- Steve Lorimer
- UCL Energy Institute, Bartlett School of the Built Environment, formally urban design consultant at Urban Initiatives
- Email s.lorimer@ucl.ac.uk

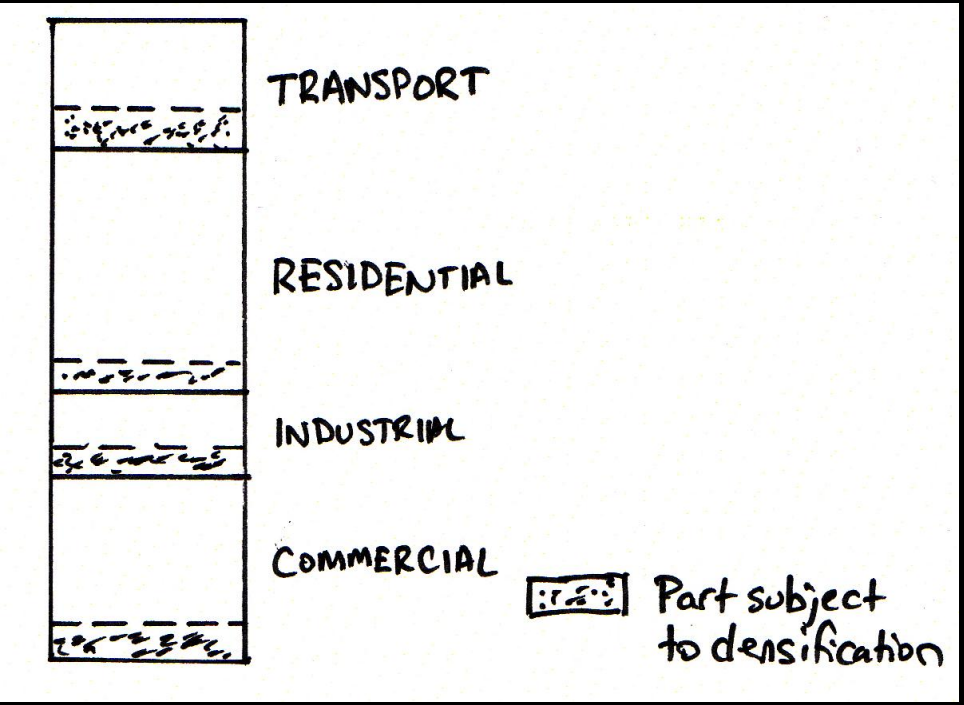
The Issues

- The background
- Behaviour change
- Reducing consumption and demand

Charles Avery, *Untitled (Chesches Players outside the One-Armed Snake)* - 2009

Why buildings?

- Buildings – 41% of all energy in the EU
- Transport / Manufacturing less than 25% each

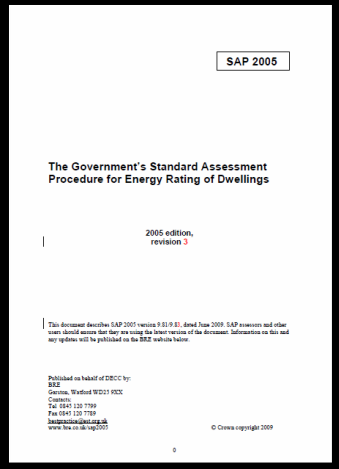


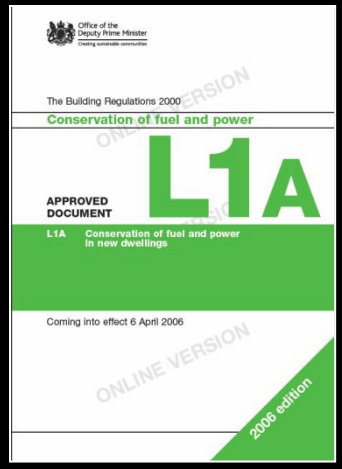
This type of analysis is difficult to do…

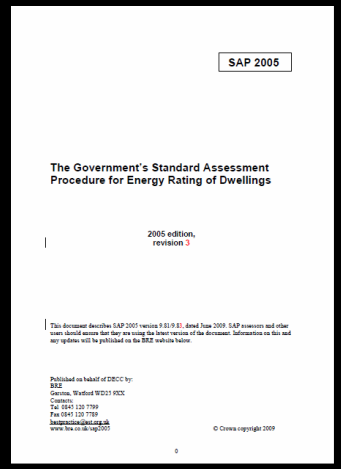
Background: Building regulations

Existing Buildings

New Buildings





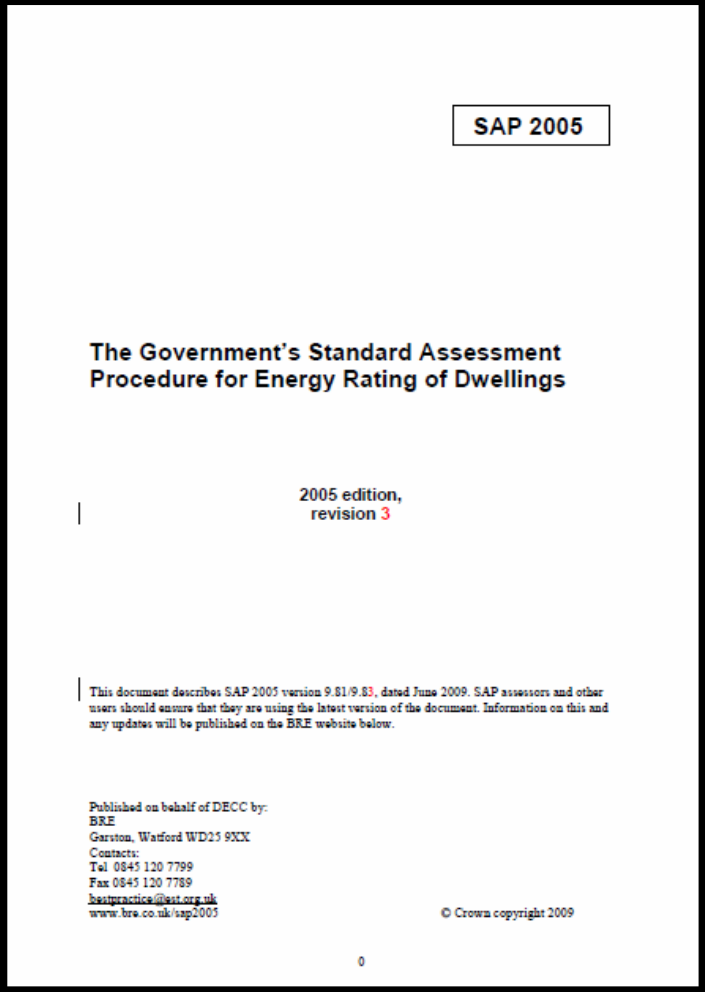


The Policy Context

- Strategic Environmental Assessment Directive 2001 (effective 2004)
- Energy Performance of Buildings Directive 2002 (effective 2009)
- Energy Performance of Buildings Directive 2010 (effective 2012)

What is the Standard Assessment Procedure?

- Simplified model for energy use
- Breaks energy use and heating requirements into heating, appliances, lighting, etc.



SAP 2005

The Government's Standard Assessment Procedure for Energy Rating of Dwellings

2005 edition, revision 3

This document describes SAP 2005 version 9.81/9.83, dated June 2009. SAP assessors and other users should ensure that they are using the latest version of the document. Information on this and any updates will be published on the BRE website below.

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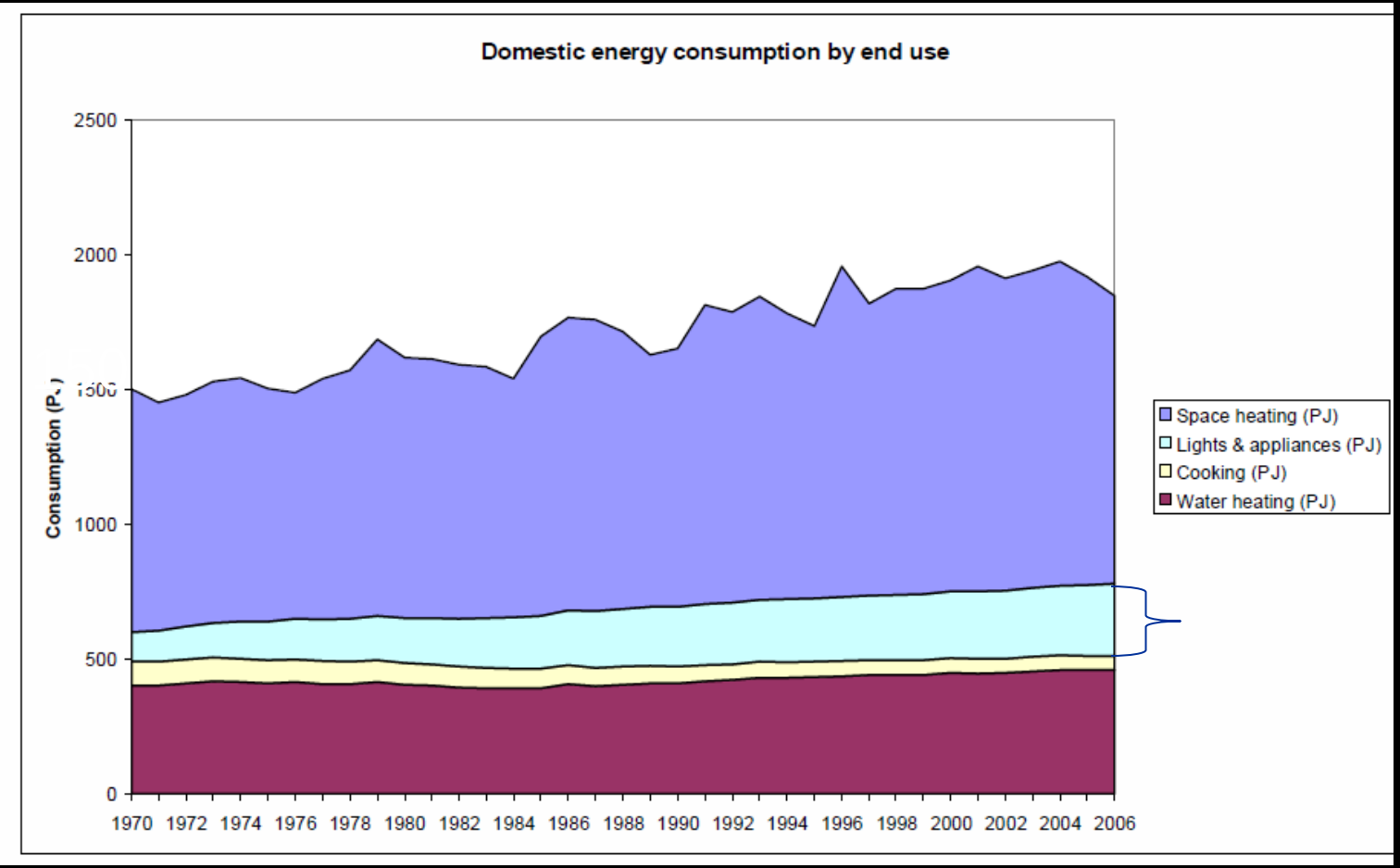
Split is very heating heavy (in the UK)



Shorrock, L. D. and J. I. Utley (2008). Domestic energy fact file 2008. p. 43

Recent changes

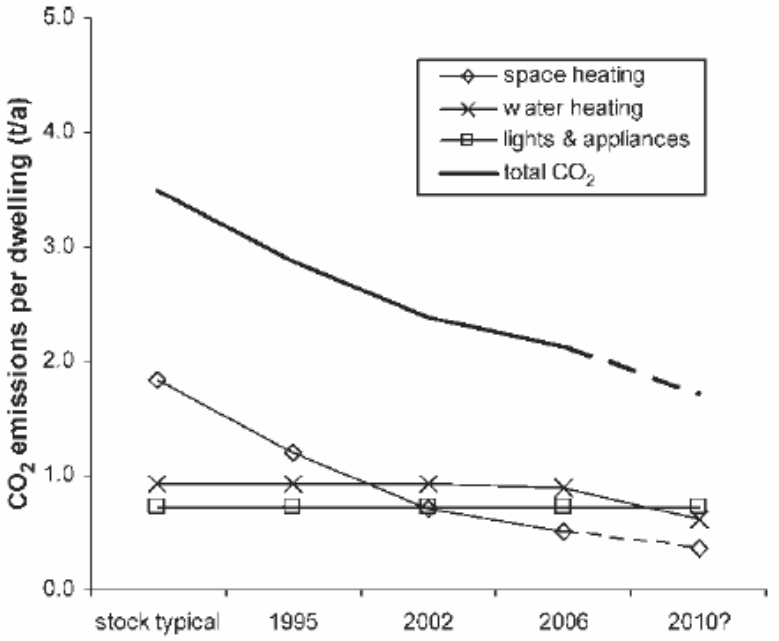
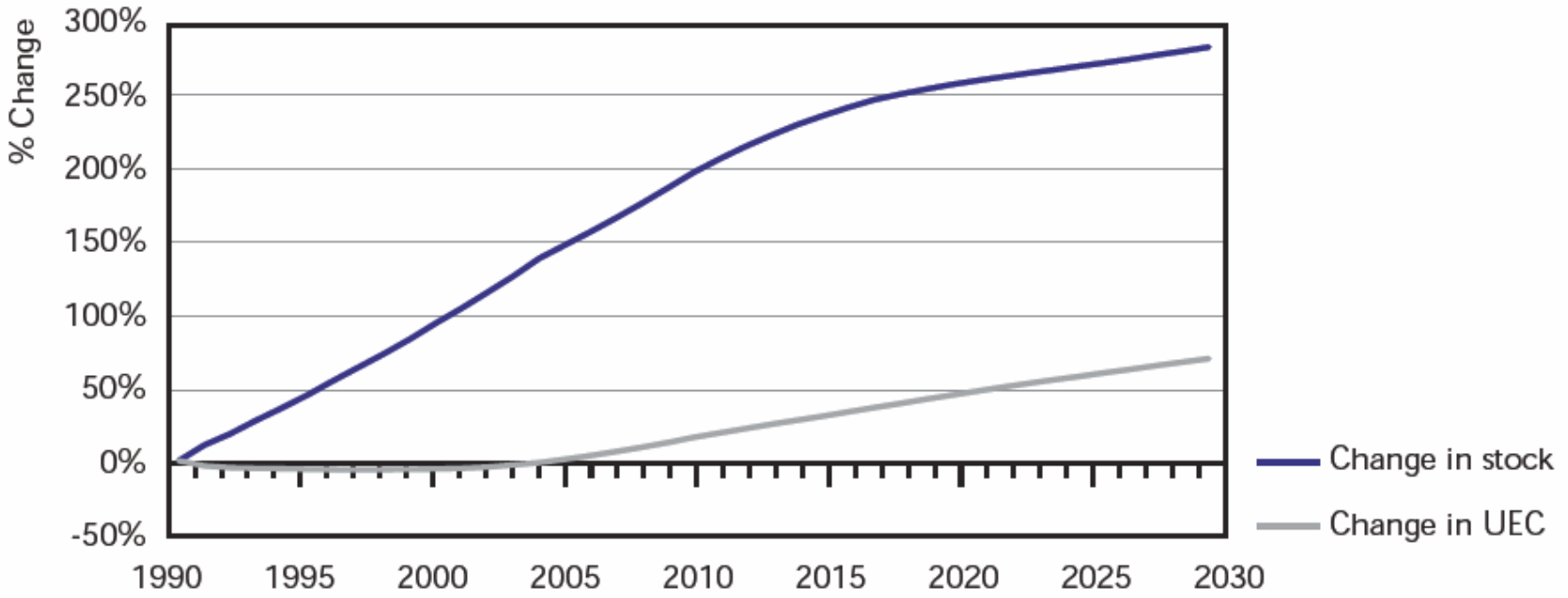


Figure 4 Predicted CO_2 emissions for a 50 m^2 flat under Building Regulations for 1995, 2002 and 2006. Indications are also given of emissions from a dwelling of the same form (1) built under a possible 2010 revision of the Regulations and (2) from a flat typical of the current stock. Note that the graph shows current energy use against date of construction. It is not a time series of energy consumption and does not, for example, imply that electricity consumption in UK housing is static

Lowe, Robert (2007) 'Technical options and strategies for decarbonizing UK housing', Building Research & Information,

Why electricity use? ...and will keep growing

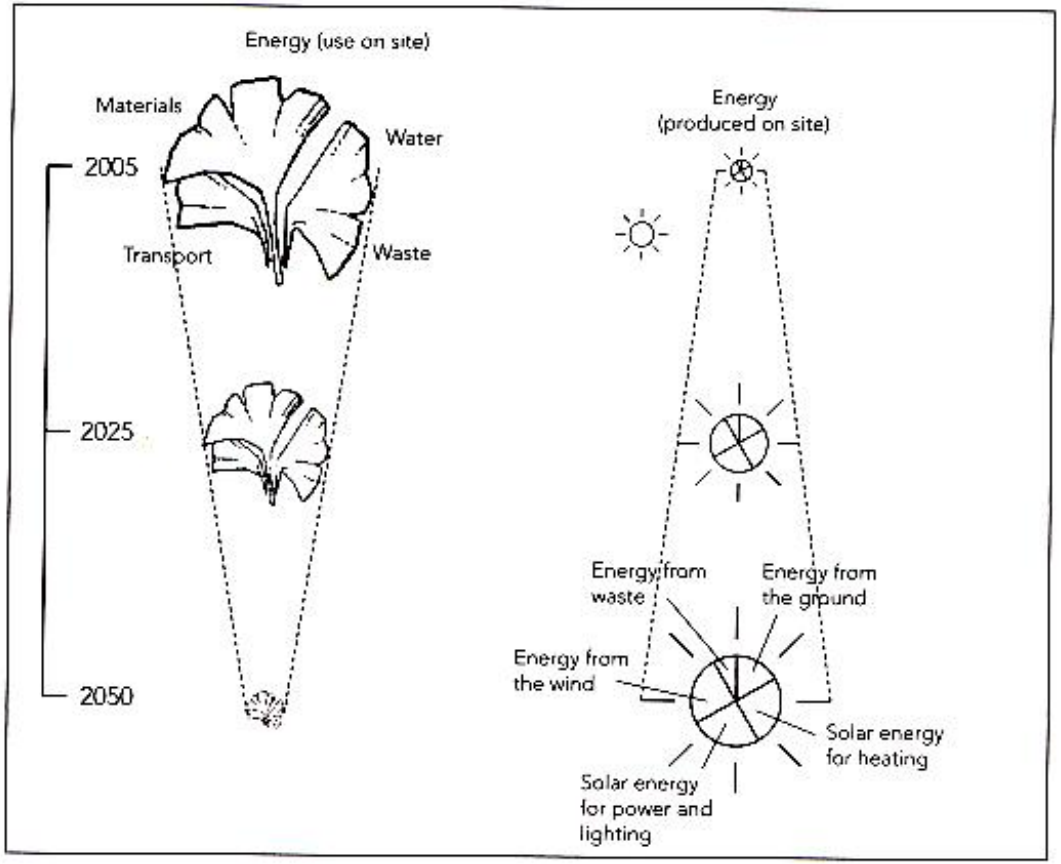
Figure 86 • Estimated change in stocks and average unit energy consumption (UEC) of residential ICT and CE appliances in OECD, 1990-2030



Source: IEA estimates.
The effect of structural changes, mainly the switch to flat screen technologies and laptop computers, is evident in the reduction of UEC values prior to 2005.

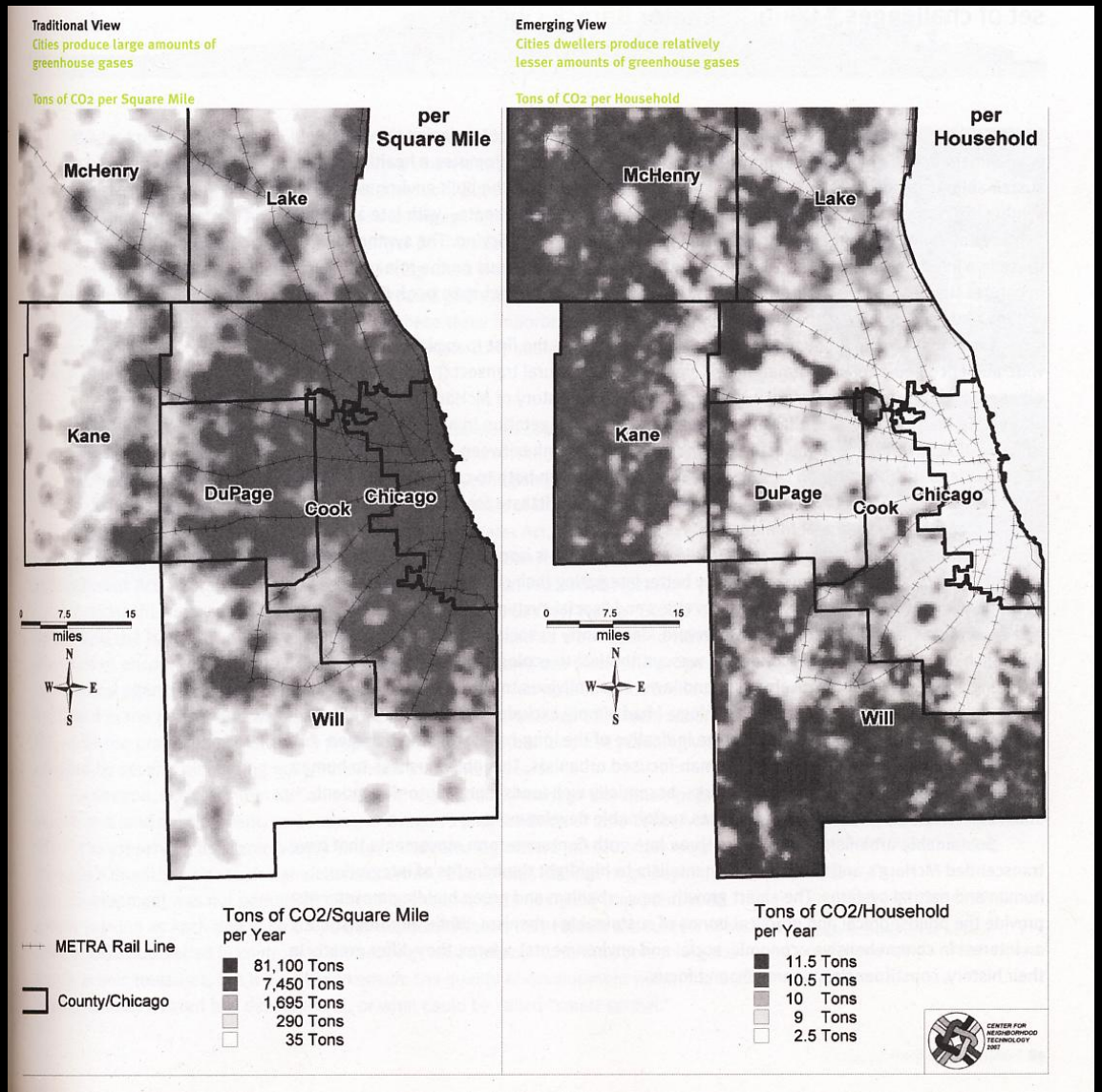
International Energy Agency (2009). Gadgets and Gigawatts - Policies for Energy Efficient Electronics.

Environmental footprint… what is expected of architects to deliver?



Richie (2009), p.8

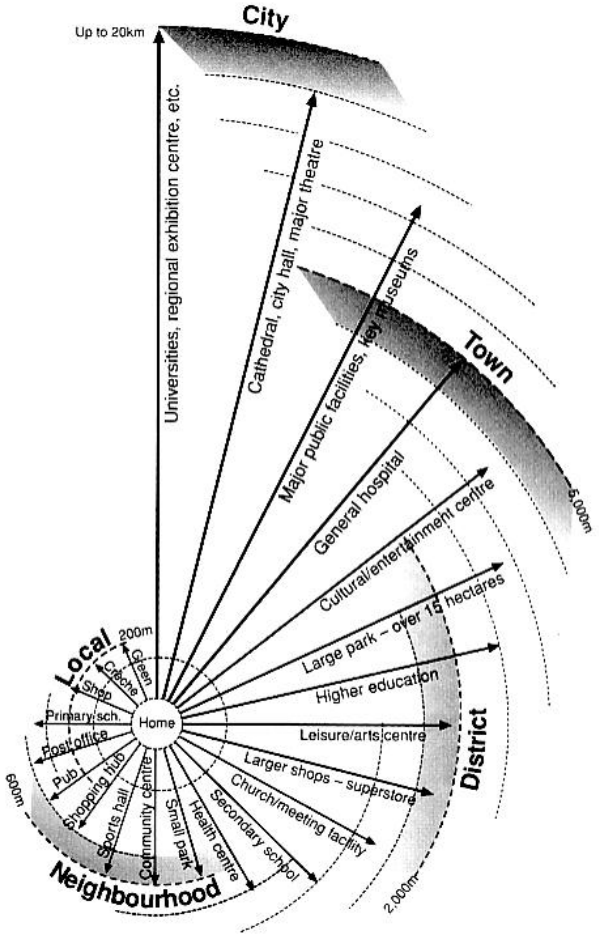
Two views of carbon emissions



Behaviour Change

- Sometimes a difficult moral question
- Pattern of a city influences pattern of people’s lives
- Example: Transport and local neighbourhoods

Connectivity and catchments



		Possible facility	Catchment population
4–10km radius	City facilities	Stadium	City
		Cathedral	City
		City Hall	City
		Theatre	City
2–6km	District or Town	Sports centre	25,000–40,000
		District centre	25,000–40,000
		Library	12,000–30,000
		Health centre	9,000–12,000
400–600m	Neighbour-hood	Community offices	7,500
		Community centre	7,000–15,000
		Pub	5,000–7,000
		Post office	5,000–10,000
150–250m	Local hubs	Primary school	2,500–4,000
		Doctor	2,500–3,000
		Corner shop	2,000–5,000

This chart is indicative and is based upon city-scale urban areas. Catchments will vary in specific areas.

How intense does development need to be?

- If basics are < ½ km with 2,500 people needed to support them…
- Translates in a normal residential area to 100 dwellings per hectare… or 1:1 FAR

Relate to real life…

Draft London Plan recommended density levels

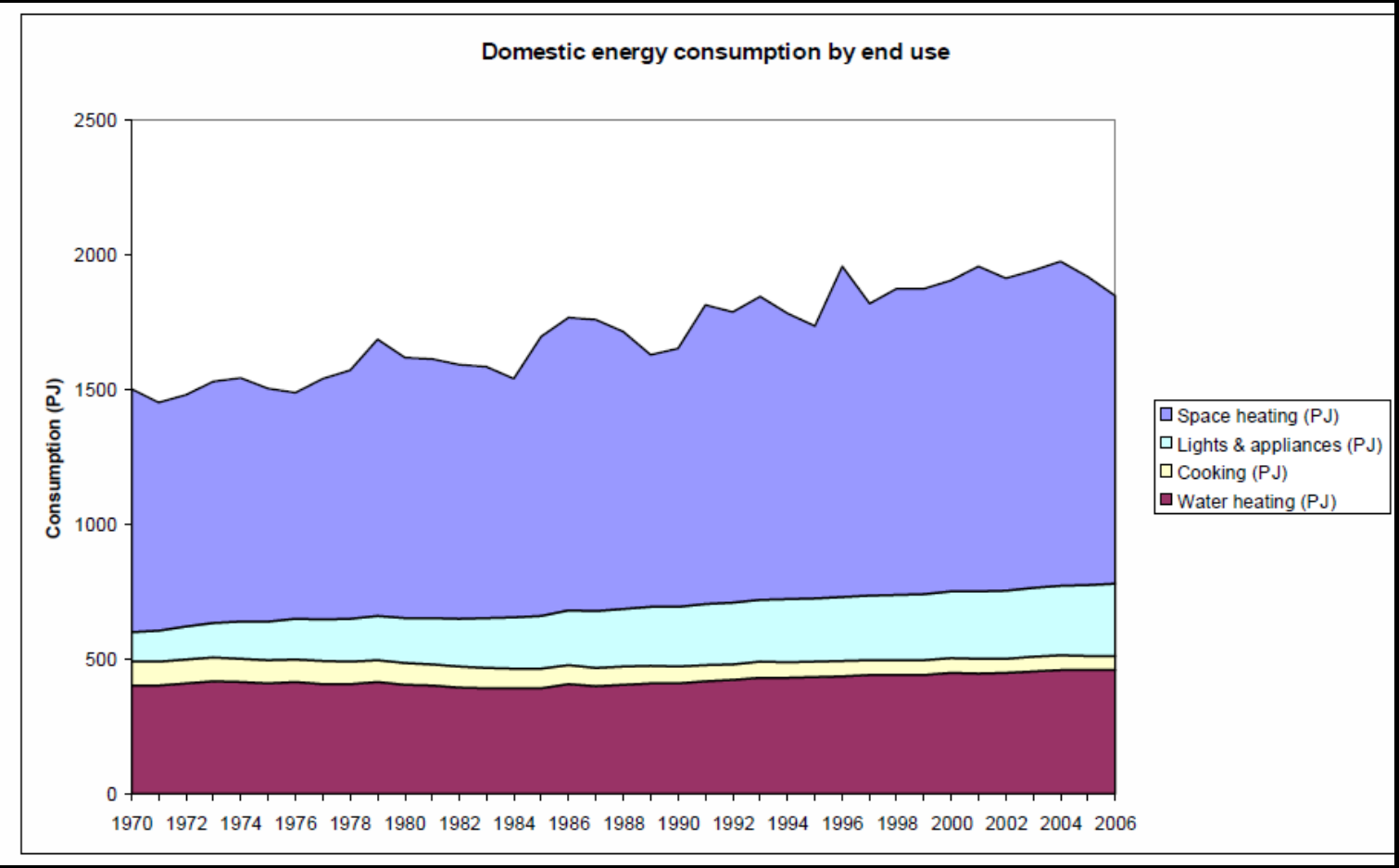
Public transport accessibility 6 is highest	Location in London	Housing density as habitable rooms per hectare and dwellings per hectare		
6 to 4	Central			650 - 1100 hrh **240 - 435 dph**
	Urban		200 - 450 hrh **55-175 dph**	450 - 700 hrh **165 - 275 dph**
	Suburban		200 - 300 hrh **50 - 110 dph**	250 - 350 hrh **80 - 120 dph**
3 to 2	Urban		200 - 300 hrh **50 - 110 dph**	300 - 450 hrh **100 - 150 dph**
	Suburban	150 - 200 hrh **30 - 65 dph**	200 - 250 hrh **50 - 80 dph**	
2 to 1	Suburban	150 - 200 hrh **30 - 50 dph**		

Car parking (spaces per unit)	High 2 - 1.5	Moderate 1.5 - 1	Low Less than 1
Predominant development type	Detached and linked houses	Terraced houses and flats	Mostly flats

Reducing consumption and demand

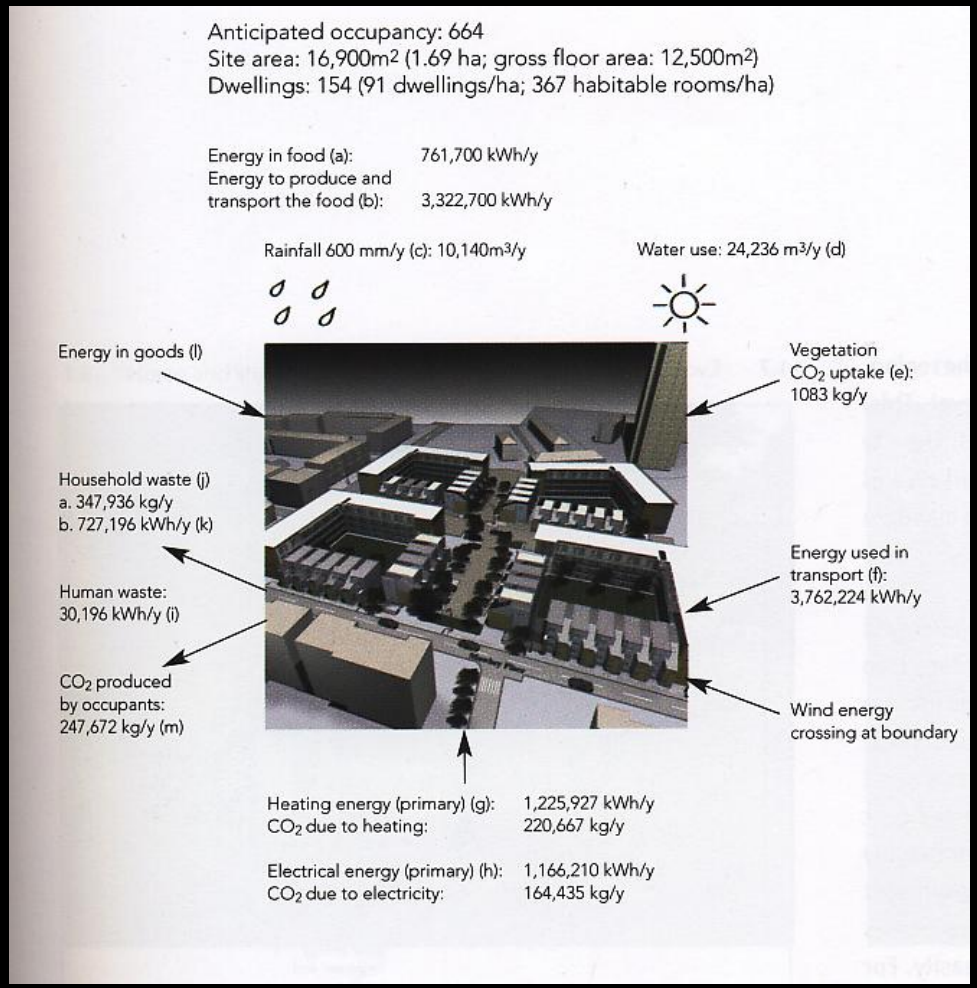
- Overall picture
- Solar design
- Ventilation
- On-site energy sources
- Water

(One) National view of building energy



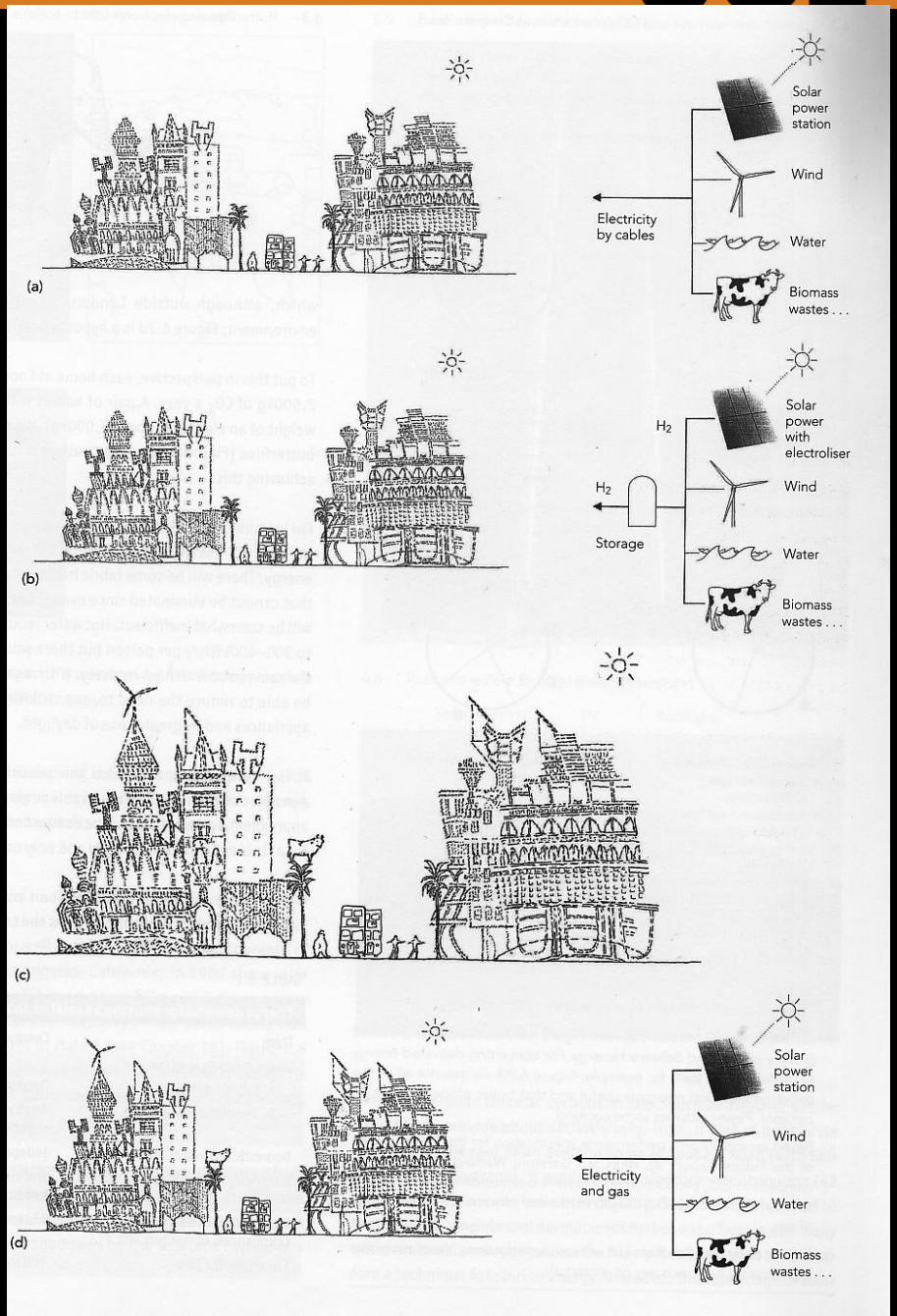
Shorrock, L. D. and J. I. Utley (2008). Domestic energy fact file 2008. p. 43
(1 PJ = 30 million kilowatt-hours)

A picture of the energy we use as a community



Coopers Road, London – courtesy Max Fordham LLP

What to choose???

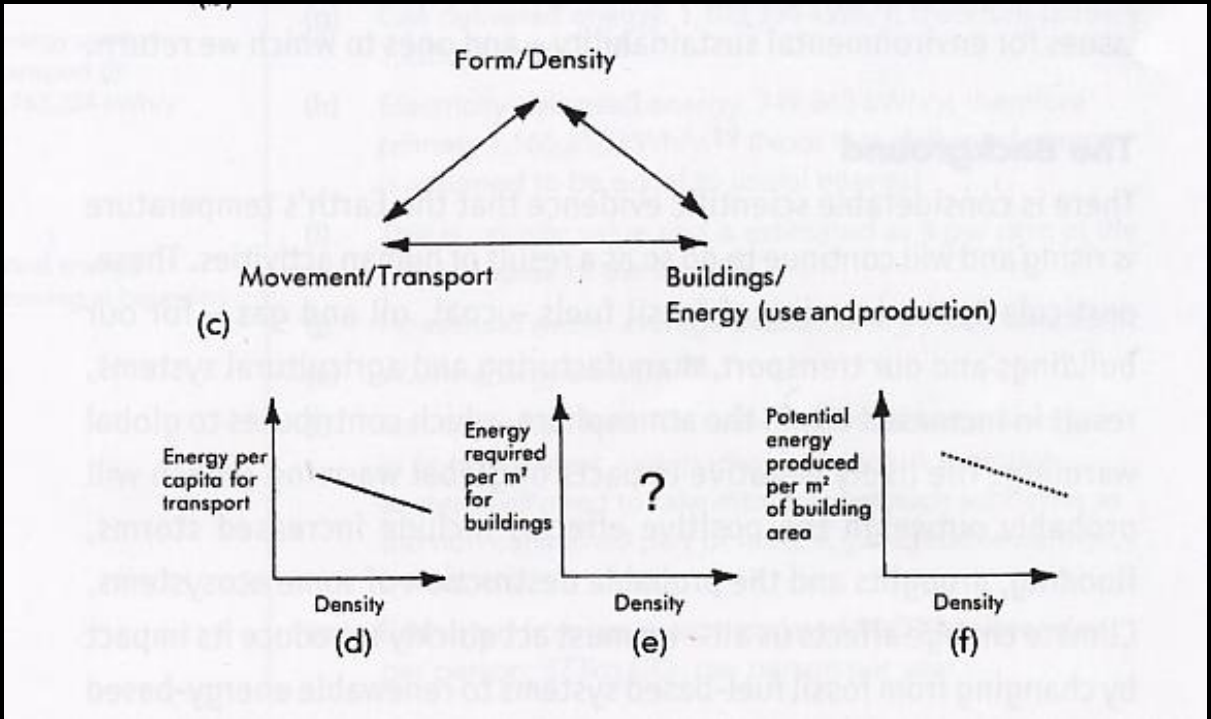


Thomas and Richie 2006, p.57

The reality

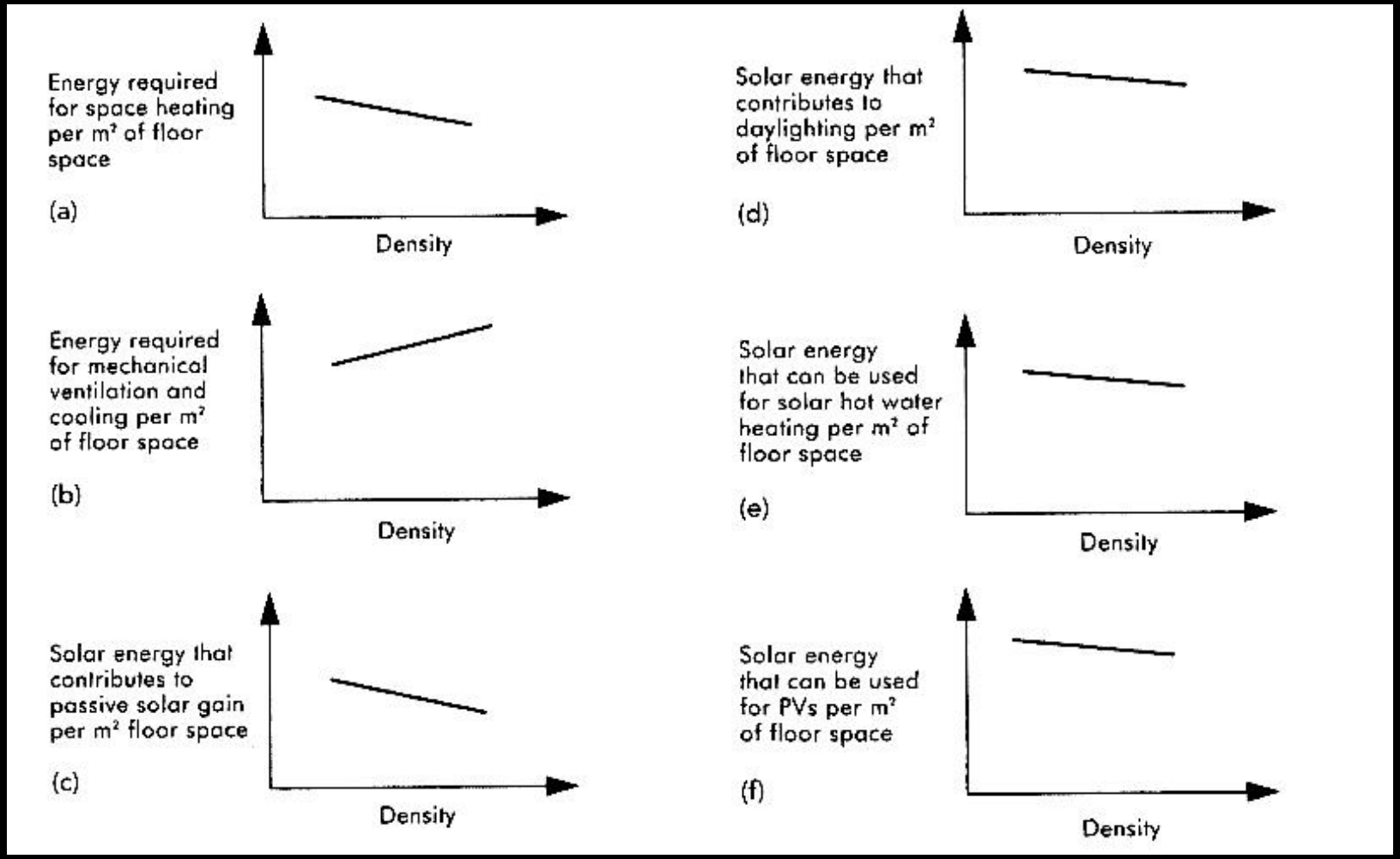
Rosalind Nashashibi,
Eyeballing - 2005

Comparison of energy and density



Richie p.5 (2006)

Comparison of energy and density

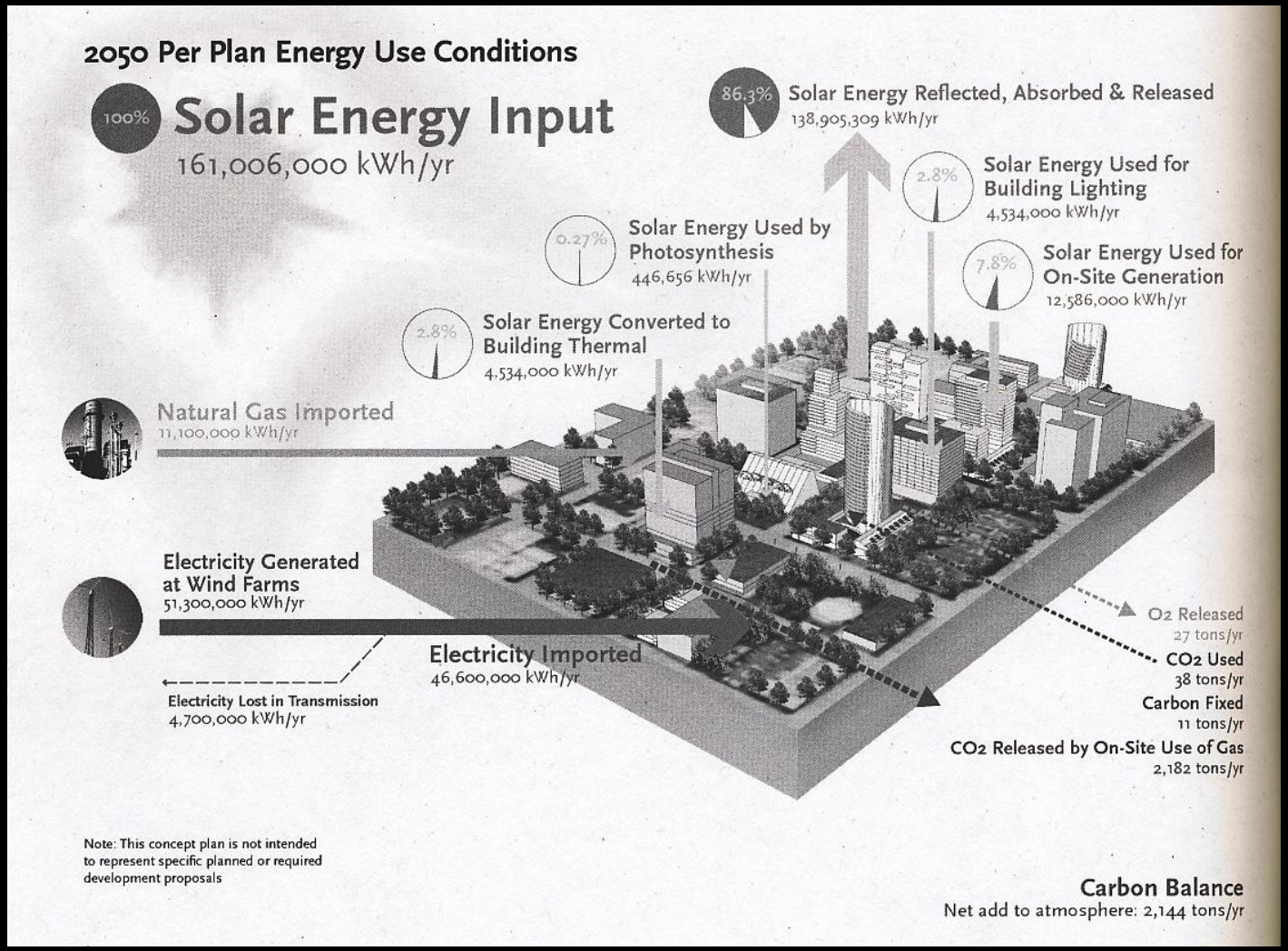


Richie 2006, p.5

On-site production

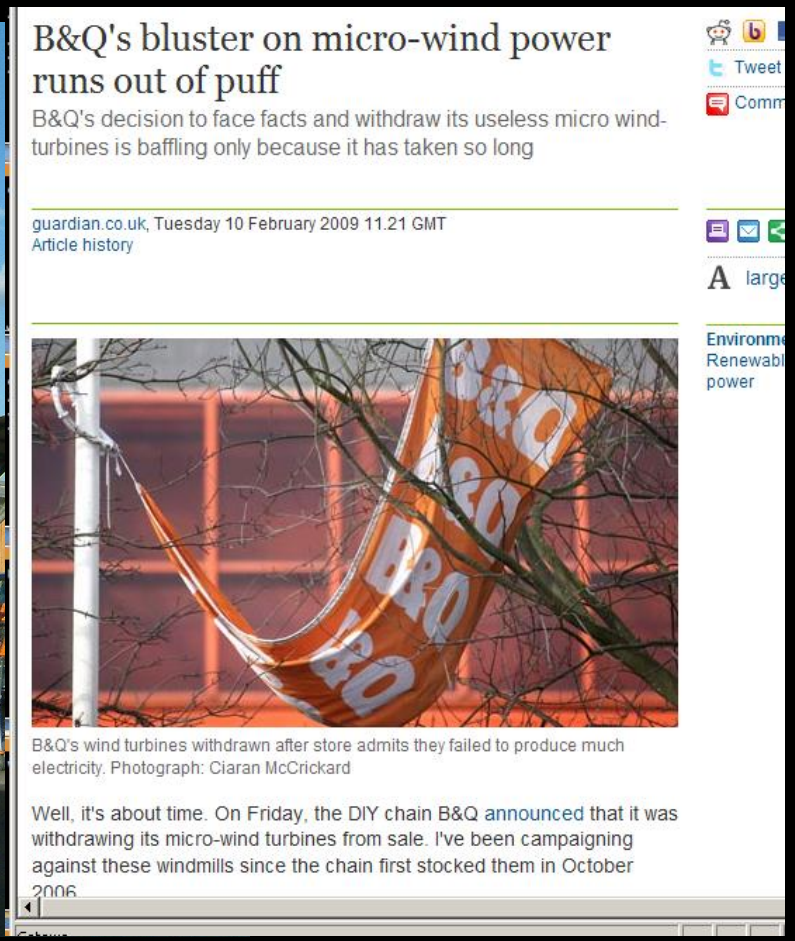
- (Photovoltaic cells)
- Wind energy
- District heating systems

On-site production – often not enough



Lloyd Crossing, Vancouver

Wind on-site….a bit discredited



B&Q's bluster on micro-wind power runs out of puff

B&Q's decision to face facts and withdraw its useless micro wind-turbines is baffling only because it has taken so long

guardian.co.uk, Tuesday 10 February 2009 11.21 GMT
Article history

B&Q's wind turbines withdrawn after store admits they failed to produce much electricity. Photograph: Ciaran McCrickard

Well, it's about time. On Friday, the DIY chain B&Q announced that it was withdrawing its micro-wind turbines from sale. I've been campaigning against these windmills since the chain first stocked them in October 2006

In a London street – 17kph; recommended 29kph!!

Solar energy methods

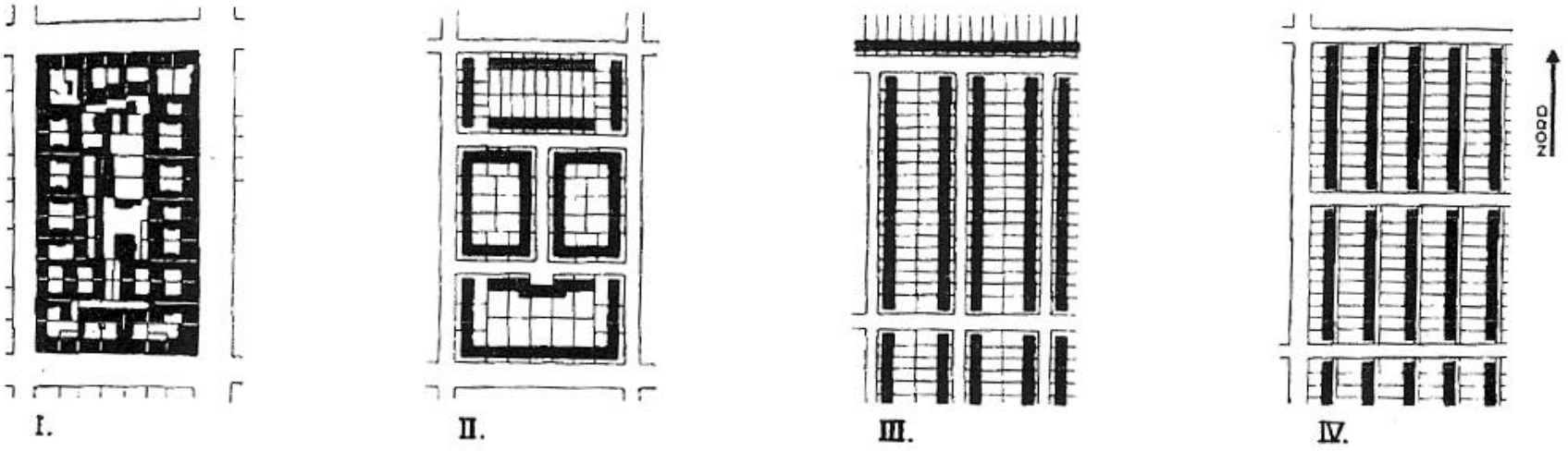
- Daylight – reduce electricity for lighting
- Passive solar heat gain (space and water)
- Photovoltaic cells

Daylighting

Table 5.2 Height to width ratios		
	Maximum	Minimum
Mews	1:1.5	1:1
Streets	1:3	1:1.5
Squares	1:5	1:4

- Both internal and external…
- But not too overblown!

17.3 Ernst May's diagrams from the 1930 article 'The Evolution of the Urban Block'.

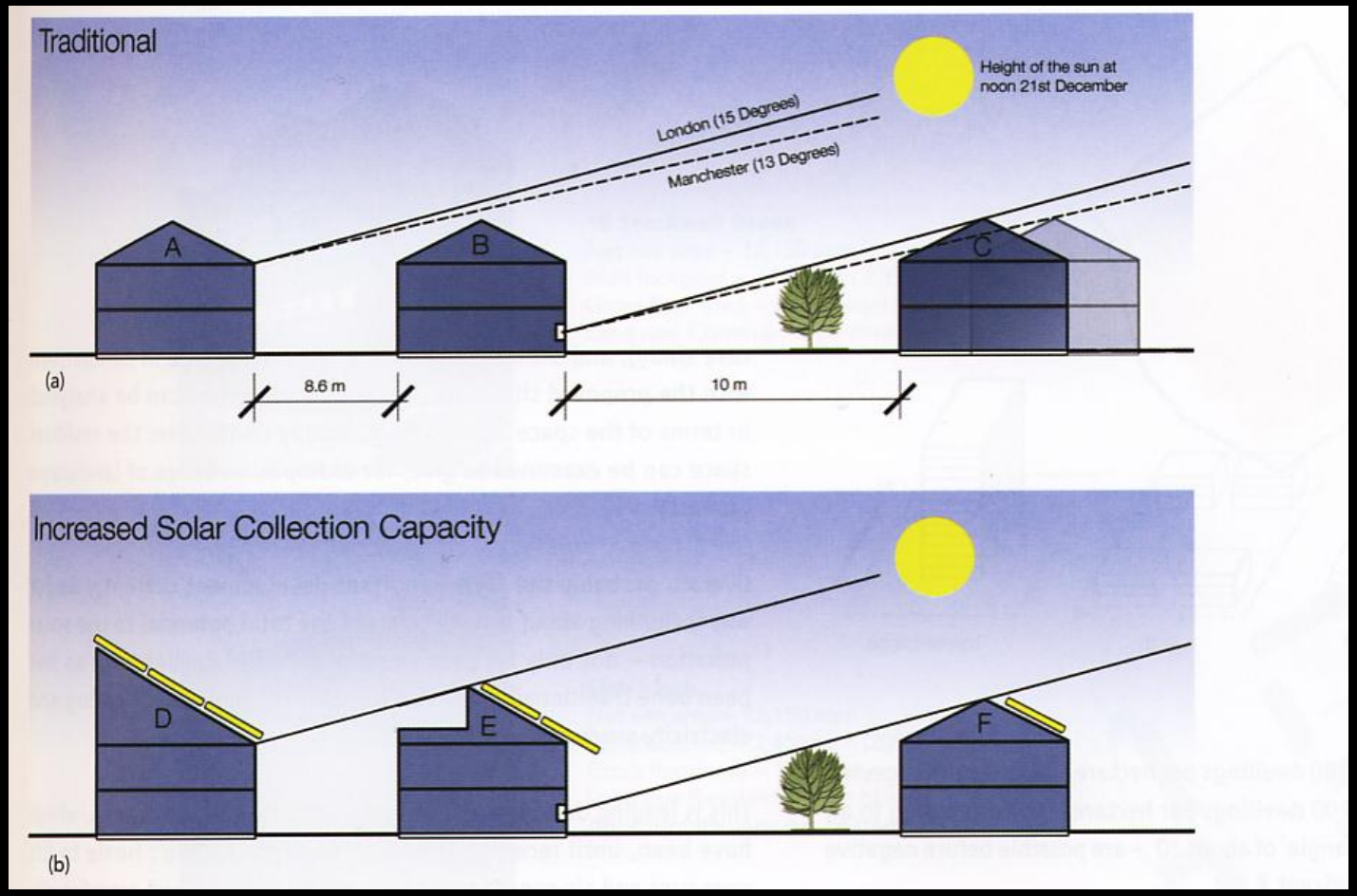


'Traditional' unbroken urban block, creating clearly defined fronts.

Fruitful hybrids possible in the middle of the spectrum.

'Modernist' linear blocks optimise orientation for daylight and sunlight.

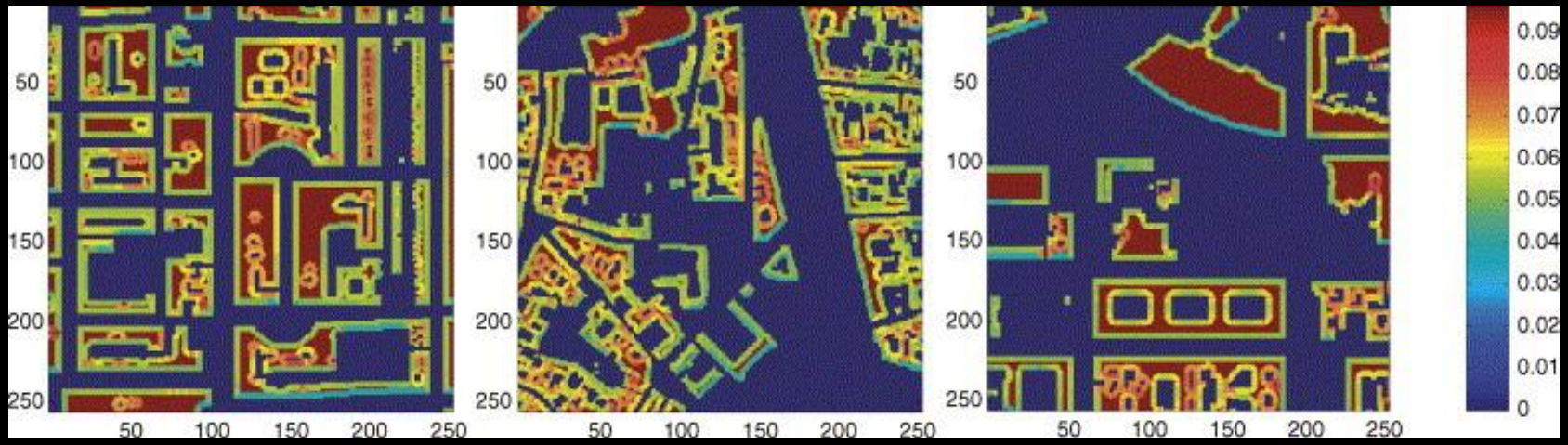
Solar heat gain and PV Cells



Thomas and Richie (2009), p.47

Solar heat gain

- Buildings gain more heat from the south
- Less energy to heat…more energy to cool



Ratti et al. 2005

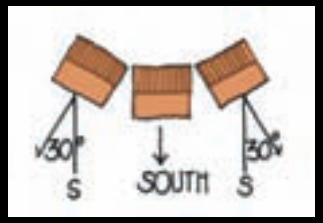
What about solar farms??

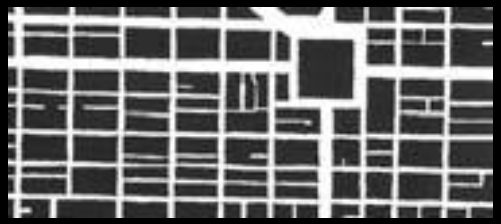
Ventilation

- Single-aspect 2.5m x ceiling height
- Double-aspect 5m x ceiling height
- Results in block depth < 15 metres to avoid mechanical systems

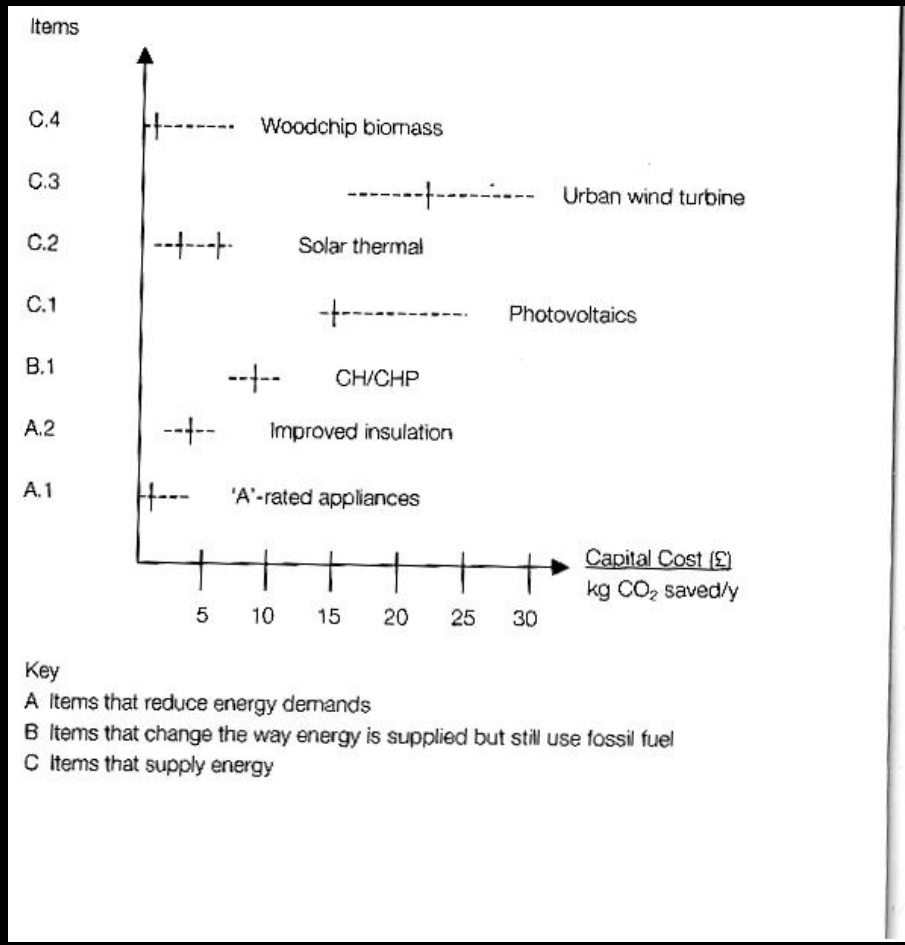
Tips on effectiveness

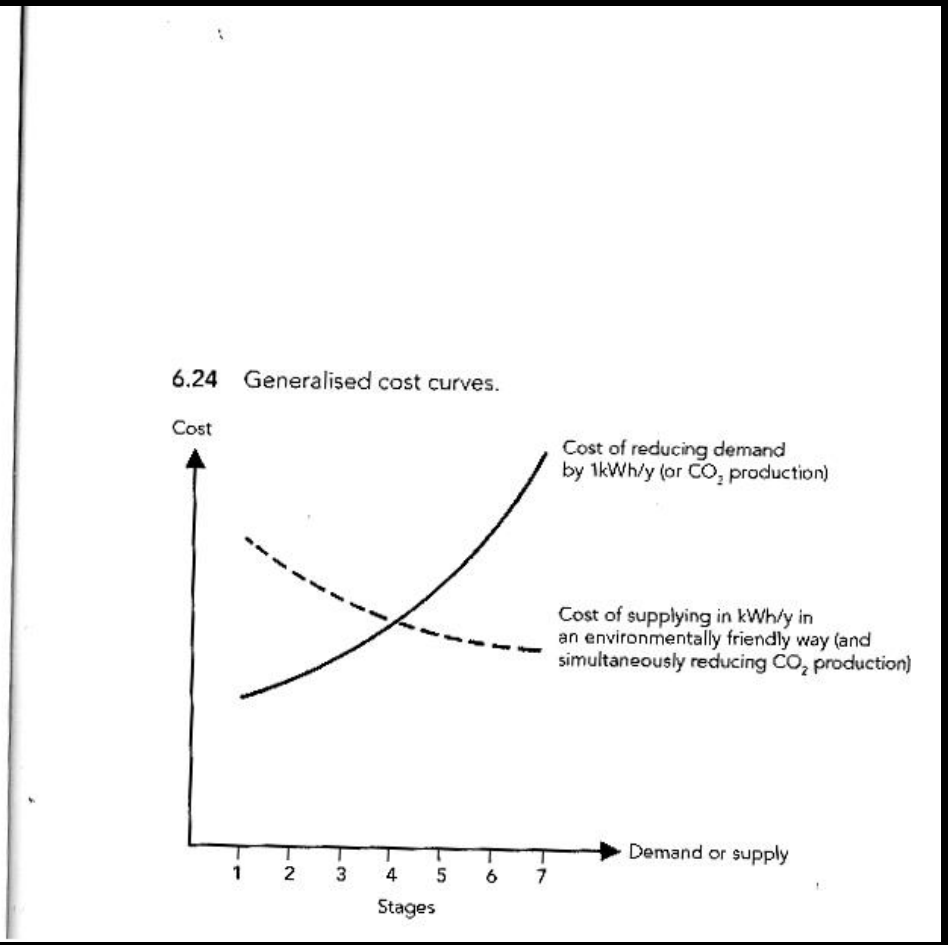
- Measure daylight in winter, 2 metres above the ground (a window)
- 20% of wall glazing as minimum
- 30 degree from south maximum
- Street grids – east to west





How much does this all cost!?





Thomas and Richie 2006, p.47

Many possible routes

Ulla von Brandenburg, 2009, *Installation 8*

New data developments: DECC Energy

				Consumption (kWh)			
	LSOA Allocation			Electricity			Gas
	LA Code	MLSOA Code	MLSOA Name	Ordinary domestic	Economy7 domestic	Ind/Com	Domestic
4	UKI1101	E0200000	City of London 001	19,333,067	5,745,434	222,845,775	36,656,7
5	UKI1102	E0200016	Camden 001	14,849,718	1,010,888	8,700,099	52,618,4
6	UKI1102	E0200016	Camden 002	18,893,166	1,737,171	13,995,289	74,509,7
7	UKI1102	E0200016	Camden 003	12,028,032	840,326	12,330,897	56,341,3
8	UKI1102	E0200016	Camden 004	19,416,352	1,133,790	7,151,249	62,817,9
9	UKI1102	E0200017	Camden 005	13,391,610	837,715	4,999,952	58,788,3
10	UKI1102	E0200017	Camden 006	12,374,646	1,468,147	4,689,204	52,035,0
11	UKI1102	E0200017	Camden 007	11,482,517	548,590	11,608,668	35,793,7

- An MLSOA is approx. 3,000 households
- Includes number of meters, population
- New release at LLSOA = 400 households

New data developments: English House Condition Survey (now renamed)

- Dwelling type
- Energy spend
- Income
- Window type
- 15,000+ per year

File-level information:

File Name = general_0506
Number of variables = 33
Number of cases = 16269

Variable-level information:

Pos. = 1 **Variable** = aacode **Variable label** = Key field
This variable is *string* the SPSS measurement level is *nominal*.

Pos. = 2 **Variable** = tenure8x **Variable label** = Tenure
This variable is *numeric*, the SPSS measurement level is *scale*.
Value label information for tenure8x
Value = 1 Label = owner occupied - occupied
Value = 2 Label = private rented - occupied
Value = 3 Label = local authority - occupied
Value = 4 Label = RSL - occupied
Value = 5 Label = owner occupied - vacant
Value = 6 Label = private rented - vacant
Value = 7 Label = local authority - vacant
Value = 8 Label = RSL - vacant

Pos. = 3 **Variable** = tenure4x **Variable label** = Tenure
This variable is *numeric*, the SPSS measurement level is *scale*.
Value label information for tenure4x
Value = 1 Label = owner occupied
Value = 2 Label = private rented
Value = 3 Label = local authority
Value = 4 Label = RSL

Pos. = 4 **Variable** = tenure2x **Variable label** = Tenure
This variable is *numeric*, the SPSS measurement level is *scale*.
Value label information for tenure2x
Value = 1 Label = private
Value = 2 Label = social

Pos. = 5 **Variable** = vacantx **Variable label** = Type of vacancy
This variable is *numeric*, the SPSS measurement level is *scale*.
Value label information for vacantx
Value = 1 Label = occupied
Value = 2 Label = vacant

Pos. = 6 **Variable** = vacprob **Variable label** = Type of vacancy
This variable is *numeric*, the SPSS measurement level is *scale*.
SPSS user missing values = 8 and 9
Value label information for vacprob
Value = 1 Label = transactional
Value = 2 Label = problematic
Value = 8 Label = occupied
Value = 9 Label = type of vacancy unknown

Pos. = 7 **Variable** = goregx **Variable label** = Government office region
This variable is *numeric*, the SPSS measurement level is *scale*.
Value label information for goregx
Value = 1 Label = North East
Value = 2 Label = Yorkshire and The Humber

Methodology

Ulla von Brandenburg, 2009, *Installation 8*

Methodology (1)

English House Condition Survey (unit scale)

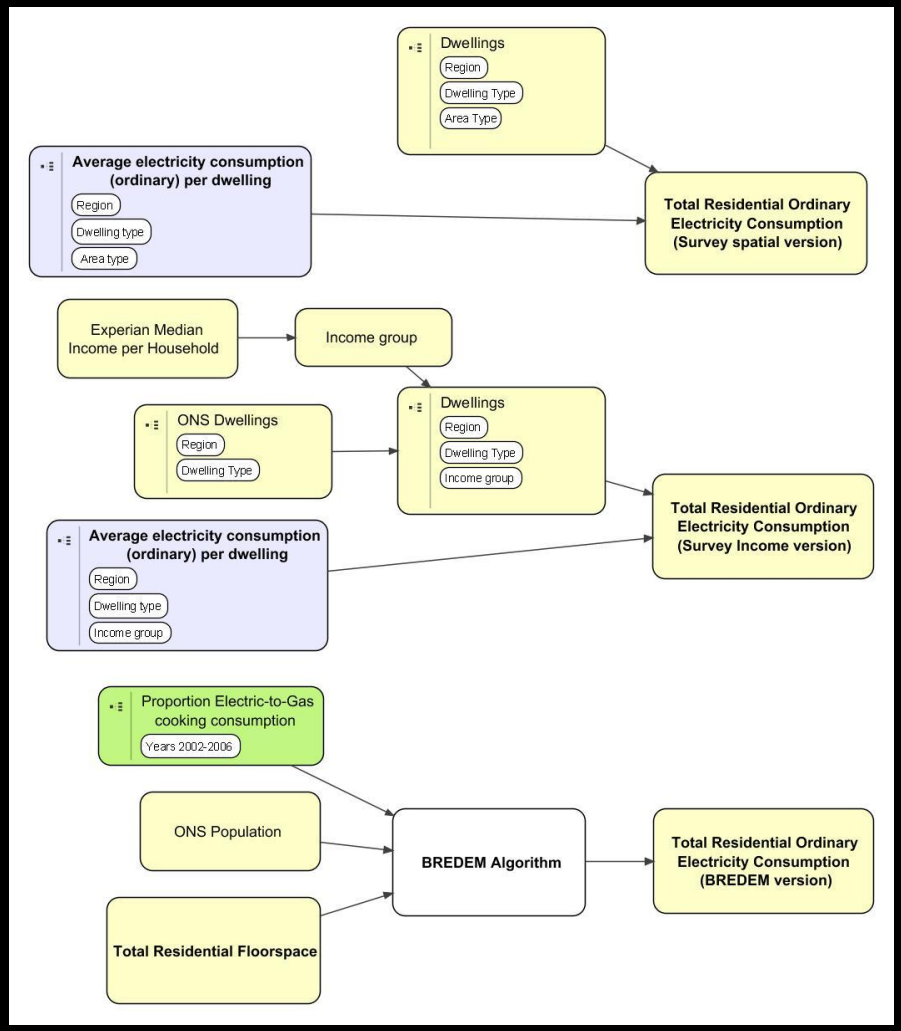
DECC Regional Price Index (Regional scale)

ONS Census data / *Experian* (MLSOA scale)

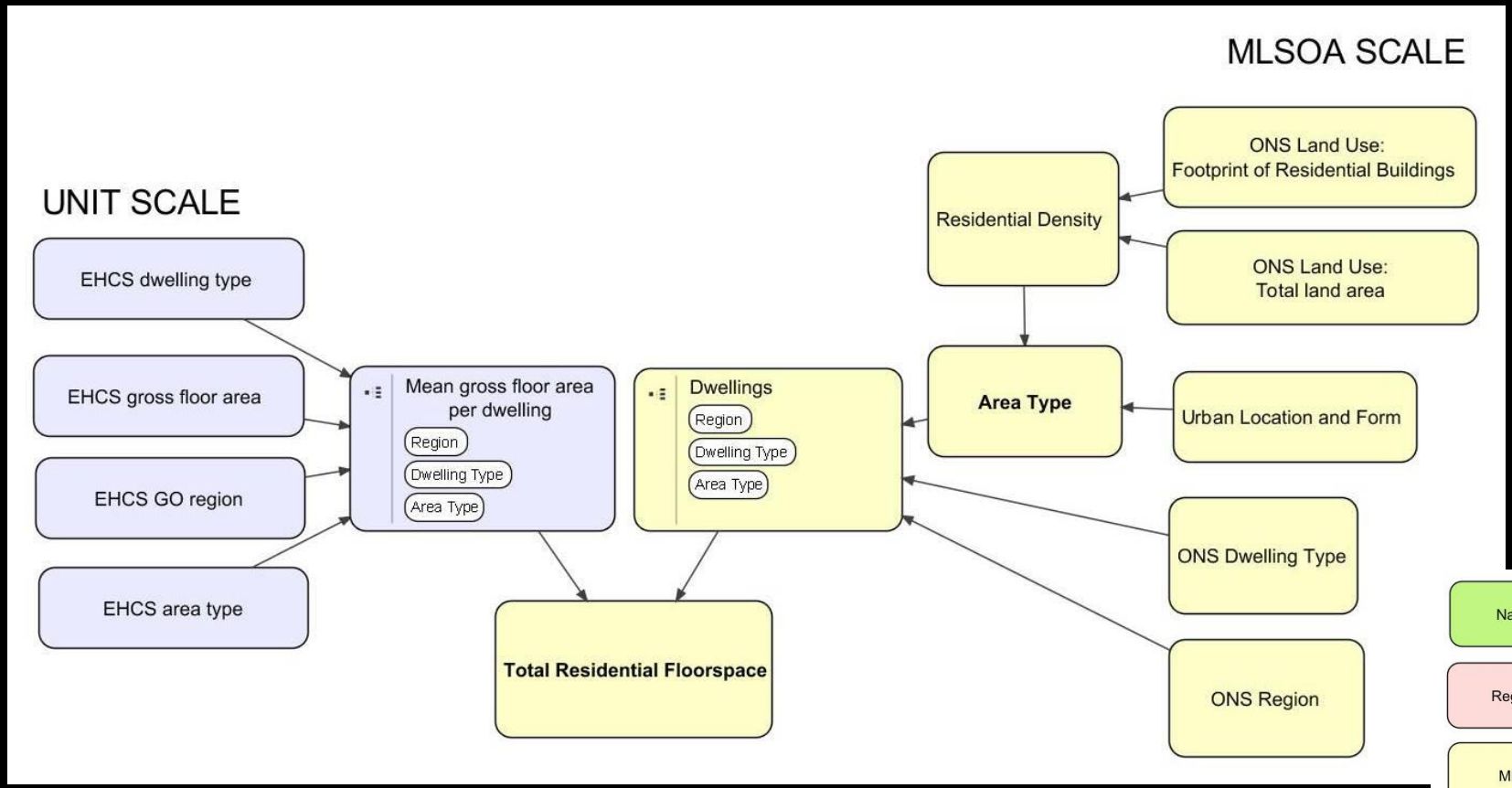
EHCS/RPI/ONS Derived Dataset (MLSOA scale)

DECC Energy Data (MLSOA scale)

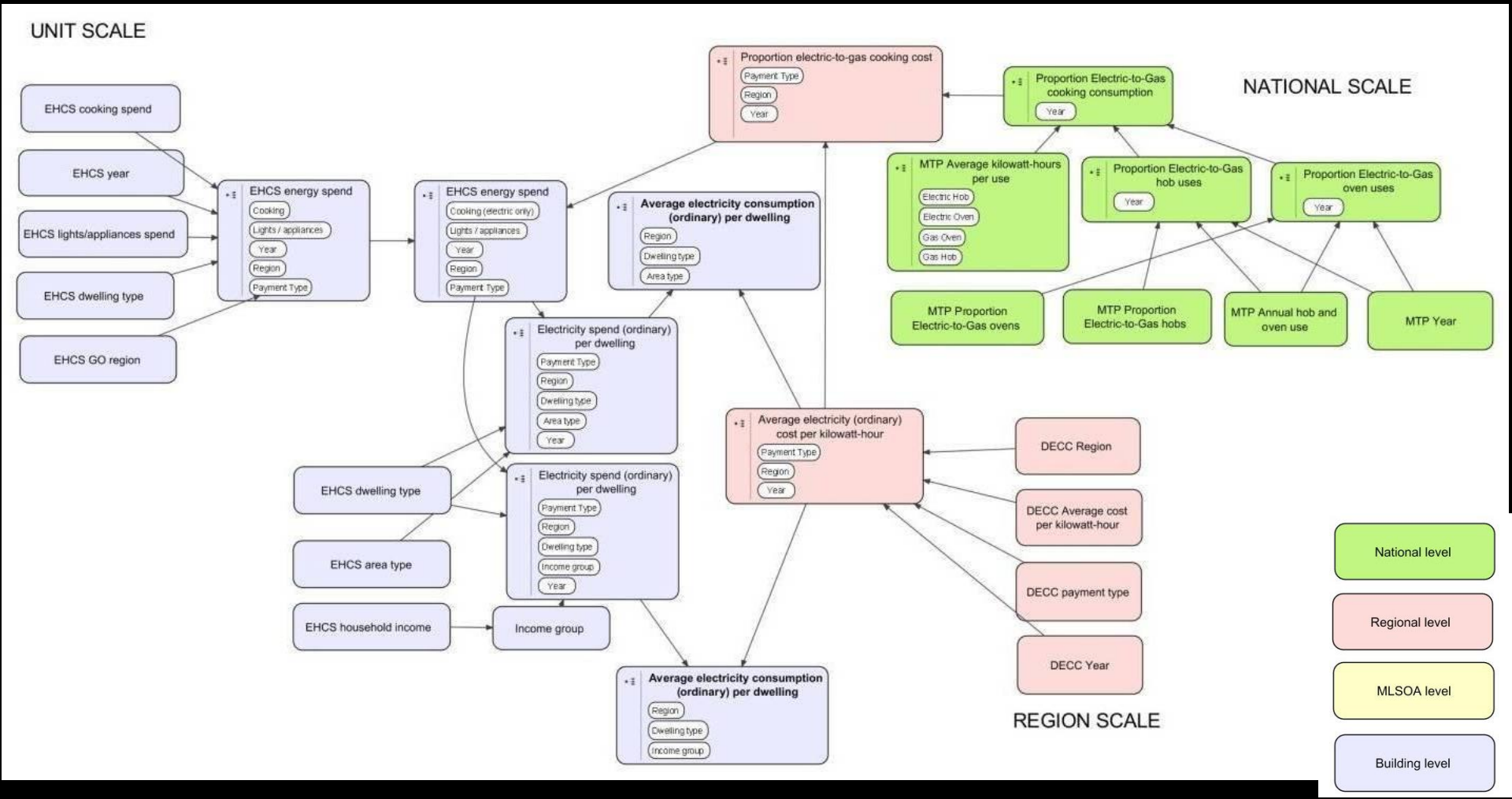
Methodology (2)



Methodology (3)



Methodology (4)



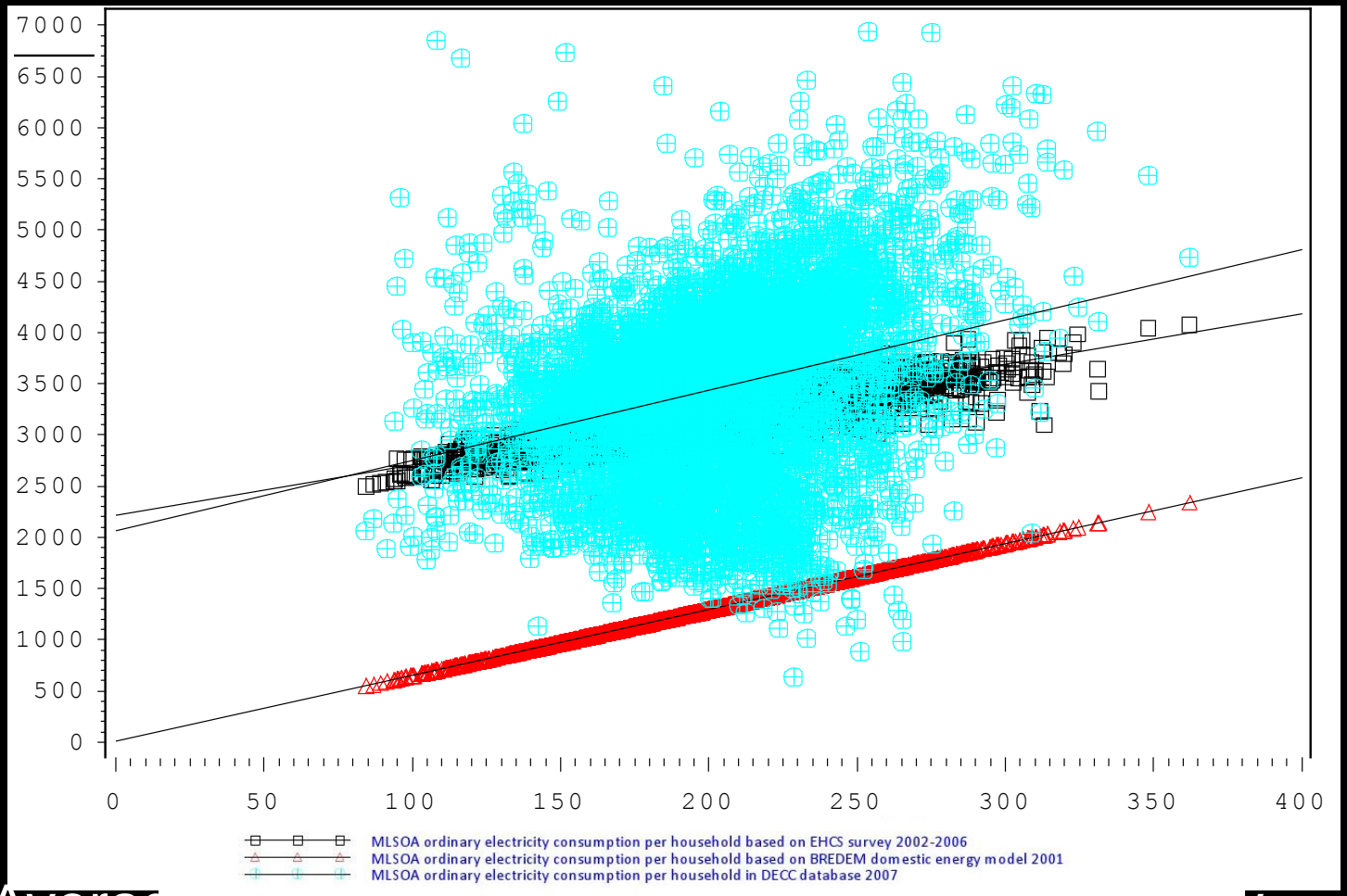
Results

Rosalind Nashashibi,
Eyeballing - 2005

Results (1)

- The planning and building regulations in force from 2001-2005 underestimated the ordinary electricity consumption of households by half

Results (1)

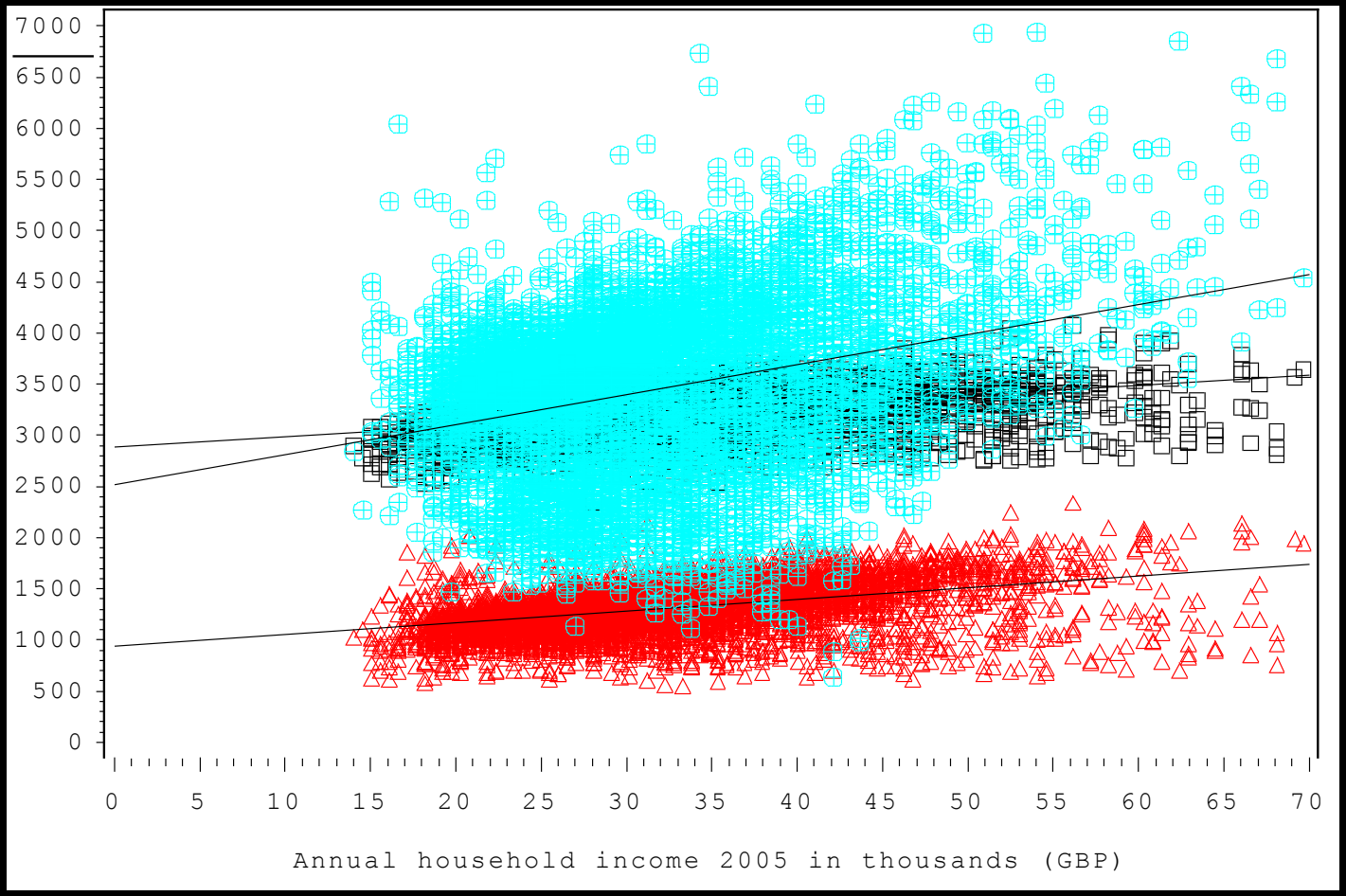


Average electricity consumption per household v
Floor area times number of occupants per household

Results (2)

- Both BREDEM and the survey data show a slower increase in consumption in proportion to income than the DECC data indicates....

Results (2)

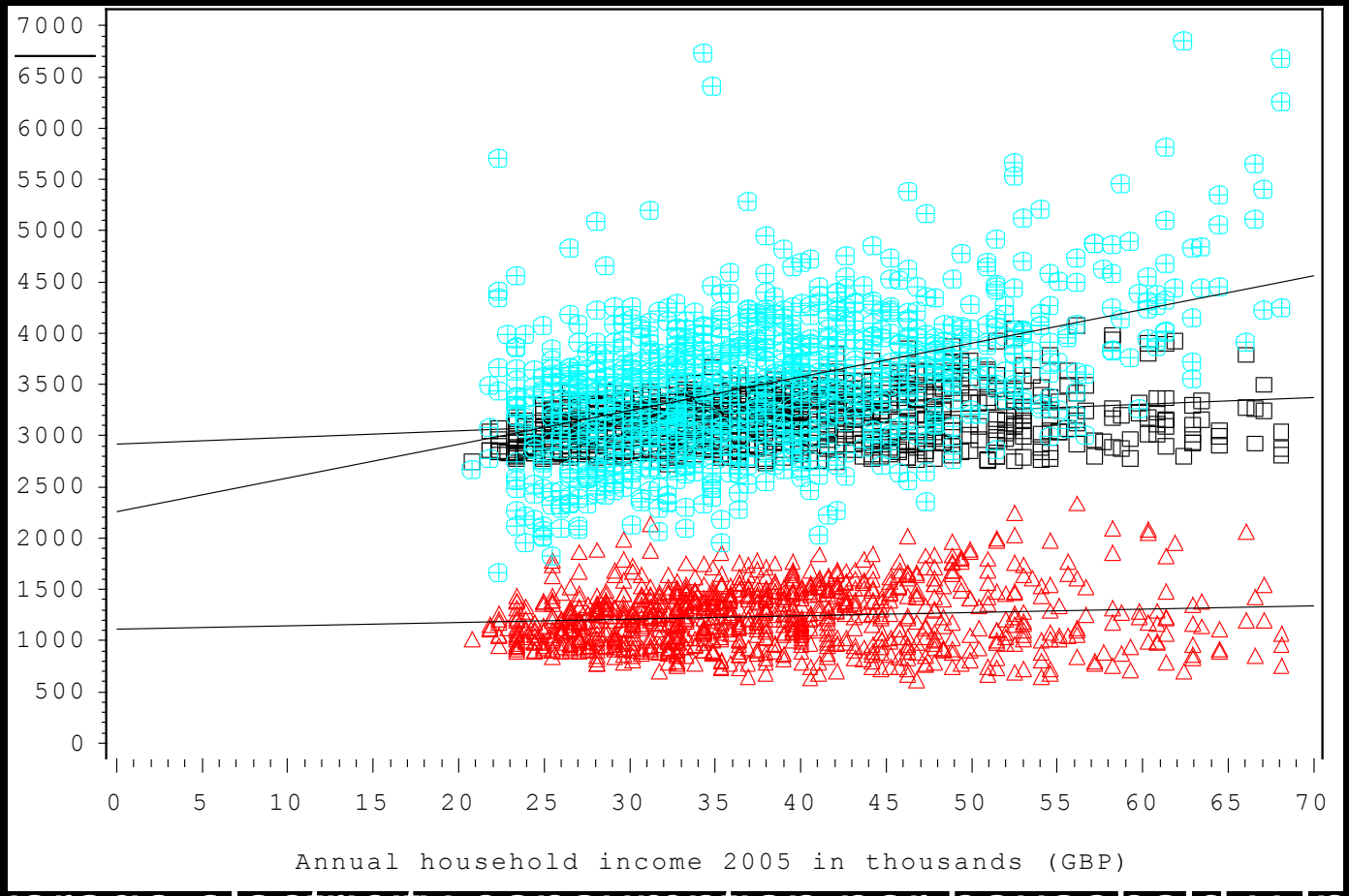


Average electricity consumption per household v Income per

Results (2)

- ...especially in heavily urbanised areas. Remember this is the spatial version of the survey data.

Results (2)

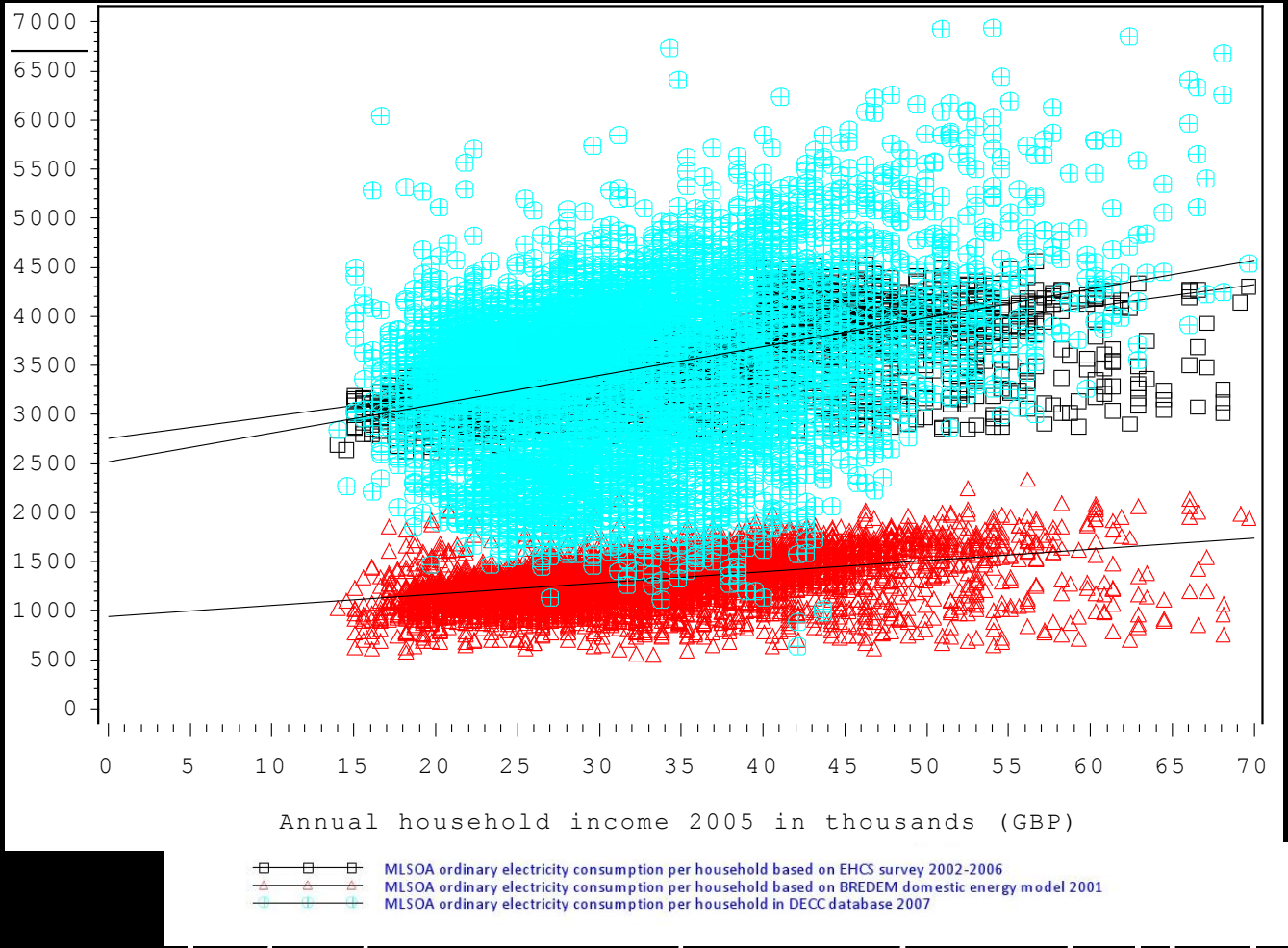


Average electricity consumption per household v Income per household (Note: Survey - spatial version, London region only)

Results (3)

- Using the income version of the survey data, the EHCS and BREDEM estimates show similar increases in energy use based on income compared with the DECC data...

Results (3)

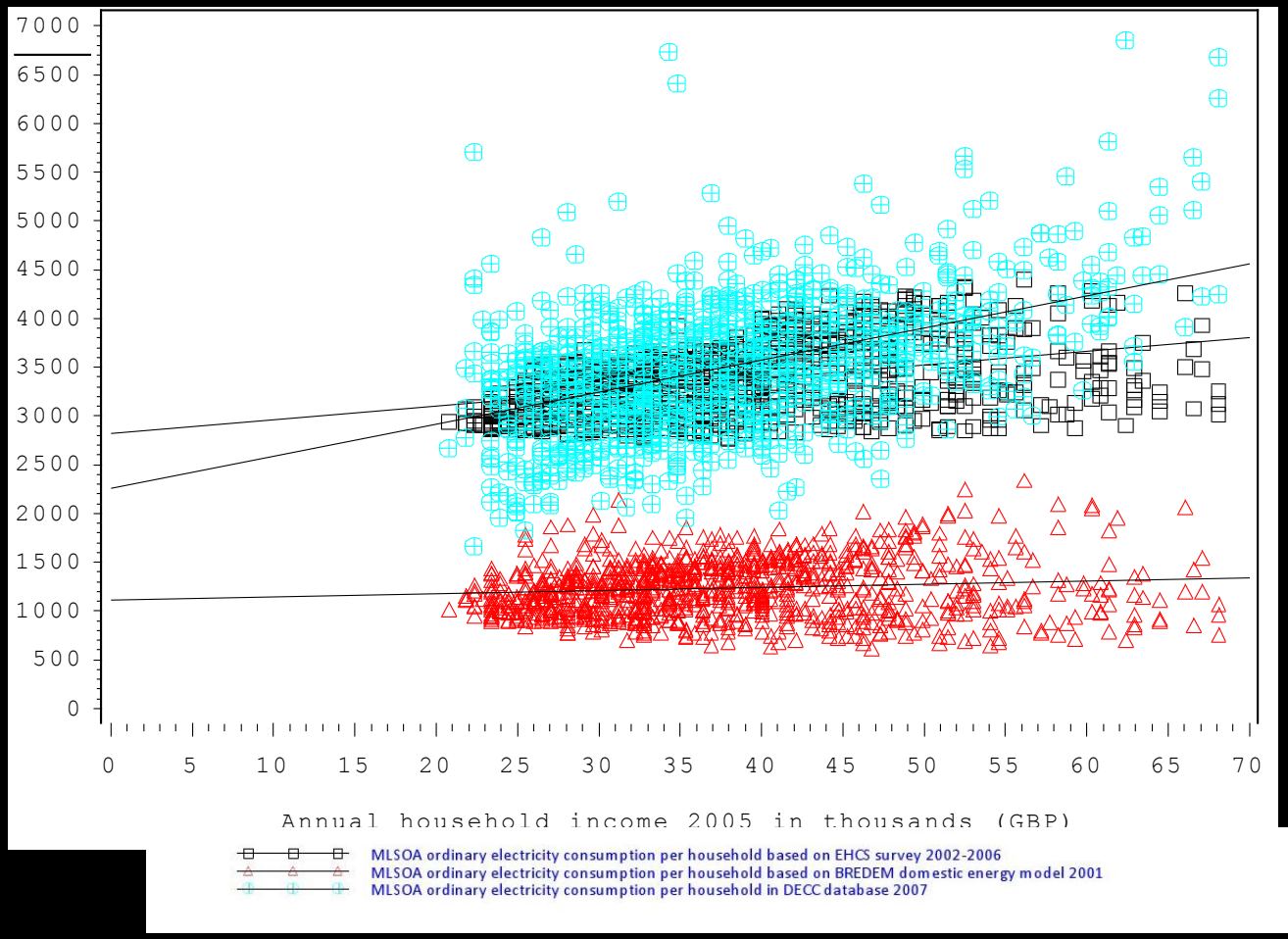


Average electricity consumption per household v Income per household (Note: Survey - income version, all England)

Results (3)

- ... in the London region, however, there is little relationship between income and energy use in the EHCS survey data and in the BREDEM model estimates of energy use.

Results (3)



Average electricity consumption per household v Income per household (Note: Survey - income version, London Region only)

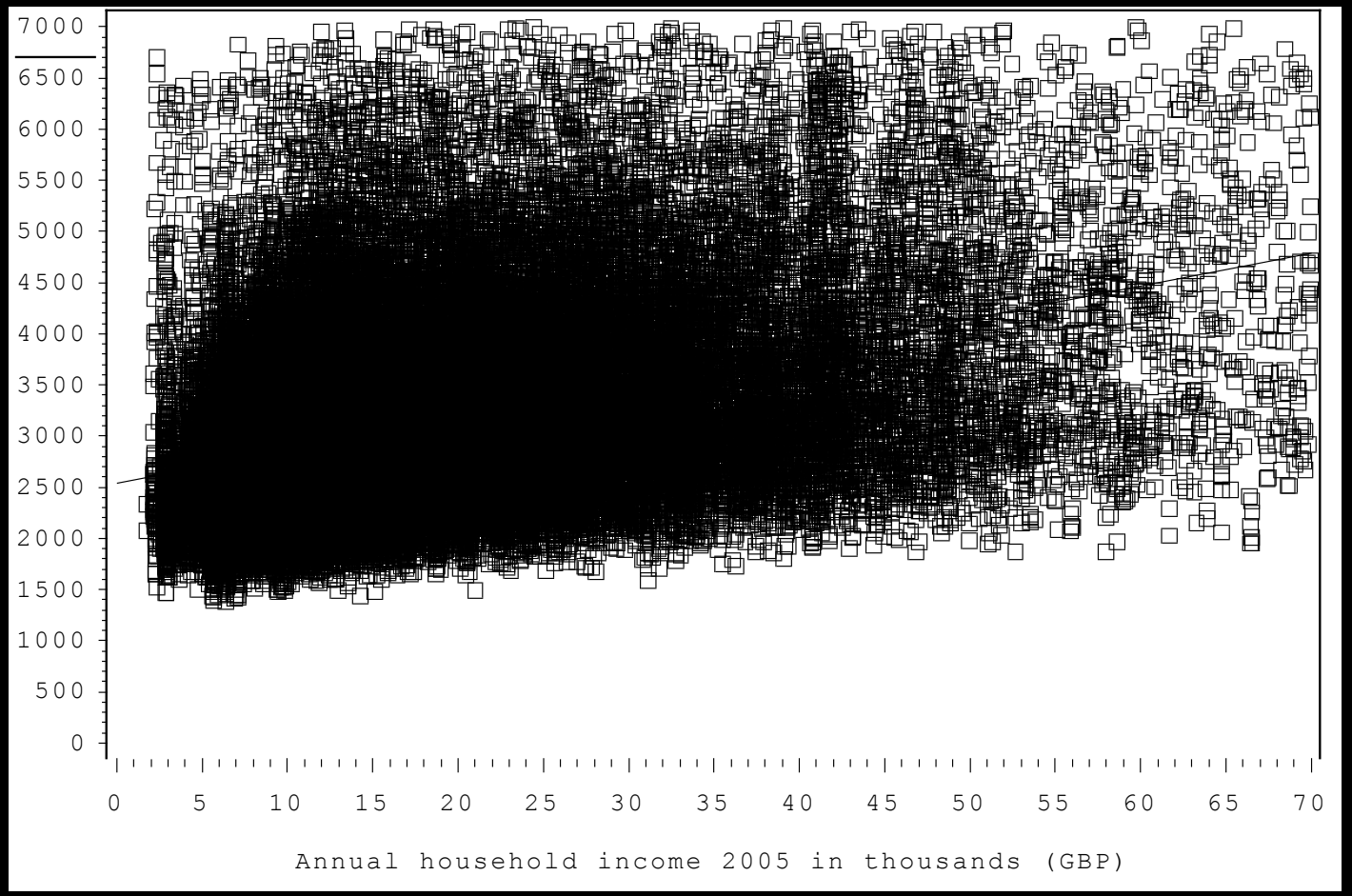
Problems and analysis

Charles Avery, *Untitled (Chesches Players outside the*

Problems and analysis (1)

- The survey deliberately had a huge spread of energy use and incomes!

Problems and analysis (1)



Ordinary electricity use v
Income in each EHCS surveyed

Problems and analysis (2)

- The survey had more lower and middle income groups, especially in London

Problems and analysis (2)

Region	Household Income – EHCS 2003-06 average	Household Income – 2004-05 Income tax report	% Difference
North East	15,715	19,127	17.8%
North West	17,778	20,483	13.2%
Yorkshire and the Humber	17,481	20,247	13.7%
East Midlands	18,573	20,868	11.0%
West Midlands	18,500	20,535	9.9%
East of England	22,115	24,401	9.4%
London	22,617	29,947	24.5%
South East	24,388	26,328	7.4%
South West	20,651	20,954	1.4%

Problems and analysis (3)

- The index of net household wealth per head more than doubled between the early 1990s when the BREDEM 2001 version was first in development, and the mid-2000 when the EHCS and DECC data was taken. Is this a 1:1 relationship?

Further work

- Isolating datasets that address low income and high income households and their energy use
- Investigating increasing household wealth as an adjustor of established domestic energy models
- Examining differences between heavily urbanised and other areas in relation to income and other socioeconomic factors

End of slide show

Lucy Skaer, *Zero Table*, 2008