

Strategic Forum for  
Construction & Carbon  
Trust

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**Construction carbon  
15% target by 2012**

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Baseline carbon  
assessment for 2008

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# 1 Introduction

## 1.1 Project background

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In June 2008, the United Kingdom (UK) Government and the Strategic Forum for Construction jointly published the *Strategy for Sustainable Construction*. The strategy set overarching industry targets for England, as well as actions and deliverables that will contribute to the overarching targets.

For the Strategy's climate change mitigation theme, one of the deliverables is: *15% reduction in carbon emissions from construction processes and associated transport compared to 2008 levels*. The Strategic Forum is responsible for delivering this target by 2012.

The target shall be considered met if by 2012:

- a) absolute emissions (tonnes CO<sub>2</sub>e/annum) in the target scope are reduced by at least 15% by 2012; and
- b) emissions relative to contractors' output (tonnes CO<sub>2</sub>e/£ million/annum) in the target scope are reduced by at least 15% by 2012.

## 1.2 About this paper

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This paper presents the results of the 2008 baseline carbon assessment, which is the reference point for measuring progress towards the target. This paper should be read in conjunction with the:

- **Scoping paper**, which provides the rationale for the boundary of the target and identifies the links between this project and other carbon reduction policies and programmes in the UK and the European Union; and
- **Data and methodology paper**, which sets out the methodology and data sets to be used to calculate annual greenhouse gas (GHG) emissions.

This paper has been produced to inform a road map for action, to be developed in consultation with the Carbon Sub-Group. The Carbon Sub-Group comprises representatives of Government departments, public bodies, trade associations and private companies. Its role is to ensure that the project reflects the sector's drivers, objectives, existing systems and initiatives, and available data sets.

## 2 Results of baseline assessment

### 2.1 Overall results

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All results shown in this section should be reviewed with reference to the key uncertainties described in Section 3. Results are provided to three significant figures.

Table 1 summarises results by construction process and region. The breakdown of emissions for Great Britain is shown graphically in Figure 1. The Great Britain breakdown is similar to that of England, Wales and Scotland, so Figure 1 can be considered a typical breakdown. Great Britain has been used in all summary figures because the Great Britain data set is more detailed than for England, Wales and Scotland.

Figure 2 also shows the emissions breakdown for Great Britain but excludes business travel emissions. A large proportion of business travel emissions may be due to air travel, which may not be directly related to construction projects in the UK. Non-domestic air travel cannot be separated out from the assessment because not enough detail is provided in the primary data.

**Table 1 Summary of results by construction process and region for the calendar year 2008**

	England	Wales	Scotland	Northern Ireland	Great Britain <sup>1</sup>	UK <sup>2</sup>
<b>Contractors' output</b> (£ million)	106,579	4,633	10,751	3,249	123,584	125,513
<b>Site activities</b> (tonnes CO <sub>2</sub> , % of regional emissions total)	1,710,000 (34%)	86,300 (35%)	195,000 (36%)		2,010,000 (34%)	
<b>Freight transport</b> (tonnes CO <sub>2</sub> , % of regional emissions total)	1,620,000 (32%)	77,300 (31%)	165,000 (30%)		1,860,000 (32%)	
<b>Waste removals</b> (tonnes CO <sub>2</sub> , % of regional emissions total)	525,000 (10%)	23,300 (9%)	53,500 (10%)		604,000 (10%)	
<b>Off-site assembly</b> (tonnes CO <sub>2</sub> , % of regional emissions total)	232,000 (5%)	11,100 (4%)	23,600 (4%)		268,000 (5%)	
<b>Off-site offices</b> (tonnes CO <sub>2</sub> , % of regional emissions total)	233,000 (5%)	11,800 (5%)	26,600 (5%)		274,000 (5%)	
<b>Business travel</b> (tonnes CO <sub>2</sub> , % of regional emissions total)	732,000 (15%)	37,000 (15%)	83,600 (15%)		861,000 (15%)	
<b>Total absolute emissions</b> (tonnes CO <sub>2</sub> , % of regional emissions total)	<b>5,050,000 (100%)</b>	<b>247,000 (100%)</b>	<b>547,000 (100%)</b>	<b>154,000<sup>3</sup> (100%)</b>	<b>5,870,000 (100%)</b>	<b>5,990,000<sup>4</sup> (100%)</b>
<b>Emissions per £ mil contractors' output</b> (tonnes CO <sub>2</sub> /£ mil)	<b>47</b>	<b>53</b>	<b>51</b>	<b>48<sup>5</sup></b>	<b>48</b>	<b>48</b>

Data sources for the results are listed in Appendix A.

<sup>1</sup> Great Britain data is an independent data set from England, Wales, Scotland and Northern Ireland so there are slight discrepancies

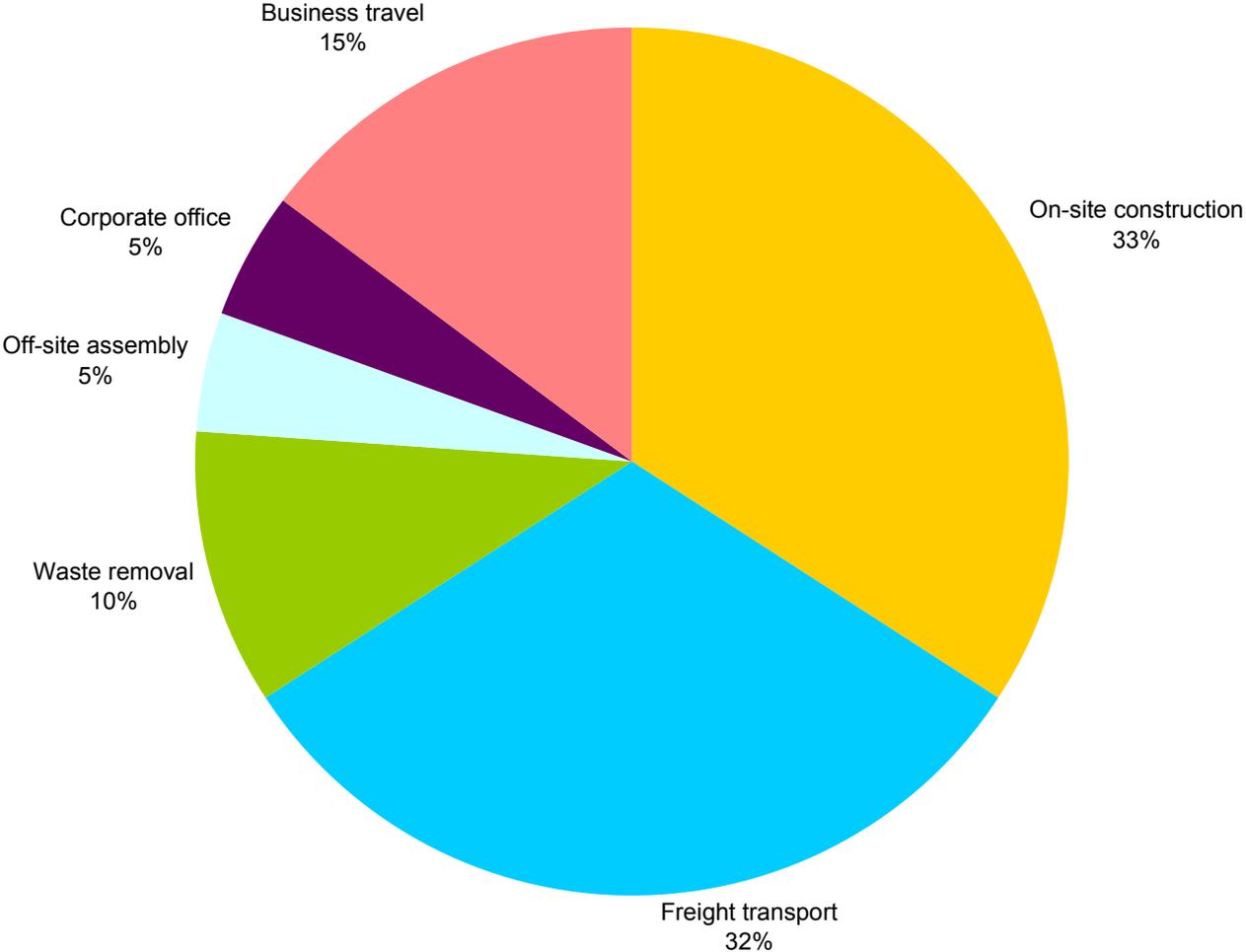
<sup>2</sup> Sum of England, Wales, Scotland and Northern Ireland data

<sup>3</sup> Northern Ireland construction statistics are not available at a level of detail to report emissions for each construction process. The methodology for calculating Northern Ireland emissions is described in the February 2010 data and methods paper.

<sup>4</sup> Due to the lack of detail in Northern Ireland data, only a total emissions figure is provided for the UK.

<sup>5</sup> Assumed Northern Ireland is the same as for Great Britain

**Figure 1 Breakdown of emissions from construction processes in Great Britain for the calendar year 2008**



**Figure 2 Breakdown of emissions from construction processes (excluding business travel) in Great Britain for the calendar year 2008**

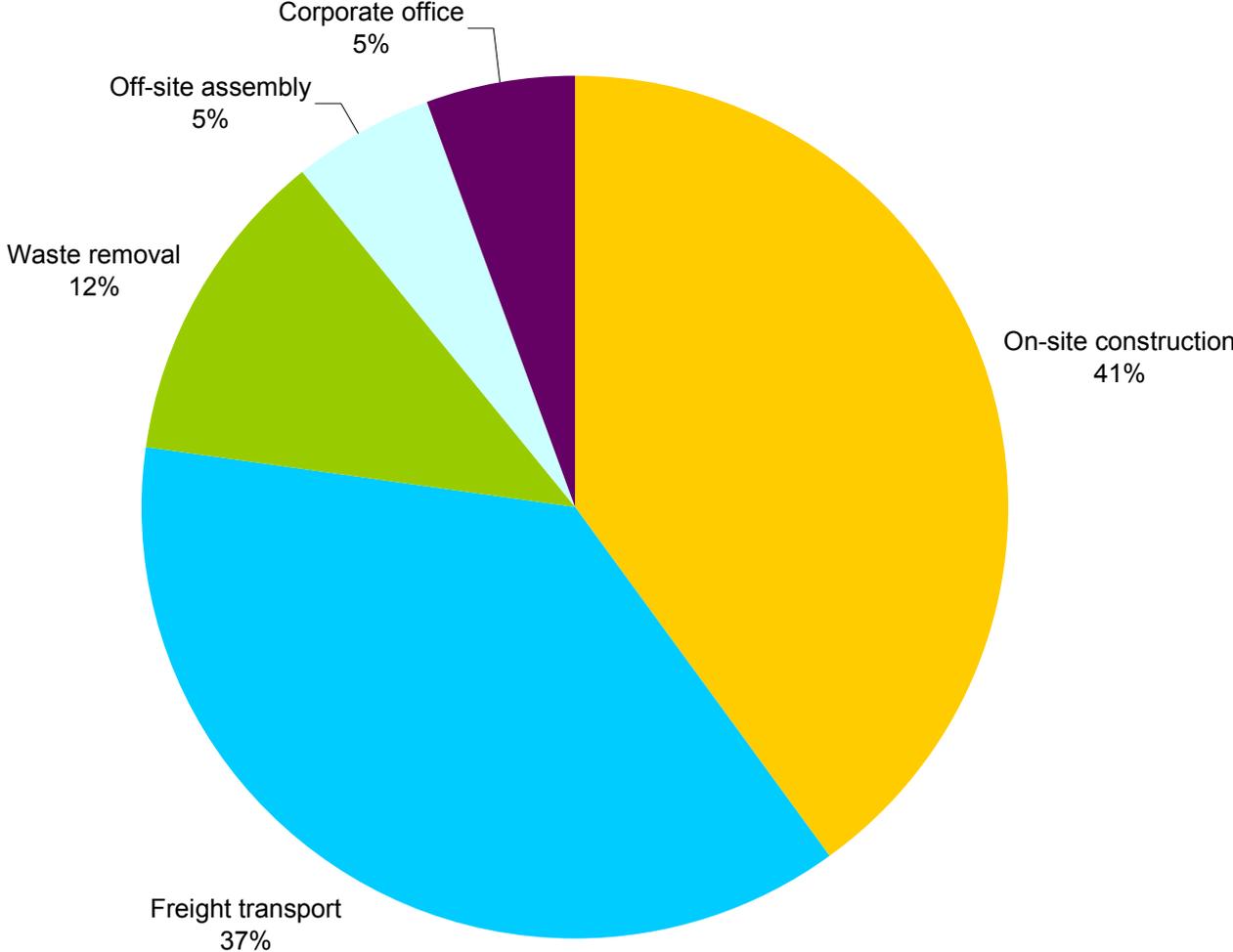


Table 2 summarises the data so that it can be compared to the 2012 reduction target. For this baseline assessment, no percentage reduction from 2008 levels has been reported. Absolute emissions have normalised to contractors' output as agreed at the scoping stage.<sup>6</sup>

**Table 2 Summary of results compared to baseline assessment for the calendar year 2008**

	England	Wales	Scotland	Northern Ireland	Great Britain	UK
<b>Absolute emissions</b> (tonnes CO <sub>2</sub> e)	<b>5,050,000</b>	<b>247,000</b>	<b>547,000</b>	<b>154,000</b>	<b>5,870,000</b>	<b>5,990,000</b>
% reduction from 2008	n/a	n/a	n/a	n/a	n/a	n/a
<b>Emissions per £ million contractors' output</b> (tonnes CO <sub>2</sub> e per £mil)	<b>47</b>	<b>53</b>	<b>51</b>	<b>48<sup>7</sup></b>	<b>48</b>	<b>48</b>
% reduction from 2008	n/a	n/a	n/a	n/a	n/a	n/a

## 2.2 Results for on site activities

Site activities are responsible for around a third of emissions. Table 3 and Figure 3 show a detailed breakdown of emissions by project type. Due to the availability of data, this detailed breakdown is only available for Great Britain. Results are shown to three significant figures.

**Table 3 Site activities emissions by project type for Great Britain for the calendar year 2008**

	Emissions per £ project value (data range provided in parantheses)		Total emissions in Great Britain (tonnes CO <sub>2</sub> )
New domestic	23	(0.15-670)	462,000
New infrastructure	34	(0.61-147)	265,000
New shops	8	(0.05-25)	38,800
New office	16	(0.01-72)	149,000
New education	10	(0.45-26)	85,600
New health	12	(0.04-43)	57,100
New other non-domestic	20	(0.37-98)	230,000
Refurbishment & maintenance	11	(0.06-87)	721,000
<b>Total</b>			<b>2,010,000</b>

<sup>6</sup> All financial data (project value for on site activities, revenue for off site assembly and contractors' output) relate to the calendar year 2008. In the case of site activities, emissions and project values were reported for projects completed in 2008. Where a project spans multiple years, as long as emissions and project value are from the same period, the emissions intensity (tonnes CO<sub>2</sub> per £ million) is relatively accurate.

<sup>7</sup> Assumed Northern Ireland is the same as for Great Britain

**Figure 3 Breakdown of site emissions in Great Britain by project type for the calendar year 2008**

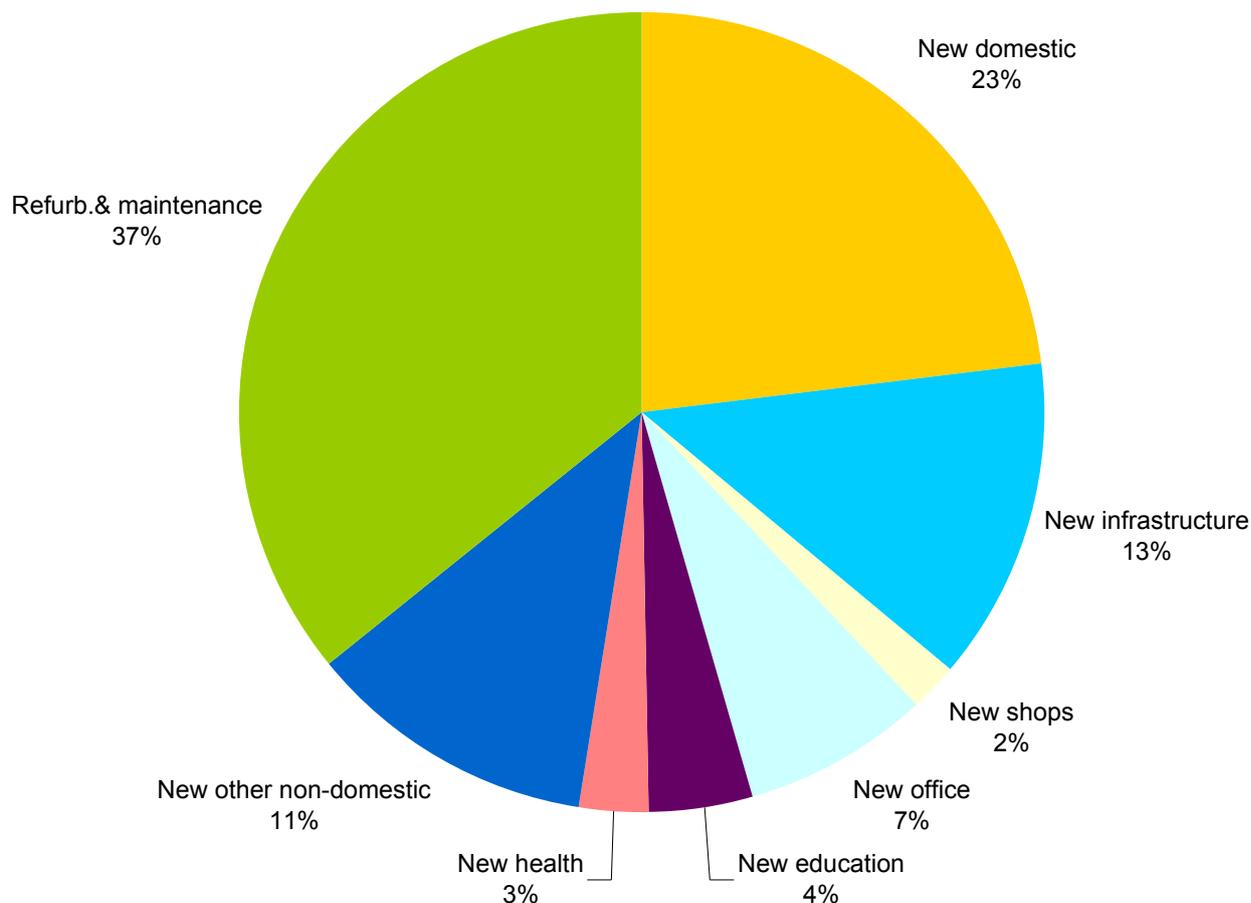


Table 4 shows the breakdown of emissions related to site activities in England, Wales and Scotland. Due to the availability of data, this breakdown is only available at a higher level of detail compared to the Great Britain results in Table 3.

**Table 4 Site activities emissions by project type for England, Wales and Scotland for the calendar year 2008**

	Emissions per £ project value (data range provided in parentheses)		CO <sub>2</sub> emissions (tonnes)		
			England	Wales	Scotland
New domestic	23	(0.15-670)	391,000	18,800	54,100
New non-domestic	14	(0.01-98)	482,000	24,900	45,900
New infrastructure	34	(0.61-147)	205,000	17,100	44,900
Refurbishment & maintenance	13	(0.06-87)	629,000	25,400	49,000
<b>Total</b>			<b>1,710,000</b>	<b>86,300</b>	<b>195,000</b>

### 2.3 Areas with potential for emissions reductions

One approach for targeting emissions reduction measures is to focus on the largest emissions sources. These may offer the greatest potential for emissions reduction, if they are not already highly efficient.

Based on the results in this section, aspects of construction processes to focus on include:

- activities in England (84% of UK emissions);
- on site construction activities (around a third of emissions);
- freight transport (around a third of emissions), particularly road freight (90% of freight emissions);
- business travel (around 15% of emissions);
- refurbishment and maintenance (37% of emissions from on site construction activities);  
and
- new domestic buildings (around a quarter of emissions from on site construction activities).

## 3 Key uncertainties in the baseline assessment

### 3.1 Overview and acknowledgements

This section discusses the data quality issues and assumptions driving uncertainties in the baseline assessment. Section 3.2 looks particularly at on site construction activities, which is the largest source of emissions and highly sensitive to data quality. Section 3.3 then provides an overview of uncertainties across all construction processes in the target scope.

For confidentiality reasons, the sources of individual data samples are not identified in this report. The following organisations have provided primary activity data and emissions data. Their support is gratefully acknowledged.

BAM	Highways Agency
Balfour Beatty	Interserve
Bovis Lend Lease	Kier
Caledonian	Laing O'Rourke
Carbon Trust	McLaughlin & Harvey
Carillion	Olympic Delivery Authority and Mace
Department of Business, Innovation and Skills	Wilmott Dixon
Environment Agency	

### 3.2 Data availability for site activities

For the baseline assessment, the major source of uncertainty is whether or not it is valid to assume that project value reported by the contractors correlates with GHG emissions. This assumption is the basis for the calculation methodology.

Figure 4 to Figure 7 show the relationship between project value and GHG emissions. The R correlation coefficient value indicates how strong this relationship is and therefore the validity of the methodology. Results are likely to be more reliable where R is 0.7 or greater. Table 5 summarises the correlations. For other construction processes (e.g. off site offices, off site assembly), refer to Section 3.3.

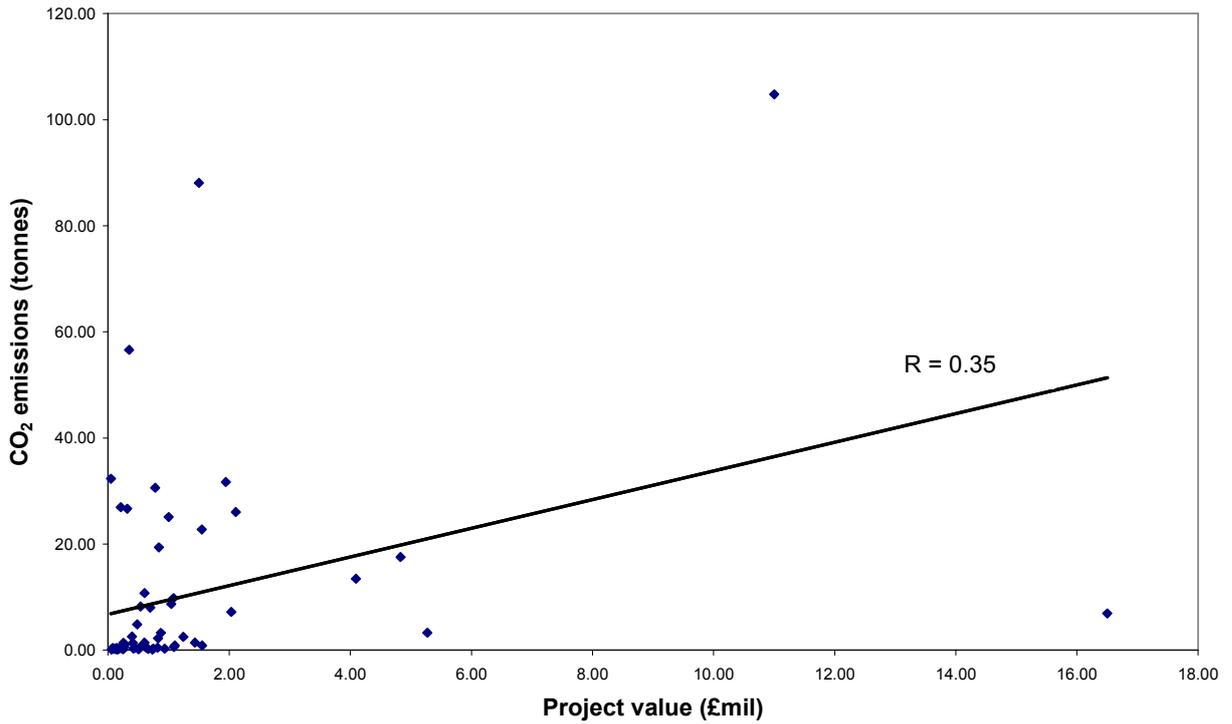
**Table 5 Strength of correlation between project value and GHG emissions**

Project type	R correlation coefficient	Strength of correlation
New domestic buildings	0.35	Low
New non-domestic buildings	0.89	Moderate to strong
New infrastructure	0.72	Moderate
Refurbishment and maintenance	0.80	Moderate to strong

### New domestic buildings

For Great Britain in 2008, new domestic construction was 16% of all contractors' output (in £ million). Figure 4 shows that there were 63 data samples (individual construction projects) for which site activity data were available, 58 of which are from the Constructing Excellence 2008 data set. Figure 4 shows there is much variability between data points. The R correlation coefficient of 0.35 indicates a low correlation between project value and emissions. Therefore, the estimate for new domestic site emissions is likely to be uncertain.

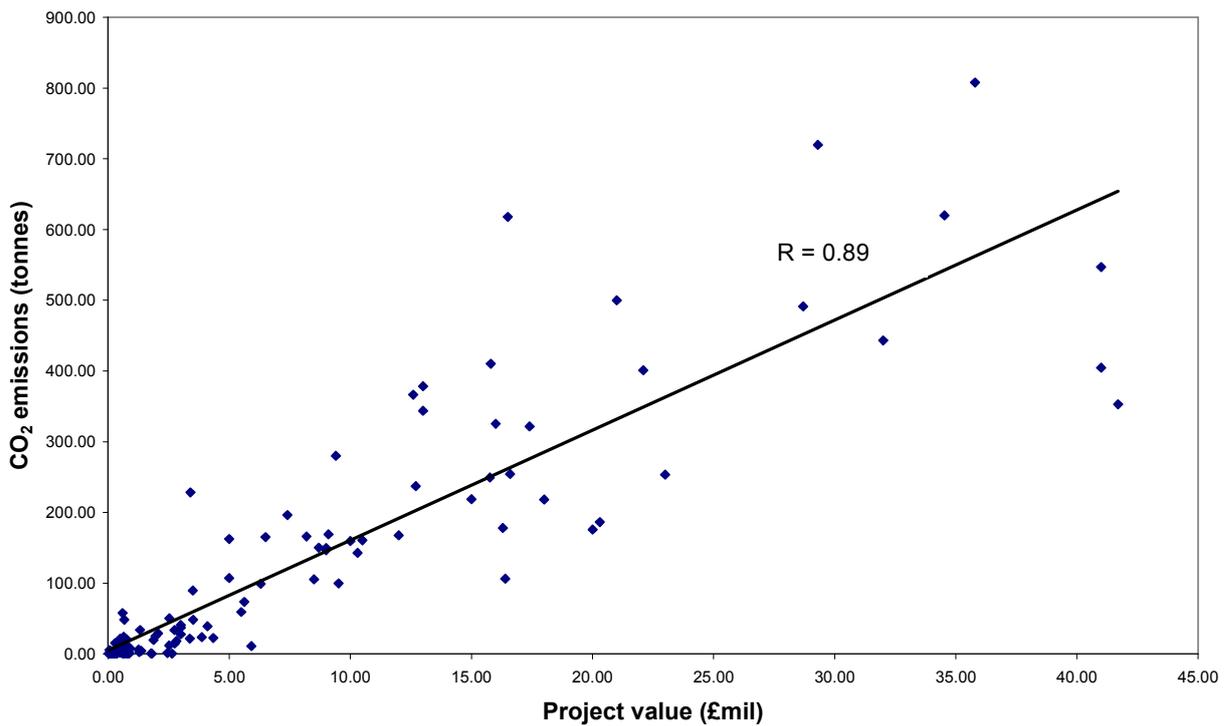
**Figure 4 New domestic site emissions, correlation between project value and emissions for the calendar year 2008 (63 data points)**



**New non-domestic buildings**

For Great Britain in 2008, new non-domestic buildings construction was 32% of all contractors’ output (in £ million). Figure 5 shows that for new non-domestic building construction, there were 139 data samples (individual construction projects) for which site activity data were available, 81 of which are from the Constructing Excellence 2008 data set. This is a good sized sample, which shows a moderate to strong correlation (R correlation coefficient of 0.89) between project value and emissions. Therefore, the estimate for new non-domestic site emissions is likely to be reasonably reliable.

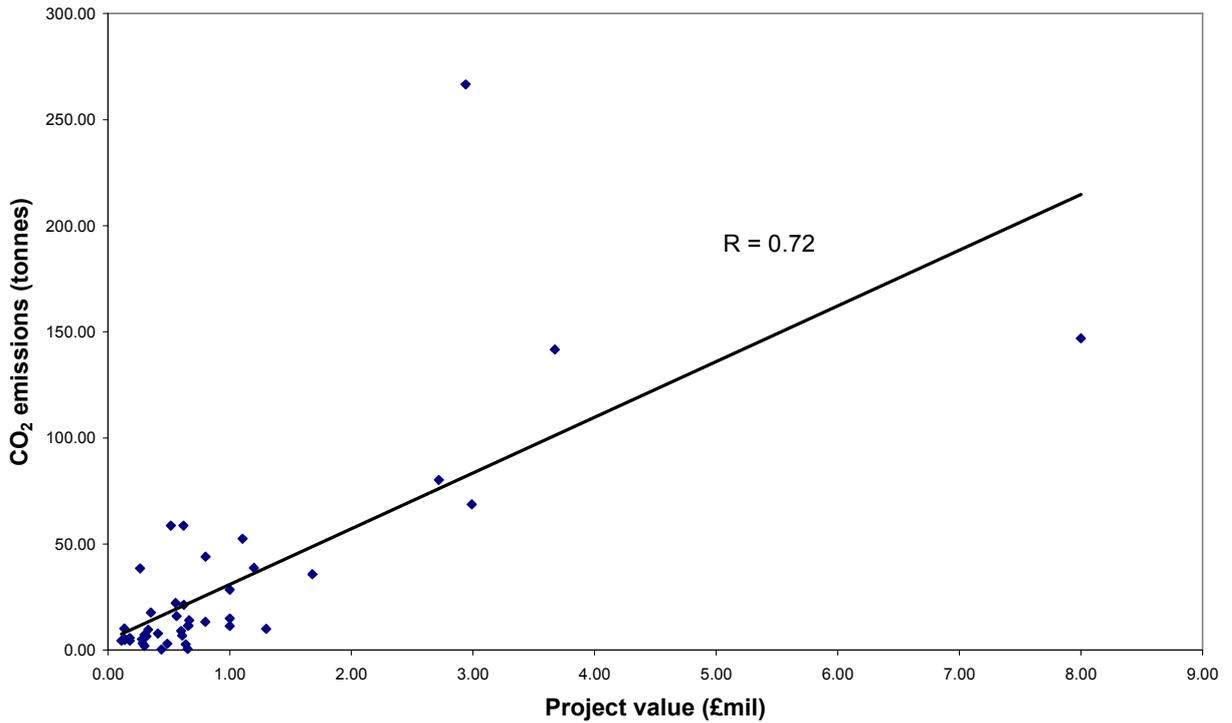
**Figure 5 New non-domestic buildings, correlation between project value and emissions for the calendar year 2008 (139 data points)**



### New infrastructure

For Great Britain in 2008, new infrastructure was 6% of all contractors' output (in £ million). Figure 6 shows that for new infrastructure construction, there were 56 data samples (individual construction projects) for which site activity data were available, 22 of which are from the Construction Excellence 2008 data set and 31 of which are from one construction client. Figure 6 shows that there is a moderate correlation (R correlation coefficient of 0.72) between project value and emissions.

**Figure 6 New infrastructure, correlation between project value and emissions for the calendar year 2008 (56 data points)**



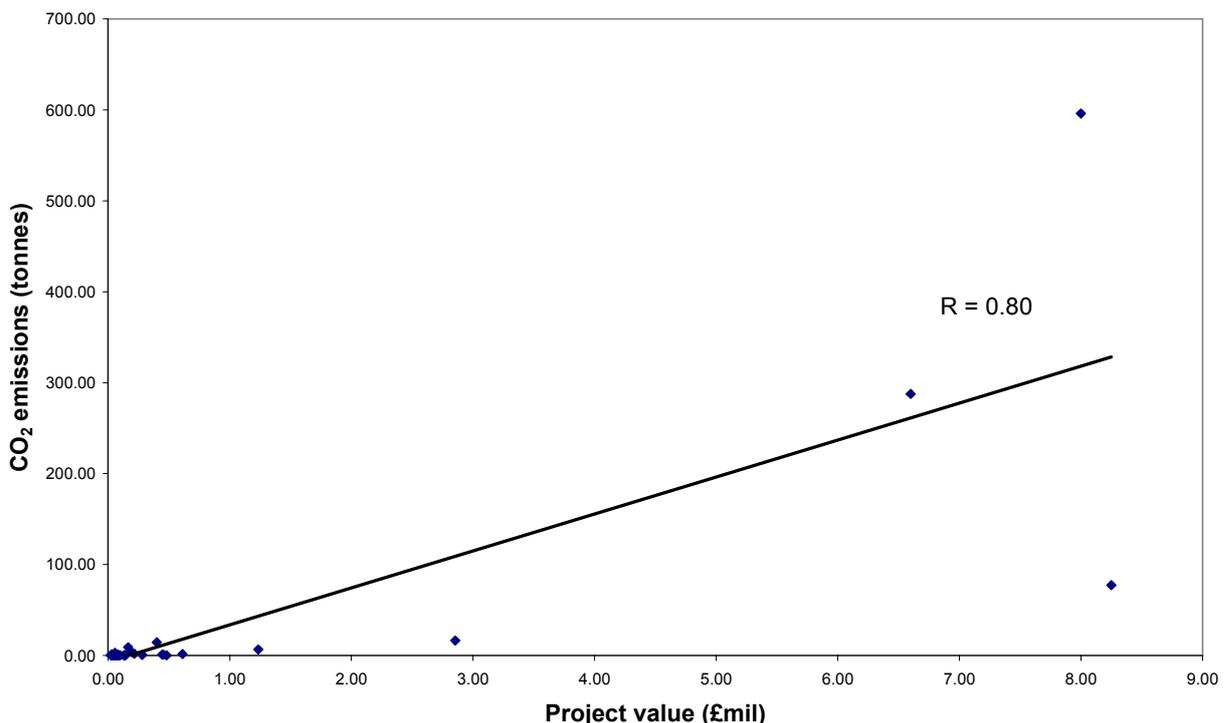
### Refurbishment and maintenance

For Great Britain in 2008, refurbishment and maintenance was 45% of all contractors' output (in £ million). Figure 7 shows that for refurbishment and maintenance, there were 44 data samples (individual construction projects) for which site activity data were available for the baseline assessment, 35 of which are from the Constructing Excellence 2008 data set. The R correlation coefficient of 0.80 shows a moderate to strong correlation between project value and emissions.

Despite this good correlation, there is still significant variation amongst data samples. For example, Figure 7 shows two projects around £8 million project value. The higher emissions project is from a retail refurbishment. Its emissions are seven times greater than an education refurbishment of similar value.

One data sample is not shown in Figure 7, as it was not provided in a level of detail for it to be included in the correlation analysis. This sample represents infrastructure maintenance and is similar in emissions intensity as the retail refurbishment described previously. Ideally, the refurbishment and repair data set from the Office of National Statistics would distinguish between buildings from infrastructure projects. However, data is not available at this level of detail. All that is known is that buildings account for at least 50% of contractors' output for refurbishment and repair.

**Figure 7 Refurbishment and maintenance, correlation between project value and emissions for the calendar year 2008 (44 data points)**



### 3.3 Effects of uncertainties

There are a number of sources of uncertainty in the baseline assessment. Table 6 lists the data quality issues, their likely effect on the baseline, the level of uncertainty, and recommended options for managing uncertainties.

**Table 6 Effects of data quality issues and uncertainties for the 2008 calendar year baseline**

Construction process	Issue	Number of data samples	Potential effect on baseline result	Potential effect on future reporting	Uncertainty associated with issue and recommendation
i. Site activities – new domestic	Very high variability in data set (refer to Figure 4)	63	Unknown effect. Actual emissions may be higher or lower than the calculated. Difference between calculated and actual may be small or large.	Future annual results may fluctuate due to data collection, rather than actual changes in emissions.	<p>Uncertainty: <b>Moderate</b></p> <p>Emissions from on site activities to construct new domestic buildings account for around slightly less than 10% of baseline. Therefore, measuring progress towards the target may be affected by changes in data collection for domestic buildings.</p> <p>Where future results appear to be affected by data collection rather than performance, the report should comment on this effect.</p>
ii. Site activities – new infrastructure	Data samples are not representative of full range of infrastructure projects due to the dominance of data from one client organisation	56	Unknown effect. Actual emissions may be higher or lower than the calculated. Difference between calculated and actual may be small or large.	If data is collected from the same organisations, annual emissions can be consistently compared, as correlation between emissions and project value are acceptable (refer to Section 3.2). However, the result may not be representative of all infrastructure emissions.	<p>Uncertainty: <b>Low to moderate</b></p> <p>Emissions from on site activities to construct new infrastructure account for slightly less than 5% of the baseline.</p> <p>Where possible, seek a more representative sample of infrastructure construction projects (water, sewerage, electricity, gas, communications, air, railways, harbours, roads).</p>
iii. Site activities – refurbishment & maintenance	High variability in data set (refer to Figure 7)	44	Unknown effect. Actual emissions may be higher or lower than the calculated. Difference between calculated and actual may be small or large.	Given the significance of refurbishment and maintenance (45% of contractors' output in 2008), changes in the site activities emissions (and consequently, the total emissions) may be unduly driven by variations in one or two data samples.	<p>Uncertainty: <b>High</b></p> <p>Emissions from on site activities to refurbish and repair buildings and infrastructure account for slightly less than 15% of the baseline. Therefore, measuring progress towards the target is likely to be affected by changes in data collection for refurbishment and repair.</p> <p>Where future results appear to be affected by data collection rather than performance, the report should comment on this effect.</p>

Construction process	Issue	Number of data samples	Potential effect on baseline result	Potential effect on future reporting	Uncertainty associated with issue and recommendation
iv. Freight transport – utilisation (% weight laden)	No data on utilisation of freight transport, therefore average emissions factors for road and rail have been adopted.	0	Unknown effect. Actual emissions may be higher or lower than the calculated. Small changes in utilisation have the potential for major changes in total emissions, as freight emissions account for 26% of the baseline footprint.	Unless data is collected, improvements in freight utilisation (e.g. through the use of consolidation centres) will not be reflected in the annual assessment.	Uncertainty: <b>High</b> Freight-related emissions account for around a third of the baseline. Establish year-to-year whether or not the average freight utilisation figure is appropriate for the movement of construction materials. If improvements are identified, then adopt the methodological approach outlined in Section 6.7.2 of the data and methods paper and select the appropriate emissions factor.
v. Freight transport – import/export balance	No data on the proportion of Great Britain freight movements that are related to domestic or foreign construction activity. Emissions should be calculated only for freight movements related to domestic construction activity.	0	Unknown effect. If the export of construction materials and products account for a significant proportion of freight movements, then total emissions will be lower.	As long as the proportion of export-related freight movements stays relatively constant, then annual emissions will be comparable.	Uncertainty: <b>Minor</b> For each reporting year, confirm that the change in exports is not significantly different to the change in domestic contractors' output. If there is a major increase or decrease in the export of construction materials and products, provide an explanatory comment alongside freight transport results.

Construction process	Issue	Number of data samples	Potential effect on baseline result	Potential effect on future reporting	Uncertainty associated with issue and recommendation
vi. Freight transport – water freight	No data on water freight movements for construction materials and products.	0	Likely to increase the baseline result. Unknown if this increase is small or large, as there is no data on how much water freight is used for construction materials and products.	As long as water freight is consistently included or excluded in reporting (subject to data availability), then annual emissions will be comparable. If there are large shifts from road/rail freight to water freight, then it will be necessary to include water freight in calculations.	Uncertainty: <b>Minor to moderate</b> If data on water freight for construction materials and products becomes available, then revise the baseline and annual reporting as per the recalculation policy in Section 7 of the data and methods paper. If a shift towards water freight is to be implemented as an industry-wide carbon reduction measure, then calculate the emissions savings due to modal shift and adopt the methodological approach outlined in Section 6.7.2 of the data and methods paper.
vii. Waste removal – tonnages	CD&E waste received by waste facilities is likely to be double-counted, as waste is moved between facilities.	One sector-level figure for each of England and Wales. Scotland and Northern Ireland are scaled based on England data.	Acceptable effect. Although CD&E waste may be counted multiple times due to movement between facilities, there are transport emissions associated with these movements, and these could be reasonably attributed to the construction sector.	None, as long as data source is consistently available each year.	Uncertainty: <b>Minor</b> No action required.

Construction process	Issue	Number of data samples	Potential effect on baseline result	Potential effect on future reporting	Uncertainty associated with issue and recommendation
viii. Waste removal – distances	Not enough data is available on transport distances between construction sites and waste treatment locations.	2, plus professional judgement	Unknown effect. Data samples are from England and from urban projects. It may be an overestimate, if waste treatment sites are largely located outside of urban areas. It may be an accurate estimate, if the majority of construction sites are in urban areas so the sample is representative of most sites.	It may be that waste removal distances do not change in the short term (between 2008 and 2012) and therefore, reasonable assumptions for distances are acceptable as an unvarying parameter. Annual results would be comparable.	Uncertainty: <b>Moderate to high</b> Waste removal is a significant emissions source (10% of Great Britain emissions). Where possible, validate the initial assumption of average waste removal distances for the regions (England, Wales, Scotland and Northern Ireland). If the industry seeks to reduce emissions by optimising distance (e.g. by agreeing to use the waste treatment sites closest to a construction site), then calculate the emissions savings and adopt the methodological approach outlined in Section 6.7.2 of the data and methods paper.
ix. Waste removal – utilisation (% weight laden)	No data on utilisation of waste removal trucks, therefore average emissions factors for road freight have been adopted.	0	Unknown effect. Actual emissions may be higher or lower than the calculated. Small changes in utilisation have the potential for major changes in total emissions, as waste removal emissions account for 18% of the baseline footprint.	Unless data is collected, improvements in truck utilisation will not be reflected in the annual assessment.	Uncertainty: <b>Moderate</b> Establish year-to-year whether or not the average freight utilisation figure is appropriate for the removal of CD&E waste. If improvements are identified, then adopt the methodological approach outlined in Section 6.7.2 of the data and methods paper and select the appropriate emissions factor.

Construction process	Issue	Number of data samples	Potential effect on baseline result	Potential effect on future reporting	Uncertainty associated with issue and recommendation
x. Off site assembly – industry output	Non-transparent and out-dated (2007) data used to make assumptions on the industry output.	Studies from 2000, 2001 and 2005. Studies are not comparable.	If the use of off site manufacturing has increased since 2007, then emissions may be greater than reported in the baseline assessment.	Data is not collected regularly. Assessment will index off site assembly output to contractors' output. If the proportion of construction activity due to off site manufacturing changes, this will not be reflected in annual results.	Uncertainty: <b>Minor</b> In 2008, off site assembly emissions accounted for less than 5% of the baseline. Other uncertainties are likely to be more significant. If a shift towards off site manufacturing is to be implemented as an industry-wide carbon reduction measure, then calculate the emissions savings due to this shift and adopt the methodological approach outlined in Section 6.7.2 of the data and methods paper.
xi. Off site assembly – emissions intensity	Not enough data samples for reliable characterisation of emissions intensity of off site assembly.	2	Unknown effect. Actual emissions may be higher or lower than the calculated. Difference between calculated and actual may be small or large.	Future annual results may fluctuate due to data collection, rather than actual changes in emissions.	Uncertainty: <b>Minor</b> In 2008, off site assembly emissions accounted for less than 5% of the baseline. Uncertainties associated with other construction processes are likely to be more significant.
xii. Off site (corporate) offices – emissions	Not enough data for reliable characterisation of the relationship between emissions from off site office activity and site activity.	4	Unknown effect. Actual emissions may be higher or lower than the calculated. Difference between calculated and actual may be small or large.	Future annual results may fluctuate due to data collection, rather than actual changes in emissions.	Uncertainty: <b>Minor</b> In 2008, off site (corporate) offices accounted for around 5% of emissions. Uncertainties associated with other construction processes are likely to be more critical. Where possible, seek more data samples (e.g. directly from contractors, and via the Carbon Disclosure Project). Data may become increasingly available and precise as companies prepare for the Carbon Reduction Commitment. Good partnership and data collection processes from individual companies will be required. CRC data should be reviewed and included as per the recalculation policy in Section 7 of the data and methods paper.

Construction process	Issue	Number of data samples	Potential effect on baseline result	Potential effect on future reporting	Uncertainty associated with issue and recommendation
xiii. Business travel – emissions	<p>Not enough data for reliable characterisation of the relationship between emissions from business travel activity and site activity.</p> <p>Not enough detail in data samples to exclude non-domestic travel.</p>	4	Baseline is likely to be lower if non-domestic travel can be identified and excluded.	Future annual results may fluctuate due to data collection, rather than actual changes in emissions.	<p>Uncertainty: <b>Moderate</b></p> <p>In 2008, business travel accounted for around 15% of emissions. Where possible, seek more data samples (e.g. directly from contractors, and via the Carbon Disclosure Project).</p> <p>Besides increasing the data sample, the precision and accuracy of business travel emissions is difficult to improve, as it is limited by the level of detail provided by organisations.</p>

## **4 Informing an action plan for the sector**

This baseline assessment paper was provided to the Carbon Sub-Group to inform the development of an action plan for the sector. On 19 January 2010, the Carbon Sub-Group met to prioritise carbon reduction options to achieve the 15% reduction target. The resulting action plan is available from July 2010.

Appendix A

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**Data quality  
assessment of sources  
used for this  
assessment**

Data source	Data set	Data quality	Acceptable	Gaps	Comment
<b>Emissions factors</b>					
Defra (2009), <i>Guidelines to Defra / DECC's Greenhouse Gas Conversion Factors for Company Reporting</i> <sup>8</sup>	Emission factors for fuel use, electricity and transport	Relevant			Emission factors apply to the UK, although some simplification of construction processes was needed to use the factors (e.g. average rail freight emission factors without distinguishing between electric and diesel trains).
		Complete			Covers the range of activities (fuel use, electricity use, transport modes) considered in this assessment.
		Consistent			Factors align with Kyoto Protocol inventory methods.
		Transparent			Defra/DECC publishes the methodology paper for emissions factors each year.
		Accurate			These are sector or regional averages (secondary data) not specific to sites, projects or processes. However, given the sector and regional scale of the project, this level of accuracy is acceptable. Indirect emissions (production and distribution of fuels) are not included.
<b>Site activities (plant, equipment and site offices)</b>					
Contractors' output Office for National Statistics (ONS) (2009), <i>Construction Statistics Annual</i> (ISSN=17580838) <sup>9</sup>	Sector-level site activity	Relevant			Largely relevant as the core services of contractors are in scope.
		Complete			Does not cover the revenue/turnover of non-contracting organisations involved in construction processes. It is assumed that the revenue of other organisations will change in proportion to changes in contractors' output. As long as this indicator is consistently measured and used for each year's calculation, this assumption is acceptable.
		Consistent			Is consistently reported for Great Britain, England, Wales and Scotland each year. Northern Ireland data is not consistent or complete compared to the other regions.
		Transparent			Data sources documented by the Office of National Statistics.
		Accurate			The data set is the most precise available.
Hutchins (2010), <i>UK Building Costs Blackbook 2010: The Capital Cost and</i>	Price indices	Relevant			Relates to regional variation in the price of construction for the reporting year.
		Complete			Covers England, Wales, Scotland and Northern Ireland.
		Consistent			Standard methodology for calculating cost and price indices.

<sup>8</sup> <http://www.defra.gov.uk/environment/business/reporting/conversion-factors.htm><sup>9</sup> <http://www.statistics.gov.uk/StatBase/product.asp?vlnk=284&Pos=ColRank=1&Rank=272>

Data source	Data set	Data quality	Acceptable	Gaps	Comment
Embodied CO <sub>2</sub> , Guide Volume Two: Major Works, Franklin+Andrews		Transparent			Detail is not provided.
		Accurate			Does not provide a level of detail to distinguish between types of construction projects.
Constructing Excellence (2008) annual contractors survey, available by request from Department of Business, Innovation and Skills and BRE	Emissions intensity (tCO <sub>2</sub> / £100k project value)	Relevant			Covers site construction processes for buildings, which is included in the scope.
		Complete			Is based on volunteer survey returns so does not cover all projects.
		Consistent			Collected yearly using the same questions to contractors. However, contractors may use different data collection boundaries (e.g. the inclusion of sub-contractors' data may vary).
		Transparent			Fuel, gas and electricity data provided.
		Accurate	?	?	Unknown accuracy and highly variable for new domestic projects. However, there are hundreds of samples so the result is likely to be representative.
Project carbon footprints and project value, provided by individual companies listed in Section 3.1.	Emissions intensity (tCO <sub>2</sub> / £100k project value)	Relevant			A sample of projects has been collected directly from companies, covering different project types, new construction and refurbishment.
		Complete			Samples shall always be incomplete relative to all live projects and contractors. In particular, there is a lack of domestic and infrastructure refurbishment data.
		Consistent			As the project data was collated by multiple people, there is a risk that each used different methodologies.
		Transparent			Carbon footprints are often not provided with details of data sources and assumptions.
		Accurate	?	?	The correlation between project value and carbon emissions was generally moderate, with good precision for new non-domestic buildings.
<b>Transport – freight</b>					
Department for Transport (2008), <i>Road Freight Statistics</i> annual	Road freight movements (tonne- kilometres) for construction products and materials	Relevant			Largely relevant, covering a range of construction materials and products. However, does not distinguish between imported and exported materials. It is assumed that the majority of construction materials road freighted in Great Britain are for Great Britain projects.
		Complete			Complete for Great Britain. No data for Northern Ireland.
		Consistent			Standard methodology to collect and report data for each year.
		Transparent			Break down of construction materials is suitably detailed, although no break down of data between England, Wales and Scotland. To attribute freight between the regions,

Data source	Data set	Data quality	Acceptable	Gaps	Comment
					assumptions were made. Data set also provides break down of types of vehicles used.
		Accurate			The data set is the most precise available.
ORR (2008), <i>National Rail Trends Yearbook</i> <sup>10</sup>	Rail freight movements (tonne-kilometres) for construction products and materials	Relevant			Largely relevant, covering the movement of construction commodities by rail in Great Britain. However, does not distinguish between imported and exported materials. It is assumed that the majority of construction materials road freighted in Great Britain are for Great Britain projects.
		Complete			Complete for Great Britain. No data for Northern Ireland.
		Consistent			Standard methodology to collect data for each quarter.
		Transparent			Single figure provided each year with no detail. 'Construction' commodities not defined.
		Accurate			The data set is the most precise available.
<b>Transport – waste removals</b>					
Environment Agency (2008), <i>Waste Data Interrogator 2008</i> (product code GEHO1109 BRHS-E-C) <sup>11</sup>	Amount of construction, demolition and excavation waste received by waste facilities (tonnes per annum)	Relevant			CD&E waste for England is relevant to construction processes.
		Complete			Complete for England and Wales, although not available for Scotland and Northern Ireland.
		Consistent			Methodology is consistent and is based on operator site returns. The definition of CD&E waste is consistent with the Sustainable Construction Task Group Waste Sub-Group (i.e. the same waste codes have been used).
		Transparent			Detailed breakdown of waste types is provided.
		Accurate			Although this data set is consistent and replicable each year, there is likely to be double counting, as CD&E waste is moved between facilities.
<b>Off site assembly</b>					
Mtech Group (2007), <i>Offsite Construction</i>	Value of off site manufacturing	Relevant			Covers the use of off site construction in all project types.
		Complete			31% response rate to survey.

<sup>10</sup> <http://www.dft.gov.uk/pgr/statistics/datatablespublications/freight/goodsbyroad/roadfreightstatistics2008>

<sup>11</sup> <http://publications.environment-agency.gov.uk/epages/eapublications.storefront>

Data source	Data set	Data quality	Acceptable	Gaps	Comment
Industry Survey 2006, Buildoffsite		Consistent	n/a	n/a	Once off study so no consistency to consider.
		Transparent			Survey methodology is clearly documented.
		Accurate			Sample size is reasonable.
Pan W., Gibb A, Dainty A., (2005), <i>Offsite Modern Methods of Construction in Housebuilding: Perspectives and Practices of Leading UK Housebuilders</i>	Value of off site manufacturing as a proportion of construction output	Relevant			Covers the use of OSM techniques in housebuilding, which is within the target scope.
		Complete			Covers only housebuilding and not the use of OSM for non-domestic buildings and infrastructure.
		Consistent	n/a	n/a	Once off study so no consistency to consider.
		Transparent			Data is stated without source and methodology details.
		Accurate			At 2005, the data is out-dated.
WRAP (2007), <i>Current Practices and Future Potential in Modern Methods of Construction</i> <sup>12</sup>	Value of off site manufacturing products as proportion of building materials and products	Relevant			Relates to products, rather than the assembly/installation processes.
		Complete			Addresses OSM products for all construction.
		Consistent	n/a	na	Once off study so no consistency to consider.
		Transparent			Data is stated without source and methodology details.
		Accurate			At 2007, the data is out-dated.
Project and company OSM factory data, project value and/or company revenue, provided by individual companies listed in Section 3.1	Emissions intensity (tCO <sub>2</sub> / £ million project value or revenue)	Relevant			Relevant where the factory processes produce construction products. Where possible, assembly processes shall be included and manufacturing processes excluded.
		Complete			Only two samples were available: one for a new domestic building and one from a pre-cast concrete factory. This does not cover the full range of off site products available.
		Consistent			Data was collated by multiple people so there is a risk that each will use different methodologies. There are potential inconsistencies in combining project-based data and data from a permanent off site facility.
		Transparent			Carbon footprints were not provided with details of data sources and assumptions.
		Accurate			The two data samples came from very different off site processes and varied greatly.

<sup>12</sup> <http://www.wrap.org.uk/document.rm?id=3663>

Data source	Data set	Data quality	Acceptable	Gaps	Comment
					Accuracy and precision limited by lack of data.
<b>Off site / corporate offices</b>					
Company off site office emissions and project site emissions, provided by individual companies listed in Section 3.1	Ratio between office and project site emissions	Relevant			The assessment only made use of data from companies and divisions whose core business is in construction processes. The assessment excluded data from companies with non-construction businesses, where only a proportion of their off site emissions is relevant.
		Complete			Only four companies provided suitable data and this is incomplete relative to the industry.
		Consistent			As organisational data was collated by multiple people, there is a risk that each has used different methodologies.
		Transparent			Carbon footprints were not always provided with details of data sources and assumptions.
		Accurate			Accuracy and precision limited by lack of data samples.
<b>Business travel</b>					
Company business travel emissions and project site emissions, provided by individual companies listed in Section 3.1	Ratio between business travel and project site emissions	Relevant			The assessment only made use of data from companies and divisions whose core business is in construction processes. The assessment excluded data from companies with non-construction businesses, where only a proportion of their off site emissions is relevant.  Only domestic travel related to construction projects should be included. However, in practice some companies report travel emissions that include non-domestic travel and travel related to non-construction functions. It was difficult to separate these out.
		Complete			Only four companies provided suitable data and this is incomplete relative to the industry.
		Consistent			As organisational data was collated by multiple people, there is a risk that each has used different methodologies.
		Transparent			Carbon footprints were not always provided with details of data sources and assumptions.
		Accurate			Accuracy and precision limited by lack of data samples.