ENERGY STRATEGY AND

SUSTAINABILITY STATEMENT REPORT FOR

ALEXANDER HOUSE

PROPOSED STUDENT ACCOMMODATION

READING

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Executive Summary

This report has been developed as a combined energy statement and sustainability appraisal for the proposed construction of a 7 storey and basement student accommodation development in Reading.

The design team have considered all the available options and opportunities associated with the scheme and site constraints and believe they have a robust approach which will meet the planning conditions and Reading Borough Council Core Strategy (adopted 2006, altered 2015) and Sustainable Design & Construction SPD (Adopted July 2011) which is in line with the Governments construction standards that requirements for energy efficiency and use of renewable, low carbon or decentralised energy are now set out in the Building Regulations.

Part of Reading Borough Council Core Strategy CS1: Sustainable Construction and Design is '*to incorporate on-site generation of energy from renewable sources and energy efficient design measures (including the use of CHP where appropriate) to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development*.

The proposed design achieves this as the scheme exceeds current Building Regulations Energy Efficiency Standards by 24.35% (64.50 tonnes CO2) based on an ADL2A 2013 baseline model approach.

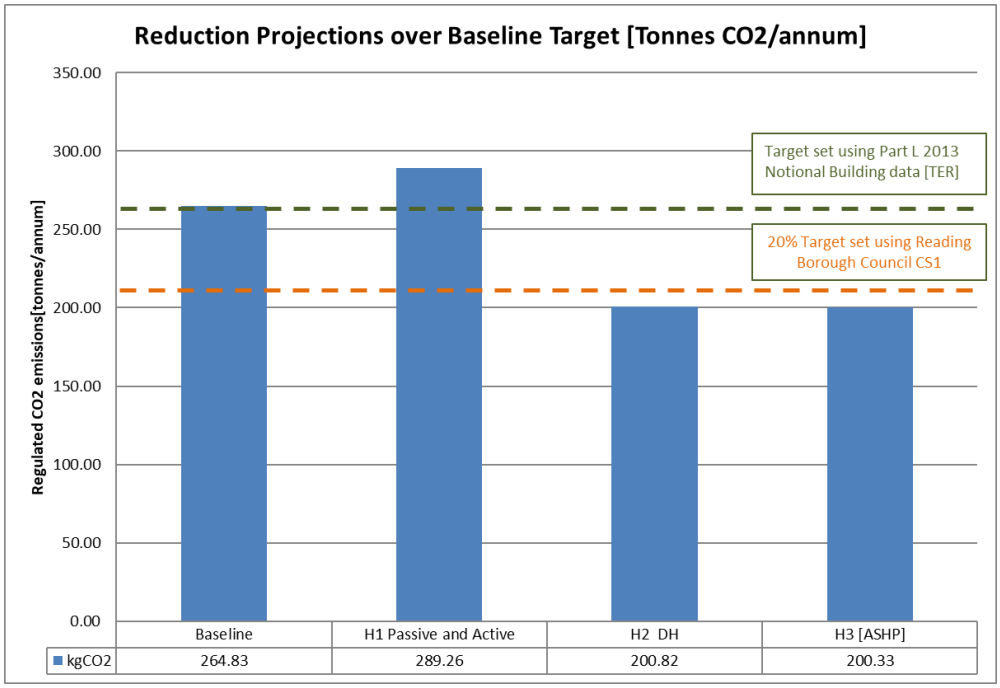
The proposed design will incorporate the following with a fabric first approach:

- Improved U values
- Improved glazing performance
- Design to maximise natural daylight
- Solar gain control measures
- LED Lighting
- Adaptive lighting controls
- Demand controlled ventilation
- Mitigate the need for high capacity cooling systems
- High efficiency Air Source heat pumps
- CHP serving Domestic Hot water systems

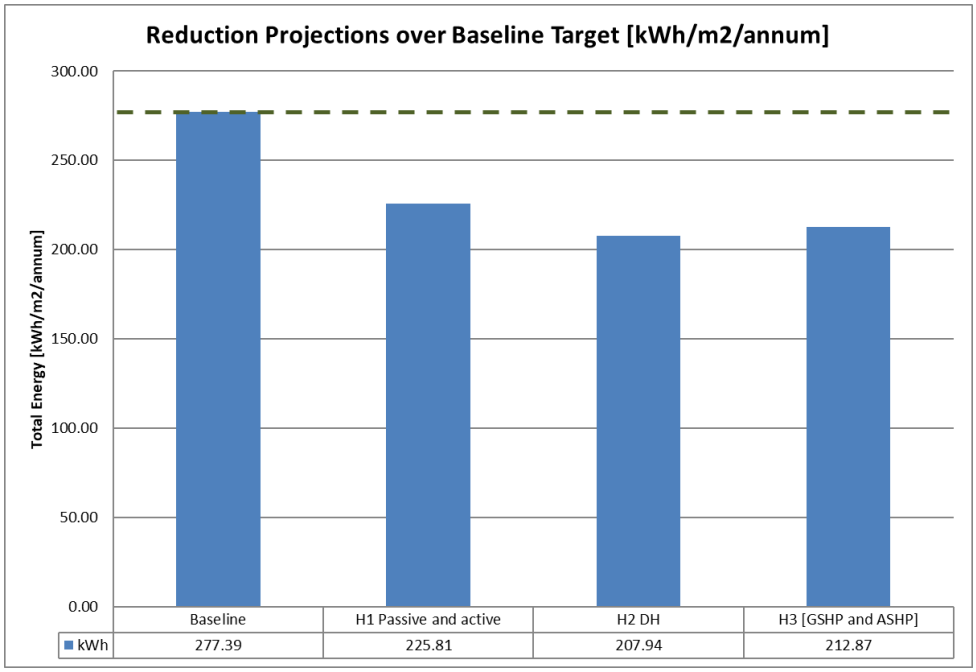
It should also be considered when reviewing this statement the carbon factor of electricity indicated in SAP10 is expected to be half the current value based on the ongoing decarbonisation of the Grid meaning that considering the efficiency of gas the electric heating option is likely to be lower in terms of carbon than gas fired heating and the team have considered this in the strategy.

The following extract shows the Baseline Target and Carbon savings for the Hierarchy actions H1 to H3 to be implemented:

Graph 1.0



Graph 2.0



Technical data and supporting BRUKL documents are included in the Appendix sections.

The following details the overall Carbon target and reduction for the Baseline and H1 to H3 analysis reported in Table 1 and Table 2 formats:

Table 1.0: Carbon Dioxide Emissions After Each Stage of the Energy Hierarchy

	Carbon Dioxide emissions for non-domestic buildings [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Building	264.83	
After energy demand reduction (Be Lean H1)	289.26	
After heat network / CHP (Be Clean H2)	200.82	
After renewable energy (Be Green H3)	200.33	

Table 2.0: Regulated Carbon Dioxide savings from Each Stage of the Energy Hierarchy

	Regulated non-domestic Carbon Dioxide Savings	
	[Tonnes CO2 per annum]	[%]
Savings from energy demand reduction (Be Lean H1)	-24.43	-9.23%
Savings from heat network / CHP (Be Clean H2)	88.44	33.39%
Savings from renewable energy (Be Green H3)	0.49	0.18%
Total Cumulative Savings	64.50	24.35%

The estimated savings anticipated from implementing this energy strategy on the Baseline 2013 energy demand for the development can be seen in Tables 1 and 2. It is anticipated that these measures in combination would achieve a 24.35% (64.50 tonnes CO2) of Carbon reduction in emissions compared to the Baseline analysis with the use of renewable technologies and systems proposed.

The combination of approaches and heat pump technologies also shows there is a 19.21% contribution from the onsite renewables in meeting the Planning requirements as indicated below.

Combined	40.89	Kwh/m2
CHP	40.81	Kwh/m2
PV	0	Kwh/m2
ASHP	0.08	Kwh/m2
	19.21%	Renewable

1.0 Introduction

1.1 Site Description

The site is located at the junction of Rupert Road and Kings Road in Reading.

The scheme involves the demolition and redevelopment of an existing office building and construction of new student accommodation in the location detailed below extracted from Google earth.

Fig 1.1

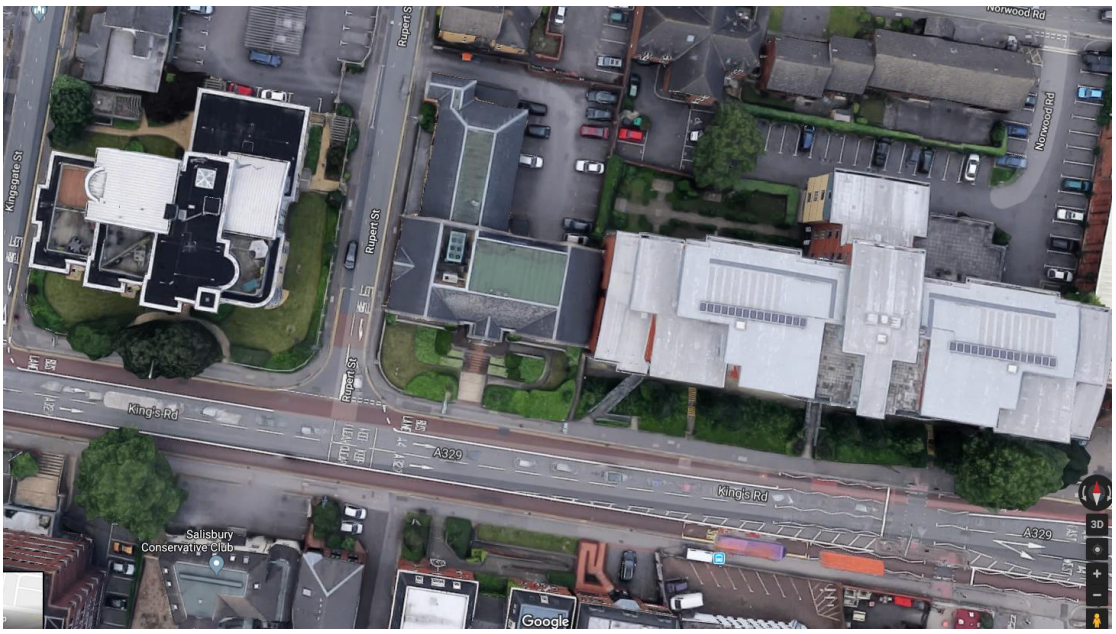


Fig 1.2

1.2 Development Description

The proposed development is a new build scheme on the site of demolished office generally as detailed in Fig. 1.3 and 1.4

Fig. 1.3

Fig. 1.4

1.3 Purpose of Report

The purpose of this energy statement assessment is to demonstrate that the design and proposed solutions have addressed climate change mitigation opportunities and details the measures necessary to comply with energy policies including the local Planning Authority for this site which is Reading Borough Council's energy policies, along with the requirements of Part L2a (2013 with 2016 amendments) of Building Regulations and with the nationally recognised Energy Hierarchy.

1.4 Planning Policies

Several regional and local policies exist which promote energy efficiency and the use of renewable technologies where appropriate to minimise carbon dioxide emissions including:

Reading Borough Council Core Strategy (adopted 2006, altered 2015) and Sustainable Design & Construction SPD (Adopted July 2011).

The relevant planning policies that relates to renewable energy, extracted from the documents are:

Policy CS1: Sustainable Construction and Design (Core Strategy)
Policy CC2: Sustainable Construction and Design (Emerging Local Plan)
Policy CC3: Adaptation to Climate Change (Emerging Local Plan)
Policy CC4: Decentralised Energy

1.5 Demonstrating Policy Compliance

This report outlines how these policies and guidance are incorporated into the design approach to reduce the energy use and CO2 emissions and achieve the targets required.

2.0 The Energy Assessment Methodology

All development proposals should take the most appropriate action to minimising Carbon emissions in accordance with the Energy Hierarchy: Be Lean- Be Clean- Be Green as well as consider the need to reduce cooling demand and asses impact of overheating.

The energy assessment is structured around the Energy Hierarchy which is generally accepted as the most effective way of reducing building Carbon emissions. The three stage strategy targets energy use by consideration of the following actions:

Be Lean [Passive]	Energy demand reduction building fabric
Be Lean [Active]	Energy demand reduction building services
Be Clean	Consideration of heating infrastructure including CHP
Be Green	Supply energy from renewable sources

The approach detailed in this document is based on and around the CIBSE methodology for energy reports and follows 4 primary steps:

Step 1	Identifying the targets
Step 2	Assessing the Baseline
Step 3	Applying energy efficiency
Step 4	Applicability of renewable and LZC's

Other guidance considered in this assessment but not limited to includes:

- Sustainable Design and Construction SPG, 2014
- Energy Planning - The GLA guidance on preparing energy assessments, 2016
- Approved Documents Part L (Conservation of fuel and power) of the Building Regulations (2013 edition)
- NCM (National Calculation Methodology) Modelling Guide for buildings other than dwellings in England (2013 Edition)
- CIBSE TM52 The Limits of Thermal Comfort: Avoiding Overheating in European Buildings
- CIBSE Guide F, Energy efficiency in buildings
- The non-domestic building services compliance guide, 2013
- CIBSE TM37 'Design for improved solar shading control
- CIBSE AM12:2103 Combined heat and power for buildings

2.1 Identifying the Targets

The scheme is a new build energy efficient student accommodation building design.

The scheme and the target has been assessed based around applying the Energy Hierarchy in relation to Part L2A of the 2013 Building Regulations in accordance with the planning requirements and the setting of a Baseline energy target based around the building fabric and building services.

Reading Borough Council current target for such new build scheme is 20% reduction in carbon dioxide (CO2) emissions. The Core Strategy and Sustainable Design & Construction SDP sets out policies which provide guidance and targets to achieve this.

This is the target adopted and used as the basis of comparison only for the following policies which has been incorporated into the design approach to reduce the energy use and CO2 emissions to achieve this requirement:

Policy CS1: Sustainable Construction and Design (Core Strategy)
This policy requires proposals for new development, including the construction of new buildings to comply with the following;
1. All new developments maximise the use of energy efficiency and energy conservation measures in their design, layout and orientation to reduce overall energy demand;
2. All developments of more than 10 dwellings or 1000m² floorspace incorporate on-site generation of energy from renewable sources and energy efficient design measures (including the use of CHP where appropriate) to off-set at least 20% of predicted carbon dioxide emissions from the estimated energy usage of the completed and occupied development

Policy CC2: Sustainable Construction and Design (Emerging Local Plan)
This policy requires proposals for new development, including the construction of new buildings to comply with the following;
1. The design of buildings and site layouts must use energy, water, minerals, materials and other natural resources appropriately, efficiently and with care and take account of the effects of climate change

CC3: Adaptation to Climate Change (Emerging Local Plan)
This policy requires proposals for new development to incorporate measures to adapt to climate change including:
1. New buildings shall be orientated to maximise the opportunities for both natural heating and ventilation and reducing exposure to wind and other elements
2. Proposals involving both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measures such as solar shading, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, etc

Policy CC4: Decentralised Energy
This policy requires proposals for new development to demonstrate how consideration has been given to securing energy for the development from a decentralised energy source (including various renewable technologies) and CHP.

Following the planning consultant's advice, the CO2 reduction requirement to be followed by the development is 20%

The analysis required a Baseline building to be generated within approved regulatory software made up generally as the 2013 ADL2A Compliant building performance as detailed in Table 3.0 of the approved documents ADL2A, this has been selected to set the Target Value as detailed in Fig 2.2 which is the extracted table out of the approved document.

General planning guidance requires the baseline heating system is set to gas and has a seasonal efficiency set to 91% and cooling fuel to be set to electric.

Other performance applied to the Baseline target has been generally taken from Table 5.0 of ADL2A or minimum performance requirements of ADL2A, these are indicated in the various tables supporting the B1 analysis

Fig 2.2 ADL2A 2013 extract

Table 3 Limiting fabric parameters

Roof	0.25 W/(m²·K)
Wall	0.35 W/(m²·K)
Floor	0.25 W/(m²·K)
Swimming pool basin[1]	0.25 W/(m²·K)
Windows, roof windows, roof-lights[2], curtain walling and pedestrian doors[3,4]	2.2 W/(m²·K)
Vehicle access and similar large doors	1.5 W/(m²·K)
High-usage entrance doors	3.5 W/(m²·K)
Roof ventilators (inc. smoke vents)	3.5 W/(m²·K)
Air permeability	10.0 m³/(h·m²) at 50 Pa

Notes:

1. Where a swimming pool is constructed as part of a new building, reasonable provision should be made to limit heat loss from the pool basin by achieving a U-value no worse than 0.25 W/(m²·K) as calculated according to BS EN ISO 13370.
2. For the purposes of checking compliance with the limiting fabric values for roof-lights, the true U-value based on aperture area can be converted to the U-value based on the developed area of the roof-light. Further guidance on evaluating the U-value of out-of-plane roof-lights is given in *Assessment of thermal performance of out-of-plane rooflights*, NARM Technical Document NTD 2 (2010).
3. Excluding display windows and similar glazing. There is no limit on design flexibility for these exclusions but their impact on CO_2 emissions must be taken into account in calculations.
4. In buildings with high internal heat gains, a less demanding area-weighted average U-value for the glazing may be an appropriate way of reducing overall CO_2 emissions and hence the BER. If this case can be made, then the average U-value for windows can be relaxed from the values given above. However, values should be no worse than 2.7 W/(m²·K).

3.0 Assessing Baseline Emissions

General guidance on preparing energy assessments defines the Baseline as a building complaint with Part L 2013 of the Building Regulations using Building Regulations approved compliance software and assuming that the heating is provided by gas boilers and any active cooling is provided by electrically powered equipment.

The 'Baseline' building represents a development which meets the minimum standards of CO2 emissions reduction and for the analysis the Target Emissions Rate (TER) as defined by Part L of the Building Regulations 2013 is used as the Baseline Carbon emission in kgCO2/m2/annum.

Assessing the Carbon emissions of the proposed and notional buildings was undertaken using computer-based simulation techniques and based on the standardised National Calculation Methodology (the 'NCM').

The TER is calculated using (IES-VE 2018) software approved for use by the Department for Communities and Local Government (DCLG) as a Dynamic Building Simulation Modelling package (DSM) software which models the Carbon Dioxide emission rates produced by a building in accordance with Part L2A of the Building Regulations (2013) with 2016 amendments.

Table 3.1 below provides the TER data for the Baseline, the BRUKL document for the Baseline has been attached in Appendix A.

Table 3.1 TER for the baseline

Performance	TER [BER from 'H' models]	54.2	kgCO2/m2 annum
	Model Floor Area	4886.2	m2
	Regulated Energy	236.96	Kwh/m2
	Total Energy	277.39	Kwh/m2
	Total Carbon	264.83	TCO2 annum

3.1 Unregulated Emissions

Part L 2013 limits certain Carbon emissions relating to the provision of heat and light to buildings.

Small power loads, i.e. electrical energy for appliances and equipment within the building, are not considered within the regulations. This type of energy use is defined as 'unregulated emissions' as they occur within the building but are not taken into consideration within compliance calculation software. The unregulated emissions have been extracted out of the BRUKL energy by end use and based on NCM templates and casual load allowances and is included in Table 3.1 above as the difference between total and regulated energy.

3.2 Baseline Summary

Using DSM modelling, Baseline energy consumption for the proposed development including for the notional building fabric and services specification detailed in general planning guidance, has been assessed using a primary DSM model [Baseline] taking account Baseline data. Results are as follows with the supporting BRUKL in Appendix A:

Table 3.2: Baseline Emissions

TER [BER from 'H' models]	54.2	kgCO2/m2 annum
Model Floor Area	4886.2	m2
Regulated Energy	236.96	Kwh/m2
Total Energy	277.39	Kwh/m2
Total Carbon	264.83	TCO2 annum

Heating	79.01	Kwh/m2
Cooling	0.17	Kwh/m2
Auxiliary	12.20	Kwh/m2
Lighting	11.79	Kwh/m2
Hot Water	133.79	Kwh/m2
Equipment	40.43	Kwh/m2
Regulated Energy	236.96	Kwh/m2
Total Energy	277.39	Kwh/m2

Building Regulations take account of energy used to heat, cool, light, provide hot water and ventilate the building. This is detailed as the 'regulated' energy use. Unregulated small power (other equipment etc.) is not considered in the calculation of energy consumption and associated emissions.

The Baseline analysis sets a baseline Carbon emission based on the data used of 264.83 tonnes of Carbon.

Table 3.3: Baseline Carbon Dioxide Emissions

	Carbon Dioxide emissions for non-domestic buildings [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Building	264.83	

The Baseline emissions are based on the building specification before the application of energy efficiency measures. The following assumptions have been made in the calculations and generally based on the notional building performance:

Table 3.4: Baseline Building Input Data

Summary		Baseline rev 0 ADL2A Limiting Values Building [2013]	
Drawings Provided	Plans	Planning	
	Sections	Planning	
	Elevations	Planning	
New Build U Values	Walls	0.35	W/m2K
	Ground Floor	0.25	W/m2K
	Exposed Floor	0.25	W/m2K
	Windows	2.2	W/m2K
	Roof	0.25	W/m2K
Air Permeability	New Build	10.00	m3/hr/m2 @ 50Pa
	Photovoltaic Systems	None	
	CHP Generators	None	
	Solar Thermal Systems	None	
	Ground Source Heat Pumps	None	
	Air Source Heat Pumps	None	
Power Factor Correction	Not Installed	< 0.9	
Lighting	Lighting Metering	Yes	
	Out of Range Values	No	
	Lamp Type	Inference	
	Luminaire Efficacy	65 ll/cW	
	Heating Efficiency	91.0% [Nat Gas]	
	lighting Control	PIR	
	Cooling SEER	3.6	
	Cooling EER	2.5	
	Other	None	

4.0 Demand Reduction [Be lean] H1

4.1 Passive Measures H1

A number of passive design measures have been considered and where applicable incorporated into the proposed scheme in order to reduce total energy demand.

The proposed development is a new building design on an existing urban site in Reading. There is limited opportunity to orientate the building to benefit from passive solar design as the site is restricted by adjacent buildings and physical constraints. However, position of windows and building proportions has been considered to maximise passive solar heating and natural light.

The internal layout has been designed to maximise the use of natural light from the light well into the basement areas.

A natural ventilation strategy is fundamental to the scheme and nearly all habitable rooms have access to natural ventilation.

All external building elements; floors, walls, roof and openings, are proposed to be above the ADL2A Limiting U Values detailed in Table 3 (Fig 2.2) beyond those required by Part L limiting values. Glazing units (improved solar g values to solar exposed windows where necessary) will reduce the energy required to heat the building during the heating season while also reducing overheating in the summer and therefore reducing cooling demands of the installed plant and will consider future climate change impacts.

Building air tightness has been reviewed by the team and the designers feel a target air permeability rate of 4.0 m3/(h.m2) at 50Pa for the new build shall be targeted if not reduced further during detailed design and building junction detailing.

4.2 Active Measures H1

The building will all be fitted with a low energy, lighting scheme. Lighting to include adequate controls to maximise efficiency sensing, proximity control or timed control, whichever proves most suitable to a given area shall be reviewed and considered.

The proposed HVAC system will utilise highly efficient systems to provide space heating. The system will be fully controlled by a Building Management System (BMS) to maximise efficiency and ensure adequate levels of environmental control to provide thermal comfort to building occupiers. Local control within the communal and office spaces will be possible within limits set by the BMS and excess set point control will be managed by the systems mitigating heating and cooling demands and energy use.

Ventilation will be required and the team have considered that the most effective systems will be the incorporation of Heat Recovery that shall allow heat to be recovered reducing the energy demands of the systems and that will also facilitate free cooling when possible.

CO2 controls shall be incorporated into the design so systems operate in low speed and or off when spaces are unoccupied and systems shall have a night purge capability to maximise free cooling opportunities.

Lighting design shall prioritise high Luminaries Efficacy LED fittings and low lighting control systems parasitic power with overriding control when spaces are unoccupied.

Because the scheme will require the use of mechanical ventilation, systems shall be designed to operate at variable speed and be selected to that systems specific fan powers [SFP] shall be lower than the limiting standards set by ADL2A.

H1 Measures are summarised as follows:

Passive measures

- U Values upgrades
- Solar G Value Improvements 0.34
- Reduced Air Permeability testing

The following table details the proposed reduction in U Value compared to the limiting ADL2A Values

Table 4.1

		Elemental U Values Minimum Standards 2013		Proposed Elemental U Values		Proposed Elemental U Values Improvements over Minimum Standards
Element	Walls	0.35	W/m2K	0.25	W/m2K	28.57%
	Ground Floor	0.25	W/m2K	0.2	W/m2K	20.00%
	Exposed Floor	0.25	W/m2K	0.2	W/m2K	20.00%
	Windows	2.2	W/m2K	1.6	W/m2K	27.27%
	Roof	0.25	W/m2K	0.18	W/m2K	28.00%
Air Permeability	New Build	10	m3/hr/m2 @ 50Pa	4	m3/hr/m2 @ 50Pa	60.00%

Active Measures

- LED Lighting upgrades
- PIR Lighting controls to toilet Pods
- Reduction of SFP's in ventilation systems
- Reduction of extract fan SFP's
- Metering and Out of Range value monitoring
- Power factor correction >0.95
- Variable speed motor drives
- CO2 Air Quality sensors to optimise the fresh air supply to the communal areas
- Full store BMS with out of range monitoring

A second DSM model has been created [H1] taking account of passive and active improvements to establish the emission reductions possible through these actions. The results and input data are shown in the following tables.

The results and details of the H1 (be lean) DSM modelling analysis are as follows:

Table 4.2: Hierarchy 1

Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic buildings

	Carbon Dioxide emissions for non-domestic buildings [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Building	264.83	
After energy demand reduction (Be Lean H1)	289.26	

Table 4.3: Hierarchy 1

Regulated carbon dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

	Regulated non-domestic Carbon Dioxide Savings	
	[Tonnes CO2 per annum]	[%]
Savings from energy demand reduction (Be Lean H1)	-24.43	-9.23%

It can be seen from the analysis the H1 [Be Lean] actions provide a -9.23% improvement over the Baseline DSM compliance results.

This equates to a non-reduction in carbon emissions (-24.43 tonnes of Carbon) against the baseline TER value although it is an improvement over the baseline BER.

The H1 supporting BRUKL output is provided in Appendix B for information.

The following table details a full comparison between the Baseline model and the H1 [Be Lean] model:

Table 4.4: Hierarchy 1 Summary

Summary		Baseline rev 0 ADL2A Limiting Values Building [2013]		Hierarchy 1 rev 0 Passive and Active be Lean Reduce the Need for Energy	
Drawings Provided	Plans	Planning		Planning	
	Sections	Planning		Planning	
	Elevations	Planning		Planning	
New Build U Values	Walls	0.35	W/m2K	0.25	
	Ground Floor	0.25	W/m2K	0.20	
	Exposed Floor	0.25	W/m2K	0.20	
	Windows	2.2	W/m2K	1.60	
	Roof	0.25	W/m2K	0.18	
Air Permeability	New Build	10.00	m3/hr/m2 @ 50Pa	4.00	
	Photovoltaic Systems	None		None	
	CHP Generators	None		None	
	Solar Thermal Systems	None		None	
	Ground Source Heat Pumps	None		None	
	Air Source Heat Pumps	None		None	
Power Factor Correction	Not Installed	< 0.9		>= 0.95	
Lighting	Lighting Metering	Yes		Yes	
	Out of Range Values	No		Yes	
	Lamp Type	Inference		LED Lamp Type	
	Luminaire Efficacy	65 ll/cW		95 ll/cW	
	Heating Efficiency	91.0% [Nat Gas]		95.0% [Nat Gas] DHWS	
	lighting Control	PIR		PIR Contactor and Daylight	
	Cooling SEER	3.6		3.6	
	Cooling EER	2.5		2.5	
	Other	None		CO2 Control	
				Improved SFP's	
				Electric Heating	
Performance	TER [BER from 'H' models]	54.2	kgCO2/m2 annum	59.2	kgCO2/m2
	Model Floor Area	4886.2	m2	4886.2	m2
	Regulated Energy	236.96	Kwh/m2	185.38	Kwh/m2
	Total Energy	277.39	Kwh/m2	225.81	Kwh/m2
	Total Carbon	264.83	TCO2 annum	289.26	TCO2
		Reduction in Carbon Emissions		-24.43	TCO2
		Cumulative Reduction in Carbon		-24.43	TCO2
		Cumulative Improvement [%]		-9.23%	
		Hierarchy Improvement [%]		-9.23%	
	Heating	79.01	Kwh/m2	54.49	Kwh/m2
	Cooling	0.17	Kwh/m2	0.15	Kwh/m2
	Auxiliary	12.20	Kwh/m2	4.49	Kwh/m2
	Lighting	11.79	Kwh/m2	7.53	Kwh/m2
	Hot Water	133.79	Kwh/m2	118.72	Kwh/m2
	Equipment	40.43	Kwh/m2	40.43	Kwh/m2
	Regulated Energy	236.96	Kwh/m2	185.38	Kwh/m2
	Total Energy	277.39	Kwh/m2	225.81	Kwh/m2

5.0 Heating Infrastructure [Be Clean] H2

There is no local Heat network within economical distance to the scheme and therefore not practical to connect into adjacent heat networks however, this section of the report as required by general planning methodology reviews the availability and locality of heat networks and the use of Combined Heat and Power systems [CHP].

5.1 Decentralised Energy

General Planning guidance and ADL2A requests that all developments investigate the feasibility of:

- Connecting to an existing or planned decentralised energy scheme.
- Installing combined heat on power (CHP) or combined cooling, heat and power (CCHP).
- Designing in the flexibility to connect to any future decentralised energy network.

District heating networks are considered to provide more efficient energy delivery as network losses are often considerably less than conventional energy supplies.

There are no current heating or cooling networks in economical proximity to the site.

5.2 Combined Heat and Power

CHP (combined heat and power) provides both heat and electricity locally for use in a single building or larger heating network. Providing heat and electricity in this way has an efficiency benefit over conventional systems due to the relative inefficiency of grid supplied power.

Small to medium scale CHP most often use purpose built or converted reciprocating internal combustion engines to drive a generator supplying three phase electricity. The efficiency of IC engines is relatively low because of the amount of energy lost as heat. In a CHP unit this otherwise waste heat is used to heat water, this water is used to provide space heating and DHW either directly or via a heat exchanger.

This size of unit will ensure the operational hours are maximised

The scheme has a good base load and as such the selection of a small CHP unit that will operate above 5000 hours is considered viable for the project.

A third DSM model has been created [H2] and was ran without a heat network being available but considered the use of a micro CHP unit. The results and input data are shown in the following tables.

The results and details of the H2 'Be Clean' DSM modelling analysis are as follows:

Table 5.1: Hierarchy 2

Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic buildings

	Carbon Dioxide emissions for non-domestic buildings [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Building	264.83	
After energy demand reduction (Be Lean H1)	289.26	
After heat network / CHP (Be Clean H2)	200.82	

Table 5.2 Hierarchy 2

Regulated carbon dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

	Regulated non-domestic Carbon Dioxide Savings	
	[Tonnes CO2 per annum]	[%]
Savings from energy demand reduction (Be Lean H1)	-24.43	-9.23%
Savings from heat network / CHP (Be Clean H2)	88.44	33.39%

It can be seen from the analysis the H2 [Be Clean] actions provide a 33.39% improvement over the Baseline DSM compliance results.

This equates to a reduction in carbon emissions of 88.44 tonnes of Carbon

The H2 supporting BRUKL output is provided in Appendix C for information

The following table details a full comparison between the Baseline model and the H2 [Be Clean] model:

Table 5.3: Hierarchy 2 Summary

Summary		Baseline rev 0 ADL2A Limiting Values Building [2013]		Hierarchy 1 rev 0 Passive and Active be Lean Reduce the Need for Energy		Hierarchy 2 rev 0 DH Be Clean Use energy More Efficiency	
Drawings Provided	Plans	Planning		Planning		Planning	
	Sections	Planning		Planning		Planning	
	Elevations	Planning		Planning		Planning	
New Build U Values	Walls	0.35	W/m2K	0.25		0.25	
	Ground Floor	0.25	W/m2K	0.20		0.20	
	Exposed Floor	0.25	W/m2K	0.20		0.20	
	Windows	2.2	W/m2K	1.60		1.60	
	Roof	0.25	W/m2K	0.18		0.18	
Air Permeability	New Build	10.00	m3/hr/m2 @ 50Pa	4.00		4.00	
	Photovoltaic Systems	None		None		None	
	CHP Generators	None		None		Yes	
	Solar Thermal Systems	None		None		None	
	Ground Source Heat Pumps	None		None		None	
	Air Source Heat Pumps	None		None		None	
Power Factor Correction	Not Installed	< 0.9		>= 0.95		>= 0.95	
Lighting	Lighting Metering	Yes		Yes		Yes	
	Out of Range Values	No		Yes		Yes	
	Lamp Type	Inference		LED Lamp Type		LED Lamp Type	
	Luminaire Efficacy	65 ll/cW		95 ll/cW		95 ll/cW	
	Heating Efficiency	91.0% [Nat Gas]		95.0% [Nat Gas] DHWS		95.0% [Nat Gas] DHWS	
	lighting Control	PIR		PIR Contactor and Daylight		PIR Contactor and Daylight	
	Cooling SEER	3.6		3.6		3.6	
	Cooling EER	2.5		2.5		2.5	
	Other	None		CO2 Control		CO2 Control	
				Improved SFP's		Improved SFP's	
				Electric Heating		Electric Heating	
						CHP	
Performance	TER [BER from 'H' models]	54.2	kgCO2/m2 annum	59.2	kgCO2/m2	41.1	kgCO2/m2
	Model Floor Area	4886.2	m2	4886.2	m2	4886.2	m2
	Regulated Energy	236.96	Kwh/m2	185.38	Kwh/m2	208.32	Kwh/m2
	Total Energy	277.39	Kwh/m2	225.81	Kwh/m2	207.94	Kwh/m2
	Total Carbon	264.83	TCO2 annum	289.26	TCO2	200.82	TCO2
		Reduction in Carbon Emissions		-24.43	TCO2	88.44	TCO2
		Cumulative Reduction in Carbon		-24.43	TCO2	64.01	TCO2
		Cumulative Improvement [%]		-9.23%		24.17%	
		Hierarchy Improvement [%]		-9.23%		33.39%	
	Heating	79.01	Kwh/m2	54.49	Kwh/m2	43.69	Kwh/m2
	Cooling	0.17	Kwh/m2	0.15	Kwh/m2	0.15	Kwh/m2
	Auxiliary	12.20	Kwh/m2	4.49	Kwh/m2	4.54	Kwh/m2
	Lighting	11.79	Kwh/m2	7.53	Kwh/m2	7.53	Kwh/m2
	Hot Water	133.79	Kwh/m2	118.72	Kwh/m2	152.41	Kwh/m2
	Equipment	40.43	Kwh/m2	40.43	Kwh/m2	40.43	Kwh/m2
	Regulated Energy	236.96	Kwh/m2	185.38	Kwh/m2	208.32	Kwh/m2
	Total Energy	277.39	Kwh/m2	225.81	Kwh/m2	207.94	Kwh/m2

6.0 Cooling Demand Reduction and Overheating Mitigation

As a major development, general planning policy seeks to reduce impact of the urban heat island effect and encourages the design of developments to avoid overheating and excessive heat generation in order to reduce the demand for cooling.

Guidance requires that measures are proposed to mitigate the demand for cooling under the following headings:

1. Minimise internal heat generation through energy efficient design
2. Reduce the amount of heat entering the building during summer
3. Use of thermal mass and high ceiling to manage the heat within buildings
4. Passive Ventilation
5. Mechanical Ventilation

The design team as a whole have considered and would provide the following statements under each of the above headings:

6.1 Minimise Internal Heat Generation Through Energy Efficient Design

The design and distribution of services have been located into general circulation spaces reducing the implied casual load on the occupied zones.

The design team have considered spacial proximity of areas and located them to reduce circulation distances of heating and hot water services but also ductwork distribution and impact on auxiliary fan energy.

6.2 Reduce the Amount of Heat Entering the Building During Summer

The building façade has been developed to provide reduction of solar gain by considering low solar g glazing where applicable along with shading provided from external façade profile but with careful consideration so that natural light is not impaired in the occupied spaces adjacent windows.

6.3 Use of Thermal Mass and High Ceiling to Manage the Heat Within Buildings

The team have considered the holistic building design and have considered thermal mass, material and building proportions where possible.

6.4 Passive Ventilation

Passive ventilation is the primary method of ventilation and the use of opening windows has been developed in the design strategy for ventilation and overheating mitigation

6.5 Mechanical Ventilation

Some occupied areas of the scheme will be dependent on mechanical ventilation and the proposed design has included the use of variable flow control and high efficiency heat recovery from the ventilated areas to reduce peak heating demands as well as reduce the ventilation flow rates where possible reducing the demand on the primary heating systems.

6.6 ADL2A Criterion 3

Part L 2013 Criterion 3 is a simple check to consider solar exposure and the potential for excessive solar gain that may influence the designer to consider the inclusion of cooling systems in mitigating overheating.

It is recognised that the Building Regulations 2013 solar limit assessment in ADL2A and reported on the BRUKL output does not cover all the factors influencing overheating and the energy assessments guidance recommends that additional design assessments should be undertaken as the detailed design develops.

Criterion 3 example output from the BRUKL document is included below for thoroughness in this report to act as a comparator to Dynamic Simulation Analysis included in later sections.

Figure 6.1: Extract from H3 BRUKL Document

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Cinema Room	N/A	N/A
Games Room	N/A	N/A
Gym	N/A	N/A
IT Hub	N/A	N/A
Kitchen	NO (-70.6%)	NO
Kitchen	NO (-63.2%)	NO
Kitchen	NO (-55.7%)	NO
Kitchen	NO (-79.1%)	NO
Kitchen	NO (-51.5%)	NO
Kitchen	NO (-74.3%)	NO
Kitchen	NO (-64%)	NO
Kitchen	NO (-65.2%)	NO
Kitchen	NO (-83.8%)	NO
Kitchen	NO (-54%)	NO
Kitchen	NO (-53.3%)	NO
Kitchen	NO (-84.9%)	NO
Kitchen	NO (-66%)	NO
Kitchen	NO (-81.3%)	NO
Kitchen	NO (-52.2%)	NO
Kitchen	NO (-80.6%)	NO
Kitchen	NO (-78%)	NO
Kitchen	NO (-77.2%)	NO
Kitchen	NO (-70.4%)	NO
Kitchen	NO (-73.7%)	NO
Kitchen	NO (-56.2%)	NO
Kitchen	NO (-81.6%)	NO
Lounge Quiet	NO (-33.2%)	NO
Lounge TV	N/A	N/A
Meeting Bookable Space	NO (-29.8%)	NO

It can be seen from the above Criterion 3 Extract the spaces follow the solar gain limit guidance

6.7 Adaptive Thermal Comfort

This section has been included to demonstrate that the proposed use of passive natural ventilation will still provide comfort conditions within most of the occupied area and mitigate the need for cooling systems in areas other than the high casual load communal areas in the lower ground floor levels.

The development as a whole has been modelled with regards to occupant comfort. IES dynamic thermal modelling software has been used to undertake the modelling. IES Virtual Environment v2018.1.0.0 thermal modelling software is approved by 2013 Building Regulations and is also compliant with CIBSE AM11 requirements.

The assessment is now based on the adaptive comfort model, which follows the methodology and recommendations from EN 15251, and is outlined in CIBSE TM52.

Fig. 6.2: Categories of Buildings in EN15251

Category	Applicability/level of expectancy	PMV range in mechanically cooled buildings
I	High: Buildings with high expectancy for sensitive occupants	± 0.2
II	Normal: New buildings	± 0.5
III	Acceptable: Existing buildings	± 0.7
IV	Low expectancy only for short periods	> 0.7

The performance standards for summertime overheating in compliance with TM52 for New Build spaces are;

Criterion 1. The number of hours (He) that ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 40 hours.

Criterion 2. To allow for the severity of overheating the weighted exceedance (We) shall be less than or equal to 6 in any one day.

Criterion 3. To set an absolute maximum value for the indoor operative temperature the value of ΔT shall not exceed 4K.

In-order to demonstrate that the proposed building will not suffer overheating; at least two of these three TM52 criteria must be met.

Weather File: London DSY05 (Design Summer Year), United Kingdom (Closest Weather Location)

Fig. 6.3: Overheating Assessment Results

The following is a summary of the TM52 analysis with a sample output of the results

Building category:	Category II (new builds.)		
Weather file:	LondonDSY05.fwt		
Days data=	365	01-Jan	31-Dec
Days (summer)=	153	01-May	30-Sep
Data OK?	OK	Full summer	

Passed:	191 rooms:					
Room Name	Room ID	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing
Cinema Room	6	100	0	0	0	-
Games Room	13	100	2.1	6	1	-
Lounge Quiet	15	100	0	0	0	-
Lounge TV	5	100	0	0	0	-
Meeting Bookable Spa	7	100	0.5	2	1	-
Meeting Room	37	100	0	0	0	-
Office	41	100	0	0	0	-
Post Room	40	100	0	0	0	-
Std Room	0400002E	100	1.3	21	4	2
Std Room	4000013	100	1.3	23	3	2
Std Room	0400000C	100	1.4	24	3	2
Std Room	0400000E	100	1.4	25	3	2
Std Room	0300002D	100	1.3	23	4	2
Std Room	1000053	100	1.9	28	4	2
Std Room	58	100	0.4	13	2	2
Std Room	3000049	100	1.9	30	4	2
Std Room	3000047	100	1.3	23	4	2
Std Room	0000007F	100	0.5	17	3	2
Std Room	3000044	100	1	22	3	2
Std Room	3000042	100	0.9	22	3	2
Std Room	0300000B	100	0.6	19	3	2
Std Room	0300000E	100	0.6	18	3	2
Std Room	3000012	100	1.5	25	3	2
Std Room	3000014	100	0.6	17	3	2
Std Room	3000017	100	0.6	18	3	2
Std Room	3000018	100	0.6	17	3	2
Std Room	0300001F	100	1.4	23	3	2
Std Room	3000027	100	1.1	21	3	2
Std Room	3000028	100	1.2	20	3	2
Std Room	0300002B	100	1	21	3	2
Std Room	0300002C	100	1.3	24	4	2
Std Room	3000033	100	1.3	22	4	2
Std Room	3000035	100	1.5	24	4	2
Std Room	60	100	0.7	18	3	2
Std Room	0300003D	100	1.9	28	4	2
Std Room	75	100	0.6	18	3	2
Std Room	3000010	100	1.5	28	4	2
Std Room	WS000000	100	1.4	25	3	2
Std Room	0200004C	100	1.7	27	4	2
Std Room	0200004A	100	1.1	21	3	2
Std Room	2000047	100	1	22	3	2
Std Room	2000045	100	0.9	24	3	2
Std Room	2000040	100	2	28	4	2
Std Room	2000038	100	1	21	3	2
Std Room	2000036	100	1.1	23	4	2
Std Room	0200002F	100	1.2	24	4	2
Std Room	0200002E	100	1	21	3	2
Std Room	0200002B	100	1.1	20	3	2
Std Room	0200002A	100	1.1	22	3	2
Std Room	2000030	100	1.2	24	4	2
Std Room	2000026	100	1.3	22	3	2
Std Room	2000023	100	1.3	24	3	2
Std Room	2000022	100	1.4	25	3	2
Std Room	0200001F	100	2.3	31	4	2
Std Room	0200001D	100	1.9	30	4	2
Std Room	0200001B	100	0.6	17	3	2
Std Room	0200001A	100	0.6	18	3	2
Std Room	2000017	100	0.6	17	3	2
Std Room	2000015	100	1.5	27	4	2
Std Room	2000013	100	1.7	30	4	2
Std Room	2000011	100	0.6	18	3	2
Std Room	0200000E	100	0.7	19	3	2
Std Room	4000027	100	1.4	23	4	2
Std Room	0300001A	100	1.6	25	3	2
Std Room	1000017	100	0.5	16	2	2

7.0 Applicability of Renewable and LZC's [Be Green] H3

The following section details the considerations and practicalities of Renewable and Low Zero Carbon (LZC) technologies.

7.1 Renewable Technologies

Energy resources accepted as Renewable or Low Carbon Technologies are defined by the Department of Energy & Climate change Low Carbon Buildings Program. Those which are suitable for consideration in this case are:

- Solar photovoltaics
- Wind turbines
- Solar thermal hot water
- Air Source Heat pumps and Ground Source Heat Pumps
- Biomass Heating

7.2 Solar Photovoltaics

Photovoltaics (PVs) generate electricity from daylight using semiconductors. PV's are also a simple technology requiring little in the way of maintenance and offer a proven way of generating zero Carbon, renewable electricity. Photovoltaics generate electricity which displaces that which would otherwise be provided by the national grid. Grid supplied electricity is very polluting when compared to other conventional fuels producing more than 2.5 times more CO2/kWh than natural gas.

Given the area of available roof space and minimal over shading, PV is considered to be a suitable low carbon technology for the project however, the cost impacts associated with the installation at this time means the team have priorities other technologies.

7.3 Wind turbines

Wind turbines generate electricity via a conventional generator connected to turbine blades which are in turn powered by the prevailing wind. Given the location of the development, building mounted turbines would be required, and for this type of application vertical axis turbines would be best suited. However, for structural implications of mounting wind turbines to the buildings frame, both in terms of impact on location, building structural loading and vibration means wind turbines are not viable.

7.4 Solar Thermal

The proposed development has a suitable heating load but limited plant space internally and it may not be the best and most viable option for the scheme.

Based on the cost impacts associated with the installation and limited plant space available the team have priorities other technologies.

7.5 Heat Pumps

The design team have considered the use of heat pumps in detail and feel it's the best solution for the schemes heating and cooling demands.

7.5.1 Ground Source Heat Pumps

This captures natural energy through boreholes hundreds of metres beneath the ground, providing the store with on-demand heating, hot water and cooling from renewable sources.

However the costs of ground source heat pumps for this site considering the existing nature of the site means it is not economically viable and has not been considered further and other technologies prioritised.

7.5.2 Air Sourced Heat Pumps

Air Source Heat Pump VRF Units provided to serve Heating and cooling requirements to designated communal areas.

The heat pump technology proposed is 3 pipe Variable Refrigerant Flow [VRF] and the design and apportionment of load allows very efficient transfer of heating and cooling between zone of variable heating and cooling demand providing high SCoP's and SEER's. Details of the typical system type are included in Appendix E.

The H1 Be Lean approach has considered the carbon benefits in previous analysis and the H3 Be Green analysis shall report the renewable carbon reduction only.

7.6 Biomass Heating

The design team have considered the use of Biomass in detail and due to the restricted access storage needs and potential air quality issues have not considered this as a viable option.

Table 7.1: LZC Summary of Considerations

Description	Comments applicable to the scheme
District Heating	There is no network within an economical distance of the proposed building and extension. However, the scheme shall consider technology that will allow the future connection into the DHWS system at a later date
Air Sourced Heat Pumps	Possible to serve the building heating and cooling demands and equipments can be selected to operate at low ambient noise levels and offer very high heating and cooling performance and is considered viable for the scheme
Ground Sourced Heat Pumps	Possible to serve the building heating demands and is considered viable for the scheme
Biomass Boiler Plant	Possible to serve the building heating demands but based on costs and restricted access has not been considered for the scheme
Solar Thermal (solar water heating)	Possible to serve the domestic hot water systems but would require roof mounted plant and equipment and considering the limited internal plant is felt unsuitable
Active Solar (Photovoltaic)	Appropriate for this scheme and could be integrated onto the roof fabric but other technology has been priorities for the scheme at this stage
Small Hydro	Not applicable to the scheme
Combined Heat and Power (CHP)	Considered the most viable technology due to the large base load and expectation the equipments will run for more than 5000 hours
Energy From Waste	Not applicable to the scheme
Anaerobic Digestion	Not applicable to the scheme

A Fourth DSM model has been created [H3] taking account renewable improvements to establish the emission reductions possible through these actions. The results and input data are shown in the following tables:

Table 7.2: Hierarchy 3

Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic buildings

	Carbon Dioxide emissions for non-domestic buildings [Tonnes CO2 per annum]	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Building	264.83	
After energy demand reduction (Be Lean H1)	289.26	
After heat network / CHP (Be Clean H2)	200.82	
After renewable energy (Be Green H3)	200.33	

Table 7.3: Hierarchy 3

Regulated carbon dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

	Regulated non-domestic Carbon Dioxide Savings	
	[Tonnes CO2 per annum]	[%]
Savings from energy demand reduction (Be Lean H1)	-24.43	-9.23%
Savings from heat network / CHP (Be Clean H2)	88.44	33.39%
Savings from renewable energy (Be Green H3)	0.49	0.18%

It can be seen from the analysis the H3 [Be Green] actions provide a 0.18% improvement

This equates to a reduction in carbon emissions of 0.49 tonnes of Carbon

The H3 supporting BRUKL output is provided in Appendix D for Information.

The following table details a full comparison between the Baseline model and the H3 [Be Green] model:

Table 7.4: Hierarchy 3 Summary

Summary		Baseline rev 0 ADL2A Limiting Values Building [2013]		Hierarchy 1 rev 0 Passive and Active be Lean Reduce the Need for Energy		Hierarchy 2 rev 0 DH Be Clean Use energy More Efficiency		Hierarchy 3 rev 0 Be Green Use of Renewable Energy	
Drawings Provided	Plans	Planning		Planning		Planning		Planning	
	Sections	Planning		Planning		Planning		Planning	
	Elevations	Planning		Planning		Planning		Planning	
New Build U Values	Walls	0.35	W/m2K	0.25		0.25		0.25	
	Ground Floor	0.25	W/m2K	0.20		0.20		0.20	
	Exposed Floor	0.25	W/m2K	0.20		0.20		0.20	
	Windows	2.2	W/m2K	1.60		1.60		1.60	
	Roof	0.25	W/m2K	0.18		0.18		0.18	
Air Permeability	New Build	10.00	m3/hr/m2 @ 50Pa	4.00		4.00		4.00	
	Photovoltaic Systems	None		None		None		None	
	CHP Generators	None		None		Yes		Yes	
	Solar Thermal Systems	None		None		None		None	
	Ground Source Heat Pumps	None		None		None		None	
	Air Source Heat Pumps	None		None		None		Yes	
Power Factor Correction	Not Installed	< 0.9		>= 0.95		>= 0.95		>= 0.95	
Lighting	Lighting Metering	Yes		Yes		Yes		Yes	
	Out of Range Values	No		Yes		Yes		Yes	
	Lamp Type	Inference		LED Lamp Type		LED Lamp Type		LED Lamp Type	
	Luminaire Efficacy	65 ll/cW		95 ll/cW		95 ll/cW		95 ll/cW	
	Heating Efficiency	91.0% [Nat Gas]		95.0% [Nat Gas] DHWS		95.0% [Nat Gas] DHWS		5.5 VRF and 95% (Nat Gas)	
	lighting Control	PIR		PIR Contactor and Daylight		PIR Contactor and Daylight		PIR Contactor and Daylight	
	Cooling SEER	3.6		3.6		3.6		6	
	Cooling EER	2.5		2.5		2.5		4.5	
	Other	None		CO2 Control		CO2 Control		CO2 Control	
				Improved SFP's		Improved SFP's		Improved SFP's	
				Electric Heating		Electric Heating		Electric Heating	
						CHP		CHP	
								ASHP	
Performance	TER [BER from 'H' models]	54.2	kgCO2/m2 annum	59.2	kgCO2/m2	41.1	kgCO2/m2	41	kgCO2/m2
	Model Floor Area	4886.2	m2	4886.2	m2	4886.2	m2	4886.2	m2
	Regulated Energy	236.96	Kwh/m2	185.38	Kwh/m2	208.32	Kwh/m2	213.25	Kwh/m2
	Total Energy	277.39	Kwh/m2	225.81	Kwh/m2	207.94	Kwh/m2	212.87	Kwh/m2
	Total Carbon	264.83	TCO2 annum	289.26	TCO2	200.82	TCO2	200.33	TCO2
		Reduction in Carbon Emissions		-24.43	TCO2	88.44	TCO2	0.49	TCO2
		Cumulative Reduction in Carbon		-24.43	TCO2	64.01	TCO2	64.50	TCO2
		Cumulative Improvement [%]		-9.23%		24.17%		24.35%	
		Hierarchy Improvement [%]		-9.23%		33.39%		0.18%	
	Heating	79.01	Kwh/m2	54.49	Kwh/m2	43.69	Kwh/m2	43.27	Kwh/m2
	Cooling	0.17	Kwh/m2	0.15	Kwh/m2	0.15	Kwh/m2	0.21	Kwh/m2
	Auxiliary	12.20	Kwh/m2	4.49	Kwh/m2	4.54	Kwh/m2	4.40	Kwh/m2
	Lighting	11.79	Kwh/m2	7.53	Kwh/m2	7.53	Kwh/m2	7.53	Kwh/m2
	Hot Water	133.79	Kwh/m2	118.72	Kwh/m2	152.41	Kwh/m2	157.84	Kwh/m2
	Equipment	40.43	Kwh/m2	40.43	Kwh/m2	40.43	Kwh/m2	40.43	Kwh/m2
	Regulated Energy	236.96	Kwh/m2	185.38	Kwh/m2	208.32	Kwh/m2	213.25	Kwh/m2
	Total Energy	277.39	Kwh/m2	225.81	Kwh/m2	207.94	Kwh/m2	212.87	Kwh/m2

8.0 Summary of Energy Strategy

The energy strategy considered is based on the Energy Hierarchy as detailed in the introduction of this report. The estimated savings anticipated from implementing this energy strategy on the Baseline energy demand for the development can be seen in Table 1

Table 1 Regulated carbon dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

	Regulated non-domestic Carbon Dioxide Savings	
	[Tonnes CO2 per annum]	[%]
Savings from energy demand reduction (Be Lean H1)	-24.43	-9.23%
Savings from heat network / CHP (Be Clean H2)	88.44	33.39%
Savings from renewable energy (Be Green H3)	0.49	0.18%
Total Cumulative Savings	64.50	24.35%

The building fabric will be improved beyond current regulatory limiting requirements by improving levels of insulation where practical generally in line with the following table:

Table 2

		Elemental U Values Minimum Standards 2013		Proposed Elemental U Values		Proposed Elemental U Values Improvements over Minimum Standards
Element	Walls	0.35	W/m2K	0.25	W/m2K	28.57%
	Ground Floor	0.25	W/m2K	0.2	W/m2K	20.00%
	Exposed Floor	0.25	W/m2K	0.2	W/m2K	20.00%
	Windows	2.2	W/m2K	1.6	W/m2K	27.27%
	Roof	0.25	W/m2K	0.18	W/m2K	28.00%
Air Permeability	New Build	10	m3/hr/m2 @ 50Pa	4	m3/hr/m2 @ 50Pa	60.00%

Passive and Active design features have been incorporated including designing internal layouts to maximise the use of natural light and high thermal insulation to reduce energy demand and help moderate internal temperatures throughout the year.

Energy efficient lighting and other system improvements that will be installed which use less energy and have suitable control so as to be operated at optimum performance while providing a comfortable internal environment. This shows that a -9.23% (-24.43 tonnes CO2) improvement is predicted over

the Baseline TER energy analysis. It should be noted that although this is showing a negative value this is because the TER value has been used as the fully compliant Part L2A pass value.

The saving compared to the baseline BER Value is 27.72% improvement which can be seen in the from the B1 BRUKL.

The use of CHP technology shows that a 33.39% (88.44 tonnes CO2) improvement is predicted over the Baseline energy analysis is possible exceeding the Planning target of 20% of the energy consumption to be met by CHP/renewable and LZC sources with 0.18% contribution from ASHP.

It is anticipated that these measures in combination would achieve a 24.35% (64.50 tonnes CO2) of Carbon reduction in emissions compared to the Baseline analysis.

Sub-meters will be provided for all substantial energy uses with automated monitoring back and the main site BMS to assist the FM teams in monitoring consumption.

All external lighting will be energy efficient and controlled for the presence of daylight.

The following table details a full comparison between the Baseline model and the H1 - H3 models:

Table 8.1: LZC Summary of Analysis

Summary		Baseline rev 0 ADL2A Limiting Values Building [2013]		Hierarchy 1 rev 0 Passive and Active be Lean Reduce the Need for Energy		Hierarchy 2 rev 0 DH Be Clean Use energy More Efficiency		Hierarchy 3 rev 0 Be Green Use of Renewable Energy	
Drawings Provided	Plans	Planning		Planning		Planning		Planning	
	Sections	Planning		Planning		Planning		Planning	
	Elevations	Planning		Planning		Planning		Planning	
New Build U Values	Walls	0.35	W/m2K	0.25		0.25		0.25	
	Ground Floor	0.25	W/m2K	0.20		0.20		0.20	
	Exposed Floor	0.25	W/m2K	0.20		0.20		0.20	
	Windows	2.2	W/m2K	1.60		1.60		1.60	
	Roof	0.25	W/m2K	0.18		0.18		0.18	
Air Permeability	New Build	10.00	m3/hr/m2 @ 50Pa	4.00		4.00		4.00	
	Photovoltaic Systems	None		None		None		None	
	CHP Generators	None		None		Yes		Yes	
	Solar Thermal Systems	None		None		None		None	
	Ground Source Heat Pumps	None		None		None		None	
	Air Source Heat Pumps	None		None		None		Yes	
Power Factor Correction	Not Installed	< 0.9		>= 0.95		>= 0.95		>= 0.95	
Lighting	Lighting Metering	Yes		Yes		Yes		Yes	
	Out of Range Values	No		Yes		Yes		Yes	
	Lamp Type	Inference		LED Lamp Type		LED Lamp Type		LED Lamp Type	
	Luminaire Efficacy	65 ll/cW		95 ll/cW		95 ll/cW		95 ll/cW	
	Heating Efficiency	91.0% [Nat Gas]		95.0% [Nat Gas] DHWS		95.0% [Nat Gas] DHWS		5.5 VRF and 95% (Nat Gas)	
	lighting Control	PIR		PIR Contactor and Daylight		PIR Contactor and Daylight		PIR Contactor and Daylight	
	Cooling SEER	3.6		3.6		3.6		6	
	Cooling EER	2.5		2.5		2.5		4.5	
	Other	None		CO2 Control		CO2 Control		CO2 Control	
				Improved SFP's		Improved SFP's		Improved SFP's	
				Electric Heating		Electric Heating		Electric Heating	
						CHP		CHP	
								ASHP	
Performance	TER [BER from 'H' models]	54.2	kgCO2/m2 annum	59.2	kgCO2/m2	41.1	kgCO2/m2	41	kgCO2/m2
	Model Floor Area	4886.2	m2	4886.2	m2	4886.2	m2	4886.2	m2
	Regulated Energy	236.96	Kwh/m2	185.38	Kwh/m2	208.32	Kwh/m2	213.25	Kwh/m2
	Total Energy	277.39	Kwh/m2	225.81	Kwh/m2	207.94	Kwh/m2	212.87	Kwh/m2
	Total Carbon	264.83	TCO2 annum	289.26	TCO2	200.82	TCO2	200.33	TCO2
		Reduction in Carbon Emissions		-24.43	TCO2	88.44	TCO2	0.49	TCO2
		Cumulative Reduction in Carbon		-24.43	TCO2	64.01	TCO2	64.50	TCO2
		Cumulative Improvement [%]		-9.23%		24.17%		24.35%	
		Hierarchy Improvement [%]		-9.23%		33.39%		0.18%	
	Heating	79.01	Kwh/m2	54.49	Kwh/m2	43.69	Kwh/m2	43.27	Kwh/m2
	Cooling	0.17	Kwh/m2	0.15	Kwh/m2	0.15	Kwh/m2	0.21	Kwh/m2
	Auxiliary	12.20	Kwh/m2	4.49	Kwh/m2	4.54	Kwh/m2	4.40	Kwh/m2
	Lighting	11.79	Kwh/m2	7.53	Kwh/m2	7.53	Kwh/m2	7.53	Kwh/m2
	Hot Water	133.79	Kwh/m2	118.72	Kwh/m2	152.41	Kwh/m2	157.84	Kwh/m2
	Equipment	40.43	Kwh/m2	40.43	Kwh/m2	40.43	Kwh/m2	40.43	Kwh/m2
	Regulated Energy	236.96	Kwh/m2	185.38	Kwh/m2	208.32	Kwh/m2	213.25	Kwh/m2
	Total Energy	277.39	Kwh/m2	225.81	Kwh/m2	207.94	Kwh/m2	212.87	Kwh/m2

Appendix A

Baseline BRUKL

Appendix B

H1 BRUKL [Be Lean]

Appendix C

H2 BRUKL [Be Clean]

Appendix D

H3 BRUKL [Be Green]

Appendix E

Example Technical Literature