

Information paper – 11

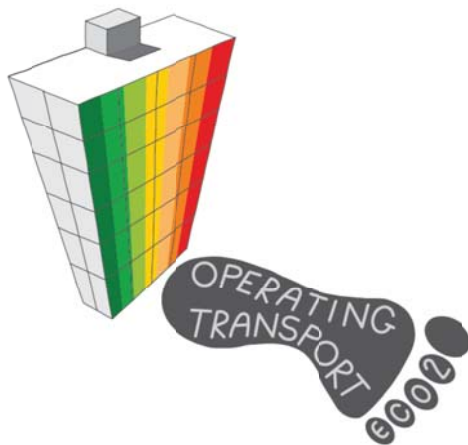
Comparison of building energy benchmark to total UK energy

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This information paper is one of a series of papers written during the preparation of the book **What Colour is Your Building?** (www.whatcolourisyourbuilding.com). The papers do not form part of the book and have not been peer reviewed. They provide further technical detail, analysis and information to support statements made in the book. All of the papers can be downloaded from www.wholecarbonfootprint.com.

Comparison of building energy benchmark to total UK energy

This information paper provides a crude comparison of the proposed office energy benchmark with total UK energy data and ‘cartoon Britain’ in David MacKay’s book *Sustainable Energy – without the hot air*.¹

1. COMPARISON WITH CARTOON BRITAIN

In Chapter 2 of the book a benchmark of 100 kgCO₂e/m² was proposed to represent a typical office building in the UK. Table 1 shows the assumed breakdown in energy consumption, and assuming an occupancy of 1 person per 15 m² of GIA the energy consumption per person is 9 kWh/day.

	Electricity	Gas	Total
kWh/m ²	140	80	220
kWh/person/year	2,100	1,200	3,300
kWh/day per person	6	3	9

Table 1 Office energy benchmark converted into kWh/day per person

In David Mackay’s book *Sustainable Energy - without the hot air* he uses ‘kWh/day per person’ so that all types of energy can be presented in a consistent ‘*nice human sized unit*’ that is also transportable between countries. He estimates the energy consumption in the UK to be 195 kWh/day per person which includes the stuff we use (embodied energy in products and buildings) some of which comes from overseas. This importing of emissions was discussed briefly in Chapter 1 of the book.

Mackay then defines a cartoon version of Britain in 2008 as having a primary energy input of 125 kWh/day per person which correlates with the UNDP Human Development Report 2007 and the Digest of United Kingdom Energy Statistics (DUKES) 2006. The breakdown is given as:

- Transport 40 kWh/day (32%)
- Heating 40 kWh/day (32%)
- Electricity consumption 18 kWh/day (14%)
- Losses in generating electricity 27 kWh/day (22%)

The benchmark building in the book has an energy consumption of 9 kWh/day per person (refer Table 1) with a split of 6 kWh/day for electricity and 3 kWh/day for heating. This equates to 33% of the cartoon electricity consumption (18kWh/day) which appears reasonable since, with lunch breaks we spend about 50 hours of a typical week working (50 / 168 hours = 30%). The

benchmark gas consumption is a small component of the cartoon total which is not surprising as heating (air and water) is much lower in offices compared to houses and other building types.

2. CARTOON BRITAIN IN 2012

Cartoon Britain’s primary energy of 125 kWh/d/p was based on 244,000 ktoe and 60 million population in 2005. How does Cartoon Britain compare to more recent energy data for 2011 from DUKES 2012 with a resident population 63.2 million?²

Table 1 shows primary and final user energy consumption.³ The kWh/day per person has reduced to 107 kWh/m². The global economic crisis and downturn, which started in 2008, is likely to be responsible for much of the 13% reduction in the UK’s energy use (244,000 ktoe to 212,400 ktoe). When the economy picks up expect to see the energy consumption rise also. It is difficult to generate or spend money without also increasing energy.⁴

	Primary energy			Final user	
	ktoe	GWh		GWh	
Solid fuels	33,144	385,465	16%	17,973	1%
Petroleum	76,015	884,054	36%	740,529	46%
Gas	77,799	904,802	37%	500,910	31%
Electricity	18,003	209,375	8%	318,009	20%
Renewables	7,457	86,725	4%	29,668	2%
All fuels	212,418	2,470,421		1,607,089	
kWh/day/person		107		70	

Table 1 UK energy consumption by fuel type (primary and final user) in 2009 (source: DUKES 2012)

3. BREAKDOWN OF UK ENERGY BY SECTOR

In considering buildings we are mainly interested in the final user energy consumption rather than the UK’s total energy balance (which was the aim of *Without Hot Air*). The CO₂e emissions factors already take into account the energy ‘lost’ in converting primary energy (such as coal) into secondary energy (electricity).

Table 2 shows the share of energy consumption in 2011 by users (primary and secondary). Table 3 shows the energy consumption by sector and fuel source in kWh/person/day based on the percentage split in energy consumption from Table 2, the final user energy consumption (GWh) in Table 1, and a population of 63.2 million.

	Percentage of each fuel			
	Industry	Transport	Domestic	Others
Solid fuels	69%	0%	30%	1%
Petroleum	7%	86%	4%	2%
Gas	25%	-	59%	15%
Electricity	32%	1%	35%	31%
Renewables	21%	44%	22%	13%
All fuels	19%	40%	28%	12%

Note: The consumption of primary fuels to generate electricity is hidden in this data. In 2009, every 1 MWh of electricity consumed by final users required 0.9 MWh of coal, 0.9 MWh of natural gas, 0.5 MWh of primary electricity (from nuclear, wind, hydro and imports) and 0.2 MWh from oil and renewables (e.g. biomass) combined.

Table 2 Primary and secondary fuels consumed by final users in 2011 – energy supplied basis
(Source: Table 1D from DUKES 2012)

	Consumption (kWh/day per person)				
	Industry	Transport	Domestic	Others	Total
Solid fuels	1	0	0	0	1
Petroleum	2	28	1	1	32
Gas	5	0	13	3	21
Electricity	4	0	5	4	14
Renewables	0	1	0	0	1
Total	13	28	20	8	69
	19%	40%	28%	12%	

Table 3 Final user energy consumption (kWh/person/day) in UK in 2011

This crude analysis using DUKES 2012 data suggests a typical energy consumption in non-domestic buildings (‘others’) of 8 kWh/d per person. The benchmark office building (100 kgCO₂e/m² of GIA) is 9 kWh/d per person which is reasonably comparable given the various sweeping assumptions made in undertaking this exercise.

Notes

All websites were accessed on 15 June 2013 unless noted otherwise.

1. The whole book can be downloaded for free from www.withouthotair.com.
2. Population on census night 2011. www.ons.gov.uk/ons/rel/census/2011-census/population-and-household-estimates-for-the-united-kingdom/stb-2011-census--population-estimates-for-the-united-kingdom.html.
3. The primary energy data is taken from Table 1.1 in Digest of UK Energy Statistics (DUKES) 2012. The final user values are taken from the ‘final consumption’ data in various tables and converted to GWh as shown below:

Fuel	Final consumption	Units	Conversion factor	GWh		DUKES 2012 reference
Solid fuels	2,453	million tonnes of coal	7327	17,973	1%	Table 2.1
Petroleum	63,674	thousand tonnes of oil	11630	740,529	46%	Table 3.2
Gas	500,910	GWh	1	500,910	31%	Table 4.1
Electricity	318,009	GWh	1	318,009	20%	Table 5.1
Renewables	2,551	thousand tonnes of oil	11630	29,668	2%	Table 6.1
All fuels				1,607,089	100%	

www.gov.uk/government/organisations/department-of-energy-climate-change/series/digest-of-uk-energy-statistics-dukes

4. In *How Bad Are Bananas?* by Mike Berners-Lee (published by Profile Books 2010) he states ‘unless you are deliberately investing in something that reduces emissions elsewhere, it is just about impossible to spend money without increasing your carbon footprint. Everything causes ripples of economic activity and with it emissions. So with wealth comes carbon responsibility.’

He provides examples of emissions (kgCO₂e) due to spending £1 depend what you buy:

- -330 kg on a well-executed rainforest preservation project
- -3 kg on solar panels
- 0.16 kg on professional advice
- 0.72 kg on a car
- 0.93 kg for typical supermarket trolley of food
- 1.7 kg on petrol for a car
- 4.6 kg on flights
- 6 kg on electricity bills
- 10 kg for budget flights

The inevitable legal bit

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