CHAPTER 8.0

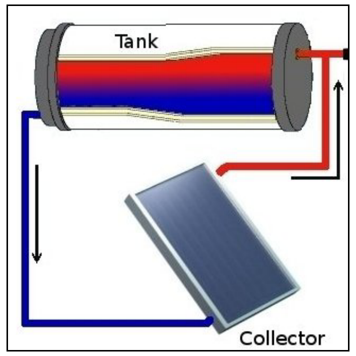
BE GREEN - RENEWABLE ENERGY TECHNOLOGIES APPRAISAL

8.0 Be Green – Renewable Energy Technologies Appraisal

8.1
Be Green – Renewable Energy Technologies Appraisal
This section provides an appraisal of renewable energy technologies suitable for the Proposed Development. The appraisal approach is based on the London Renewables Toolkit (Ref. 19) and involves a feasibility analysis of renewable technologies.

8.2
Wind Technology
The location of wind turbines is critical to their performance and they are typically situated in regions that frequently develop strong winds. London does not generally have a good wind climate for power generation – the high density of buildings considerably slows the wind as it passes across the city. Compared to open spaces with uninterrupted laminar air movement, the highly turbulent air movement in built up urban areas makes this technology poorly suited for the Proposed Development location.

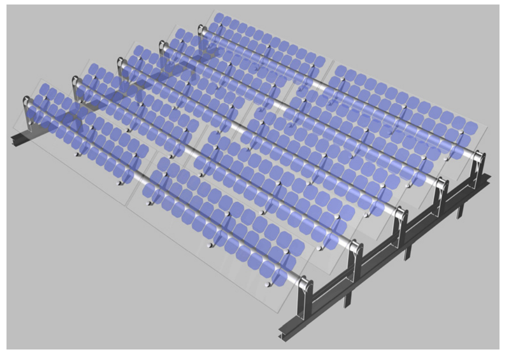
8.3
Additionally, wind turbines are subject to vibration and would be detrimental to the sensitive equipment installed within the Proposed Development. There are also concerns that the inevitable blade wind noise could prove problematic with regard to the local residents. Wind technology is therefore considered impractical for the Proposed Development.



8.4
Solar Thermal (Solar Collectors)
Solar collectors use free energy from the sun to provide domestic hot water. Solar thermal systems can offer a cost effective sustainable option for the provision of domestic hot water for the site by making a contribution to the site's hot water demands during the summer months. Solar thermal heating could provide low grade heat to the site that could be used for preheating feed water to the boilers, or other low grade applications.

8.5
Solar collectors are incompatible with CHP as they compete to offset the heating base load and also compete with Photovoltaic (PV) arrays for roof space. These systems are therefore not considered appropriate for the Proposed Development.

8.0 Be Green – Renewable Energy Technologies Appraisal



8.6
Photovoltaic arrays
Solar PV panels offer the opportunity to generate electricity from solar energy. However, PV cells on a large scale often have long payback periods on a purely financial basis.

8.7
The Proposed Development has an architectural structure which encloses the upper plant levels. It is proposed to install 1,700 m^2 of PV arrays (with a minimum efficiency of 15%) in the south facing area of this roof structure. This area is the maximum practicable, as it ensures optimal orientation, and is free from overshadowing from plant enclosures, risers, etc. Figure 8-1 presents the elevation drawing showing the proposed layout of the PV panels. The proposed PV installation will produce 221 MWh/year, displacing 125 tonnes CO_2 per year.

8.8
PVs will provide green energy and at the same time act as visual features, showcasing the renewable technology to the local community.

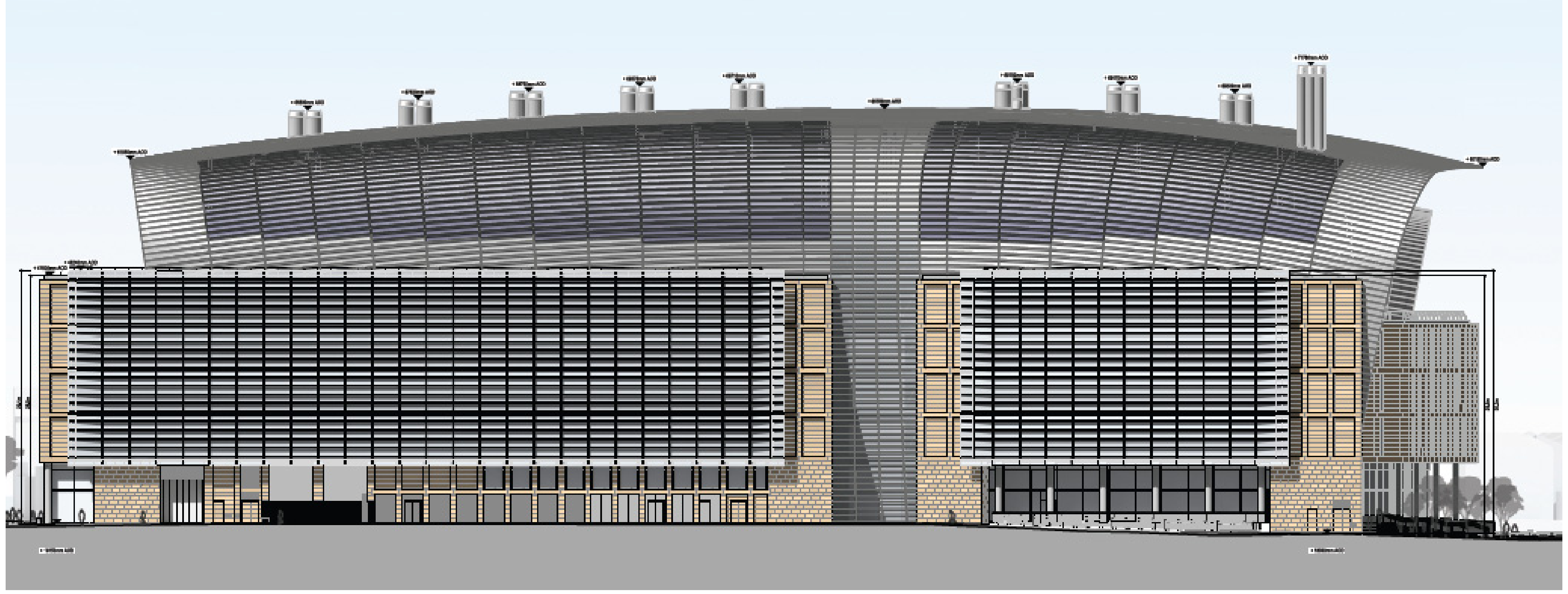


Figure 8-1: South elevation illustrating areas dedicated to PV arrays

8.0 Be Green – Renewable Energy Technologies Appraisal

8.9
Biomass
Biomass heating works effectively where it supplies for the base heating load all year round.

8.10
The implementation of biomass has issues related to space constraint, transport, supply chain and air quality:

- A biomass boiler would require additional plant room space, and fuel storage.

  In addition to the 25 m^3 of storage space that would be required for each 15 tonne delivery, a 74 m^3 store would be required to give 48 hours of backup storage. This means a total storage space of around 100 m^3 would be required in the basement, close to the boiler, to give one day supply of normal running and two days backup.

  The proposed site is space constrained and as such has no available area for additional plant room and fuel storage areas.

- To run one of the UKCMRI LTHW boilers (3.1 MW) on wood pellets would require approximately 120 deliveries per year. Spread evenly throughout the year, this would be 2.5 deliveries per week, however, at the peak heating demand the LTHW boiler would require more than 1 delivery per day.

  It will not be feasible to source the annual requirement of 1,800 tonnes of wood pellets locally in London. The transportation of pellets from further away would create CO_2 emissions during transport reducing the overall CO_2 saving from the implementation of biomass technology.

- Although the biomass supply chain is rapidly developing, there are constraints linked to the sustainability of biomass sources (i.e. uncertainties about the provision of biomass from certified sources); and

- Biomass boilers emit more NO_X and PM10 (i.e. particles with a diameter smaller than 10 µm) than conventional gas boilers, which would cause air quality concerns.

8.11
In addition to the above, biomass heating competes with the proposed CHP system for the base heating load and is therefore not considered feasible for the Proposed Development.

8.12
Borehole Cooling
In borehole cooling systems, ground water is abstracted from an aquifer (abstraction borehole) and used for cooling, either by cooling the ventilation supply air via cooling coils or by being pumped through chilled ceilings, beams or floors. Borehole cooling either depletes the aquifer (discharge to drain) or increases the temperature of the aquifer due to heat rejection (rejection borehole). Due to these constraints borehole cooling is not considered a sustainable option and is therefore not recommended for the Proposed Development.

8.13
In order to ensure a sustainable utilisation of the ground/aquifer the coolth and heat abstraction should be balanced over the year. This also results in high seasonal efficiencies, leading to efficient savings in CO_2 emissions. Ground source heating and cooling systems are considered more sustainable than borehole cooling only systems.

8.14
Ground Source Heating and Cooling
In ground-coupled systems heat from or to the ground is drawn into a building to provide space heating/cooling via ground source heat pumps.

8.15
In order to ensure sustainable utilisation of the ground/aquifer as a heat source/sink, the coolth abstraction and heat rejection should be balanced against the heat abstraction and coolth rejection.

8.16
Heat pumps are devices which are capable of moving heat from cold areas to hot areas, the reverse of its normal direction of flow. Ground Source Heat Pumps (GSHP) are low energy systems that use the near constant temperature of the soil and/or ground water together with a heat pump to provide space heating, cooling and potentially, heat for domestic hot water.

8.17
There are two primary methods by which the ground may provide energy:

- Open Loop

  Ground water in London is held within a chalk aquifer, confined by a layer of London Clay. This water can be pumped out of the aquifer via a borehole and used for cooling or used as a heat source/sink for heat pumps. A typical borehole installation is 300 mm in diameter with a steel pipe casing, drilled into the chalk approximately 60 m below ground level, although this can vary dramatically and there are instances where borehole depths of 100 m+ are required. A submersible pump is installed in the borehole casing, attached to the borehole pipe to pump water up from the borehole and through heat exchangers serving the building's cooling and heating systems. The bore water is then either re-injected to the aquifer or discharged to drain.

  A preliminary desktop investigation into the potential to use Open Loop Ground Water Cooling and Heating for the UKCMRI site has been undertaken. The assessment suggests that two boreholes (one doublet, i.e. extraction and injection wells) could be located on the site 100 m apart, supplying 200 kW – 300 kW heating or cooling, provided that the annual heating and cooling loads are balanced, with an annual running time of 2,000 hours in each mode. This system could save approximately 168 tonnes CO_2/year.

  The assessment also suggests that subject to a more detailed investigation, there is a possibility that a further doublet pair of boreholes could be installed increasing the capacity to 400 kW – 600 kW. This system could save approximately 336 tonnes CO_2/year.

  The development of an open loop ground source heating and cooling system would require licensing by the Environment Agency. This process would require a program of test pumping and impact assessment to be completed and is likely to take up to 12 months from application until a fully licensed scheme could commence operation.

There is also an operational risk associated with an open loop application due to uncertainty of the achievable aquifer water volume flow rate and temperature.

Extra plant space will also be required in the basement for the heat pumps (circa 30-50 m^2) as well as space for the two (or four) well heads.

- Closed Loop

In closed loop systems, ground coupling is achieved via a buried closed loop pipe circuit through which water is circulated. The loop can be installed either vertically or horizontally depending upon site geology, space availability and structural conditions of the site. A vertical loop arrangement is an appropriate choice for most urban locations, where space is restricted.

There is very limited external space on the site so horizontal pipe loops are not likely to be feasible. This leaves the option to use ‘energy piles’, where the ground loops are installed in the building piling.

The assessment looked into the viability of 30No. 100 m deep, vertical closed loop GSHP and concluded that a peak heating load of 193 kW and a peak cooling load of 111 kW could be serviced provided the annual load profile was balanced. This system could save approximately 62 tonnes CO_2/year.

A closed loop system has very a limited capacity compared to the building loads and would not pay back within the life of the building.

8.18
In addition to the constraints described above, GSHPs are incompatible with CHP technology (as they compete to offset the heating baseload) and produce considerably smaller CO_2 savings compared to the proposed CHP. This option is therefore not deemed appropriate for the Proposed Development.

8.19
Fuel Cells
A fuel cell is an electrochemical device that combines hydrogen and oxygen to produce electricity, heat and water. Currently, most fuel cells use hydrogen derived from gas. Long-term proposals include hydrogen from renewable sources to be made available to the mass market.

8.20
A 1.4 MWe fuel cell could be operated for 6,200 hours per year, producing 8,700 MWh of electricity per year and 4,000 MWh of LTHW saving approximately 1,200 tonnes CO_2/year, (assuming the heat from the fuel cell was reclaimed as LTHW). Such a system would require approximately 210m^2 of plant space, and some of this space may require a clear height of up to 8m.

8.21
The fuel cell could not run alongside the proposed CHP plant (as they compete to offset the heating baseload), which saves twice as much CO_2 and saves approximately 9 times more money over a 30 year period.

8.22
Alongside the limited CO_2 savings compared to CHP, fuel cell technology is not mature enough (maintenance costs are likely to be high) and not cost-competitive (capital cost > £5 million) for this option to be pursued for the Proposed Development.

8.23
Energy from Waste
Methane gas from sewage or waste can be captured and used for firing boilers or CHP plant.

8.24
The Proposed Development is unlikely to generate sufficient waste to make this option worthwhile. Moreover plant space requirements and emissions (air quality and odour) would be an issue. This option is therefore not considered feasible.

8.25
Micro-Hydro
Turbines placed within a flow of water produce mechanical energy that drives a generator that converts the mechanical energy into electrical energy.

8.26
This option is not suitable for a site having no running watercourse passing through or nearby the site, and cannot therefore be applied to the Proposed Development.

8.0 Be Green – Renewable Energy Technologies Appraisal

8.27
Enhanced, Clean, Green Baseline – Be Green
The 'enhanced, clean, green' scheme considers the incorporation of the energy efficiency and passive design measures (described in Sections 6.1 and 6.2), an on-site CHP plant (described in Section 7) and PV arrays into the baseline scheme.

8.28
The feasibility analysis of renewable technologies shows PV arrays are the most appropriate green energy option for the Proposed Development. The incorporation of 1,700 m^2 of PV will produce 221 MWh/year, displacing 125 tonnes CO_2 per year. This equates to approximately 0.6% savings in CO_2 emissions over the 'be clean' scheme.

8.29
The 'be green' energy consumption and CO_2 emissions for each energy use are shown in Table 8-1. Figure 8-2 represents the breakdown of CO_2 emissions for energy uses, i.e. by heating, hot water, cooling, auxiliary, lighting, CHP and PV arrays.

UKCMRI - GREEN						
	Gas		Electricity			Sum
Regulated	Heating	Hot Water	Cooling	Lighting	Auxiliary	
Energy (MWh/year)	7,187		1,091			8,278
CO_2 Emissions (tonnes CO_2/year)	1,394		-13			1,381
Non Regulated	Equipment, Cooking, BRF, Data centre etc.					
Energy (MWh/year)	101,865					101,865
CO_2 Emissions (tonnes CO_2/year)	20,739					20,739
Total	Regulated and Non-Regulated					
Energy (MWh/year)	110,144					110,144
CO_2 Emissions (tonnes CO_2/year)	22,120					22,120

Table 8-1. 'Be green' energy consumption and CO_2 emissions breakdown by use

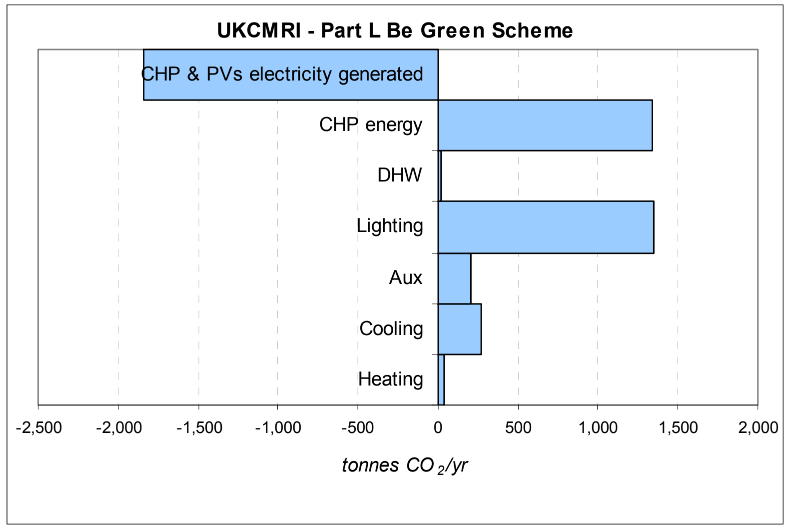


Figure 8-2. 'Be green' CO_2 emissions breakdown by use – regulated energy uses only

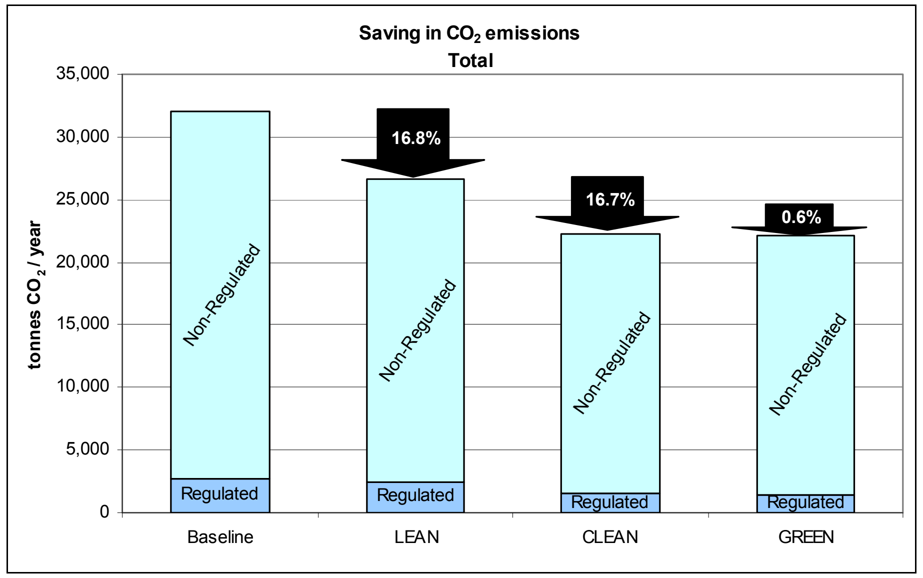


Figure 8-2. CO_2 emissions for baseline, 'be lean', 'be clean' and 'be green' – regulated and non-regulated energy uses

CHAPTER 9.0

PROPOSED ENERGY STRATEGY

9.0 Proposed Energy Strategy

9.1
Proposed Energy Strategy
From the above analysis, the following energy strategy option has been identified for the Proposed Development:

- Incorporation of energy efficiency and passive design measures, with associated 17% savings in CO_2 emissions over the baseline scheme;
- 1,822 kWe/1,463 kWth CHP plant, meeting a majority of the development's heating demand and a 53% of the electricity demand, with associated 17% savings in CO_2 emissions over the enhanced ('be lean') baseline scheme; and
- 1,700 m² PV arrays on the roof of the Proposed Development meeting part of development's electricity demand, with associated 0.6% savings in CO_2 emissions over the 'be clean' scheme.

9.2
Incorporation of the proposed energy strategy will result in approximately a 31% saving in CO_2 emissions over the baseline scheme. This corresponds to approximately 9,950 tonnes CO_2/year savings.

9.3
Figures 9-1 and 9-2 show the improvement in CO_2 emissions for regulated and total (including both regulated and non-regulated) energy uses, respectively. Table 9-1 reports energy consumption and CO_2 emissions for baseline, 'be lean', 'be clean' and 'be green' schemes.

9.4
Details on the thermal templates, glazed construction data and system characteristics input for the IES model are included in Appendix A. The BRUKL output document for the proposed energy strategy is included in Appendix B.

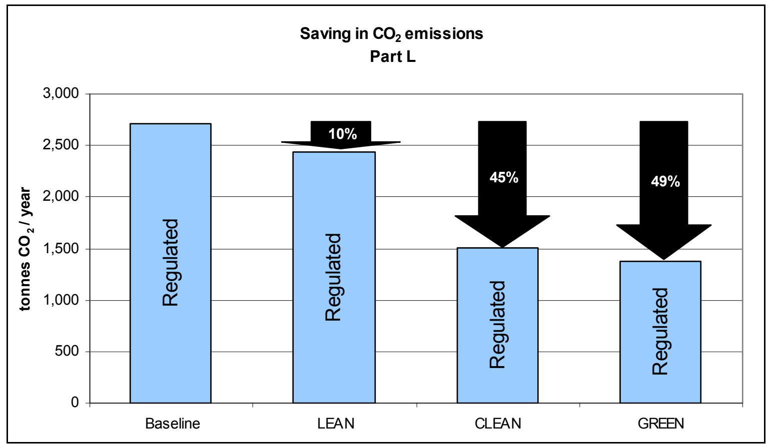


Figure 9-1. Regulated (ADL2A 2006) savings in CO2 emissions for the Energy Strategy stages

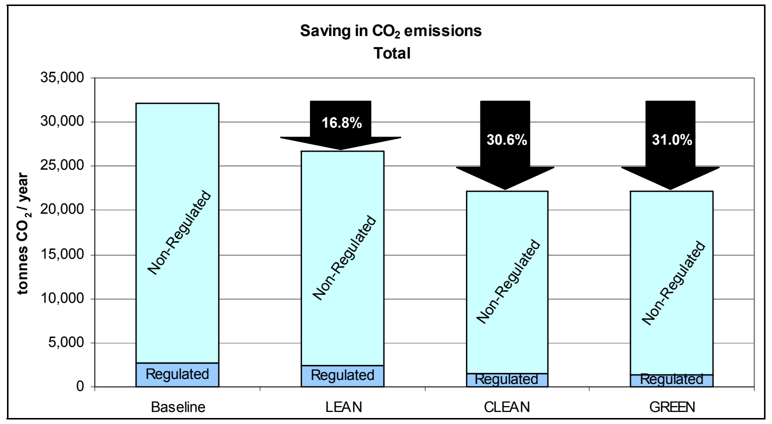


Figure 9-2. Total savings in CO_2 emissions for the Energy Strategy stages

UKCMRI										
	Regulated Energy (MWh/year)						Non-Regulated energy (MWh/year)			
	Gas		Electricity				Gas	Electricity		
	Heating	Hot Water	Cooling	Lighting	Auxiliary	Sum	Equipment, Cooking, BRF, Data centre etc.		Sum	Total
Baseline	1,058	2,379	1,156	3,208	489	8,289	83,563	31,148	114,711	123,000
LEAN scheme	801	2,351	639	3,208	489	7,488	75,201	22,884	98,085	105,573
CLEAN scheme	7,187		1,312			8,499	90,322	11,543	101,865	110,365
PV contribution	0		-221			-221	0		0	-221
GREEN scheme	7,187		1,091			8,278	101,865		101,865	110,144

UKCMRI										
	Regulated CO_2 emissions (tonnes CO_2/year)						Non-Regulated CO_2 emissions (tonnes CO_2/year)			
	Gas		Electricity				Gas	Electricity		
	Heating	Hot Water	Cooling	Lighting	Auxiliary	Sum	Equipment, Cooking, BRF, Data centre etc.		Sum	Total
Baseline	205	461	488	1,354	206	2,714	16,211	13,144	29,356	32,070
LEAN scheme	155	456	270	1,354	206	2,441	14,589	9,658	24,247	26,688
CLEAN scheme	1,394		112			1,507	17,522	3,216	20,739	22,245
PV contribution	0		-125			-125	0		0	-125
GREEN scheme	1,394		-13			1,381	20,739		20,739	22,120

Table 9-1. Energy consumption and CO_2 emissions for the Energy Strategy stages – for regulated and non-regulated energy

9.0 Proposed Energy Strategy

9.5
Compliance with Energy BREEAM Requirements
The proposed energy strategy for the Proposed Development will allow the scheme to comply with the following BREEAM requirements:

- Energy 1: Reduction of CO_2 Emissions

  The Proposed Development will achieve a CO_2 Index (from the Energy Performance Certificate Rating) below 40. This enables the scheme to comply the mandatory credits of an 'Excellent' BREEAM rating. The formal Energy Performance Certificate will be provided post-planning as part of the Formal BREEAM Design and Procurement Assessment scope of work.

- Energy 5: LZC Technologies

  The LZC technologies specified for the Proposed Development (i.e. CHP and PV arrays) will result in a 20% reduction in the building's CO_2 emissions over ADL2A 2006 of the Building regulations, allowing the Proposed Development to meet 'exemplary level' BREEAM requirements and achieve a BREEAM innovation credit.

9.6
A BREEAM-compliant feasibility study of the LZC technologies will be revised post-planning as part of the Formal BREEAM Design and Procurement Assessment.

9.7
Refer to Sustainability Statement Appendix – Preliminary BREEAM Bespoke Assessment for further detail.

CHAPTER 10.0

CONCLUSION

10.0 Conclusion

10.1
Conclusion
The Proposed Development will meet its heating, cooling and electrical demands while at the same time reducing to realistic minima its energy consumption and associated CO_2 emissions to the atmosphere. In particular, the Proposed Development is being designed to comply with ADL2A 2010, which involves an aggregate 25% improvement in CO_2 emissions over the current 2006 Building Regulations.

10.2
CO_2 emissions will be reduced by specifying energy-efficient building services (including heat recovery to ventilation systems, low energy cooling to the data centre, and high efficiency lighting) and an on-site CHP plant, with future-proofing to facilitate potential connection to any future Euston Road district heating scheme. To further reduce CO_2 emissions an analysis of the feasibility of renewable energy technologies for the Proposed Development has been undertaken and PV arrays have been identified as the technology of choice. PV arrays will be installed on the south facing roof of the building – a position which optimises their orientation. PV arrays will provide green energy and at the same time, act as visual features, showcasing renewable technologies to the local community.

10.3
The proposed energy strategy will allow UKCMRI to save circa 9,950 tonnes of CO_2 per year, corresponding to a reduction of approximately 31% of the total building load.

10.4
To ensure the energy efficient operation of the building, a comprehensive commissioning strategy and energy management and targeting system will be implemented and all building users will be provided with information and guidance on how to use energy efficiently.