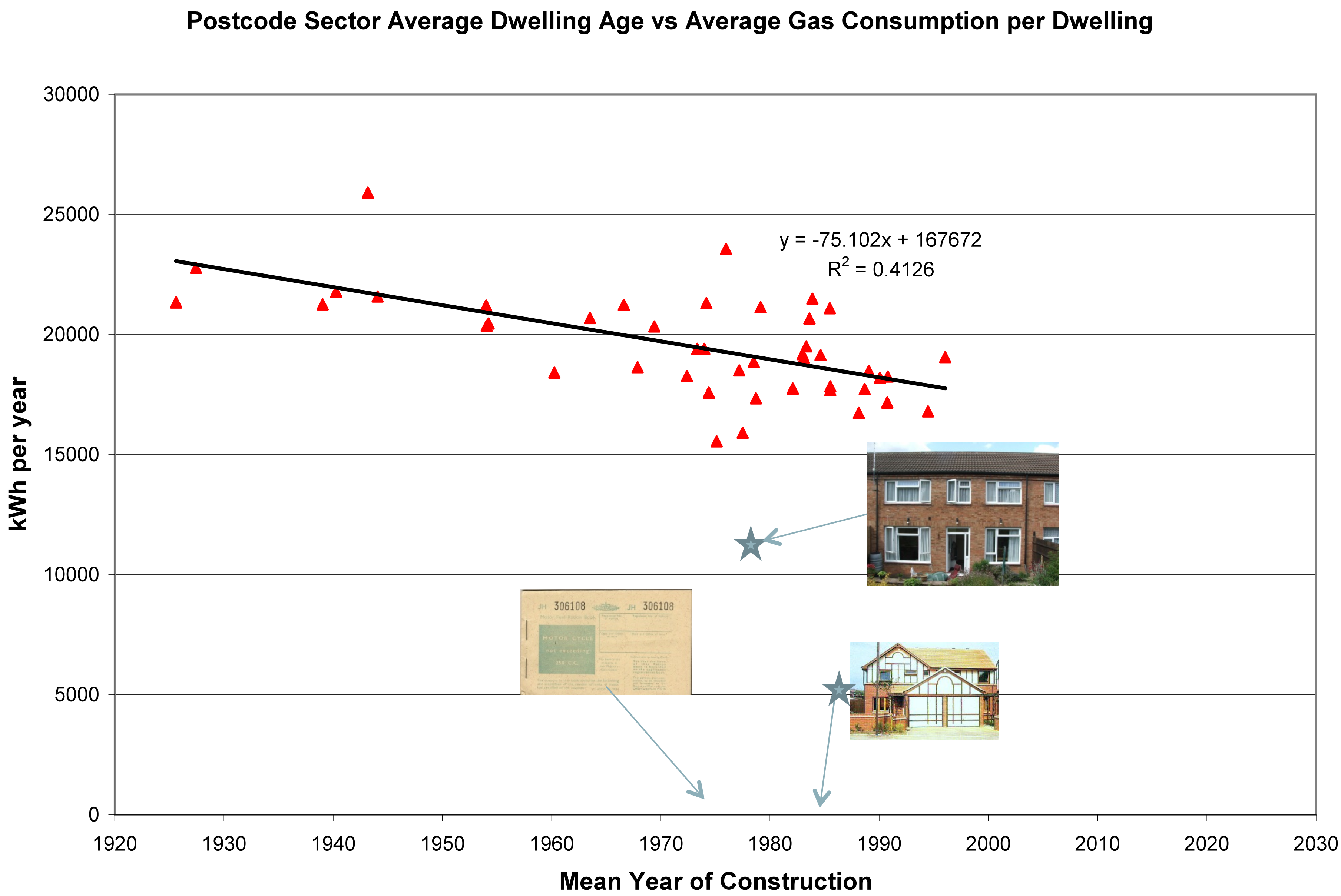


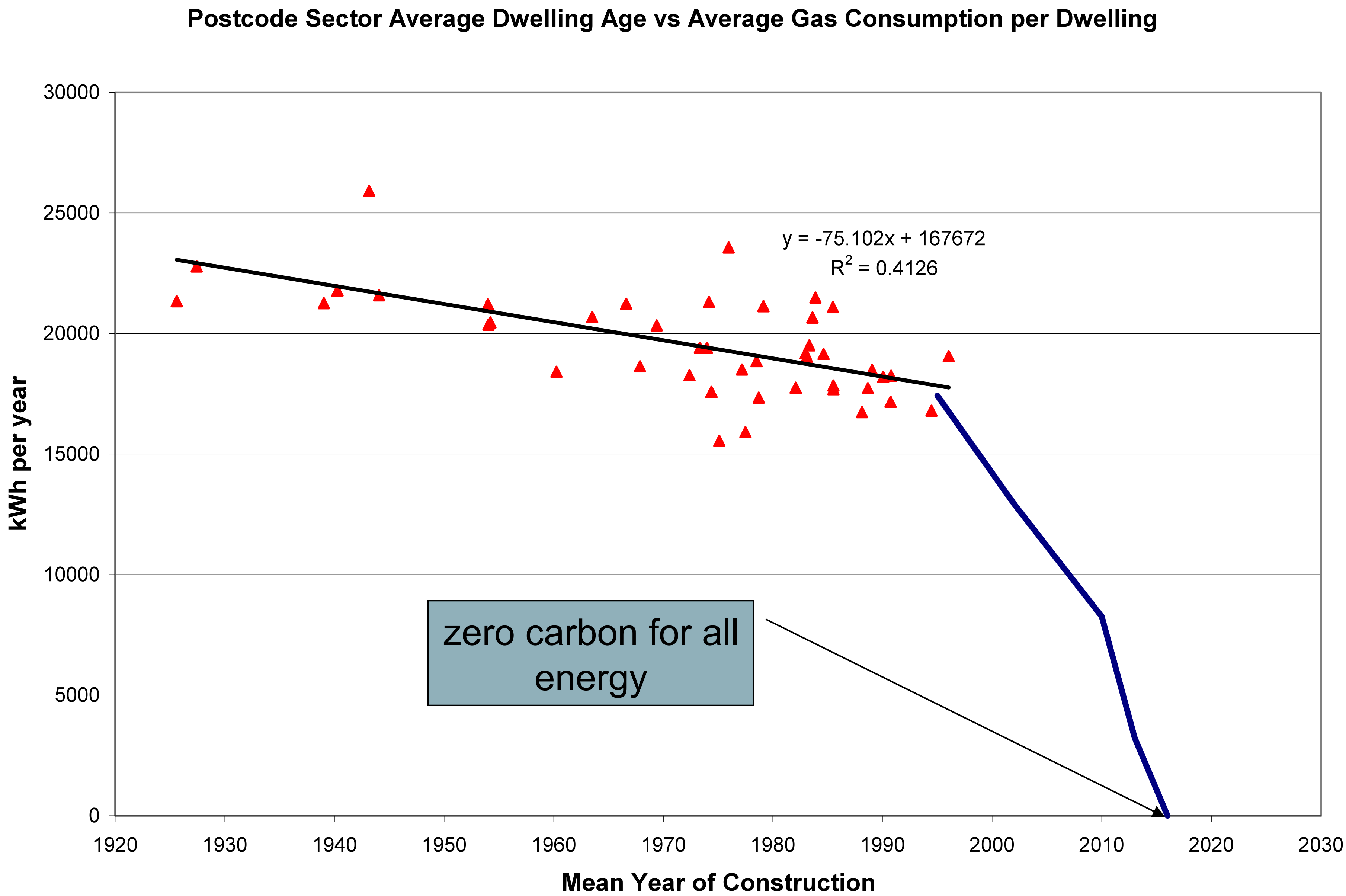
Source: CCC modelling; DECC (2010).
Note(s): Direct emissions only. This reference projection assumes recommended implementation of measures in CCC's Extended Ambition scenario.

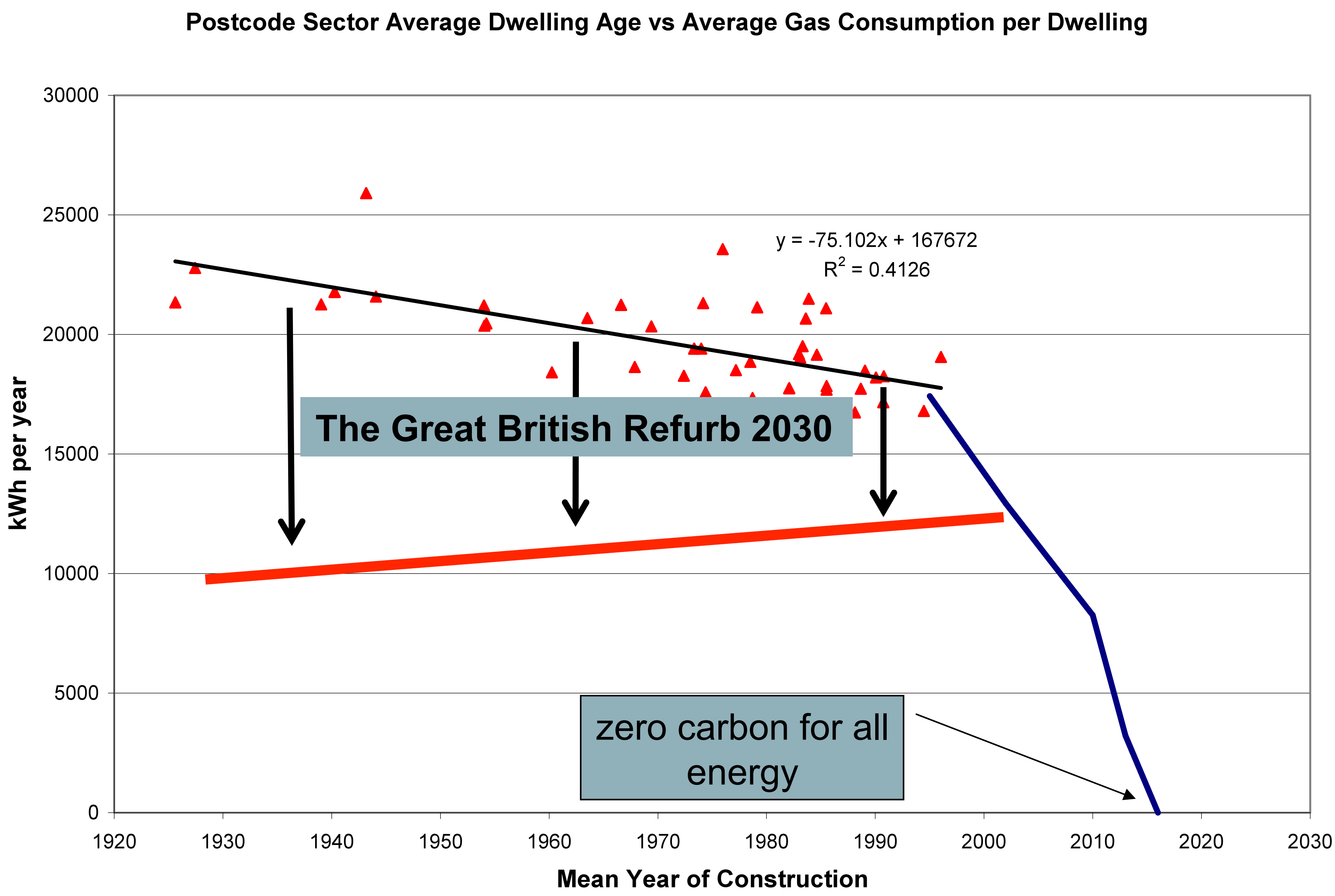
4th CCC budget



Postcode Sector Average Dwelling Age vs Average Gas Consumption per Dwelling
y = -75.102x + 167672
R2 = 0.4126
kWh per year
30000
25000
20000
15000
10000
5000
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
Mean Year of Construction


Postcode Sector Average Dwelling Age vs Average Gas Consumption per Dwelling
y = -75.102x + 167672
R^2 = 0.4126
kWh per year
Mean Year of Construction
30000
25000
20000
15000
10000
5000
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030

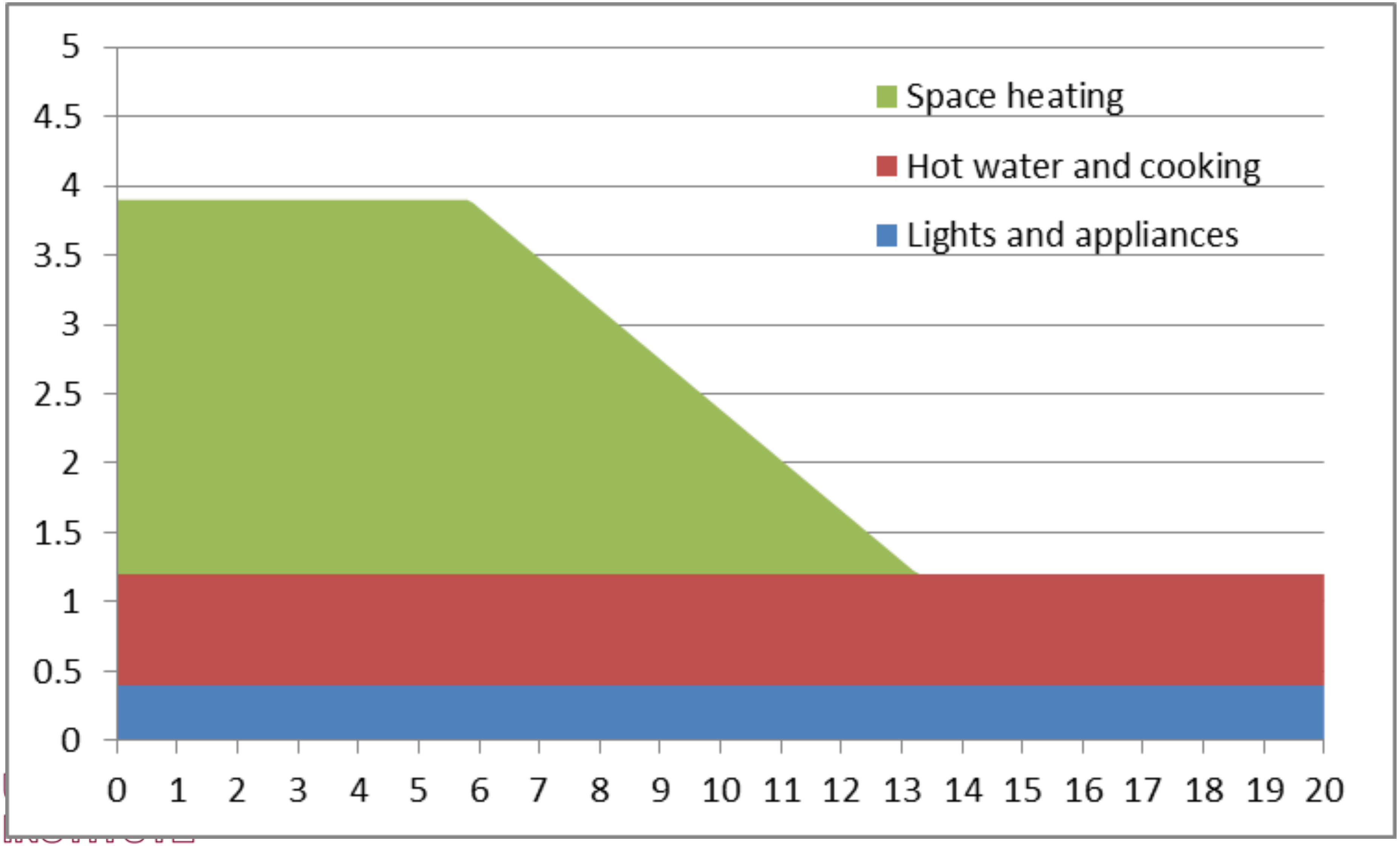

Postcode Sector Average Dwelling Age vs Average Gas Consumption per Dwelling
y = -75.102x + 167672
R2 = 0.4126
zero carbon for all energy
kWh per year
30000
25000
20000
15000
10000
5000
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
Mean Year of Construction

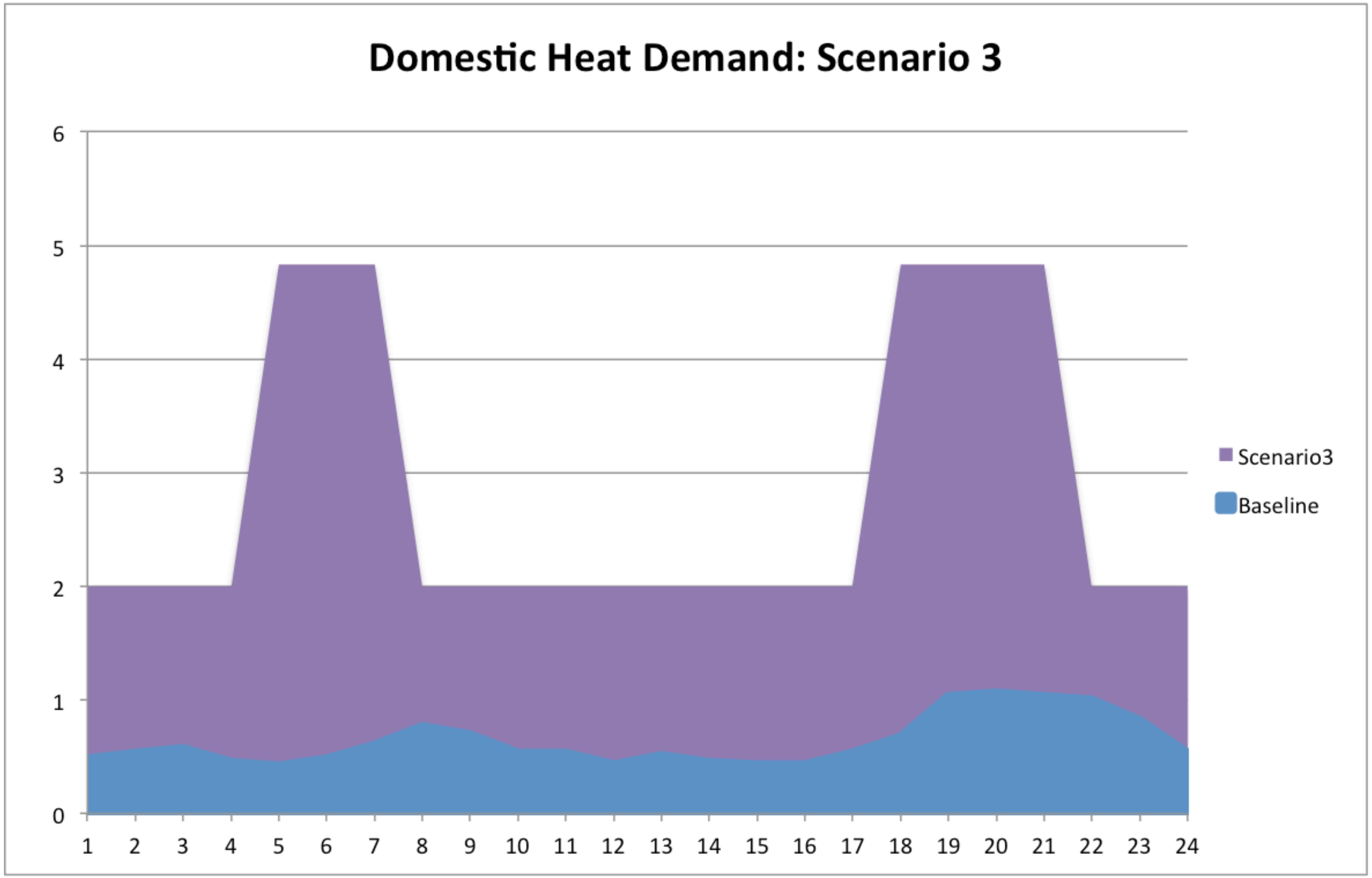


Postcode Sector Average Dwelling Age vs Average Gas Consumption per Dwelling
y = -75.102x + 167672
R2 = 0.4126
The Great British Refurb 2030
zero carbon for all energy
kWh per year
30000
25000
20000
15000
10000
5000
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
Mean Year of Construction

UCL

As is:
Tin=18C, HL = 230 W/C, Effic = 70%





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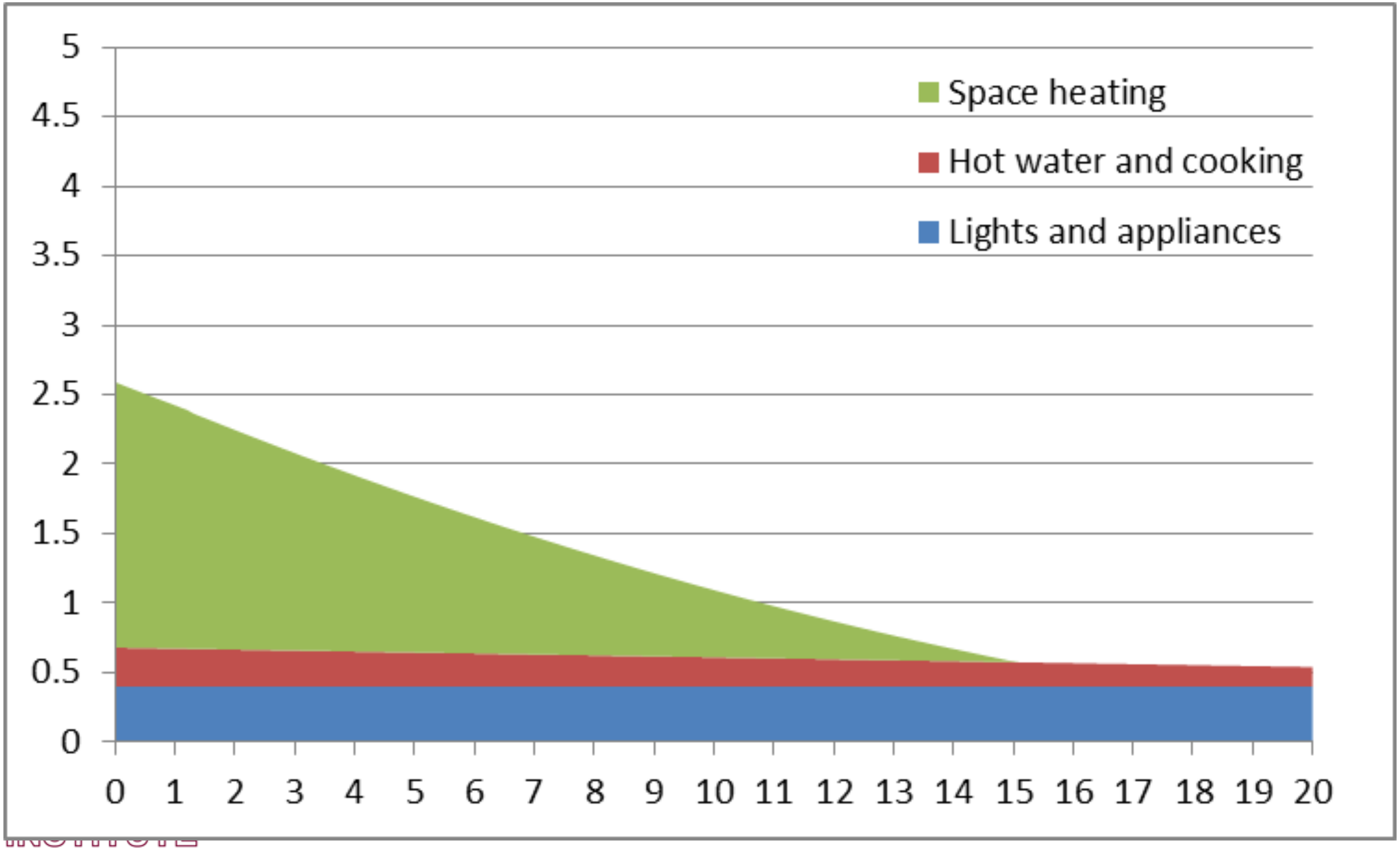
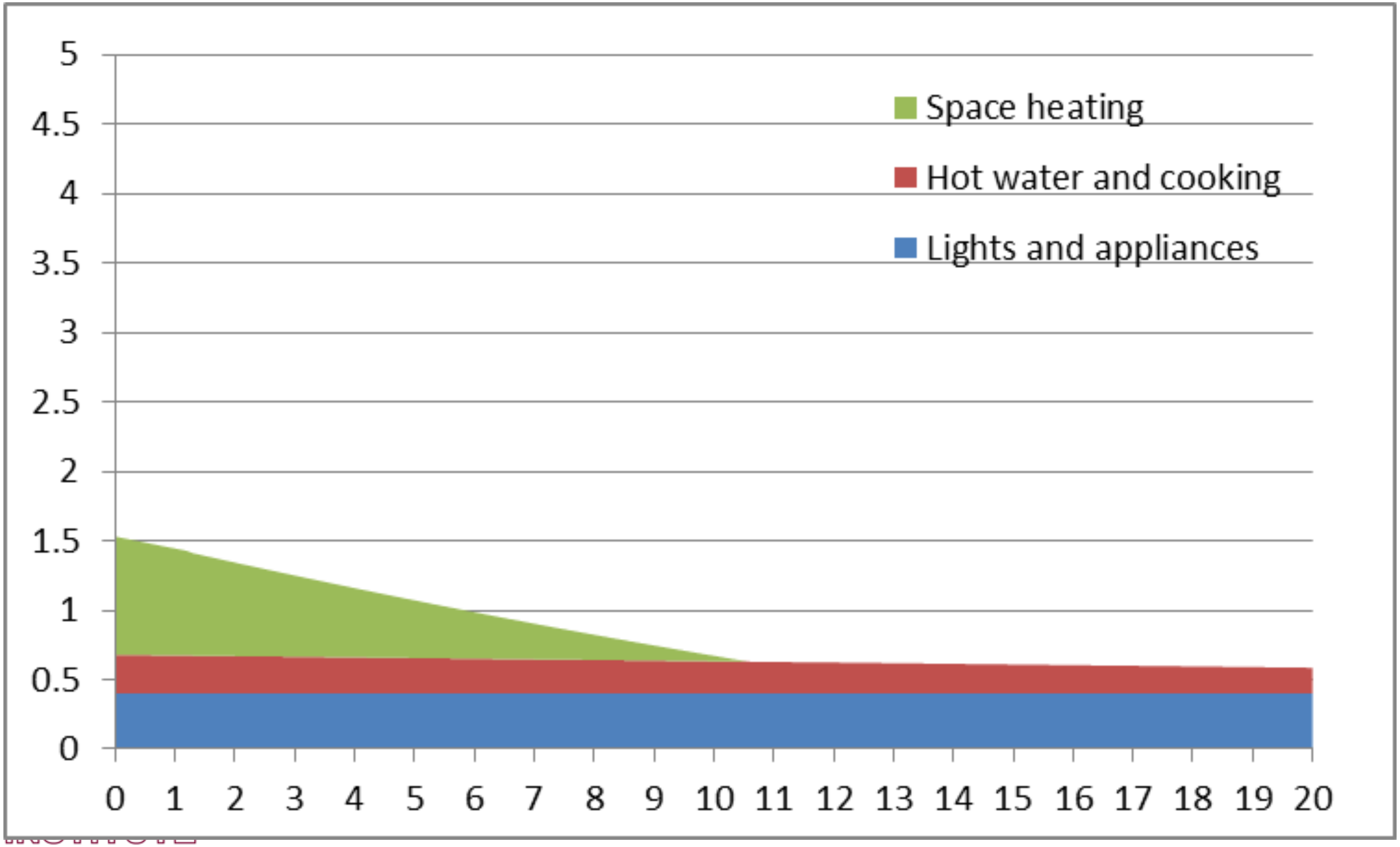
Heat pumps no Green Deal: Tin= 20C, HL = 230 W/C, Effic = 200 to 300%

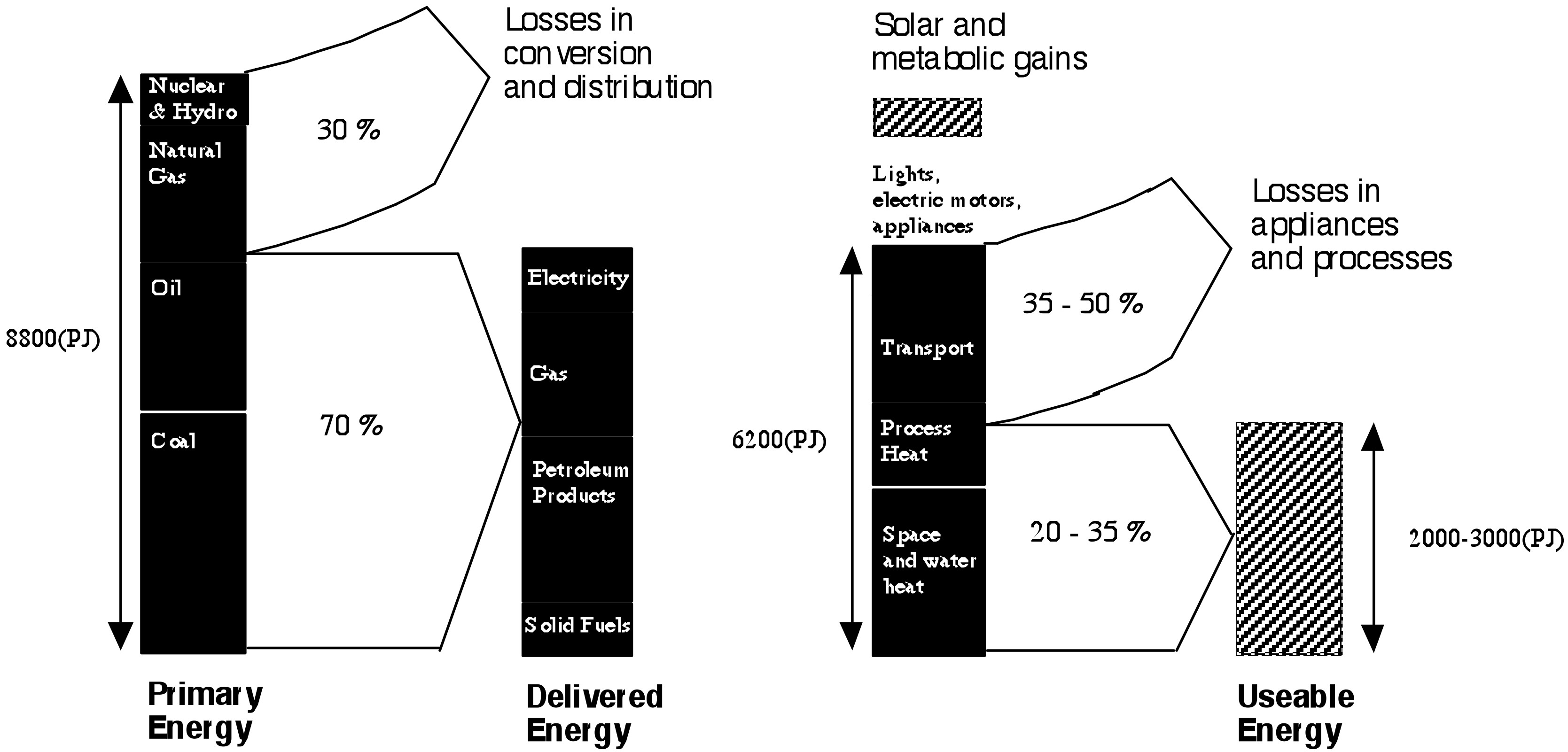


Green Deal plus Heat Pumps:
Tin= 20C, HL = 138 W/C, Effic = 200 to 300%



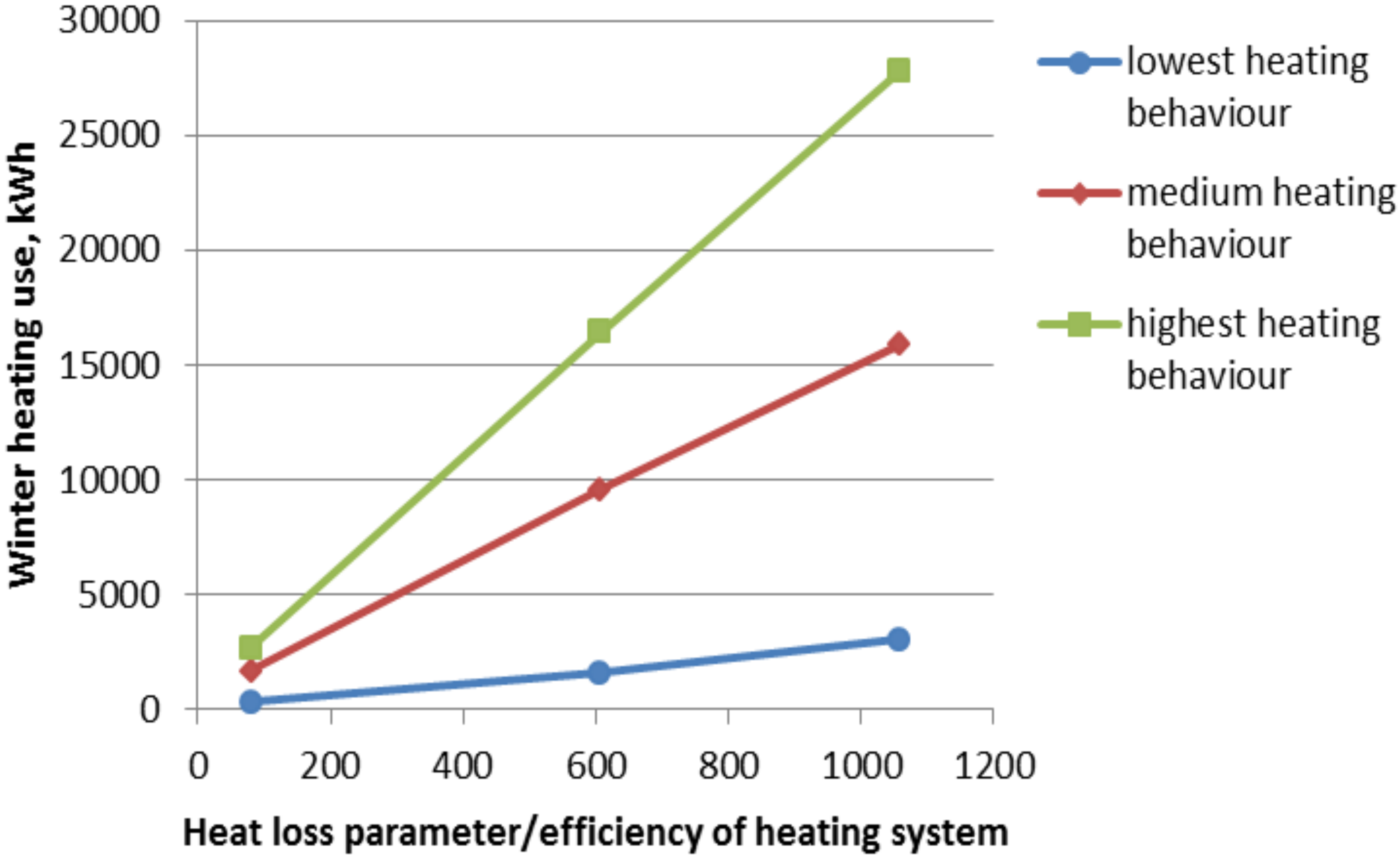
Balancing supply and demand

- Insulation can:
  - Reduce demand – directly
  - Enable buildings to be thermal stores
  - Reduce the supply infrastructure investment
  - Theory and practice not always the same
    - Apply physics wrongly
    - Quality control very poor
    - Occupant behaviour
- How much of our energy is not useful?



Note: 1 (PJ) Peta Joule = 10^{15} Joules

Impact of occupant behaviour on heating energy use



Mapping the impact of changes in occupant heating behaviour on space heating energy use as a result of UK domestic retrofit

Jenny Love

UCL Energy Institute,
University College London, Gower Street, London, WC1E 6BT

Email: j ennif er.love.09@ucl.ac.uk

Tohoku Earthquake

- Hit Tohoku area (North East Japan) on 11 March 2011
- Earthquake and subsequent tsunamis (海嘯) killed more than 20,000 people
- Tsunami caused melt-down of the reactors of one of the main nuclear power stations.
- Other nuclear power stations were shut down for safety reasons

Electricity shortage!

Taku Fujiyama
University College London

Results

So far,

- Maximum usage: 46.3 billion Watt (15 July, 2pm)

  Supply capability: 53.8 billion Watt

←in comparison with the last year's peak (60 billion Watt), a **23%** cut has been achieved.

No blackout

Taku Fujiyama

University College London

- a population of 30,000 in USA, has managed to cut consumption by 30 per cent in less than a month

The Independent, 17 May 2008.

- “After 36 years of self-imposed environmental abstinence, Miss Pick, 67, is now being recognised as an eco-heroine with one of the smallest carbon footprints in the country.”
- “She never heats her flat and eats all her food raw”

The Times, November 12, 2008

Thank You

www.ucl.ac.uk/energy

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