

1 Technical Annex B – Calculation of Unmitigated Scheme Energy Consumption & Carbon Di-oxide Emissions

Unmitigated CO₂ emissions are defined as the CO₂ emissions as a consequence of energy consumption arising from the usage of buildings on the site after the proposed development has taken place, if buildings are built to current standards without extra energy efficient measures or renewable energy generators. It does not account for emissions from transport or natural processes taking place on the site.

1.1 Building areas and uses

The areas in Table 1—1 have been used as the basis for the energy demand calculations. These areas have been derived from the information provided by Broadway Malyan on Revision R of the masterplan dated 22/10/07.

Application	Gross Internal Floor Area (m ²)	Treated Area Factor	Treated Floor Area (m ²)
Residential	10,200	1.00	10,200
Retail	55,167	0.65	35,859
Restaurant	1,936	1.00	1,936
Office	3,720	0.95	3,534
Stadium	20,000	1.00	20,000
Supermarket	14,374	1.00	14,374

Table 1—1 Treated floor area broken down by building type – South of Cherryfield drive

Application	Gross Internal Floor Area (m ²)	Treated Area Factor	Treated Floor Area (m ²)
Retail	28,931	0.65	18,805
Hotel	4,226	0.80	3,381

Table 1—2 Treated floor area broken down by building type – North of Cherryfield drive

1.2 Energy Benchmarks

Energy Benchmarks are reference figures for building energy consumption used widely to predict building energy consumption. They are given as the number of kilowatt-hours of energy used in a particular building type per square metre of treated floor area per year (kWh/m²/year). They are taken from a number of institutions who have assessed existing buildings to provide a mean energy consumption benchmark.

Table 1—3 gives the energy benchmarks used for the buildings on the Kirkby site, and Table 1—4 gives the origins of this information.

Application	Fossil Fuels	Electrical Consumption
	kWh/m ² /annum	kWh/m ² annum
	Good Practice	Good Practice
Residential	60	40
Retail	175	185
Restaurant	550	650
Office	97	128
Stadium	10	37
Supermarket	227	913
Hotel	300	90

Table 1—3 Energy use benchmarks by building type

Application	Heating and Hot Water	Electricity
	kWh/m ² /year	kWh/m ² /year
	Good Practice	Good Practice
Residential	From a SAP calculation for a typical townhouse based on meeting Part L regulations 2006	From a SAP calculation for a typical townhouse based on meeting Part L regulations 2006
Retail	CIBSE Guide F : Retail Energy Consumption : Good Practice	CIBSE Guide F : Retail Energy Consumption : Good Practice
Restaurant	CIBSE Guide F : Retail Energy Consumption : Good Practice	CIBSE Guide F : Retail Energy Consumption : Good Practice
Office	CIBSE Guide F : Standard Air Conditioned Office: Good Practice	CIBSE Guide F : Standard Air Conditioned Office: Good Practice
Stadium	Buro Happold Design Experience	Buro Happold Design Experience
Supermarket	Metered Energy Consumption for TESCO exemplar store in Diss, UK. It is estimated that a store would be built to this standard for the unmitigated case.	Metered Energy Consumption for TESCO exemplar store in Diss, UK. It is estimated that a store would be built to this standard for the unmitigated case.
Hotel	CIBSE Guide F: Luxury Hotel: Good Practice	CIBSE Guide F: Luxury Hotel: Good Practice

Table 1—4 References for energy usage benchmarks

1.3 Unmitigated energy consumption and CO₂ emissions – Site south of Cherryfield Drive

The energy benchmarks were applied to the areas of the masterplan and yielded the following total energy consumption, as displayed in Table 1—5.

Application	Annual Energy consumption based on good practice benchmarks			Total annual carbon emissions kg CO ₂ /annum
	Fossil Fuels	Electrical	Total	
	kWh/annum	kWh/annum	kWh/annum	
Residential	610,000	410,000	1,020,000	290,000
Retail	6,280,000	6,630,000	12,910,000	4,020,000
Restaurant	1,060,000	1,260,000	2,320,000	740,000
Office	340,000	450,000	790,000	260,000
Stadium	200,000	740,000	940,000	350,000
Supermarket	3,260,000	13,120,000	16,380,000	6,170,000
Total	11,750,000	22,610,000	34,360,000	11,830,000

Table 1—5 Breakdown of energy consumption and CO₂ emissions

Figures are based on indicative floor areas. Using the CO₂ Conversion Factors shown in the previous chapter regarding baseline emissions, the CO₂ emissions of the site were calculated.

Energy consumption benchmarks are broken down between electricity use and fossil fuel use. All fossil fuels were assumed to be natural gas and the conversion factor was applied accordingly.

The CO₂ emissions are broken down by fuel type and building type and are detailed in Table 1—6.

Application	Annual CO ₂ emissions based on good practice benchmarks		
	Fossil Fuels	Electrical	Total
	% CO ₂ emissions	% CO ₂ emissions	% CO ₂ emissions
Residential	1.0%	1.5%	2.5%
Retail	10.3%	23.7%	33.9%
Restaurant	1.7%	4.5%	6.2%
Office	0.6%	1.6%	2.2%
Stadium	0.3%	2.6%	3.0%
Supermarket	5.3%	46.8%	52.1%
Total	19.3%	80.7%	100.0%

Table 1—6 Matrix percentage breakdown of CO₂ emissions by building type and fuel type

The fuel type breakdown indicates the type of energy which will emit the most CO₂. The building type breakdown clarifies which building typologies provide the best opportunity for CO₂ emissions mitigation. Looking at building type, it can be seen that the supermarket is estimated to be the greatest CO₂ emitter – around half of the site’s CO₂ emissions. Looking at fuel type, it can be seen that around 80% of site CO₂ emissions are a consequence of electricity drawn from the national grid.

1.4 Unmitigated energy consumption and CO₂ emissions – Site North of Cherryfield Drive

Different levels of planning have been applied for the areas both north and south of Cherryfield drive. For the purposes of planning as well as differing applicability of renewable technologies to both north and south areas of the site, the two have been kept separate.

The energy benchmarks were applied to the areas of the master plan and yielded the following total energy consumption in

Application	Annual Energy consumption based on good practice benchmarks			Total annual carbon emissions
	Fossil Fuels	Electrical	Total	
	kWh/annum	kWh/annum	kWh/annum	kg CO ₂ /annum
Retail	3,290,000	3,480,000	6,770,000	2,110,000
Hotel	1,010,000	300,000	1,310,000	320,000
Total	4,300,000	3,780,000	8,080,000	2,430,000

Table 1—7 Unmitigated energy consumption and CO₂ emissions – site north of Cherryfield drive

As for the area south of Cherryfield drive, the CO₂ emissions are broken down by fuel type and building type and are detailed in Table 1—8.

Application	Annual CO ₂ emissions based on good practice benchmarks		
	Fossil Fuels	Electrical	Total
	% CO ₂ emissions	% CO ₂ emissions	% CO ₂ emissions
Retail	26.3%	60.4%	86.7%
Hotel	8.1%	5.2%	13.3%
Total	34.3%	65.6%	100%

Table 1—8 CO₂ emissions broken down by fuel type and building type

The majority of the projected CO₂ emissions are again due to grid electricity consumption, and the retail areas account for over 80% of CO₂ emissions. These areas thus provide the best opportunity for energy saving/renewable energy. However much of the 10% obligation will be met by the area south of Cherryfield drive, and may offset the 10% obligation for the north.

1.5 Unmitigated energy consumption and CO₂ emissions – Whole site

The analysis provided for individual areas north and south of the site is now applied to the site as a whole.

The energy benchmarks were applied to the areas of the masterplan and yielded the following total energy consumption. An estimated 42 GWh is anticipated as the annual energy consumption for the proposed development, without mitigation measures.

Application	Annual Energy consumption based on good practice benchmarks			Total annual carbon emissions
	Fossil Fuels	Electrical	Total	
	kWh/annum	kWh/annum	kWh/annum	kg CO ₂ /annum
Residential	610,000	410,000	1,020,000	290,000
Retail	9,570,000	10,110,000	19,680,000	6,130,000
Restaurant	1,060,000	1,260,000	2,320,000	740,000
Office	340,000	450,000	790,000	260,000
Stadium	200,000	740,000	940,000	350,000
Supermarket	3,260,000	13,120,000	16,380,000	6,170,000
Hotel	1,010,000	300,000	1,310,000	320,000
Total	16,050,000	26,390,000	42,440,000	14,260,000

Table 1—9 Unmitigated energy consumption and CO₂ emissions – whole site

The CO₂ emissions are broken down by fuel type and building type and are detailed in Table 1—10.

Application	Annual CO ₂ emissions based on good practice benchmarks		
	Fossil Fuels	Electrical	Total
	% CO ₂ emissions	% CO ₂ emissions	% CO ₂ emissions
Residential	0.8%	1.2%	2.0%
Retail	12.9%	29.7%	42.7%
Restaurant	1.4%	3.7%	5.1%
Office	0.5%	1.3%	1.8%
Stadium	0.3%	2.2%	2.4%
Supermarket	4.4%	38.6%	43.0%
Hotel	1.7%	1.1%	2.8%
Total	20.3%	76.7%	100%

Table 1—10 CO₂ emissions broken down by fuel type and building type

1.5.1 Conclusions

The fuel type breakdown indicates the energy source which will emit the most CO₂. The building type breakdown clarifies which building typologies provide the best opportunity for CO₂ emissions mitigation. Looking at building type, it can be seen that the supermarket and retail units are the most CO₂ intensive. However the retail spans large areas of both the north and south of the site, and the supermarket is the most compact unit type. The supermarket therefore provides the best opportunity for CO₂ mitigation.

Looking at fuel type, it can be seen that around 80% of site CO₂ emissions are a consequence of electricity drawn from the national grid. Renewable energy sources that provide electricity (solar photovoltaic power and wind power) may not be the most appropriate for the

site due to planning and economic considerations, nevertheless the greatest cause of CO₂ emissions is grid electricity and therefore it provides the best opportunity for mitigation.