Barnsley Markets
Sustainable Design and LZC / Renewable Energy Report

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Hulley & Kirkwood Consulting Engineers Ltd

Bass Warehouse

4 Castle Street

Castlefield

Manchester

M3 4LZ

(**t**): 0161 839 9572

(**f**): 0161 839 9573

(**e**): hk.manchester@hulley.co.uk

(**w**): www.hulley.co.uk

Prepared By: S. Dewberry / P. Wright

Authorised By:

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Sustainable Design and Renewable Energy Report

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E	Site energy modelling completed	PMW	16/05/11

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1.0 Sustainable Delivery

1.1 Introduction

This document has been produced to identify the strategy in meeting the sustainability obligations identified under Building Regulations Approved Document L2 and Barnsley MBC planning requirements – namely to assess how the development complies with policies CSP2 and CSP5 (covering sustainable construction and the inclusion of renewable energy in developments).

The following document explores the issues of providing a sustainable energy solution for the development at Barnsley Markets. A preliminary site energy assessment is considered, which will serve to highlight the feasibility of various strategies and inform the recommendations for the sustainable approach to servicing the development.

An assessment of sustainable issues and features is made and those which score highly within the context of the site are proposed to be incorporated with the design.

The sustainable issues considered here relate to those which reduce the energy demand of the new buildings and/or reduce their CO_2 emission rate.

The Building Regulations Approved Document L2 requires the buildings CO_2 emission rate to be one of the assessment criteria used for demonstrating compliance with the Building Regulations. This emission rate is calculated using an approved tool in line with the National Calculation Methodology (NCM), with this report using approved software package IES Virtual Environment v6.3.

1.2 Proposed Renewable and Low or zero carbon (LZC) energy solutions

Following correspondence with Barnsley Metropolitan Council (Joe Jenkinson) The requirement is for the scheme to ‘incorporate decentralised, renewable or low carbon energy sources to reduce the development's CO_2 emissions by at least 15%’. This reduction in emissions can be demonstrated as compared against Building Regulations Part L2 criterion 1 (predicted CO_2 emissions) compliance.

The 15% reduction is site wide and due to the nature of the scheme needs commitment to aspire to this mark by both the developer and the tenant fit out occupiers. To this end a combined approach needs to be considered at both the initial build phase of the development by means of construction with energy efficient building components, minimising the energy required for the heating, ventilation, cooling systems needed to maintain the environmental conditions. In addition, at the shop fit out stage, ensuring the future tenants can and will provide appropriate technology to achieve the CO_2 emissions reduction commitment.

Early stage design input is therefore vital to ensure the design strategies implemented from the outset are in line with the planning requirements and coherent with the practicalities and limitations of the site.

The development will also require to achieve a BREEAM rating of ‘Very Good’ and the results as presented within this report can be used to inform various aspects of this assessment.

These technologies and the impacts on the site-wide infrastructure and energy demand / CO_2 emissions are discussed further in the next section, specific to the different areas within the whole development and the anticipated energy demands of the site.

2.0 Site Energy Analysis

2.1 Energy Demand

The following table shows a breakdown of the expected site energy use, by area, of the individual unit types and areas present within the Barnsley Markets development. These are presented in this summary table as simply high / low or medium to help describe the general energy demands of the site. These are comparative values based on benchmark figures with reference made to CIBSE Guide F, BSRIA Guide 14/2003 and also to predicted energy demands as taken from the initial modelling results obtained.

The areas below are (where appropriate) sub-categorised in to the five areas of analysis covering the main separate areas of the scheme. These are: Market Building, Servicing (inc. car parks etc.), General Retail, Department Store and Cinema.

Occupancy Type	Zone Ref	General Elec Ltg and Small Power loading	Heating Demand	Cooling Demand	Domestic Hot Water Demand
Meat and Fish Market	A	Medium	Low	High	Low
Market Stalls, Open	B	Low	Low	Low	Low
Market Stalls, Enclosed	C	Medium	Medium	Medium	Low
Café Areas	D	Medium	Medium	Medium	Medium
Offices	E	Medium	Low	Medium	Low
Servicing	F	Low	None	None	None
General Retail, Shop Units	G	High	Medium	Medium	Low
Department Store, Retail	H	High	Medium	Medium	Low
Cinema, Leisure	I	Medium	High	Low	Low
Car Parking	J	Medium	None	None	None

Zone Ref	Approx. Area m²	Occupancy Type	Notes
A	975	Meat and Fish Market	All zones within Market Building
B	4019	Market Stalls, Open	
C	450	Market Stalls, Enclosed	
D	950	Café Areas	
E	350	Offices	
F	8050	Servicing	Basement car park etc.
G	22687	General Retail, Shop Units	All tenanted retail units
H	7398	Department Store, Retail	
I	2792	Cinema, Leisure	
J	19131	Car Parking	Car parking at upper levels

This site-wide demand allows us to develop a solution for the site-wide energy strategy that responds to the likely split of loads and ensures that any solution put forward is practically and technically appropriate.

The site largely consists of tenanted retail space. This type of accommodation will be a heavy user of general electric power, of which the main usage is predicted to be via artifical lighting (alongside equipment small power, pumps / fans etc.). Consideration of the types of lighting and lamp types (especially display lighting) and the controls systems to be used will be a key issue in reducing overall energy usage. The design of the artificial lighting will especially be important due to the deep plan aspect of most of the retail units thereby limiting the possible benefits of daylighting.

Heating loads will be significant to the retail areas, but will be of major consideration for the Cinema area due to the large volumes of the seated auditoria, and is predicted to be the main energy demand for this particular area. These loads can be minimised by investigating the benefits of improved U-Values, reducing the air permeability of the envelope, and seeking to use systems and equipment that offer the best efficiencies and reduce peak energy requirements as well as energy demand over time.

The nature of the development means that it is likely that the large majority of occupied spaces will have a requirement for cooling. Total energy use over the course of the year is not predicted to be as large as those loads provided by lighting or heating, although good practice design is assumed in order to achieve this. Solar control glazing should be provided where there is a risk of excessive solar gains to the envelope. Minimising lighting gains as described above will have a secondary benefit of reducing associated cooling loads. High efficiency cooling systems and equipment should be considered.

Design standards to other less obvious, but significant systems should also be considered. E.g. by limiting specific fan powers of systems and specifying improved ductwork and system leakage rates energy use associated with operation of fans can be reduced.

These aspects are covered in further detail in section 2.4 and section 4.0.

2.1.1 Principal Design Methodologies

In understanding the energy demands, technical issues and practicalities of the site along with initial energy performance analysis through computer modelling, design methodologies can be put forward. These are described below and it is these general principles that form the basis of the development of the detailed modelling and results discussed further in this report.

It is considered that the primary method of cooling throughout the site will be achieved by the use of air source heat pumps. This is envisaged to generally take the form of refrigerant-based VRF systems to individual zones that require cooling.

Where this system type is to be employed, the heat pumps will be capable of providing the heating requirements to the spaces.

This heating will be supplemented by gas-fired boilers where space heating only is required (with no cooling) and could also be used to provide domestic water generation for landlord operated facilities areas.

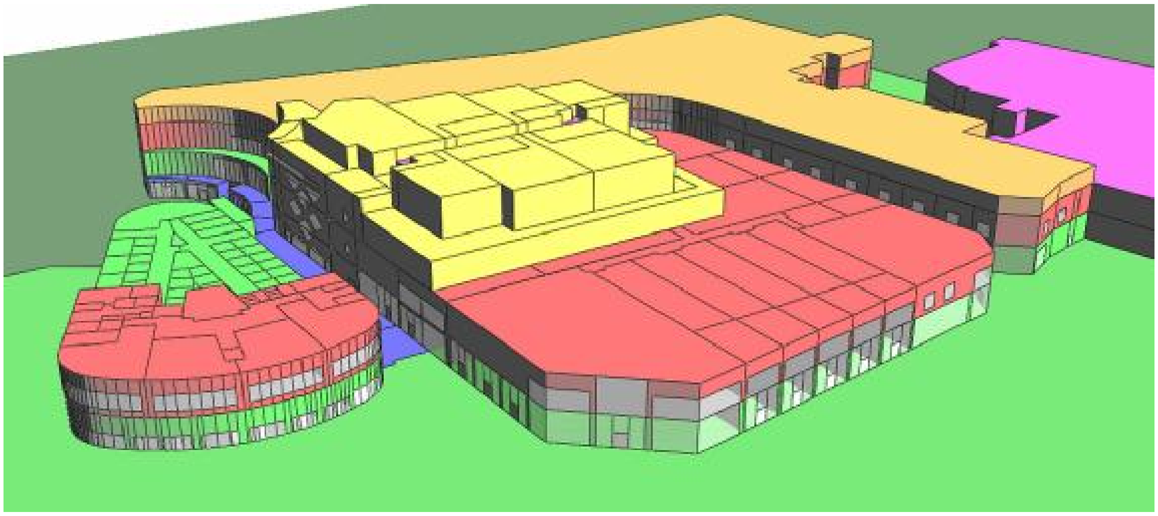
Tenant areas will generally be served using high efficiency air-source heat pumps to meet the heating and cooling requirements. Dedicated air handling units (AHUs) and toilet extract systems are to be provided by the tenant to meet the ventilation requirements of the building. These ventilation systems should, where appropriate, use high efficiency heat recovery methods to minimise energy use associated with ventilation.

Analysis of the energy demands associated with the retail areas shows a high energy demand attributable to lighting. Significant CO_2 emissions reductions can therefore be made against the Part L benchmark by ensuring that lighting energy demands within the retail units are minimised. This will include the use of lower energy display lighting, limits on the power density of the general lighting, as well as control systems that can manage the operation of the lighting effectively by the use of daylight sensing, addressable fittings and zoning.

All service systems within the retail units will require to be installed to the latest energy efficiency standards. This includes specifying leakage classes to the ventilation systems ductwork and AHUs to ensure a high standard of workmanship. The heating & cooling installations within the retail units will also require appropriate controls systems to manage the operation of the systems and reduce wasted energy.

Key to implementation of the above will be the requirement for the specific energy performance criteria requirements to be communicated to the eventual tenants such that the carbon emission targets are achieved. This will be carried out through the use of a BREEAM 'Green Lease Agreement' or similar appropriate mechanism.

2.2 Part L Compliance and CO_2 Emissions



Dynamic thermal analysis has been carried out on the building with a view to developing the shell specification and servicing strategy appropriate for all spaces within the development. This modelling and analysis has been carried out using the NCM approved software package - IES Virtual Environment v6.3.

The results from this modelling are used to test Part L compliance, and the stated requirements of Barnsley MBC - namely achieving a 15% improvement over Part L.

A representative screenshot of the 3-dimensional model used to carry out this analysis is shown above. For further details of the modelling inputs and zoning data, please refer to appendices 1 and 2.

A detailed base M&E specification has been developed in order to assess the Part L compliance of all the spaces within the site, and the servicing strategy recommendations to these areas are covered in more detail in section 2.4.

The onus is on the site to demonstrate a combined 15% CO_2 emissions reduction, and the whole site Part L2 criterion performance is summarised below along with each specific area of the development considered in isolation.

2.2.1 Whole Site CO_2 Emissions and Part L Compliance

The Part L2 criterion 1 compliance has been considered for the whole site, taking in the assumed fit-out to all tenanted areas (including the Retail Areas, Department Store and Cinema) as well as the areas that will be provided fitted out for the 'Base-Build' (Market Building management suite etc.). Un-heated and minimally heated areas not subject to Part L2 compliance such as the car parking areas, open market stall areas etc. are not considered as part of this analysis due to the difficulty of assigning a consistent performance 'benchmark' with which to assess a 15% CO_2 reduction against.

Please refer to Appendices 1 and 2 for further details of the modelling including geometry, zoning and inputs.

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

	Whole Site	
1.1	CO2 emission rate from notional building, kgCO2/m².annum	36.8
1.2	Target CO2 Emission Rate (TER), kgCO2/m².annum	36.8
1.3	Building CO2 Emission Rate (BER), kgCO2/m².annum	30.8
1.4	Are emissions from building less than or equal to target?	BER =< TER
1.5	Are as built details the same as used in BER calculations?	Separate submission

As a site the predicted CO_2 emissions due to the low carbon solutions and energy efficiency measures designed in to the scheme result in **a reduction of approximately 16%** from that required by 'baseline' Part L2 (2010) compliance.

For further details of the measures taken to each area of the site to achieve this, please refer to the recommendations in section 2.4.

This improvement is calculated by comparing the predicted CO2 emissions ($kgCO_2/m^2$) of the 'as-designed' building (1.3) against the 'notional' building (1.2). As per the case above, 30.8 $kgCO_2/m^2$ can be expressed as approximately 84% of the emissions of a building with 36.8 $kgCO_2/m^2$; therefore the building is performing approximately 16% better, in CO_2 terms, than the 'target' building.

In terms of building regulations compliance, the 'target' or 'notional' building is a building of identical shape, volume, usage etc. to the 'as-designed' building, but substituted with services systems and construction performance levels which serve to dictate the 'compliant' standard that a building must achieve.

2.2.2 CO_2 Emissions Breakdown to Site

The current design to the scheme predicts the CO_2 emissions savings to the whole site are in line with those required by BMBC. In order to allow for further analysis and consideration of the current performance this report also breaks down the performance of the 'whole site' in to the constituent areas as follows:

Retail Space

Tenanted retail space forms the majority of the floor area, and hence energy use and CO_2 emissions of the development. The performance of this area is particularly important in achieving the required performance levels through the site.

It can be seen from the Criterion 1 table below, covering the tenanted retail units only (excluding the area designated for a department store) that these areas are predicted to perform well in terms of CO_2 emissions reduction, with an approximate 21% comparative reduction as a result of the design measures proposed.

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target		
	Tenanted Retail Space (exc. Department Store)	
1.1	CO2 emission rate from notional building, kgCO2/m².annum	40.8
1.2	Target CO2 Emission Rate (TER), kgCO2/m².annum	40.8
1.3	Building CO2 Emission Rate (BER), kgCO2/m².annum	32.3
1.4	Are emissions from building less than or equal to target?	BER =< TER
1.5	Are as built details the same as used in BER calculations?	Separate submission

Leisure Space (Cinema)

The design measures considered to the Cinema area results in a building that if considered on its own would be compliant with the requirements of Part L, however the comparable reduction in CO2 emissions to this area is small, at just over 2%.

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target		
	Leisure Space (Cinema)	
1.1	CO2 emission rate from notional building, kgCO2/m².annum	27.6
1.2	Target CO2 Emission Rate (TER), kgCO2/m².annum	27.6
1.3	Building CO2 Emission Rate (BER), kgCO2/m².annum	27.0
1.4	Are emissions from building less than or equal to target?	BER =< TER
1.5	Are as built details the same as used in BER calculations?	Separate submission

Market Building

The market building, including tenanted kiosks, stores, meat & fish sales area, management suite and tenanted café areas is quite a complex building with a wide variety of differing, discrete energy demands. The assumptions made currently in terms of the design strategy to these areas should however lead to a space which would comply with the current Part L in terms of CO_2 emissions, although with a reduction in emissions of less than 1%.

	Criterion 1: Predicted CO2 emission from proposed building does not exceed the target	
	Market Building (Inc. Management Suite etc.)	
1.1	CO2 emission rate from notional building, kgCO2/m².annum	27.6
1.2	Target CO2 Emission Rate (TER), kgCO2/m².annum	27.6
1.3	Building CO2 Emission Rate (BER), kgCO2/m².annum	27.4
1.4	Are emissions from building less than or equal to target?	BER =< TER
1.5	Are as built details the same as used in BER calculations?	Separate submission

Department Store

The department store area is another fairly large part of the development, and it is considered that this will be served by similar means to the other tenanted retail areas. The usage of the department store is essentially identical to that of the other retail spaces, and therefore this area also performs well in terms of CO2 reductions, at approx 12% better than the Part L 2010 baseline.

	Criterion 1: Predicted CO2 emission from proposed building does not exceed the target	
	Department Store	
1.1	CO2 emission rate from notional building, kgCO2/m².annum	36.1
1.2	Target CO2 Emission Rate (TER), kgCO2/m².annum	36.1
1.3	Building CO2 Emission Rate (BER), kgCO2/m².annum	31.9
1.4	Are emissions from building less than or equal to target?	BER =< TER
1.5	Are as built details the same as used in BER calculations?	Separate submission

2.3 Systems and Technology Appraisal Summary

The following tables show a breakdown of the systems and technologies considered in the collation of this report, and where these are recommended for inclusion. Advantages and disadvantage of the systems are also presented, as applied to the Barnsley Markets scheme.

Sustainable Option	Feasible For this Project	Implications Of Incorporating	Reliability
District Heating & Cooling	No	Difficulties in obtaining buy-in with tenants in terms of agreements to provide energy via district heating / cooling and interface systems. Risk that if installed would not be taken on-board by the tenants, subsequently there are difficulties in accurately sizing initial plant. Risk of certainty of supply placed on plant operator.	Varies dependent on technology applied (see further discussions of technologies)
Biomass Boilers	No	Subject to finding suitable size location for fuel storage of pellets. Boilers need to be located at Ground Floor level (weight and fuel supply). Boiler flues more onerous than natural gas requirements. Transport to site (fuel deliveries) increased. Is more appropriate for incorporation as part of district heating scheme (see above).	Security of supply of Biomass fuel is still an uncertain, however is improving. Boilers have 15 to 20 year life span.
Absorption Cooling	No	Would be feasible only in conjunction with CHP (to provide heat energy) and district cooling.	
Combined Heating & Power (CHP)	Yes (small scale)	Feasible on a very small scale based on availability of constant heat load. Larger scale CHP would require the use of district heating throughout the site.	15 to 20 year life span. Subject to engine change after 45,000 hrs
Ground Source Heat Pumps	No	Geological Survey required to minimise risk of failure. Would require that loops are located below the buildings (greatly complicating future access). All works for system moved to start of programme to accommodate, adds to construction programme significantly. More appropriate as part of a district heating / cooling scheme.	Because operates on principle that ground is at constant temperature it is a constant energy source unlike other sustainable heat pump sources. Compressor will require periodic maintenance.
Air-Source Heat Pumps	Yes	Spatial requirement externally, or with access to external air. Seperate system can be provided for each retail unit, system will be appropriately sized, ties in well with the requirements of tenant fit-outs.	10-15 year life span. Maintenance of external condensor and compressors required periodically. FGAS regulations apply.
Solar Water Heating	Yes	Reliant on adequate solar energy, however is considered viable for Hot Water Pre heat to landlord operated areas.	20 year Life Span. Maintenance of pumps required as with any pumped water system.
Borehole Cooling	No	Ground investigation necessary to identify suitable source of water. Agreements necessary to obtain licence to abstract groundwater. Only really feasible as part of a district cooling solution.	Maintenance of pumps required as with any pumped water system.

Sustainable Option	Feasible For this Project	Implications Of Incorporating	Reliability
Condensing Hot Water Boilers	Yes	Should be utilized due to their superior performance where the primary fuel is gas. System design needs to take in to account reduced operating temperatures to take advantage of condensing.	
Photo Voltaic Panels (façade integrated or standalone)	No	Require appropriate space for initial installation. Are technically feasible however will give limited output for high initial capital costs. Apparent risk of FIT for larger systems (>50kW) not being available, further decreasing financial viability.	25 year Life Span for Electricity Generation. Electricity only generated when sun is shining.
Wind Turbines	No	Urban placement of wind turbines is not ideal due to unreliable wind direction, and corresponding reduction in efficiency of systems. Would likely present planning issues. Smaller scale building mounted wind turbines could be utilised, for small unreliable outputs.	25 year Life Span for Electricity Generation. Electricity only generated when wind is blowing.
Natural daylight	Yes	To be provided by external windows and or roof lights wherever possible.	Roof lights may be considered as a long term maintenance issue with regard to water ingress.
Addressable lighting control system	Yes	Addressable, programmable lighting control system with daylight sensors and presence detectors (where appropriate). Will reduce energy consumption and allow for future flexibility of systems.	
Low energy display lighting	Yes	Avoidance of all higher energy lamp types will reduce energy usage. Display lighting should be timed to turn off at night.	LEDs can have much reduced maintenance costs (due to long life).
Controlling Water Consumption	Yes	Minimal on-cost. Inclusion of flow rate limiting equipment to all appliances, and selection of appropriate sanitaryware by Architect.	Ultra low flush WCs can make drainage system requirements more onerous.

2.4 Recommendations

The following servicing strategies form the basis of the modelling exercises on which the displayed results are based. These therefore form the basis of the recommendations to the Barnsley Market development in order to achieve the 15% CO_2 emission reduction. Alternative solutions to those presented below (for example through design development) could reasonably be considered if the nett effect to the site CO_2 emissions is neutral.

Where areas are to be fitted out by an eventual tenant, strategies have been assumed within this report for compliance with the stated requirements. Although it is expected that these areas could take different approaches in terms of the detail, each tenant will be expected to perform at an equivalent performance as that dictated by the servicing strategy assumed within this report. Should this assumed performance level not be met by all tenants, the overall carbon emissions reduction target will be affected.

Please refer to appendix 2 for specific design-based inputs as used in the modelling.

Tenanted Retail Space (Inc. Department Store)

Whilst all internal fit-out works to the retail units are to be carried out by the tenant, a detailed strategy has been developed in order to validate the shell specification. This can be summarised as follows:

- Minimum fresh air supply and extract air handling unit with heat recovery
- Specified AHU specific fan powers and system leakage rates.
- Common ducted toilet extract system for toilet ventilation
- High COP air source heat pumps, electrically powered, for heating and cooling
- Addressable lighting control system, with zone control as appropriate for a retail unit
- Lower energy lighting used throughout, including for display lighting
- Domestic hot water generation dealt with by local point of use electric water heaters

Leisure Space (Cinema)

The cinema area is also to be fitted out by the tenant, and a strategy has been developed for the purposes of the modelling which can be summarised as follows:

- Heating and cooling air handling unit provided to each individual screen
- Common ducted toilet extract system for toilet ventilation
- Heating to screens provided by high efficiency gas-fired condensing boiler
- Cooling to screens provided by high COP air source heat pumps, electrically powered
- Minimum fresh air supply and extract ventilation to public spaces e.g. foyer
- High COP air source heat pumps, electrically powered, for heating and cooling to public spaces e.g. foyer
- Radiator heating to toilet areas using the high efficiency boiler
- Lower energy lighting used throughout
- Domestic hot water generation by high efficiency gas fired water heaters

Market Building

The market building consists of various different types of areas which are subject to either tenant fit-out (such as the ground floor ‘kiosk’ areas) or fit-out as part of the base-build (such as the management suite). In line with the differing requirements of the spaces there are varying servicing strategies assumed for each area. The key aspects can be summarised as follows:

Management Suite:
- Minimum fresh air supply and extract ventilation
- High COP air source heat pumps, electrically powered, for heating and cooling

Public Toilet Areas:
- Radiator heating using high efficiency, condensing boiler
- Domestic hot water generation by high efficiency gas fired water heaters
- Common ducted toilet extract system

Meat and Fish Stalls:
- Heating and Cooling to space delivered by air handling system
- Specified AHU specific fan powers and system leakage rates.
- Heating generated by high efficiency, condensing boiler
- Cooling generated by high COP air source chiller
- Lower energy lighting used throughout, including for display lighting

Tenanted Kiosks and Café Areas
- Minimum fresh air supply and extract air handling unit with heat recovery where mechanical ventilation required
- Specified AHU specific fan powers and system leakage rates.
- Natural ventilation where possible to Kiosks
- Separate kitchen extract system
- High COP air source heat pumps, electrically powered, for heating and cooling
- Addressable lighting control system, with zone control as appropriate for a retail unit
- Lower energy lighting used throughout, including for display lighting
- Domestic hot water generation dealt with by local point of use electric water heaters

Landlord and Common Areas

The landlord common areas such as the car parking at interchange level and upper levels, general circulation space, external courtyards etc. will have associated energy demands with them in order to provide lighting, general small power, background heating etc.

These areas are not directly subject to Part L CO_2 emissions compliance targets, and therefore it is difficult to assign a benchmark performance on which to provide comparison and hence demonstrate a CO_2 emissions 'saving'. Due to the comparatively small energy use associated with these areas this report does not consider these areas in terms of the CO_2 emissions figures contained within.

The energy use and CO_2 emissions associated with these areas will not be insignificant and the following recommendations are made to these areas:
- External light fittings for the building, access ways, pathways, car parking, roads etc. have high luminous efficacy lamps with appropriate colour rendering indices.
- External light fittings should be controlled through a time switch or daylight sensor to prevent operation during daylight hours.

This should aim to be in line with the BREEAM requirements of ENE4 – External Lighting, in order to aid compliance in this regard and functionally to minimise ongoing energy use associated with these areas.

Lighting design in the basement area should seek to minimise energy use whilst maintaining a secure, well-lit environment through the appropriate choice of light fittings and control systems.

3.0 Sustainability Vision and Technology Background

The following sustainable/renewable energy options have been considered for the new development.

3.1 Air Source Heat pumps

Air source heat pumps (ASHP) absorb heat from the outside to heat buildings. It is even possible for air source heat pumps to extract useful heat from air at temperatures as low as minus 15°C.

For every unit of electricity used to power the pump, 3-4 units of heat are produced, making it an efficient way of heating a building.

In the same way that a fridge uses refrigerant to extract heat from the inside, keeping food cool, an air source heat pump extracts heat from the outside air, and uses it to heat the building and produce hot water. An air-source heat pump has three main parts:

- The evaporator coil absorbs heat from the outside air;
- The compressor pumps the refrigerant through the heat pump and compresses the gaseous refrigerant to the temperature needed for the heat distribution circuit;
- The heat exchanger transfers the heat from the refrigerant to air or water.

Air source heat pumps can be designed as centralised air to water systems, but in order to maximise system efficiency these typically heat water to a maximum of 40°C – 45°C. This is well suited to underfloor heating installations, and can be used with more ‘traditional’ heat emitters although these have to be sized appropriately.

Refrigerant based systems can also be used, e.g. packaged VRF systems, although the sizes of these are limited to the constraints of the individual systems as manufactured. Refrigerant based systems are well suited to a decentralised approach, whereas the air-to-water system would typically be more suited to a central plant where distribution systems are independent of the packaged system.

The use of centralised ASHP systems or zoned systems (e.g. VRF installations) would be widely applicable to either landlord or tenant fit-out areas and is presented in further detail as a primary option for consideration.

3.2 Solar Water Heating

Single flat plate water based collector panels consisting of tubes containing water have been used successfully on south facing roofs over many years in the UK. The basic principle is to collect heat from the sun and circulate it to pre heat space heating or domestic water in either a separate tank or a twin coil hot water cylinder.

This system can provide a useful means which can typically lead to a reduction of up to 50% of carbon emissions associated with domestic hot water systems in the UK climate.

Costs for solar thermal systems are expected to be in the region of £700/kW (rated) installed.

Solar water heating is likely to be eligible for Renewable Heat Incentives (RHIs). Further details are expected to be available on this scheme in March 2011.
The use of solar thermal hot water generation is investigated further to supplement the landlord domestic hot water requirements.

3.3 Combined Heating and Power

A Combined Heating & Power (CHP) Plant is an electricity generator situated at the point of use. It consists of an engine that generates electricity with the waste heat used for heating. The units range from large industrial units to small domestic size units.

CHP provides Carbon Dioxide savings because both heat and electricity are produced, The system uses typically 35% less primary energy than traditional Generation because the waste heat is not dumped and there are little transmission loses.

Medium size CHP has a proven reliability record of 12-15 years.

A CHP engine will practically require the installation of a heat and power distribution network in order to ensure the heating energy can be utilised and the system can be made to generate energy efficiently.

Large and medium scale CHP systems are not considered viable due to the requirement that practically these would form a part of a district heating or tri-generation scheme. Small scale 'micro-CHP' is considered further as a potential option for carbon efficient energy generation to serve landlord requirements.

3.4 Photovoltaics

Photo voltaic materials commonly known as solar cells generate direct current electrical power when exposed to light. Solar cells are constructed from conducting materials that absorb solar radiation, electrons are displaced within the material thus starting current flow through an externally connected circuit.

Integrated photovoltaics are available, which are generally lower performance (energy-wise) than standalone systems such as monocrystalline, however they can give a low aesthetic impact solution by being integrated with the building envelope.

Potentially more suitable for this site would be the use of a stand-alone series of frame mounted photovoltaic (e.g. monocrystalline) panels, which could stand on the large expanse of roof. This would ensure the maximum output could be achieved using the given roof area, which would consequently serve to maximise the potential carbon savings offered.

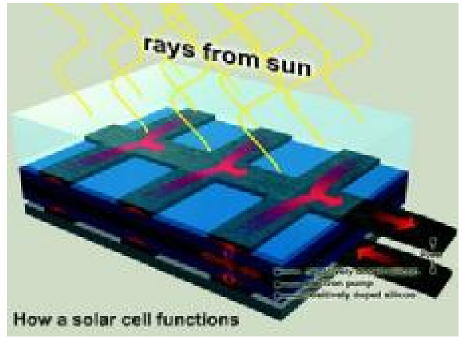
The 'Feed-in-tariff' (FIT) scheme has recently been introduced with the intention of encouraging the up-take of Photo-voltaic technologies within the UK by providing operators with financial incentives for energy generation, and should be considered with all financial analyses.

Due to the financial benefits offered by the FIT scheme, there is the potential for a third party supplier to provide the installation of a large scale PV installation with no capital cost requirement for a developer. Typically this supplier would require that there is sufficient space to make this beneficial, and contracts will need to be exchanged such that the PV generation capacity can be integrated with the site electrical infrastructure. In exchange for space to install a PV system, long term the supplier aims to benefit financially from the on-site power generation and subsequent receipt of the Feed-in Tariff.

Alternatively, the installation of a similar scale PV system could be carried out by the developer, which would involve taking on the capital and risk requirements necessary for the installation, and long term the site should benefit financially. Typically with the FIT scheme a PV installation might achieve simple financial payback in approximately 12-14 years, with the panel installations having an expected life of 20+ years.

Panel outputs will degrade over time, but manufacturers may be able to give performance guarantees (e.g. 80% output at 20 years).

The use of a roof mounted PV installation is considered viable given the financial benefits offered by the FIT scheme.



3.5 Wind Turbines

In a suitable location wind energy can be an effective source of renewable power generation. The most common arrangement is for a machine with a 3 blade rotor connected to a generator which is mounted on a tower or increasingly in city areas on top of a building. Average site wind speeds of 4m/s can produce useful amounts of electricity from a small generator but larger generators needs wind speeds in access on 7m/sec. A small increase in wind speed results in a large increase in output power.

Tower height is critical in that installing a tower as high as possible ensures that the propellers are located within the strongest wind forces and in some instances permits the land below the tower to be utilised.

Multiple Wind turbines need a large area – As a rule of Thumb the spacing between adjacent towers should be 8x the rotor diameter.

Consideration need to be given to site location (Planning Conditions) and noise generated by the wind turbine rotors, effect on any local TV or mobile telephone signal transmitters when in operation.

Reliability is intermittent as it is dependant upon wind and therefore any energy generation should not be relied upon. Design life is in the order of 20 years.

Costs for installed wind turbines are typically in the region of £2000 / kW (rated), and these systems can also benefit from the FIT scheme.

Large scale wind turbines are not considered appropriate for this scheme, although the incorporation of building mounted micro-wind could contribute usefully to the reduction in carbon for the site.

3.6 Building U Values

Further improvements against the Building Regulation minimum standards may be attainable. We would envisage further improvement of 10% - 15% on Part L should be technically achievable, subject to cost implications. These would be:

- Ground floor / exposed Floor - 0.21 W/m²K
- Roof / Floor - 0.21 W/m²K
- External Wall - 0.30 W/m²K
- Glazing - 2.00 W/m²K

3.7 Rainwater and Grey Water Reclamation

A combined system of rainwater and grey water allows rainwater from the roof and grey water from showers, wash hand basins etc to be collected and stored in an underground tank which is then pumped back to the building and utilised in non potable uses such as WCs, irrigation purposes etc.

Advantages of rainwater and grey water use are –

- A reduction of mains cold water storage of up to 37% dependant upon the project.
- A reduction in the amount of mains water required reducing costs of overall water services in use.
- A reduction to the amount of water discharged to the sewers reducing sewage charges.

Grey water recycling is more technically demanding than rainwater recycling, and is not often considered in the UK climate. Rainwater recycling is widely used, however, and overall costs are strongly linked to the extent of extra-over distribution pipework that will be provided to serve a particular site.

The following strategies could be considered:

- Provision of recycled rainwater to Landlord areas only, for toilet flushing and similar.
- Provision of recycled rainwater also to Tenants with connection and meter at boundary of unit for extension to toilets (toilet flushing only) by tenant fit-out.

3.8 Water Consumption

Install water control devices should be installed to minimise wastage and should include;-

- Flushing systems in toilets.
- Self Closing Push Taps for hand basins.
- Waterless Urinals
- Flow Restrictors on Outlets

3.9 Leak Detection System

A leak detection system should be specified to monitor for leakage of systems such as the incoming mains cold water supply, to minimise associated waste that may be associated with undetected leaks.

3.10 Natural Ventilation

Natural ventilation principles should be encouraged and employed where practicable with mechanical ventilation provided where necessary to supplement shortfalls in natural ventilation.

The use of natural ventilation will be limited on site due to the deep plan nature of the majority of accommodation. Given the limitations on this approach the use (or not) of natural ventilation where appropriate is not expected to have a significant contribution to the site-wide carbon reduction.

Natural ventilation is however proposed to be used to the outer facing 'kiosks' throughout the market building, and as the market is generally 'open to the elements', the relevant systems should be designed to attempt to maximise the benefit of the natural ventilation that can be utilised.

3.11 Combined Lighting (PSALI)

Although natural light is more pleasant to work in than artificial light the levels of light available daylight vary throughout the day, illumination levels provided by the daylight are uneven i.e. high illumination near windows with poor illumination towards the inner areas of a room.

A compromise is to combine artificial with natural daylight this system is known as Permanent Supplementary Artificial Lighting of Interiors (PSALI).

PSALI is a combination of artificial and day lighting where to two are blended together to provide an even illumination, parts of the room are permanently lit by artificial light.
PSALI retains most of the advantages of artificial lighting but can illuminate deeper plan rooms than could be lit by natural day lighting alone.

Installation of lighting controls that switch off spaces when unoccupied or when adequate daylight is available, lumen output is adjusted to compliment the natural daylight within the space.

Luminaires shall be complete with energy efficient ballasts and be able to regulate the output from 0-100% when installed within specific lighting zones.

3.12 Brise Soleil

Brise soleil are opaque or semi-opaque constructions that are positioned as part of the façade design of a building to directly protect solar gains from entering a building. Typically these are fixed and can be horizontal or vertical, but movable brise soleil controlled by mechanical actuators can be utilised to vary the protection as the sun tracks across the sky.
Average solar gain to any perimeter room must be limited to 15W/m² of the floor area between the hours of 8.00 a.m. and 5.00 p.m.

Typical Brise Soleil installations, vertical and horizontal

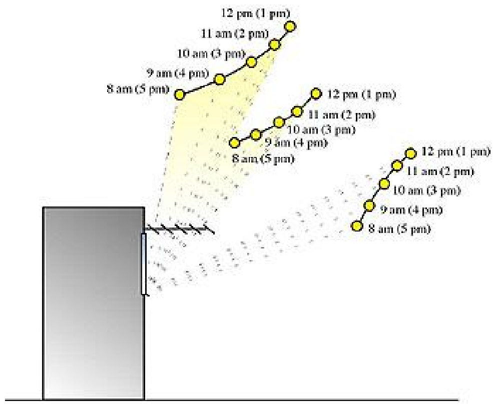


Diagram showing the relative position of the Sun, throughout the year, relative to Brise Soleil

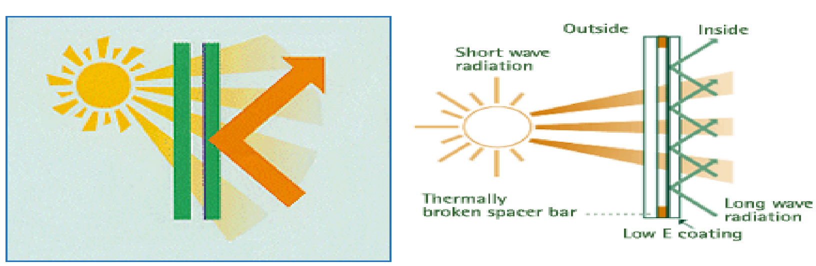
For a predominately South facing facade, effective solar shading can be achieved using a fixed horizontal solar shading system.

3.13 Solar Control Glazing

The glass in windows absorbs heat then radiates it again on the colder, outside, surface. ‘Low emissivity’ glass has a coating on the surface that faces into the air gap of the double glazing unit.

‘Low emissivity’ means the coating is a poor radiator. The heat absorbed by the coated glass is inhibited from radiating across the air gap and then from the outer pane to the cold outside world. Instead the heat is reflected back into the room by the coating.

Glazing units should have a maximum Total Solar Transmission of 40% and a minimum daylight factor of 65%. This ensures good solar control while maintaining a reasonable admission of daylight.



Diagrams illustrating the performance of ‘Low-emissivity’ solar control glazing

3.14 Ground Source Heat Pumps

The ground temperature remains fairly constant throughout the year and heat can be extracted by circulating a fluid (usually water or a refrigerant) through a system of pipes and into a heat exchanger. An electrically driven pump is then used to raise the fluid temperature through the compression cycle and hot water is delivered to the building load as if from a boiler. In order to operate most efficiently, temperatures delivered by ground source heat pumps are lower (typically 35°C – 45°C) than a boiler system (typically 50°C – 70°C).

As a consequence of the fairly constant ground temperature the system is reliable and efficiencies of the system are predictable and stable.
Pipe configurations can be horizontal but should only be considered where a large surface area is available.

Vertical U Loops are installed in boreholes up to 150M in depth (depending on particular circumstances – site conditions, load required etc.).
The vertical U Loop is normally the best choice as it offers high capacity and a high quality installation at reasonable cost.

A geological investigation may be needed to minimise risk of failure and improve cost certainty.

Such systems can offer a coefficient of performance (heat output to electrical energy Input) of between three and four achieving good savings on energy when compared with traditional fossil fuels.

Costs for ground source heat pump installations are typically in the region of £1000 / KW, however electricity consumed by pumps needs to be taken into account, and site conditions.

A ground source heat pump installation to the site would likely require a large number of boreholes, which would necessarily be located underneath the market or interchange levels. A site wide system is not considered to be viable due to the cost and risk associated with a district heating/cooling solution and the constraints this will put on tenants.

A potential ground source heat pump solution to the market landlord areas alone may be viable but would require extensive and early geotechnical investigations, with the requirement to carry out the necessary work early on in the build programme prior to all other construction works. Given the nature of the market site it is considered that other options are more viable from a practical, technical and financial point of view and hence the use of a ground source heat pump is not considered in further detail.

3.15 Borehole Cooling

The constant ground temperature is well below ambient air temperature during the summer so cool water can be extracted and used to replace or supplement conventional building cooling systems. Such borehole systems may either be open discharging water to a river or sewer after passing it through a heat exchanger or closed circulating a fluid often water through a heat exchanger and vertical pipes extending below the water table.

Ground source heating and cooling systems are only partial renewable energy, because they rely partly on electrical power for pumping. Considerable carbon savings can be achieved by avoiding the use of fossil fuels for heating and electrical power to drive chiller motors.

The use of Borehole cooling on this site has not been considered further due to the nature of the energy use throughout the site and this report considers that other solutions are more viable.

3.16 Biomass Boilers

The biomass boiler can bring all the convenience and efficiency of a traditional fossil fuel boiler but using a renewable energy source which is in abundant supply across the UK.

The boilers have simple but effective controls which are connected to the building management system in the traditional way to provide flexibility and ease of control.

A dosing silo needs to be installed to allow Coordinated large deliveries of biomass fuel to be stored on site to be used as and when required. Either wood chip or wood pellets may be used for best efficiency but with ability to burn other biomass fuels if required. These are obtained commercially and are considered to be carbon neutral having absorbed carbon during their growth providing they do not have to be transported over long distances. With an automatic screw drive and controls, a biomass boiler can replace conventional boilers with little technical or aesthetic impact.

Due to the high combustion temperatures, the fuel is entirely clean burning and suitable for use in smokeless fuel areas. The system also uses an automatic de-ashing technique resulting in the easy maintenance of the system.

Biomass boilers are available in a wide range of domestic and commercial sizes. For larger systems they are more likely to be considered as part of a modular system rather than displacing conventional boilers completely.

There is a cost premium for biomass storage and feed systems.

The design and layout of this scheme will give significant access / storage issues for fuel supply should this option be considered appropriate for tenant fit-out. As a site-wide solution fuel supply routes and storage can be 'designed-in' if considered early enough. This solution would (practically) require the use of a 'district-heating' type system, and coupled with the nature of the loads throughout the site, the use of Biomass Boilers is not considered in further detail.

Biomass fuel store access and a Biomass Boiler.

3.17 Biomass Combined Heating and Power

Conventional heat and power installations consist of either an internal combustion engine or gas turbine driving an alternator, with maximum recovery of heat particularly from the exhaust system. For optimum efficiency there needs to be a constant source of heat requirements and the generated electricity should also be used locally.

There is not yet a Biomass CHP Installation operational in the UK.

Unless a source of fuel is available from a local biomass digester then an on site biomass to gas conversion plant is required to fuel the CHP engine.

Given the cost, fuel supply and technical risks associated with the use of biomass CHP, this has not been considered further.

3.18 Bio Fuel Combined Heating and Power

There are also a number of liquid forms of biomass that can be used as a fuel within a Combined Heat and Power (CHP) system.

- Bioalcohols such as ethanol. Ethanol fuel produced from sugar cane is being used as automotive fuel in Brazil. Ethanol produced from corn is being used as a gasoline additive (oxygenator) in the United States. Cellulostic ethanol can be manufactured from straw (an agricultural waste product)

- Methanol, which is currently produced from natural gas, can also be produced from biomass, although this is not economically viable at present. The methanol economy is an interesting alternative to the hydrogen economy.

- Butanol is formed by A.B.E. fermentation (Acetone, Butanol Ethanol) and experimental modifications of the ABE process show potentially high net energy gains with butanol being the only liquid product. Butanol can be burned "straight" in existing gasoline engines (without modification to the engine or car), produces more energy and is less corrosive and less water soluble than ethanol, and can be distributed via existing infrastructures.

Biologically produced oils (bio-oils) can also be used in diesel engines :

  - Straight vegetable oil (SVO).
  - Waste vegetable oil (WVO).
  - Pure Plant Oil (PPO - also can be called SVO)
  - Biodiesel obtained from transesterification of animal fats and vegetable oil, directly usable in petroleum diesel engines.
  - Oils and gases can be produced from various wastes:
  - Thermal depolymerization can extract methane and oil similar to petroleum from waste.
  - Methane and oils are being extracted from landfill wells and leachate in test sites.

Green powers PPO CHP unit GP 30

This report considers that only Micro-CHP can be considered viable to this site, and in the use of biofuels as described above, units generally are not available to serve this small demand. Given the requirement for fuel storage and the technical risks, this option is not considered in further detail.

3.19 Feed-in tariffs (FITs) and Renewable Heat Incentives (RHIs)

FITs

The Feed-in tariff scheme is a method of encouraging the installation of electrical micro generation throughout the UK. The scheme guarantees a minimum payment for all electricity generated by the system, as well as a separate payment for the electricity exported to grid. These payments are in addition to the bill savings made by using the electricity generated on-site. Feed-in tariffs became available in April 2010.

Feed-in tariffs are designed so that the average monthly income from a micro generation installation will be significantly greater than a typical monthly loan repayment (with a 25 year loan).

The scheme covers the following electricity-generating technologies, up to an installation size of 5 Mega Watts:

- Solar electricity (PV) (roof mounted or stand alone)
- Wind turbine (building mounted or free standing)
- Micro combined heat and power (micro CHP) (limited to a pilot at this stage)

The tariffs available and the process for receiving them vary, depending on when the technology is installed, and whether the system and the installer are certificated under the MCS scheme.

For this development the only viable options that can be considered are the potential installation of wind energy generation, or PV.

Technology	Scale	Tariff level (p/kWh)	Tariff lifetime (years)
Solar electricity (PV)	10-100kW	28.7 – 31.4	25
Solar electricity (PV)	100kW – 5MW	26.8 – 29.3	25
Wind	≤1.5 kW	32.6 – 34.5	20
Wind	>1.5 - 15 kW	25.5 – 26.7	20

Typical tariff levels, for technologies installed between 15th July 2009 and 31st March 2012

(Tariff levels vary depending on the scale of the installation.)

The tariff levels shown in the table above apply to installations completed from 15th July 2009 to 31st March 2012 for the lifetime of the tariff. After this date, the rates will decrease each year for new entrants into the scheme.

All generation and export tariffs will be linked to the Retail Price Index (RPI) which ensures that each year they follow the rate of inflation.

RHIs

The Renewable Heat Incentive (RHI) is designed to provide financial support that encourages individuals, communities and businesses to switch from using fossil fuel for heating, to renewables such as wood fuel.

Eligible technologies

- Air, water and ground-source heat pumps
- Solar thermal
- Renewable combined heat and power

Final details of the scheme are not available, but the scheme is expected to be launched in late summer 2011. Further details along with tariff levels are expected to be confirmed by March 2011.

4.0 Sustainability Features to tenant fit out.

The following technologies should be considered to all tenant fit-outs, in order to reduce whole site energy use, comply with good practice, and ensure the carbon reduction requirements of Barnsley MBC can be achieved. This will be in addition to the measures described in section 2.

A tenant strategy document has been produced in order to detail how the tenants can comply with the requirements of Part L2a and Barnsley MBC, and a description of some of the appropriate measures are discussed below. If the tenant moves away from the given recommendations then it will be the responsibility of the tenant to show full compliance by alternative means.

4.1 Heat Recovery to Ventilation Plant

Heat recovery devices such as plate heat exchangers, run around coils or thermal wheels would be fitted the supply and extract sides of the air handling plant. The choice of heat recovery system would be dependent on location and function, but high efficiency of operation should be sought.

4.2 Inverter Drives to Air Handling Plant

The application of inverter drive controls to ventilation plant provides the following benefits-

(a) Plant supply and extract volumes match design requirements. (10% over supply results in 20% more electrical energy).

(b) Plant can be scheduled to part load or shutdown areas when not required.

4.3 Inverter Drives to Pumps

The application of inverter drivers to pumps provides the following benefits-

(a) Plant supply and extract volumes match design requirements. (10% over supply results in 20% more electrical energy).

(b) Plant can be scheduled to part load or shutdown areas when not required.

4.4 Higher Efficiency Motors

The specification of “higher efficiency motors” on larger items of plant can produce a saving of 2% in energy consumption during normal operation.

4.5 Occupancy and PIR Sensors

The proposals would include the provision of occupancy sensing to areas with an intermittent occupancy. The occupancy detectors could automatically reschedule temperature set points and dead bands, schedule off heating / cooling and ventilation and lighting unless a presence is detected in the space.

4.6 Enhanced Metering and Diagnostics through the BMS / Control Systems

The design would maximise the benefits provided through the automatic control systems to provide useful energy metering information (including 'out-of-range' monitoring) to allow early recognition of operational problems and their early diagnosis and rectification resulting in the earliest possible return to correct and efficient operation.

4.7 Enhanced Control Systems

We would recommend that the proposed heat pump system to the tenant areas is provided with a fully functional control system provided with the facility for detailed time scheduling control, including optimum start/stop on a room by room basis.

Room temperature control should be on a room by room basis and be compensated against the local weather conditions. These would all be provided to mitigate unnecessary operation of the heating / cooling system and therefore reduce wasted energy.

4.8 Lighting Control System

The lighting installation whether this is tenant fit out or landlord should be optimise the building design in relation to natural daylight and be supplemented by a lighting control system which will reduce the energy consumption when artificial lighting is not required.

Use of occupancy sensors, daylight linking photocells and regulating ballasts should be incorporated to into the lighting control system to either reduce the output or turn the luminaire off when not required or sufficient natural lighting is available.

The luminaires should all be complete with high efficiency lamps such as compact fluorescent T5, TC-L, TC-T and PL lamps. Consideration to LED lighting should be given to replace traditional display lighting such as tungsten halogen and other incandescent lamps.

4.9 Enhanced Glazing Specification

Compliance with The Building Regulations Approved Document L2A will result in a glazing solution which is more energy efficient. We would propose a glazing solution utilising a clear solar reflecting glass on the affected elevations in order to minimise cooling loads but maximise the benefit of day lighting.

5.0 Appendices

5.1 Appendix 1 – Modelling and Zoning Information

<u>Note on modelling information and Architectural Information</u>

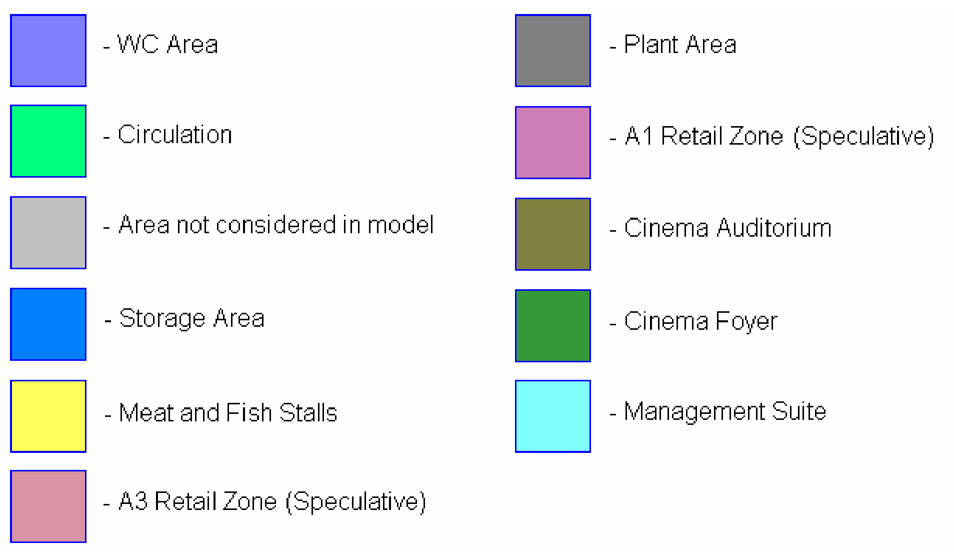
This appendix contains floor plans as outputted from the IES modelling data as used to collate the information contained within this report. The model presented in this report is representative of the Architectural information available 9th March 2011. This information is representative of the final Architectural scheme that is to be submitted for planning, and it is felt that the results presented are appropriate in line with the current stage of the design.

Various areas are 'not considered' as part of the Part L compliance modelling. These are areas defined as zones by the modelling software which are outside the development (e.g. The Alhambra Centre, modelled for adjacency issues) or areas not subject to Part L compliance (e.g. Market Stalls).

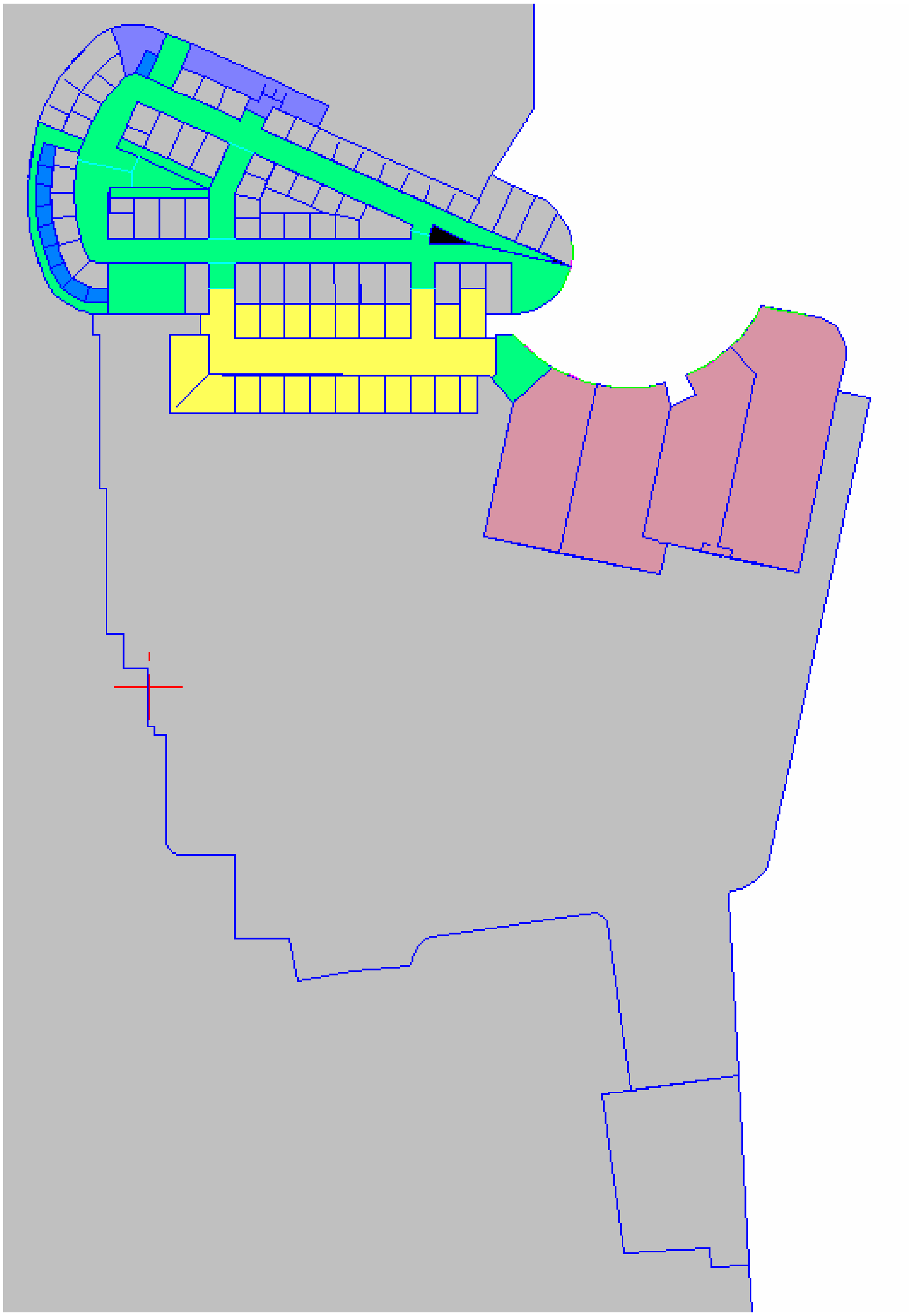
It has been agreed in principle with the BCB that market stalls shown as 'not considered' will not be subject specifically to Part L compliance due to the associated environmental load to these areas being minimal. As the design and use of the scheme develops, possible changes may affect the detail in this area, although this effect is likely to be minor in respect to the 'whole site' results.

Further modelling and analysis work may be required to be carried out as the ongoing scheme develops to ensure the targets identified are carried through to the further design stages.

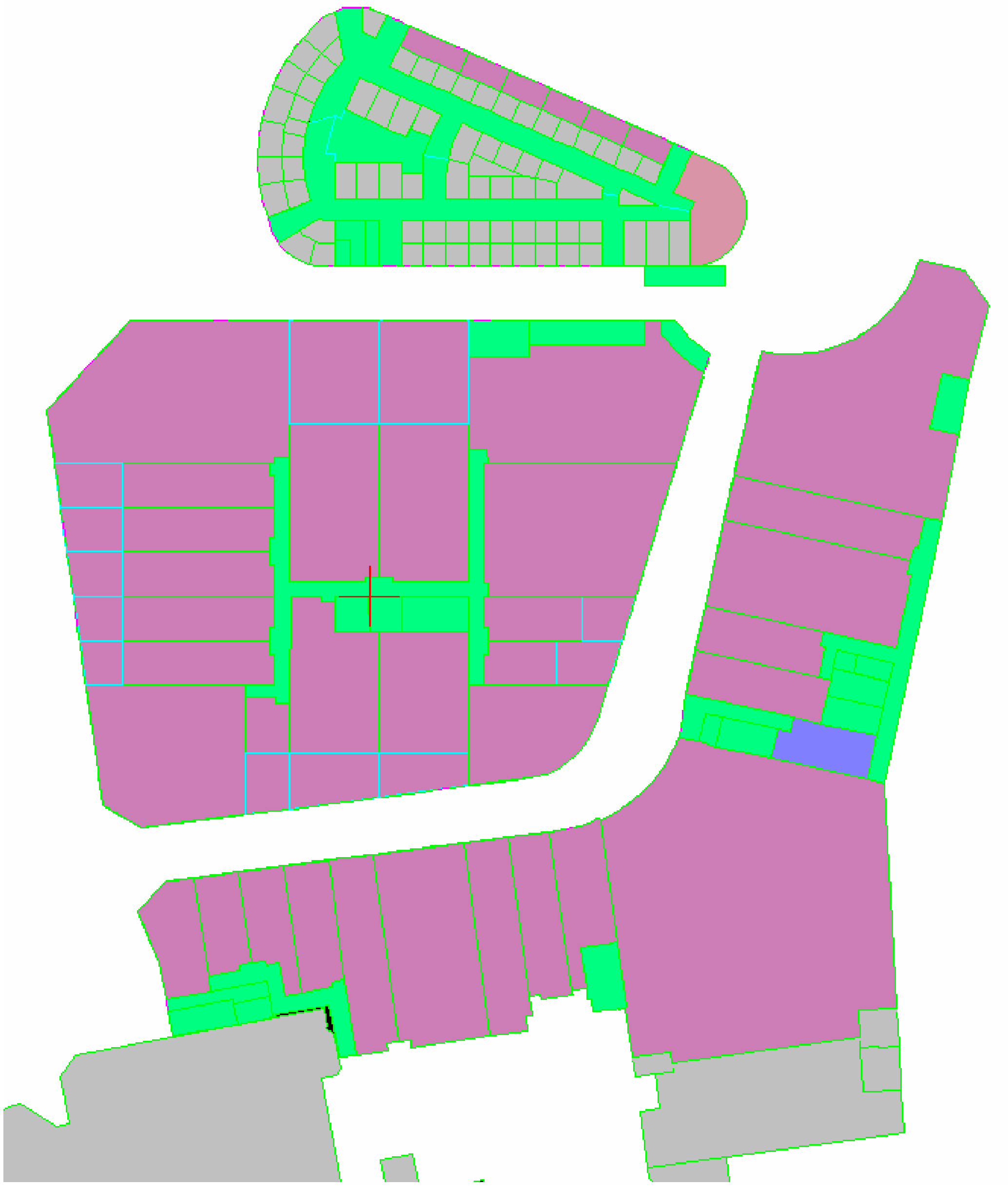
<u>Floor Plan Key</u>



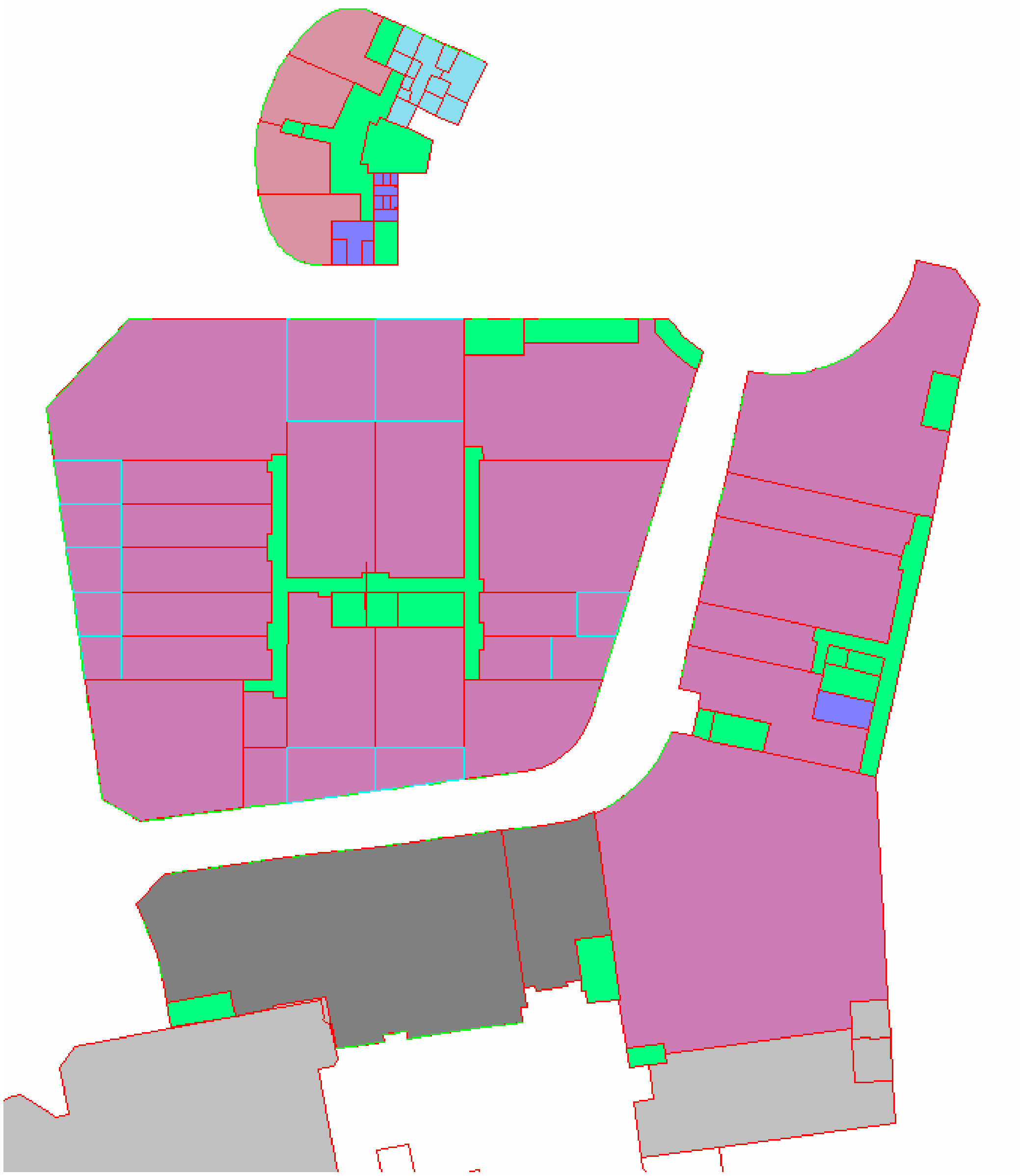
Interchange Level Zoning



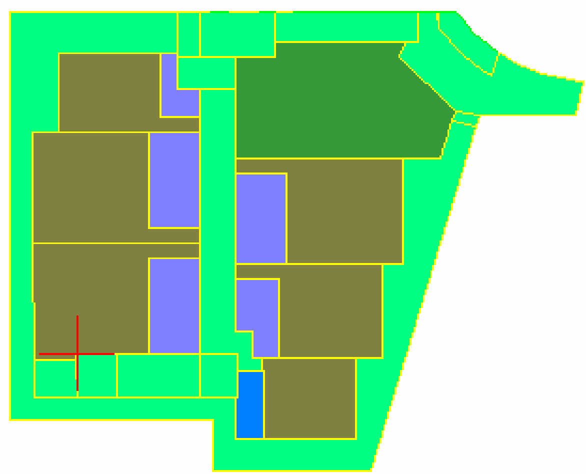
Cheapside Level Zoning



Upper Level Zoning



Leisure Level Zoning



5.2 Appendix 2 – Modelling Inputs

Appendix 2.0 Thermal Model Inputs

Hulley & Kirkwood consulting engineers

Project Title: Barnsley Markets

Stage: Pre-Planning, For Information

Sheet No: 1 of 1
Project No: 50315

Consulting Engineers – Manchester

System	Info. Imported	Notes
Construction		
U Values		
Ground Floor / Exposed Floors	0.25 W/m²K	
Roofs	0.25 W/m²K	
External Wall	0.35 W/m²K	
Glazing	2.00 W/m²K	U-Value
	0.34 W/m²K	G-Value
Air Permeability	4.0 at 50Pa (m3/(h.m²))	Assumed good practice Benchmark figure
Cooling		
VRV Seasonal EER	3.80	Based on manufacturer supplied Seasonal EERs, grid supplied Electricity ASHPs
Heating		
Boiler Seasonal Efficiency	95%	Based on manufactuer published data, High Efficiency Condensing Boilers
VRV Seasonal EER	3.80	Based on manufacturer supplied Seasonal EERs, grid supplied Electricity ASHPs
Automatic Controls & Metering		
Retail Units Tenancies (Inc. Dept. Store) Cinema Tenancy	Central Time Control, Optimum Start/Stop Room by Room local time & temperature control Weather compensation	Features assumed to be provided as part of system automatic controls package by tenant
General LTHW system to Landlords	Central Time Control, Optimum Start/Stop Room by Room local time & temperature control Weather compensation	To be provided as part of landlord BEMS installation
Metering (throughout)	Compliant with CIBSE TM39	
Domestic Hot Water		
Retail Units (A1 - Inc. Dept. Store)	Point of use water heaters, fed via grid electricity	Assumed specification, fit-out by tenant
Retail Units (A3 - Inc. Café Areas)	Point of use water heaters, fed via grid electricity	Assumed specification, fit-out by tenant
Landlord inc. Public WCs, Management Suite etc.	Direct gas-fired condensing water heater, 90% eff.	To be provided as part of base build for servicing of general services
Cinema	Direct gas-fired condensing water heater, 90% eff.	Assumed specification, fit-out by tenant
Ventilation		
All AHU Heat Recovery Efficiency	65%	Based on Plate Heat Exchanger
Specific Fan Power (SFP) to Extract Only	0.8 W/l/s	Based on compliance with minimum Part L 0.8 W/l/s figure
Specific Fan Power (SFP) to S&E AHUs	1.8 W/l/s	Based on All AHU's having a general improvement over the minimum Part L 2.2 W/l/s figure
AHU Leakage Class (CEN)	Class L2	Performance requirements to be specified
Ductwork Leakage Class (CEN)	Class B	Performance requirements to be specified
Lighting (Tenanted Retail Units)		
Retail Unit Power Density (General Lighting)	15 W/m² (at 600 lux - 2.5 W/m²/100lux)	Design limit to tenant fit-out
Display Lighting efficacy	40 lumens/circuit Watt	Will discount 'traditional' display light fittings (e.g. halogen). High efficiency alternative fittings required (e.g. LEDs)
Lighting Control System	Photoelectric Sensing, with zoning to back of unit Automatic dimming Addressable light fittings Display lighting time switching	