1 Technical Annex C – Calculation of Mitigated Scheme Energy Consumption & Carbon Di-oxide Emissions

Mitigated 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, and all energy efficiency and renewable energy generation methods have been implemented. It does not account for emissions from transport or natural processes taking place on the site.

1.1 Summary of Energy Policy

1.1.1 Knowsley Metropolitan Borough Council

The main driver for renewable energy on the site is the Knowsley Metropolitan Borough Council planning requirement to provide 10% of the site energy from renewable sources.

1.1.2 Unconfirmed Requirement for Code for Sustainable Homes (CSH) Level 3

The recent consultation document published by The Department for Communities and Local Government entitled 'The future of the Code for Sustainable Homes – Making a rating Mandatory' contains the following:

"As well as those private developments that are being built to the Code (for sustainable homes) standards, all new Government funding (for example through the Housing Corporation) for homes built by registered social landlords, as well as those developed by English Partnerships or with direct funding from the Government's housing growth programmes will in future comply with Level 3 of the Code (for sustainable homes)".

Thus for the purposes of this assessment we will assume that all homes on site may be social housing and therefore may be required to meet the CSH level 3.

Buro Happold have undertaken some preliminary work which sets out the most cost effective means of achieving CSH level 3 for Energy. The following shall be required:

- Maximised daylight and limited solar gains
- Low Energy Lighting
- A rated appliances
- Gas fired condensing boilers
- Air tightness to 6 air changes per hour @ 50 Pa
- U Values:
    - Window 1.4 W/m^2/K
    - Wall and Floor 0.25 W/m^2/K

- Mechanical ventilation with heat recovery

Our models show that these energy efficiency measures will achieve building CO_2 emissions reductions of around 22% for a dwelling, where 25% is required for CSH level 3. This figure is a rough indication – if a small additional CO_2 saving is required, it is suggested that solar thermal panels may be the most cost effective means of providing this small additional saving.

1.2 Renewable Energy Targets

10% of the development's energy demand is equivalent to around 4.2 GWh as displayed in Table 1—1.

10% energy demand mitigation for site	10%	4,244,000 kWh
CO_2 mitigation if 10% energy is provided by renewable electricity producer	13%	1,790,000 kgCO2
CO_2 mitigation if 10% energy is provided by renewable heat producer	6%	820,000 kgCO2
CO_2 intensity of grid electricity	0.422	$kgCO_2/kWh$
CO_2 intensity of natural gas	0.194	$kgCO_2/kWh$

Table 1—1 Table illustrating different methods of providing 10% renewable obligation

It should be noted that the carbon intensity of grid electricity is around twice that of gas.

Gas is the most common fossil fuel for onsite heat production and it is therefore assumed that any heat produced from renewable sources displaces heat that would otherwise be generated through the combustion of gas.

If the '10% energy from renewables' obligation is met by, for instance, wind turbines or solar photovoltaic panels, the operational CO2 savings will be around 13%. However, if the '10% energy from renewables' obligation is met by, for instance biomass district heating, the operational CO2 savings will be around 6%. In reality, the 10% obligation will be met by a mixture of renewable heat producers and electricity producers, and therefore the CO2 savings will be somewhere between 6 and 12%.

1.3 Combined Heat and Power

Combined Heat and Power is a well known means of making better use of natural gas as a primary energy resource, and reducing CO_2 emissions. However, the site energy consumption in total kWh will increase due to the use of CHP, making the 10% renewable obligation harder to meet. Additionally, CHP is an energy efficiency measure, and is not a source of renewable energy, and therefore does not count towards meeting the 10% renewables obligation.

1.4 Options for meeting 10% renewables obligation

As mentioned previously, if the energy consumption is reduced by 10%, the CO_2 emissions are reduced by anywhere between 6 and 13%, depending on the means of renewable energy technology chosen. This section examines the CO2 reduction benefits of the preferred options.

1.4.1 Ground Source Heat Pump (GSHP)

A ground source heat pump system has been proposed to provide heating and cooling to the retail areas and supermarket on the area south of Cherryfield drive. It is indicated that there is a suitable aquifer on the site but issues to do with abstraction have not yet been resolved. A summary technical specification for the proposed ground source heat pump system is given in Table 1—2.

	kW/borehole	boreholes	Total Output (kW)
Open loop	250	18	4500

Table 1—2 GSHP summary

18 boreholes will be required. The estimated size of the GSHP system allows for 9 abstraction boreholes and 9 injection boreholes so that there is a heat balance across the year.

Ground energy, although using grid electricity to provide the pumping energy, is considered a renewable energy source. It is the renewable heat from the ground that is being harnessed.

A ground source heat pump system of this size is estimated to provide an energy saving of around 16%, meeting and exceeding the 10% renewables obligation necessary for planning.

Because heat is being replaced rather than electricity, the CO2 emissions reduction is lower than the energy reduction. The CO2 mitigation realised by a GSHP of this size is estimated to be in the region of 8%.

The logistics of a ground source heat pump system are described more thoroughly in technical annex F.

An open loop ground source system is the preferred option, and this is taken forward on the energy chapter.

With the preferred renewable option and the 25% reduction in energy consumption for the residential properties to meet CfSH level 3, the estimated energy use and carbon dioxide emissions from the site are summarised in

Application	Annual Energy consumption based on good practice benchmarks			**Total annual carbon dioxide emissions**
	Fossil Fuels	Electrical	Total	
	kWh/annum	kWh/annum	kWh/annum	**kg CO2/annum**
Residential	457,500	307,500	765,000	**218,520**
Retail	4,815,122	10,436,598	15,251,719	**5,338,378**
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	810,517	13,288,247	14,098,765	**5,764,881**
Hotel	1,010,000	300,000	1,310,000	**320,000**
Total	**8,693,139**	**26,782,345**	**35,475,484**	**12,991,779**
% Saving	**46%**	**-1%**	**16%**	**9%**

Table 1—3 Mitigated case – annual energy consumption and savings from preferred ground source heat pump system

1.4.2 Biomass Heat

In the case that a GSHP system proves inappropriate for use on the site, the combustion of biomass (wood chips or pellets) could provide a suitable source of renewable heating. The proximity of the buildings and the mixed use of the development provide an opportunity for using a district heating system served by a central energy centre. District heating would help to 'future proof' the development as the energy centre could be adapted as new technologies emerge, without requiring retrofitting of every building connected to the system. District heating could also be extended to connect other local buildings such as the local college and leisure centre buildings. Biomass boilers are an effective energy option for use with district heating to meet the baseload heating and hot water demand for the site; however they could also be used to meet all the heating requirements of a smaller area of the site.

It is considered that a 1.8MW biomass boiler system providing the heating and hot water requirements for the supermarket and the residential is the most feasible option, reducing the need for installing large quantities of pipework for the district heating system and yet still providing more than 9% of the site's energy requirement. Combined with some small renewable energy technologies, such as PV panels or micro-wind turbines this is proposed as an alternative option if permission for the GSHP system cannot be gained from the EA.