PRELIMINARY ENERGY STRATEGY FOR CLIENT
BRUNSWICK PARK

elementa

PRELIMINARY ENERGY STRATEGY FOR CLIENT
BRUNSWICK PARK

- Predicted energy consumption and associated CO_2 emissions from this proposed development
- Passive design and energy efficiency measures that will reduce energy consumption
- Low and zero carbon fuels and technologies to reduce the total CO_2 emissions per annum associated with this proposed development

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A	Preliminary Issue	02 February 2010	Knights T	Wise R
B	Revised in line with design team comments	12 February 2010	Knights T	Wise R

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EXECUTIVE SUMMARY

The proposed mixed-use development at Brunswick Park incorporates the following accommodation:

a) NHS primary care medical centre
b) Acorn nursery
c) Children's centre
d) Library
e) Shared accommodation, including waiting areas, cafeteria, office and meeting rooms
f) Hydrotherapy pool and associated ablutions

The development is approximately 2342m^2 in size (total gross internal area) and is oriented on an east to west axis.

Options have been reviewed for a range of renewable energy technologies with the aim of enabling the building to meet the Low and Zero Carbon (LZC) benchmarks required under Part L of the Building Regulations, the requirements of London Borough of Barnet and BREEAM.

Detailed thermal modelling of the building has not yet been carried out. This report is therefore based on benchmark standards.

In the absence of building thermal modelling and simulation, the expected energy requirements of the building have been estimated by reference to industry benchmarks including CIBSE Guide F, CIBSE publication TM46 'Energy Benchmarks' and the Health Technical Memorandum HTM 07-02 Encode.

Based on the above documentation, the energy benchmarks used in this study are:

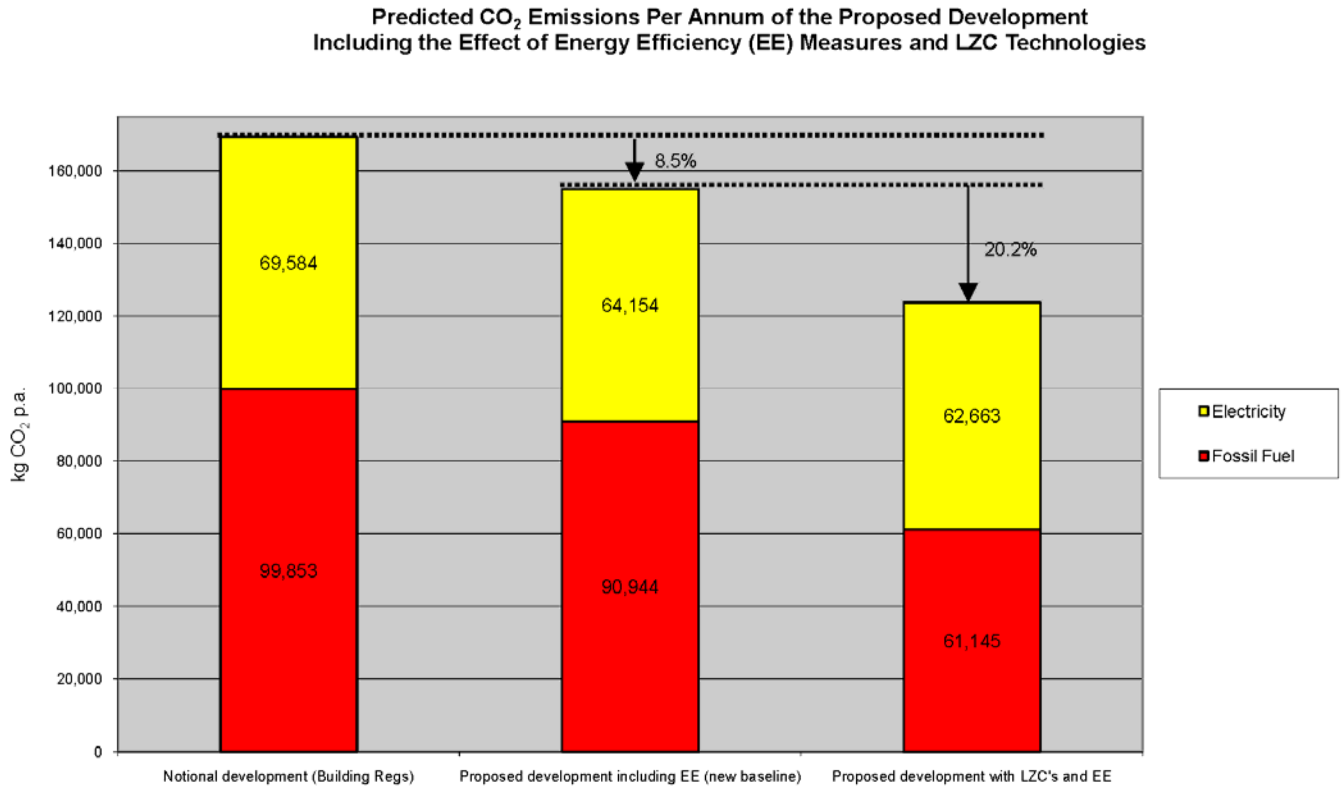
	Heating & Domestic Hot Water Consumption (kWh/m^2 p.a.)	Electrical Consumption (kWh/m^2 p.a.)
Acorn / Children Centre / Nursery Accommodation	150	70
Circulation & Waiting Areas	120	30
Library	200	70
NHS	221	70
Hydrotherapy Pool & Associated Ablutions	1130	245
Shared Accommodation	200	70
Office Accommodation	120	95

These figures have been used in determining the CO_2 emissions for the 'notional development'.

Passive design and energy efficiency (EE) measures were then considered, and this led to a 8.5% reduction in CO_2 emissions over the original prediction. This then gave a new baseline against which the low and zero carbon (LZC) fuels and technologies were evaluated.

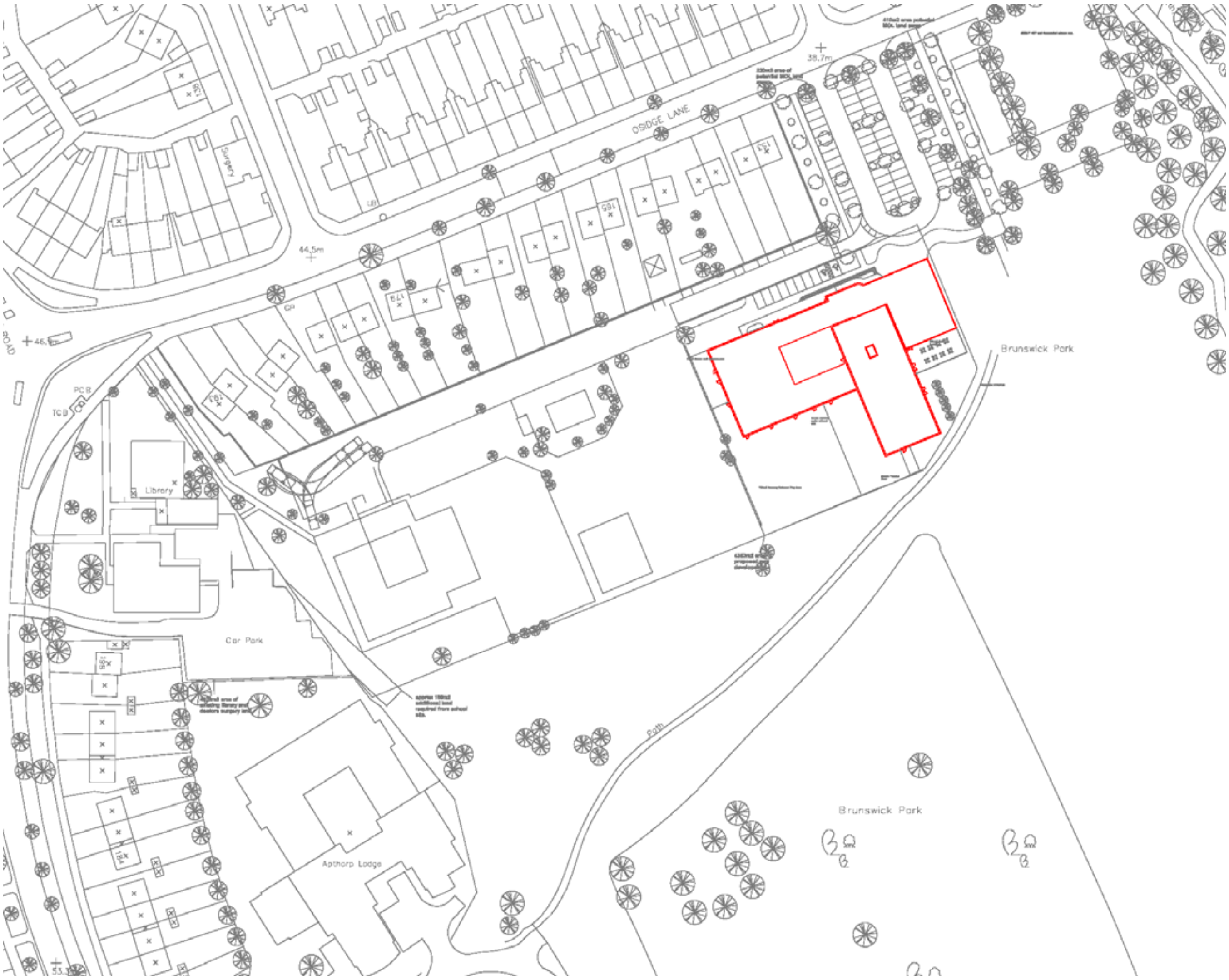
Following the methodology in the London Renewables Toolkit, the LZCs from the toolkit were evaluated, and a 19.2% reduction in CO_2 emissions over the new baseline was predicted by utilising a ground-source heat pump system to contribute towards 65% of the predicted annual heating energy consumption. Therefore, in order to achieve the minimum 20% required to be met by renewable technologies by London Borough of Barnet and the GLA, an additional 0.8% reduction in CO_2 emissions per annum is required. One method of achieving this additional emissions reduction would be to provide photovoltaics (PV). It is therefore predicted that the provision of 30m^2 of photovoltaic panels would provide an additional 1% reduction in CO_2 emissions per annum.

EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

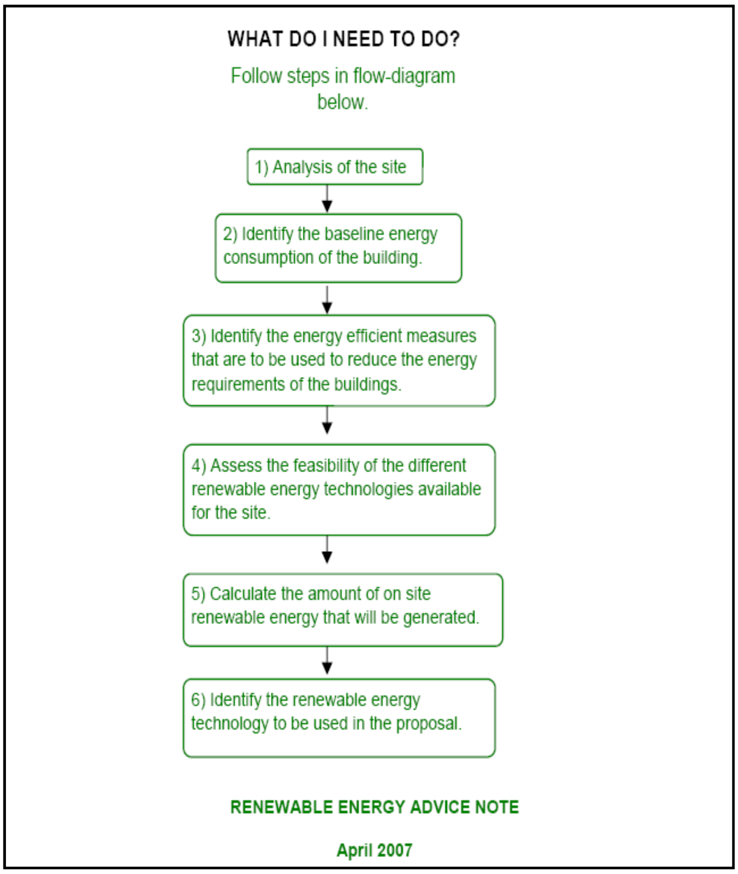
SITE LOCATION



EXECUTIVE SUMMARY

METHODOLGY

The London Renewables Toolkit LRT calculation methodology meets most Borough Council's stipulated outline planning requirements, as shown in the figure below:



THE ENERGY HIERARCHY

The LRT defines an Energy Hierarchy to help guide decisions about which energy measures are appropriate in particular circumstances. When each step of the Hierarchy is applied in turn to an activity, it will help ensure that London's and the rest of the UK's energy needs are met in the most efficient way. The Energy Hierarchy is the foundation on which this report is developed from. The three steps are:

1. Reduce Demand (*Be Lean*)
2. Apply Energy Efficiency *(Be Clean)*
3. Supply from Renewable or Low Zero Carbon Technologies *(Be Green)*

PASSIVE DESIGN & ENERGY EFFICIENCY MEASURES

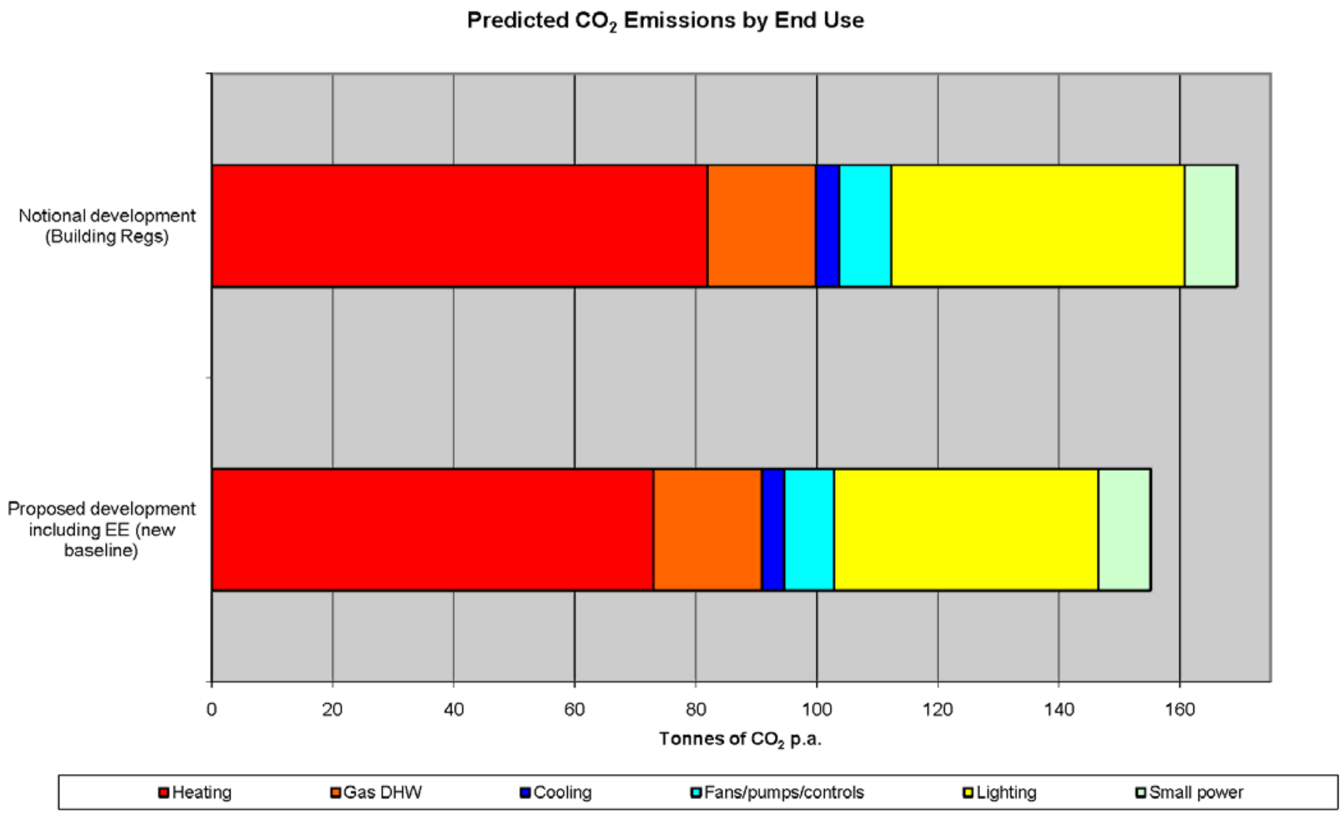
Elements	BEST PRACTICE	
EPC Target (BREEAM 6 POINTS)	40	
U-Values	Wall	0.28
	Average Window	1.76
	Roof	0.20
	Ground Floor	0.20
Air Permeability	<6m^3/hr/m^2	
Ventilation	Mixed mode ventilation strategy to be adopted. Natural ventilation to all possible rooms other than those that are deep sited or to have controlled environments	
Day Lighting	80% office space daylight to meet criteria of BS8206: part 2	
Artificial Lighting Controls	Luminance and presence detectors throughout building.	
Cooling Systems	Passive solar control (external shading, internal blinds) to be incorporated. Night time cooling system to be incorporated. Mechanical cooling only to be provided where clinical or operational needs or Building Regulations compliance dictates.	
Water Usage	PIR on tap operation where appropriate.	
Drainage Systems	Potentially use soakaways to reduce the burden on the sewage system. Rainwater harvesting to be incorporated.	
Toxicity of Materials	Eliminate the use of PVC cabling to LSF. Avoid all 'C' rated materials in BRE design Guide.	
Insulation Materials	Use non petro-chemical based insulation materials where ever possible	
Commissioning and Staff Training/Feedback/and monitoring in use	Post occupancy evaluation of building and energy use patterns to be undertaken and with seasonal commissioning.	

PASSIVE DESIGN & ENERGY EFFICIENCY MEASURES

The associated CO_2 emissions for the predicted energy profile outlined in Section 1 were calculated using the carbon intensity factors (kg CO_2/kWh) from Part L: 2006 of the Building Regulations (ADL2A) for natural gas and mains electricity, which are as follows:

Gas CO_2 Emissions Factor	0.194 kg CO_2 / kWh
Biomass CO_2 Emissions Factor	0.025 kg CO_2 / kWh
Grid Supplied Electricity CO_2 Emissions Factor	0.422 kg CO_2 / kWh
Grid Displaced Electricity CO_2 Emissions Factor	0.568 kg CO_2 / kWh

The passive design and energy efficiency measures highlighted in Section 2 were then considered, and the predicted CO_2 emissions were adjusted, according to the Renewables Toolkit methodology, to produce a new baseline figure that includes the energy efficiency measures.

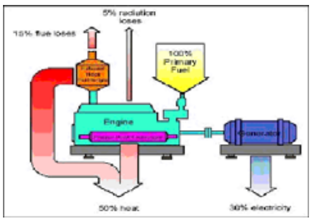


In Section 4, using the Renewables Toolkit methodology, the new baseline has been used to evaluate the impact of the proposed LZCs for this development.

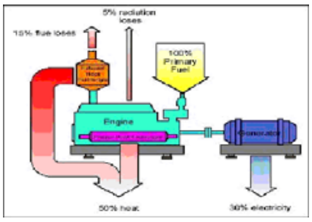
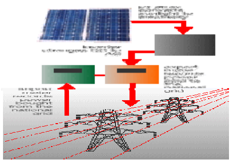
PREDICTED INFLUENCE OF LOW AND ZERO CARBON (LZC) FUELS AND TECHNOLOGIES ON THIS DEVELOPMENT'S CO_2 EMISSIONS

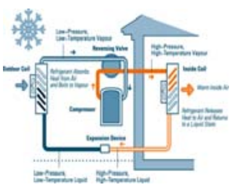
The guidance and methodology detailed in the "London Renewables Toolkit" were used to quantify the potential influence of LZCs on this development's total predicted CO_2 emissions.

Rules of thumb figures were taken from the toolkit where appropriate. Where a more relevant figure is known this has been used. The carbon intensity factors (kg CO_2/kWh) for natural gas and mains electricity were taken from the Building Regulations Part L: 2006 (ADL2A).

LZC Fuel/ Technology	**Description/Comments**	**Potential kg CO_2 p.a. savings**	**Potential % savings p.a.**
Combined Heat and Power (CHP)  	The use of CHP is not viable for this development for a number of reasons. The demand profile associated with this multi-use development does not lend itself to CHP, due to the lack of a heat sink outside of the normal heating season (i.e. hydrotherapy pool will have insufficient load due to size, and the development has limited domestic hot water demand). Heat generated by the CHP could be exported to surrounding buildings, but the existing buildings within the vicinity of the development again will not provide a sufficient heat sink outside of the heating season (e.g. adjacent school closed for significant periods during summer). We understand that the master plan for the area includes the redevelopment of the adjacent school; should this include community leisure facilities this may make CHP a more viable proposal (due to possible increased demand for heat). However, currently there is no guarantee such a development will take place. Heat from the CHP plant could be utilised to drive an absorption chiller during the summer months (tri-generation), but due to the sustainable design of the building fabric, and the use of natural ventilation wherever possible, we anticipate that the cooling load will be minimal, making this a non-viable proposition.	Nil	0 %

PREDICTED INFLUENCE OF LOW AND ZERO CARBON (LZC) FUELS AND TECHNOLOGIES ON THIS DEVELOPMENT'S CO_2 EMISSIONS

LZC Fuel/Technology	**Description/Comments**	**Potential kg CO_2 p.a. savings**	**Potential % savings p.a.**
Combined Heat and Power (CHP) continued 	The creation of an energy centre to serve buildings within the local area would become more viable if a development with a suitable heat sink was planned for the area (e.g. leisure centre/swimming pool). We understand that there are currently no existing energy centres/district heating schemes within the area which could be utilised to serve this development.	Nil	0 %
Wind Turbines 	The site and context for the proposed building has been examined. The outcome indicates that the site although open is within a high density residential area. There are likely to be planning issues associated with siting wind turbines of a size necessary to effect any significant CO_2 savings. In comparison to other technologies this would be an expensive option.	Nil	0 %
Photovoltaics (PV) 	PV's could be utilised and carbon savings based on a $30m^2$ PV array have been calculated. Although the installed cost of PV's is decreasing, they remain relatively expensive compared to other technologies.	1,491	1.0%
Solar Water Heating 	The roof space would be ideal for the location of solar water heating panels. However the low level of hot water usage in a development of this nature and the recent cost reductions in other technologies make PV's a more attractive proposition.	1,794	1.2 %

LZC Fuel/Technology	Description/Comments	Potential kg CO_2 p.a. savings	Potential % savings p.a.
Bio-fuel Heating 	The use of a biofuel boiler with a minimum output of 86kW would provide a meaningful contribution to the overall heating load and would represent a cost effective means of meeting the carbon reduction target. Careful consideration would need to be given to siting the boiler plant and associated fuel store. However, we understand that a biofuel system is not acceptable to the London Borough of Barnet on planning grounds.	31,184	20.1 %
Ground Source Heat Pumps (GSHP) Heating & Cooling 	GSHP could be viable (subject to geothermal investigation). GSHP would need to be sized carefully to work within the constraints of the site. A GSHP solution would represent a relatively expensive option in comparison to other renewable technologies available.	29,799	19.2 %
Air Source Heat Pump 	ASHP's could be viable for this site offering a practical and flexible solution at reasonable cost. However, ASHP's have been dismissed by London Borough of Barnet due to concerns over noise levels and the subsequent effect on surrounding residents.	23,861	15.4%

The low and zero carbon (LZC) technologies have been evaluated using the methodology in the London Renewables Toolkit. This evaluation indicates a 28.7% reduction in CO_2 emissions over the notional building by incorporating energy efficient measures and a ground-source heat pump system and PV's.

The savings from a biofuel boiler system have been calculated and this system would be ideal for this site, not just from a financial perspective. However, we understand that the London Borough of Barnet does not currently accept biofuel systems on planning grounds.

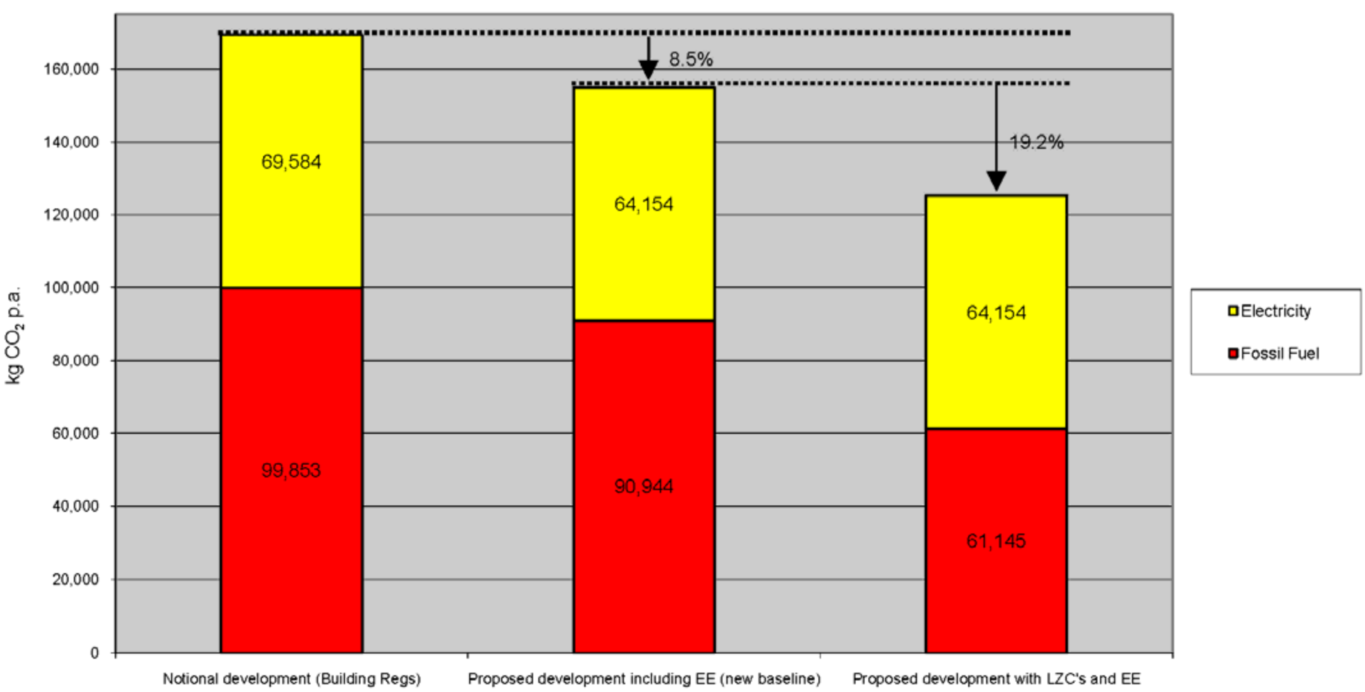
Alongside the passive and energy efficiency measures, such as using PIR, daylight sensors and presence detection lighting controls, mixed-mode ventilation and improved U-values for the fabric beyond that required for Part L; a ground-source heat pump system is proposed to contribute towards the minimum 20% reduction in CO_2 emissions required by the planning authority and the GLA.

PREDICTED INFLUENCE OF LOW AND ZERO CARBON (LZC) FUELS AND TECHNOLOGIES ON THIS DEVELOPMENT'S CO_2 EMISSIONS

The energy and carbon savings based on a ground-source heat pump system contributing 65% towards of the estimated annual heating energy consumption are indicated in the table and graph below:

Predicted Energy Consumption & CO_2 Emissions	Proposed development (kWh p.a.)	Proposed development with EE (kWh p.a.)	Proposed development with EE and LZC (kWh p.a.)	Proposed development with EE and LZC (kg CO_2 p.a.)
Heating	422,240	401,128	401,128	43,206
Gas DHW	92,466	92,466	92,466	17,938
Fossil Fuel subtotal	**514,706**	**493,594**	**493,594**	**61,145**
Cooling	9,037	8,585	8,585	3,623
Fans/pumps/controls	20,449	19,529	19,529	8,241
Lighting	114,955	103,459	103,459	43,660
Small power	20,449	20,449	20,449	8,630
Electricity subtotal	**164,890**	**152,023**	**152,023**	**64,154**
			Total kg CO_2 p.a.	**125,298**

Predicted CO_2 Emissions Per Annum of the Proposed Development Including the Effect of Energy Efficiency (EE) Measures and LZC Technologies



PREDICTED INFLUENCE OF LOW AND ZERO CARBON (LZC) FUELS AND TECHNOLOGIES ON THIS DEVELOPMENT'S CO_2 EMISSIONS

The provision of a ground-source heat pump solution alone will not provide the minimum 20% reduction in CO_2 emissions from on site renewable energy generation required by the London Borough of Barnet.

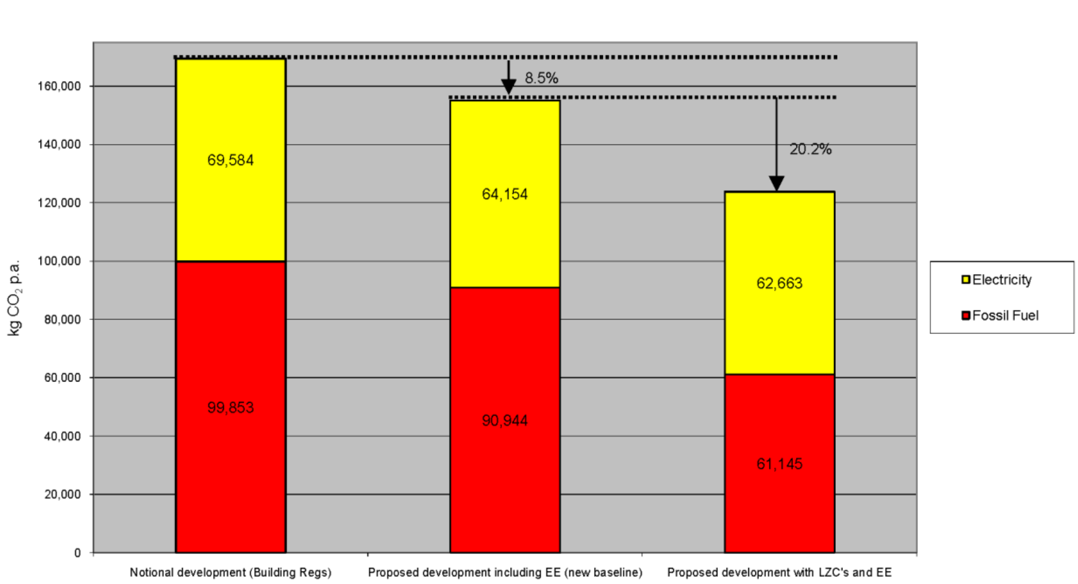
Therefore, by providing a carbon saving of 1.0% from the use of photovoltaic's in conjunction with a saving of 19.2% from the ground-source heat pump system, the target carbon reduction of 20% from baseline could be met.

In order to achieve this carbon saving, a PV array of 30 m^2 would need to provided.

The estimated energy and carbon savings provided by the use of a ground-source heat pump system and PV's are indicated in the table and graph below:

Predicted Energy Consumption & CO_2 Emissions	Proposed development (kWh p.a.)	Proposed development with EE (kWh p.a.)	Proposed development with EE and LZC (kWh p.a.)	Proposed development with EE and LZC (kg CO_2 p.a.)
Heating	422,240	401,128	401,128	43,206
Gas DHW	92,466	92,466	92,466	17,938
Fossil Fuel subtotal	**514,706**	**493,594**	**493,594**	**61,145**
Cooling	9,037	8,585	8,585	3,623
Fans/pumps/controls	20,449	19,529	19,529	8,241
Lighting	114,955	103,459	103,459	43,660
Small power	20,449	20,449	20,449	7,139
Electricity subtotal	**164,890**	**152,023**	**152,023**	**62,663**
			Total kg CO_2 p.a.	**123,807**

Predicted CO_2 Emissions Per Annum of the Proposed Development Including the Effect of Energy Efficiency (EE) Measures and LZC Technologies



BREEAM

AN IMPORTANT ASPECT OF THIS DEVELOPMENT IS THE REQUIREMENT TO ACHIEVE BREEAM 'EXCELLENT'. UNDER CATEGORY ENE5 'LOW OR ZERO CARBON TECHNOLOGIES' BREEAM AWARDS UP TO 3 CREDITS, OF WHICH 1 CREDIT IS MANDATORY TO ACHIEVE AN OVERALL EXCELLENT RATING.

A single credit is available for carrying out a feasibility study into the use of LZC technologies.

A second credit is available for installing the LZC technology in line with the recommendations of the feasibility study, and achieving a 10% reduction in the buildings CO_2 emissions, based on the output from approved energy modelling software.

A third credit is available for installing the LZC technology in line with the recommendations of the feasibility study, and achieving a 15% reduction in the buildings CO_2 emissions, based on the output from approved energy modelling software.

Therefore, the requirement stipulated by the London Borough of Barnet and the GLA to achieve a minimum of 20% reduction in CO_2 emissions from on site renewable energy generation exceeds the BREEAM requirements, which provides the potential to obtain all 3 BREEAM credits available.

APPENDIX

POTENTIAL RENEWABLE ENERGY SOURCES

Wind Generators
Wind turbines convert the kinetic energy of the wind into rotational mechanical energy using an aerodynamic rotor. This is then converted into electrical energy via a generator. The UK is the windiest country in Europe, and therefore wind power is one of the UK's most promising technologies.

There are two types of wind turbine available, smaller units which are roof mounted or fixed to the building and larger free standing turbines. The roof mounted units are limited in size due to wind induced stresses which are transmitted to the building structure. Most roof mounted turbines currently on the market are approximately 2m diameter and capable of producing 1-1.5kW each. However, the output is dependent on the surrounding obstructions and local wind speed. In developed urban areas outputs can be greatly reduced. Small scale wind turbines would not make any meaningful impact on a site such as this. Large free standing turbines are capable of producing hundreds of kilowatts which makes them a more attractive proposition in terms of energy generation. However, there are problems with noise, obtrusiveness and shadow flicker which means that generally large wind turbines need to be located at least 300m from any residential properties, which would not be possible on this site.

Photovoltaics
Solar Photovoltaic cells generate electricity using a silicon semiconductor material. The cells are electrically connected in series to form a module which forms the building block of solar arrays. Arrays would normally be formed of panels mounted on the roof, preferably facing south at an angle of 30° to horizontal for maximum efficiency. Photovoltaics remain an expensive form of renewable technology although installed prices have reduced recently. Pay back periods remain longer than most other technologies..

Solar Water Heating
Solar thermal systems utilise the heat from the sun to provide hot water. In the UK, solar thermal is most effective during the summer months, when space heating is not normally required, hence systems are normally used to provide a heating source for domestic hot water. Solar heat is stored within a collector panel and then transferred by a working fluid to a storage tank which stores the heat until required by the user. Evidence indicates that photovoltaic installations are becoming less costly to install than solar hot water heating systems.

Biomass Heating
The combustion of biofuels returns carbon dioxide to the atmosphere, but if the fuel is from a waste product or a plantation which is continually replanted then its use can be sustainable and it is considered a low carbon fuel. Biomass boilers tend to be larger and more expensive than their gas equivalents. This is due to the higher temperatures required for efficient combustion which requires a larger fire box. Fuel storage and handling is less simple than for conventional oil or gas fuels. Fuel is typically delivered by truck and is stored in a bunker adjacent to the boiler room. This has implications for delivery as lorries need to be able to draw up alongside the store to deliver the fuel. If fuel delivery from a reliable source within a reasonable distance of the site can be achieved and the logistics surrounding lorry deliveries can be overcome, then this can be a viable option to serve a proportion of the heating and hot water requirements of this site.

Combined Heat and Power (CHP)
CHP is the production of electricity and the use of the waste heat generated in the process. The use of waste heat can make a CHP system very efficient if the balance of electrical and heating loads are suitable. CHP plants are normally best suited to very large communal heating developments where they would be sized to meet the base heating demand, but the site may still require additional electricity from the national grid. During low or zero periods of heat demand, the CHP plant may be switched off, at which time grid electricity would be used.

APPENDIX

Ground Source Heat Pumps (GSHP)
Heat pumps use electricity to raise the temperature of water from a heat source, such as the ground to a suitable level, this heat can then be used to heat the building. A heat pump operates more efficiently with a higher heat source temperature. The ground is typically 10°C at 1 metre below the surface throughout the year and so in winter it acts as a better source of heat than air, whose temperature in winter can drop to freezing point. For a GSHP to be used most efficiently in a heating capacity it is best used with underfloor heating coils, due to the relatively low temperatures they operate at.

The heating cycle can be reversed in summer to provide some level of cooling via a low grade heat sink. Using GSHP's in this way is recommended in order to replenish the grounds heat store.

Air Source Heat Pumps (ASHP)
An air source heat pump works in a similar manner to a ground source heat pump except the heat source is the air rather than the ground. In place of a ground loop are fan assisted heat exchangers located in positions with a free air supply. Air is driven across the heat exchangers and heat energy is extracted. Like GSHP's, ASHP's can be reversed to provide cooling during summer operation. Air source heat pumps are currently, not approved by Southend Borough Council as a renewable technology.

APPENDIX

CHART DATA

ENERGY CONSUMPTION AND CO_2 EMISSIONS (BENCHMARK BASED ON BUILDING REGULATIONS 2006)

Floor area – Acorn / Childrens / Nursery	505.1	
Floor area - Circulation	546.1	
Floor area - Library	295.7	
Floor Area - NHS	509.3	
Floor Area – Hydrotherapy pool	118.9	
Floor Area - Shared Accommodation	289.4	
Floor Area - Office	77.9	
Total floor area	**2,342.3**	m^2
Gas CO_2 emissions factor	0.194	kg CO_2/kWh
Electricity CO_2 emissions factor	0.422	kg CO_2/kWh
On-site Elec CO_2 emissions factor	0.568	kg CO_2/kWh

TOTAL ENERGY CONSUMPTION

	kWh p.a.	kg CO_2 p.a.	
Heating	422,240	81,915	
Gas DHW	92,466	17,938	
Fossil Fuel subtotal	**514,706**	**99,853**	
Cooling	9,037	3,813	
Small Power	20,449	8,630	
Fans/pumps/controls	20,449	8,630	
Lighting	114,955	48,511	
Electricity subtotal	**164,890**	**69,584**	
		169,437	**Total CO_2 emissions p.a.**

PASSIVE DESIGN AND ENERGY EFFICIENCY (EE) MEASURES

Total floor area	2,342		
Gas CO_2 emissions factor	0.194	kgCO2/kWh	(ADL2A)
Mains elec CO_2 emissions factor	0.422	kgCO2/kWh	(ADL2A)
Biomass	0.025	kgCO2/kWh	(ADL2A)
On-site elec CO_2 emissions factor	0.568	kgCO2/kWh	(ADL2A)

CO2 Emissions Baseline	**169,437**	**Kg CO_2 p.a.**

Lighting Controls - PIR Presence Detection + Daylighting Sensors at Perimeter

Lighting energy	114,955	kWh p.a.		
Predicted reduction	10%			
Savings (energy)	11,495	kWh p.a.		
Savings (CO_2) from lighting controls	4,851	kg CO_2 p.a.	**2.9%**	**CO_2 savings over baseline**

Improved U-Values Beyond Part L

Heating energy	422,240	kWh p.a.		
Predicted reduction	5%			
Savings (energy)	21,112	kWh p.a.		
Savings (CO_2)	8,909	kg CO_2 p.a.	**5.3%**	**CO_2 savings over baseline**

Mixed Mode Ventilation

Cooling energy	9,037	kWh p.a.		
F/P/C energy	20,449	kWh p.a.		
	90%	% of F/P/C that is for fans		
Energy used for fans	18,404			
Estimated % savings from "mixed mode"	5%	Assumes openable windows with interlocks		
Estimated energy saved (cooling)	452	kWh p.a.		
Estimated energy saved (fans)	920	kWh p.a.		
Estimated CO_2 saved (cooling)	191			
Estimated CO_2 saved (fans)	388			
	579	kg CO_2 p.a.	**0.3%**	**CO_2 savings over baseline**

Savings over predicted emissions	14,339		**8.5%**	**Total CO_2 savings over baseline**

New Emissions Baseline (incl. EE)	**155,097**	kg CO_2 p.a.