

# WHAT COLOUR *is* YOUR BUILDING?

Measuring and reducing the energy  
and carbon footprint of buildings

David H. Clark



## Appendix F Transport carbon data

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## Appendix F: Transport carbon data

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*I have found out that there ain't no surer way to find out whether you like people or hate them than to travel with them.*

Mark Twain, American author.

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## F1. TRAVEL SURVEY DATA

The data used in Figure 4.3 in Chapter 4 was obtained from various published travel surveys and studies. These are summarised in Figure F.1 and described in more detail below. It should be noted that the travel surveys use different survey techniques and different CO<sub>2</sub> emission factors for travel modes, which means that direct comparison between surveys is not possible. Instead, the intention is to put the kgCO<sub>2</sub>e/person into perspective so that it can be compared to operating and embodied carbon.

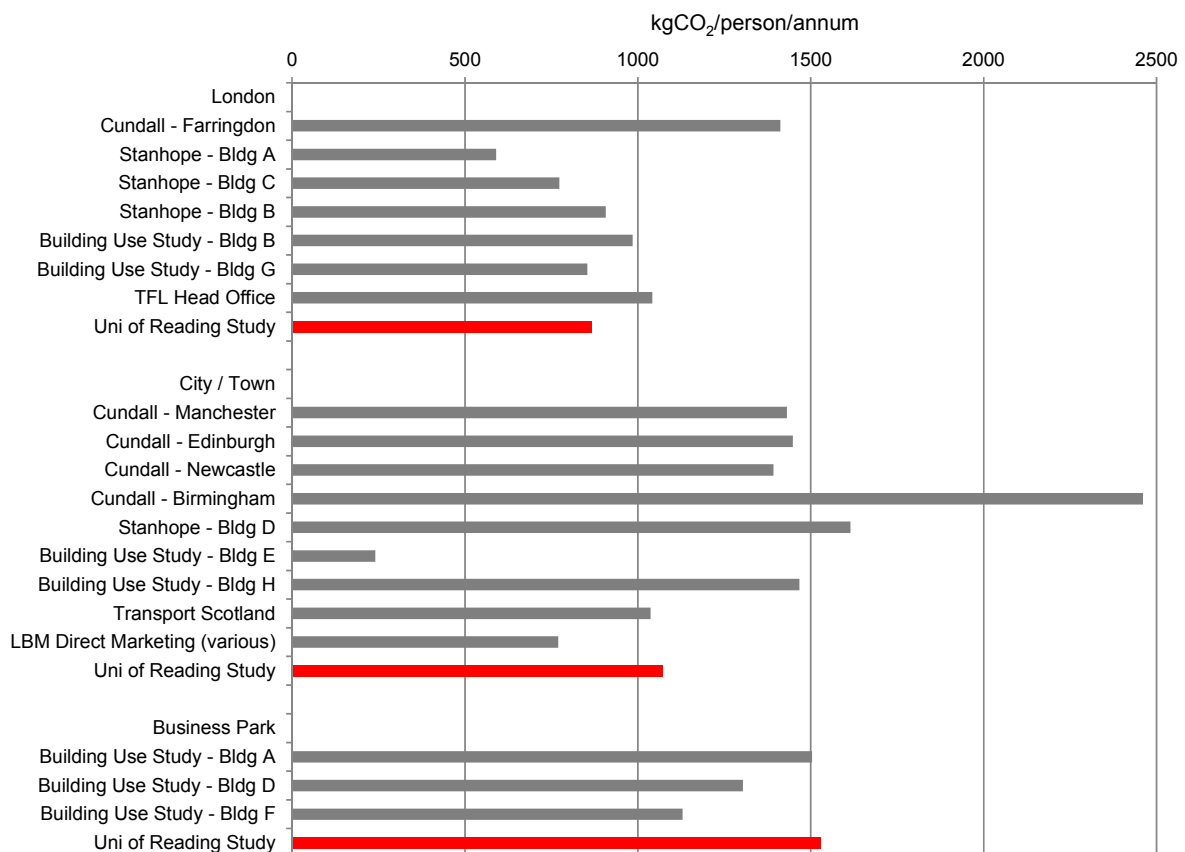


Fig F.1 Selection of travel survey and commuting study results

### Stanhope

In their 2010 report *Energy Labelling: a broader perspective*,<sup>1</sup> development company Stanhope examined four of their office developments, comparing standard assessment methods with a wider analysis of the carbon impacts of occupancy, commuter travel and embodied energy. This showed that ‘*The carbon emissions of the commute represents between a quarter (city centre commute) and over a half (suburban commute) of the operational energy from the buildings surveyed.*’ The average for the three London offices was 757 kgCO<sub>2</sub>/person.

Building	A	B	C	D
Location	Central	Central	Urban	Suburban
Location category	London	London	London	City / Town
Commuting (kgCO <sub>2</sub> /person)	590	773	907	1615
Occupancy (person per m <sup>2</sup> of NIA)	13	19	14	15
Operational Energy (kgCO <sub>2</sub> /m <sup>2</sup> of NIA)	270	128	178	209
Operating Energy (kgCO <sub>2</sub> /person)	3,510	2,432	2,492	3,135
% of commute to actual operating	17%	31%	36%	51%
Average one way distance (km)	28	36	19	23
Public, cycle or walk	98%	98%	68%	6%
Car, motorcycle, taxi	2%	2%	32%	94%
Car parking ratio (car space per m <sup>2</sup> )	1: 2,000m <sup>2</sup>	1: 1,500m <sup>2</sup>	1: 100m <sup>2</sup>	1: 25m <sup>2</sup>

**Table F.1 Summary of Stanhope travel survey data (source: Stanhope)**

The CO<sub>2</sub> emission factors used in the Stanhope assessment are lower than those stated in Appendix B: lower by 22% for buses, 26% for underground, 42% for cars and 49% for rail. Consequently, the kgCO<sub>2</sub>/person in Figure F.1 are likely to be at least 30% higher if Appendix B factors are used.

### Building use studies 2008

In 2008, Kate Fewson and Adrian Leaman examined eight British office buildings to see how they compared in terms of CO<sub>2</sub> contributions made by journeys to work<sup>2</sup> – refer to Table F.2. The offices were selected to cover a mixture of types and locations, ranging from large city centre offices to smaller buildings in semi-rural and urban fringe/ring-road settings in England and Wales.

	Location	Category in Fig 4.3.	kgCO <sub>2</sub> per person per year	Main mode of journey to work			
				Car	Public transport	Cycle	Walk
A	Business park, city outskirts	Business Park	1,504	86%	6%	8%	0%
B	City centre	London	985	34%	52%	5%	10%
C	Centre of small town in rural setting*	City / Town	620	41%	10%	27%	23%
D	Business park in medium sized town*	Business Park	1,304	50%	26%	5%	18%
E	Academic offices in city centre	City / Town	241	17%	3%	53%	27%
F	Business park, city outskirts*	Business Park	1,129	84%	5%	1%	8%
G	West London	London	854	16%	63%	10%	7%
H	Suburban fringe	City / Town	1,467	86%	4%	0%	10%

Green shading indicates where the transport mode accounts for at least 50% of all travel.

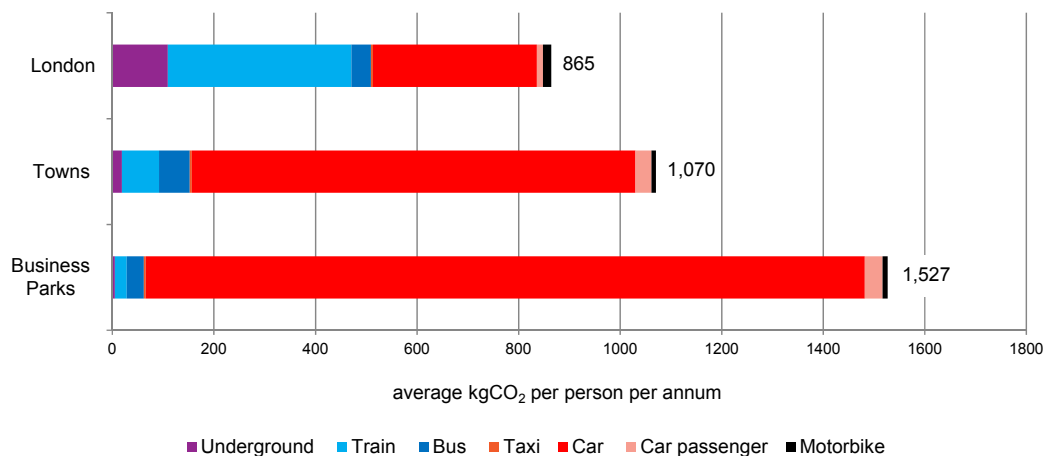
\* Buildings with green credentials in which the occupier has an environmental agenda

**Table F.2 Summary of building use studies travel survey data (source: Fewson & Leaman)**

The study buildings where over 80% of people were commuting to work by car (A, F and H) were up to six times worse for commuting-related CO<sub>2</sub> emissions than those where 80% walk or cycle (E). The study also suggested that *‘buildings with occupiers with a committed green agenda are likely to get commuting-related emissions down by a half, even if they have locational problems, such as being located on an out-of-town business park with relatively poor public transport where the temptation to drive is overwhelming.’*

University of Reading research paper

A research paper in 2011 by Peter Wyatt<sup>3</sup> used the 2001 Census Special Workplace Statistics (which record people’s residences, usual workplaces and modes of transport between them, distances travelled and modes of travel) to calculate commuting emissions for a sample of city centre and out-of-town office locations. Figure F.2 shows a summary of the results. The census does not distinguish between workers employed in offices, retail, factories, or other environments. This may help explain the low proportion of rail-based commuting to and from town centres.



**Fig F.2 Summary of University of Reading census travel study results**

The CO<sub>2</sub> emission factors used in the University of Reading assessment are different to those stated in Appendix B. The kgCO<sub>2</sub>/person calculated using the factors in this book would be approximately 936, 1,234 and 1,750 for the three categories in Figure F.2, an increase of 8% for London and 15% for towns and business parks.

### EDF Energy research project

Research commissioned by EDF Energy in 2011 and compiled by Imperial College London<sup>4</sup> used data from the 2008 UK National Travel Survey to estimate rush hour carbon emissions (7am to 10am, 4pm to 7pm) in regions throughout the UK. The data was extrapolated from 8,094 household surveys and included business, commuting, school drop-off, leisure, shopping, visiting friends, and 'other'. The total CO<sub>2</sub> was calculated and then normalised for the number of people in each region. The results are therefore an average for a region and do not give an indication of the emissions for commuters to offices (which will typically involve longer travel distances than dropping children off at school or going shopping). Consequently the data hasn't been included in Figure 4.3 in Chapter 4.

However, the data is useful when comparing travel emissions between London boroughs and other urban area types. For example, the rural emissions are more than twice those of London boroughs. Table F.3 summarises the typical daily rush-hour CO<sub>2</sub> emissions for each region, converted into annual emissions by multiplying by 230 days.

	Urban area type	(kgCO <sub>2</sub> /capita)	kgCO <sub>2</sub> /person/year	Increase
1	London boroughs	1.35	311	
2	Metropolitan built-up areas	1.49	343	10%
3	Other urban over 250k	1.96	451	45%
4	Urban over 25k to 250k	2.03	467	50%
5	Urban over 10k to 25k	2.47	568	83%
6	Urban over 3k to 10k	2.86	658	112%
7	Rural	3.1	713	130%

**Table F.3** Average daily and annual rush-hour emissions in each urban area type (source: Keirstead & Brandon)

### Other travel surveys

Table F.4 summarises other sources of travel survey data used in Figure 4.3.

Organisation	Source of data	Type	Reported data	kgCO <sub>2</sub> per person per annum
Transport for London Head Office	The TfL Travel Plan <a href="http://www.tfl.gov.uk/assets/downloads/the-tfl-travel-plan.pdf">www.tfl.gov.uk/assets/downloads/the-tfl-travel-plan.pdf</a>	Central London	4.53 kgCO <sub>2</sub> /person/day	1,060
Transport Scotland	Travel Plan 2010-2013 <a href="http://www.transportscotland.gov.uk/files/documents/reports/j11995/j11995.pdf">www.transportscotland.gov.uk/files/documents/reports/j11995/j11995.pdf</a>	Regional City Centre	-	1,037
LBM Direct Marketing Ltd	Carbon Footprint 2008-09 <a href="http://www.lbm.co.uk/Public/content/about/LBM%20Carbon%20Footprint%20report.pdf">www.lbm.co.uk/Public/content/about/LBM%20Carbon%20Footprint%20report.pdf</a>	various	1245 tCO <sub>2</sub> for 1616 staff	770

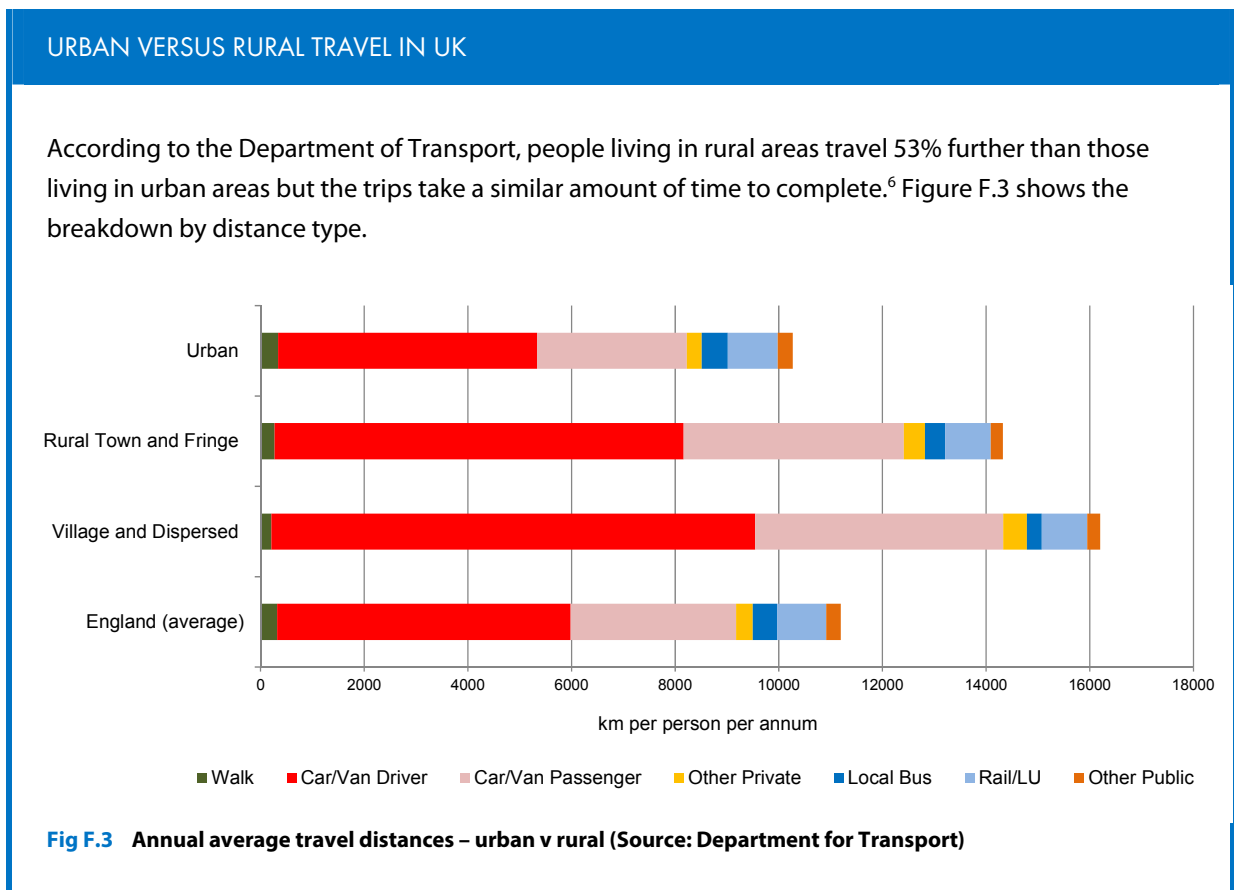
**Table F.4** Summary of various other UK travel surveys

British Council for Offices (BCO)

In the BCO report *Whole-Life Carbon Footprint Measurement & Offices: Executive Summary*,<sup>5</sup> commuting emissions for generic office locations were expressed in kgCO<sub>2</sub>/m<sup>2</sup> based on 60 years and an occupancy of 1 person per 15 m<sup>2</sup>. Table F.5 shows the values converted into kgCO<sub>2</sub> per person per annum. The values are substantially lower than other office travel survey findings, and as the data sources are not clear, they have not been included in Figure 4.3.

Location type	Bus	Train	Car	kgCO <sub>2</sub> /person
Central London	72	144	96	312
Regional city centre	72	96	288	456
Out-of-town business park	72	36	672	780

**Table F.5** BCO whole life carbon report transport data (source: BCO)



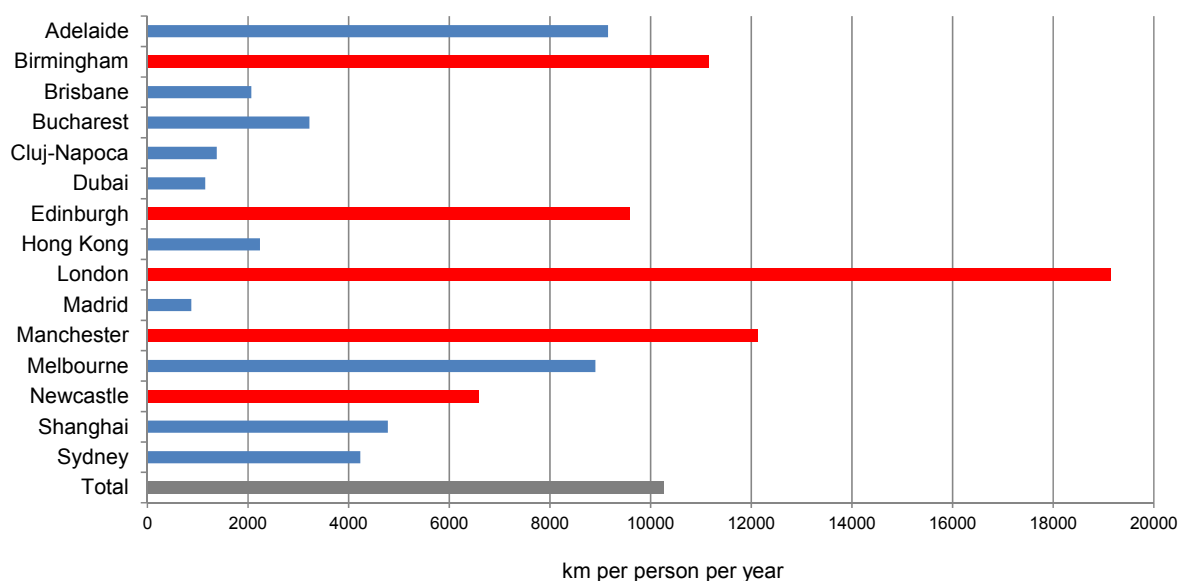
## F2. CUNDALL OFFICE TRAVEL SURVEY

A commuting travel survey of Cundall employees was undertaken in September 2011 and had an average response rate of 60%. The average annual emissions globally were 1.2 tCO<sub>2</sub>/person. In the UK, the average emissions were 1.5 tCO<sub>2</sub>e/person while in Australia they were 0.7 tCO<sub>2</sub>/person. The much lower emissions in Australia are primarily due to all the offices being located in city centres close to good public transport with no cheap car parking nearby. The breakdown of UK office emissions is shown in Table F.6

Office	Location type	No. of survey responses	% of staff	km/person per day (one way)	kgCO <sub>2</sub> e/ person/ annum
Birmingham	City / Town	18	58%	24	2,358
Edinburgh	City / Town	9	61%	21	1,387
Manchester	City / Town	18	67%	26	1,353
Newcastle	City / Town	63	71%	14	1,371
London	London	50	54%	42	1,334

**Table F.6** Cundall UK office travel survey results 2011

All of the offices, except Birmingham, had similar emissions per person. The Newcastle office is located in an outer suburb with lots of free parking and has a high use of cars, but staff tend to live closer to the office and travel the least distance to work. London staff travel the furthest, more than double the average of the other UK offices, but the majority use public transport for all or part of their journey to work. Despite the Birmingham office being only a 10 minute walk from the main railway station, the emissions are dominated by staff driving to work. Figures F.4 to F.7 provide a graphical summary of the survey results.



**Fig F.4** Cundall travel survey – distance (km) per person per year



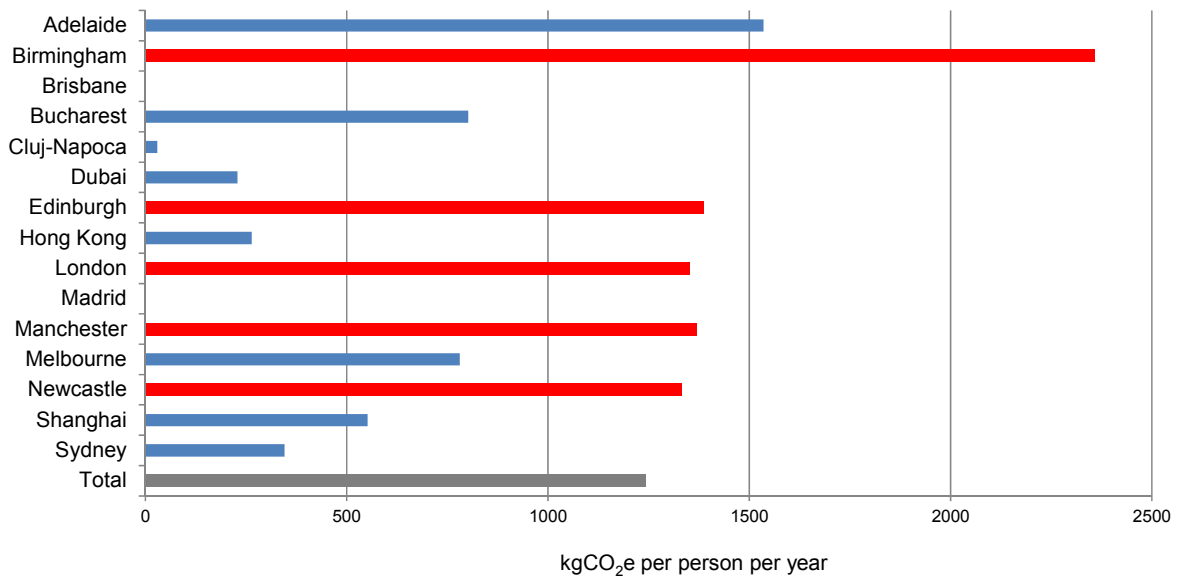


Fig F.5 Cundall travel survey – kgCO<sub>2</sub>e per person per year

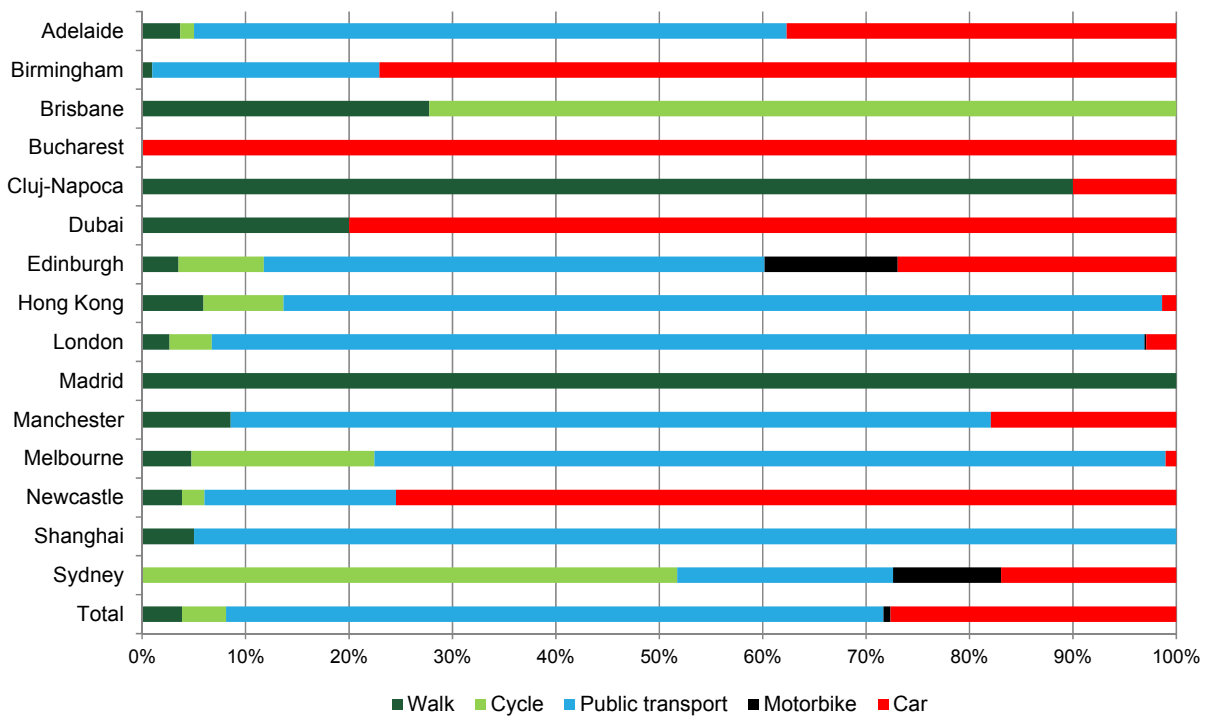
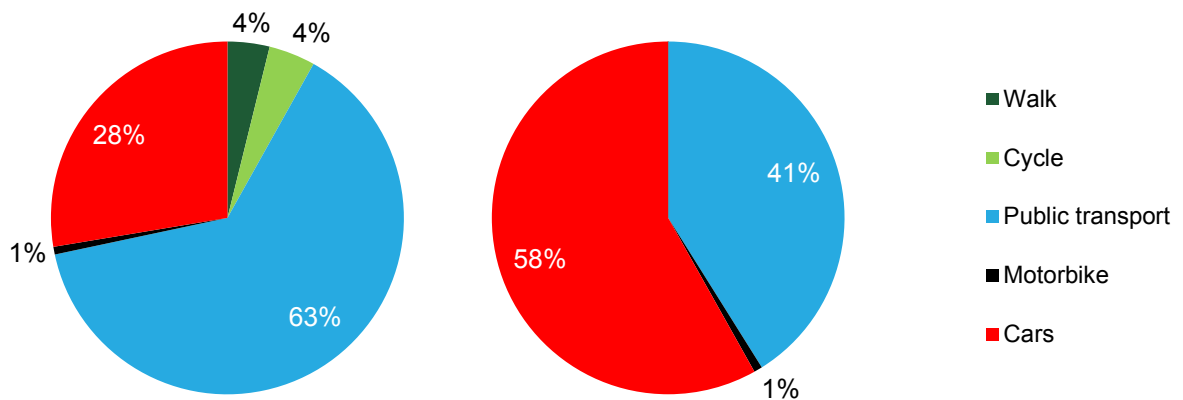


Fig F.6 Cundall travel survey – distance for each office by type



**Fig F.7** Cundall travel survey – split in travel mode by distance (left) and CO<sub>2</sub> (right)


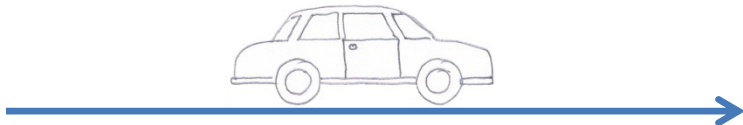
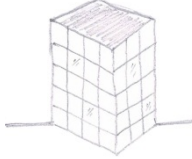
The travel survey was undertaken using Cundall's global intranet. It required three fields to be completed for each mode of transport used to get to work in a typical week (during the period 1 July 2010 and 30 June 2011):

- Mode of transport.
- Distance travelled (one way).
- No. of days this mode was used.



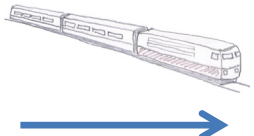

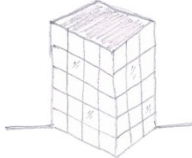
Figure F.8 shows the guidance that was given to respondents on how to treat:

- multiple modes of transport each day
- different modes of transport on different days (either in a typical week or averaged out over the year – e.g. cycle in summer, bus in winter).

Example 1: Single mode of transport - same every day

		
<b>Home</b>	Travel Leg 1	<b>Office</b>
Type	Car	
Distance	10 km	
No. of days	5	

Example 2: Multiple modes of transport - same every day

				
<b>Home</b>	Travel Leg 1	Travel Leg 2	Travel Leg 3	<b>Office</b>
Type	Walk	Train	Walk	
Distance	1 km	12 km	0.5 km	
No. of days	5	5	5	

Example 3: Multiple modes of transport - different every day





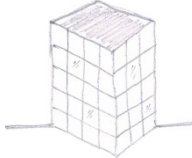


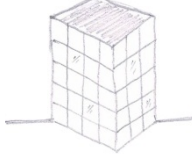
				
<b>Home</b>	Travel Leg 1	Travel Leg 2	Travel Leg 3	<b>Office</b>
Type	Walk	Bus	Walk	
Distance	1 km	6 km	0.5 km	
No. of days	3	3	3	
				
<b>Home</b>	Travel Leg 4			<b>Office</b>
Type	Cycle			
Distance	4 km			
No. of days	2			

Fig F.8 Cundall travel survey – guidance on how to enter travel modes and distances

### F3. BREEAM TRANSPORT SCORE FOR CUNDALL OFFICES

To estimate the BREEAM Transport category score in Figure 4.4 in Chapter 4, the data in Table F.7 was assessed against the criteria in BREEAM 2011 New Construction. It was assumed that a travel plan was available for each office.

Type	London	City / Town	City / Town	City / Town
Address	Kirby St, Farringdon	Portland Street, Manchester	Regent Centre, Gosforth	St Pauls Sq, Birmingham
GIA (m <sup>2</sup> )	1439	526	1481	649
No. of occupants	92	27	89	31
<b>Car parking</b>				
No. of car parking spaces provided for the tenant	0	0	>10	7
No. of free car parking spaces nearby	0	0	> 100	0
No. of paid car parking spaces nearby	> 300	> 300	n/a	> 100
<b>Cyclist facilities</b>				
Bike spaces	10	5	10	5
Showers & changing room	Yes	Yes	Yes	Yes
<b>Regular public transport routes within 500m</b>				
Train	> 10	> 10	0	2
Bus	> 10	> 10		
Tube	4	-	-	-
Tram / light rail	0	5	1	1
<b>Proximity to amenities</b>				
Shops, etc	Yes	Yes	No	No

**Table F.7 Cundall offices – car parking, cycling facilities and public transport**

The breakdown of BREEAM credits is shown in Table F.8.

	No. of points available	London	City / Town	City / Town	City / Town
		Farringdon	Manchester	Newcastle	Birmingham
Public transport accessibility	3	3	3	2	2
Proximity to amenities	1	1	1	1	1
Cyclist facilities*	2	0	0	0	0
Maximum car parking capacity	2	2	2	0	1
Travel plan	1	1	1	1	1
Total points	9	7	7	4	5
<b>Category score</b>	<b>100%</b>	<b>78%</b>	<b>78%</b>	<b>44%</b>	<b>56%</b>

\* all of the Cundall offices except Newcastle have facilities for cyclists (secure bike racks, showers and change rooms), but none comply with all of the strict BREEAM credit requirements for locker size, etc.

**Table F.8 Indicative BREEAM transport category score for Cundall offices**

## F4. TRANSPORT ASSESSMENT

National census data contains travel data for each census ward and region in the UK.<sup>7</sup> The two types of data that can be used to estimate transport emissions for offices are shown in Table F.9. Other proprietary databases which summarise the results of different travel surveys are available, such as TRICKS and TRAVEL, but these are not free.

Type	Comments
Distance travelled to work	<p>Data based on census wards and regions. The workplace population is defined as the people aged 16 to 74 who are in employment and whose usual place of work is in the area. The distance travelled to work is measured in kilometres of a straight line between the residence postcode and the workplace postcode.</p> <p>The data is expressed as percentage of travel distance within ranges (e.g. 13% travel between 5 and 10km). It does not separate out travel modes or types of business.</p>
Method of travel to work - daytime	<p>Data based on census wards and regions. The method of travel to work is for the longest part, by distance, of the usual journey to work.</p> <p>The data is expressed as the percentage of travel by method (e.g. 67% travel by car). It does not separate by type of business or distance travelled.</p>

**Table F.9 Sources of statistical data for travel in the UK**

The census data was used to estimate the travel emissions of the UK Cundall office locations. The calculation methodology was as follows:

- Calculate the average straight line distance travelled to work from the Census data by assuming the middle distance in each travel range (e.g. 5 km to 10 km = 7.5 km) and then multiply this by the percentage of people travelling that distance from the census data. Then multiply by 2 (for return trip) and 230 days (5 days x 46 weeks) per year.
- Assume the travel distance applies to each travel mode, ignoring the fact that walking will be for short distances and that trains tend to be longer, as there is no simple formula to guesstimate this.  
Determine the kgCO<sub>2</sub>/km emissions factor for each transport mode (refer to Table F.10).
- Calculate kgCO<sub>2</sub>e/person  
= SUM [Ave Distance (km) x Mode (%) x Emissions Factor (kgCO<sub>2</sub>e/km)]
- Multiply the result by an adjustment factor to reflect that distances given are in a straight line, and that commuting to and from offices may be higher than to other types of workplace. A factor of 2.0 was used but further research is required to determine an appropriate value.

The results of the analysis for each UK Cundall office are shown in Table F.11.

	UK kgCO <sub>2</sub> e/km	London kgCO <sub>2</sub> e/km
Underground, metro, light rail or tram	0.077	0.082
Train	0.067	
Bus, minibus or coach	0.150	0.100
Taxi or minicab	0.177	0.188
Driving a car or van	0.234	
Passenger in a car or van	0.117	
Motorcycle, scooter or moped	0.142	
Bicycle	0	
On foot	0	

**Table F.10** Transport CO<sub>2</sub>e emissions factors (from Appendix B)

Location	Birmingham	London	Manchester	Newcastle
Address	St Pauls Square	Kirby St, Farringdon	Portland Street	Regent Centre, Gosforth
Census Ward / Region	Birmingham	London	Manchester	Fawdon
<b>Distance to Work</b>				
Less than 2km (1km)	15%	17%	21%	13%
2km to less than 5km (3.5km)	23%	23%	32%	29%
5km to less than 10km (7.5km)	30%	28%	30%	39%
10km to less than 20km (15km)	19%	24%	10%	12%
20km to less than 30km (25km)	6%	5%	2%	2%
30km to less than 40km (35km)	2%	1%	1%	1%
40km to less than 60km (50km)	2%	1%	2%	1%
60km and over (70km)	3%	1%	2%	3%
<b>Average distance to work</b>	<b>5,223</b>	<b>4,405</b>	<b>3,847</b>	<b>4,287</b>
<b>Type of travel</b>				
Underground, metro, light rail or tram	0%	18%	3%	8%
Train	6%	19%	7%	1%
Bus, minibus or coach	19%	11%	17%	13%
Taxi or minicab	0%	1%	1%	1%
Driving a car or van	59%	37%	57%	61%
Passenger in a car or van	6%	3%	6%	8%
Motorcycle, scooter or moped	1%	2%	1%	1%
Bicycle	1%	2%	2%	1%
On Foot	8%	8%	7%	7%
kgCO <sub>2</sub> /person (unadjusted)	935	576	674	774
Adjustment factor	2	2	2	2
<b>kgCO<sub>2</sub>e/person</b>	<b>1,870</b>	<b>1,152</b>	<b>1,348</b>	<b>1,548</b>

**Table F.11** Estimate of kgCO<sub>2</sub>e/person for Cundall office locations using census data

Table F.12 summarises the data shown in Figure 4.4 in Chapter 4.

Cundall office	kgCO <sub>2</sub> e / person / annum			
	Birmingham	London	Manchester	Newcastle
2011 travel survey	2,358	1,353	1,371	1,334
Transport assessment method	1,870	1,152	1,348	1,548
BREEAM transport score	78%	78%	44%	56%

**Table F.12** Summary of transport data for Cundall offices

## Notes

All websites were accessed on 25 May 2013 unless noted otherwise.

1. [www.stanhopeplc.com/?page=42&id=601](http://www.stanhopeplc.com/?page=42&id=601) (downloaded on 20 Jan 2013).
2. *Comparing British office workers journeys-to-work*, September 2008 by Kate Fewson (Closed Loop Projects) and Adrian Leaman (Building Use Studies). [www.bsria.co.uk/news/journeys-to-work](http://www.bsria.co.uk/news/journeys-to-work)
3. *Business parks and town centre workplaces in England: a comparative analysis of commuting-related energy consumption* by Peter Wyatt, School of Real Estate & Planning, Henley Business School, University of Reading, May 2011. [www.reading.ac.uk/REP/fulltxt/0511.pdf](http://www.reading.ac.uk/REP/fulltxt/0511.pdf).
4. *Low Carbon Rush Hour summary report*, James Keirstead and Nigel Brandon, Imperial College London, 23 June 2011. [www.businessgreen.com/digital\\_assets/3138/Low\\_Carbon\\_Rush\\_Hour\\_summary\\_report.pdf](http://www.businessgreen.com/digital_assets/3138/Low_Carbon_Rush_Hour_summary_report.pdf). Also refer to [www.edfenergy.com/media-centre/press-news/Commuters-in-the-capital-](http://www.edfenergy.com/media-centre/press-news/Commuters-in-the-capital-found-to-release-the-lowest-rush-hour-carbon-emissions-of-any-region-in-the-UK.shtml)
5. *Whole-Life Carbon Footprint Measurement & Offices* for British Council for Offices By Angus McIntosh, King Sturge LLP & Gareth Roberts, Sturgis Carbon Profiling LLP, dated 17 May 2011.
6. *Transport and travel in rural and urban areas* published by DEFRA, 25 May 2011. [www.gov.uk/government/publications/transport-and-travel-in-rural-and-urban-areas](http://www.gov.uk/government/publications/transport-and-travel-in-rural-and-urban-areas)
7. Travel data from the UK national census can be downloaded from [www.neighbourhood.statistics.gov.uk/dissemination/](http://www.neighbourhood.statistics.gov.uk/dissemination/)