Thornley & Lumb

Stephenson Way Euston

Energy Strategy

Project

Stephenson Way Euston

Document

Energy Strategy

Client

Churchgate

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TLP Project Reference

C7127

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Document Control

Document	Energy Strategy
Project	Stephenson Way Euston
Client	Churchgate
Job Number	C7127
Issue	Draft issue 13.04.18

Document	Energy Strategy
Project	Stephenson Way Euston
Client	Churchgate
Job Number	C7127
Issue	First issue 16.04.18

Document	Energy Strategy
Project	Stephenson Way Euston
Client	Churchgate
Job Number	C7127
Issue	Second issue 20.11.18

Document	Energy Strategy
Project	Stephenson Way Euston
Client	Churchgate
Job Number	C7127
Issue	Third issue 21.02.18

Executive Summary

This Energy Strategy produced by Thornley & Lumb on behalf of Churchgate details aspects of sustainable building design relating to energy and carbon emissions of the proposed Student Accommodation development on Stephenson Way in Euston. The building fabric first design philosophy and efficient building services analysis are combined with the available Low and Zero Carbon LZC technology to provide a methodology for achieving a sustainable low energy use development. This process is illustrated by following the Energy Hierarchy which details the measures included at each stage. The Energy Hierarchy helps qualify the carbon emissions due to various measures by reporting the emission reductions at each stage.

The current target for carbon emissions of new-build non-domestic developments in London is a 35% reduction in carbon emissions when compared to the Part L 2013 Baseline building (gas boilers providing heating). The measures included are detailed below with the results of the energy modelling and details of carbon reduction given in the Chart below.

Be Lean Measures

- Low external envelope u-values with green roof
- Low air permeability
- Natural ventilation to studio bedrooms
- Low energy LED lighting & BMS with auto M&T
- Low energy bathroom ventilation system dMEV with trickle ventilation

Be Clean Measures

- Provision for future connection to a heat network

Be Green Measures

- Air to water heat pump providing space heating
- High efficiency CO_2 Heat Pump for hot water services HWS
- Solar PV on site renewable electricity generation 9.75 kW

These measures enable the development to achieve a 44% reduction using Part L carbon emissions factors and 71% using SAP 10 carbon factors (see appendix).

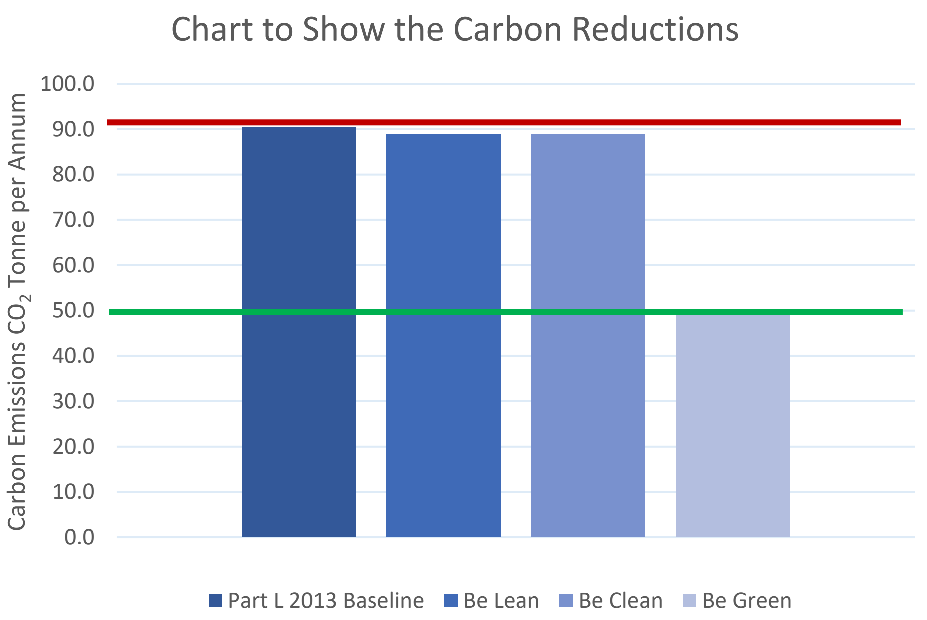

Chart to show the overall carbon reductions of the proposed development

Carbon Dioxide Emissions Per Annum for non-domestic Buildings

	Regulated CO_2 Tonnes CO_2 per annum	Unregulated CO_2 Tonnes CO_2 per annum
Baseline Part L (2013)	90.4	51.9
Including Be Lean Measures	88.8	51.9
Including Be Clean Measures	88.8	51.9
Including Be Green Measures	50.1	51.9

Regulated Carbon Dioxide Savings Per Annum for non-domestic Buildings

	Tonnes CO_2 Per annum	Percentage Reduction %
Savings from Be Lean Measures	1.5	1.7
Savings from Be Clean Measures	0.0	0.0
Savings from Be Green Measures	38.7	43.6
Reduction Compared to Baseline	40.3	44.6
Annual Deficit / Contribution £	£0	0

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1.0 Introduction

The proposed development on Stephenson Way in Euston will consist of a seven-storey building plus basement for dual student accommodation (C2) and hotel (C1) use. The development will involve 78 rooms of accommodation on the upper floors with shared amenity space at ground level and basement level storage. In addition, the development will be designed to retain vehicular easement from Stephenson Way to the rear of 222 Euston Road.

The proposed development will be designed with sustainability as the principle design metric and accordingly this Energy Strategy will detail how energy usage and carbon emission have been minimised using the energy hierarchy, as developed by the Greater London Authority GLA and detailed in the document “Guidance on Preparing Energy Assessments”.

The carbon reductions detailed in this energy strategy have been calculated using Part L accredited compliance dynamic simulation modelling DSM software IES VE Compliance DSM. This ensures that the proposed development’s carbon emissions have been calculated using a more sophisticated carbon calculations methodology, as opposed to the less sophisticated standard SBEM methodology.

Accordingly, this Energy Strategy will detail how the proposed development will be a low carbon sustainable development by following the four energy strategy design principles as detailed in Section 1.1 Sustainable Low Carbon Design.

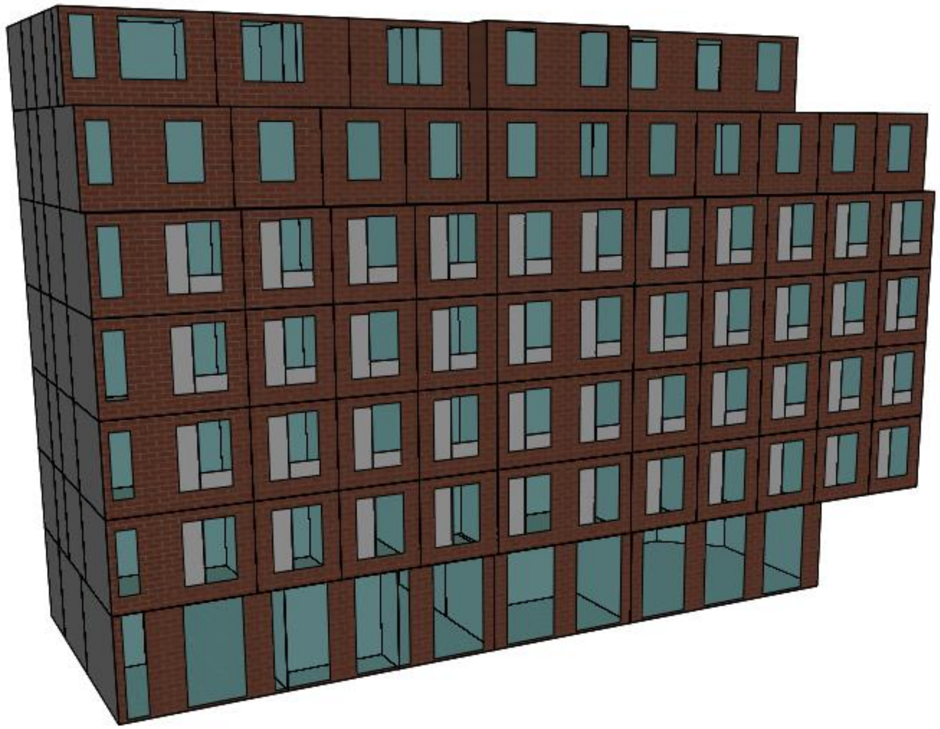


Figure 1.0 Image to show the proposed development building energy model

1.1 Sustainable Low-Carbon Design

Thornley and Lumb will consider the sustainability of the proposed development and the building's energy usage throughout the design process by developing an energy strategy design philosophy. This will consist of four underling design principles which will be implemented to ensure the sustainability of the proposed development. The principles used to develop the energy strategy are: reduce demand, meet demand efficiently, supply from low carbon sources, supply from renewables.

Energy Strategy Design Principles

Reduce Demand

The energy demand of the building is intrinsically linked to the design of the building envelope and its services. Therefore, ensuring a thermally efficient and relatively air tight building envelope will enable reduction in energy usage.

Meet Demand Efficiently

The application of building services which improve upon the minimum efficiencies detailed in the government's document the Non-Domestic Building Services Compliance Guide NDBSCG, will ensure that where energy is used for servicing the building, it is used efficiently with minimal wastage.

Supply from Low Carbon Sources

Where energy is used to service the building, the carbon emissions of the source will be taken into account as part of the design process. This involves using carbon factors of energy sources to calculate potential carbon emissions.

Supply from Renewable Sources

The further reduction of carbon emissions will be met with energy supply from renewable sources. These are zero carbon energy sources which provide servicing for the building without increasing the carbon emissions of the building.

2.0 Design Considerations

This section discusses the design considerations for the proposed Student Accommodation development on Stephenson Way in Euston. This section will detail the design methodology and detail the planning criteria established by national and local policy.

2.1 Design Methodology

The energy usage figures used in this Energy Strategy have all been calculated using industry recognised software. The geometry of the building is modelled in the software and then all fixed building service efficiencies are integrated with the model to provide energy usage figures.

2.1.1 Energy Modelling Software

The IES VE software is dynamic building simulation modelling DSM application which includes industry standard thermal modelling and Part L compliance software. The IES VE uses local climate weather data for the specific locations and then combines these with the building geometry and fixed building services efficiencies to calculate an hourly annual analysis of the building's energy usage.

2.1.2 Carbon Emissions Calculations

Following annual energy rate calculations, the carbon factors for each fuel type then allow for a prediction of the annual carbon emission of the development. The carbon factors currently used in Part L are detailed in the Standard Assessment Procedure SAP 2012 documents. Given that the carbon factors haven't been updated in recently years following the reduction in coal electricity generation and increase in renewable energy sources, it is likely the calculations will overestimate carbon emissions generated by electrical equipment.

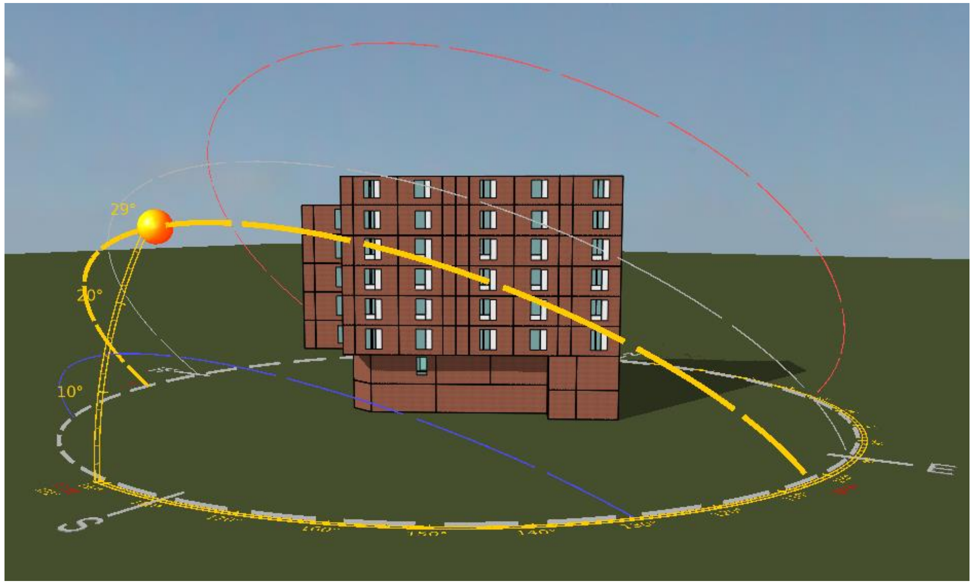


Figure 2.0 Image to show the orientation of the building in energy modelling software IES VE

2.2 National Planning Policy

The National Planning Policy Framework NPPF was most recently published in March 2012. The document details that the purpose of planning is “to help achieve sustainable development”. Applications for planning permission are determined in accordance with the development plan and local planning policy. The National Planning Policy Framework states that there are three dimensions to achieving sustainable development.

Economic

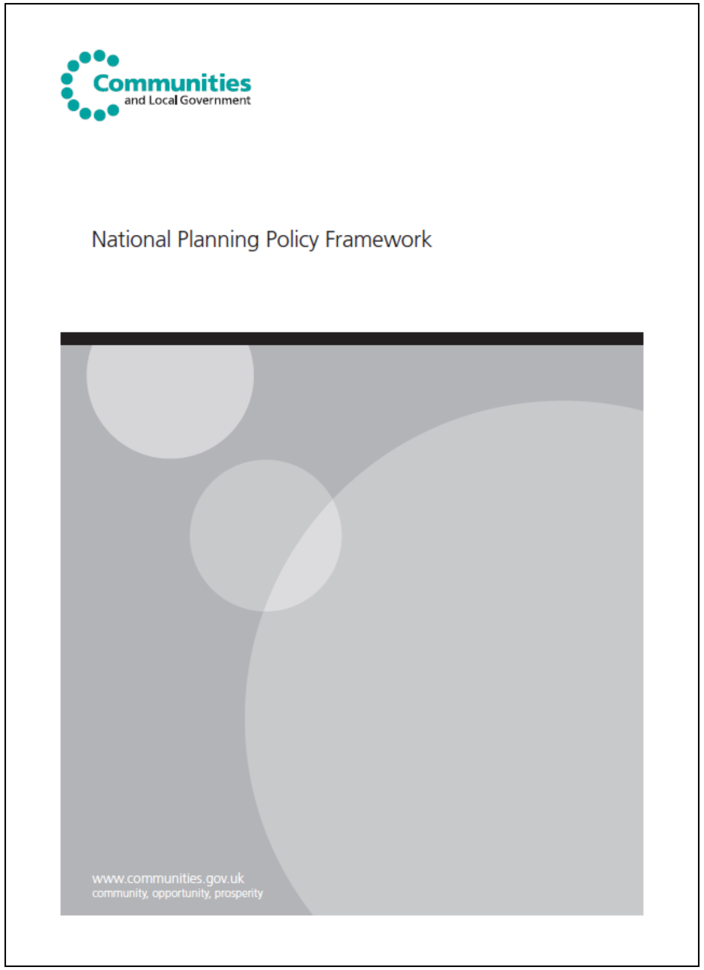
Contributing to building a strong, responsive and competitive economy, by ensuring that sufficient land of the right type is available in the right places and at the right time to support growth and innovation; and by identifying and coordinating development requirements, including the provision of infrastructure.

Social

Supporting strong, vibrant and healthy communities, by providing the supply of housing required to meet the needs of present and future generations; and by creating a high quality built environment, with accessible local services that reflect the community’s needs and support its health, social and cultural well-being;

Environmental

Contributing to protecting and enhancing our natural, built and historic environment; and, as part of this, helping to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate and adapt to climate change including moving to a low carbon economy.


Communities and Local Government

National Planning Policy Framework

www.communities.gov.uk
community, opportunity, prosperity

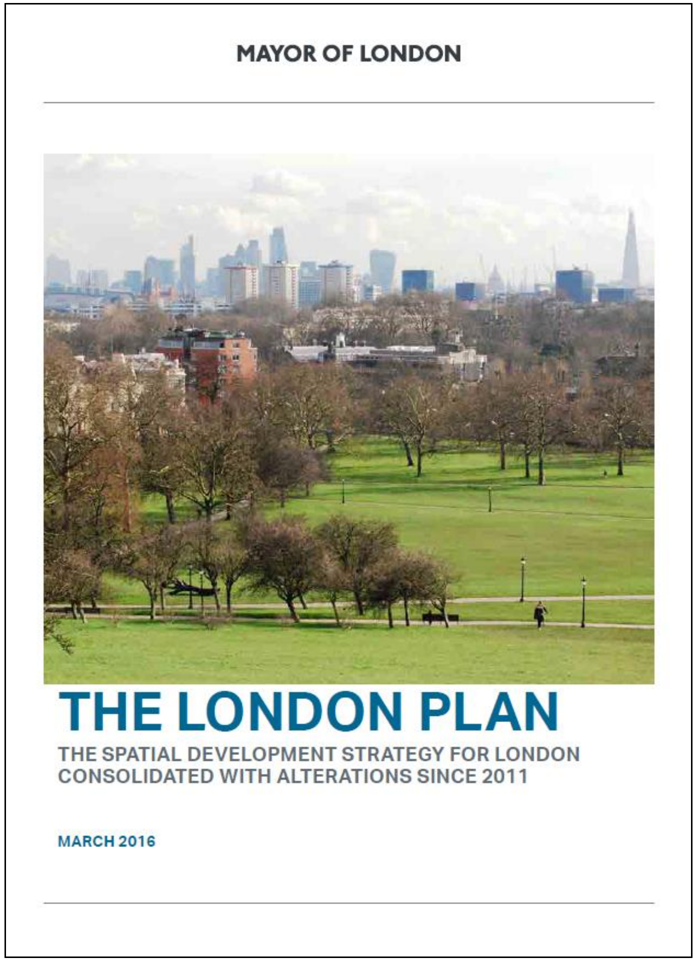
2.3 Local Planning Policy

2.3.1 The London Plan

The City of London has a very progressive spatial development strategy which includes detailed energy and carbon policy defined as The London Plan. The strategic planning in the capital is the shared responsibility of the Mayor of London and the 32 London boroughs. The Greater London Authority GLA and the Mayor have developed a spatial development strategy SDS. The aim of The London Plan is to provide integrated economic, environmental, transport and social framework for the development of London over the next 20-25 years.

The energy and carbon requirements of The London Plan are detailed in Chapter 5 London's Response to Climate Change. Policy 5.2 Minimising Carbon Dioxide Emissions, coupled with GLA's guidance on preparing energy assessments, requires all new-build non-domestic developments to reduce carbon emissions by 35% against the Part L 2013 Baseline.

The Greater London Authority Guidance on Preparing Energy Assessments details the GLA's expectation that all non-domestic developments seek to achieve a 35% reduction in carbon emission against the Part L 2013 baseline. The document details the Energy Hierarchy which states how the carbon reduction needs to be reported at each stage Be Lean, Be Clean, Be Green. The London Plan and Guidance on Preparing Energy Assessments therefore both define the requirements and metrics for this Energy Strategy.



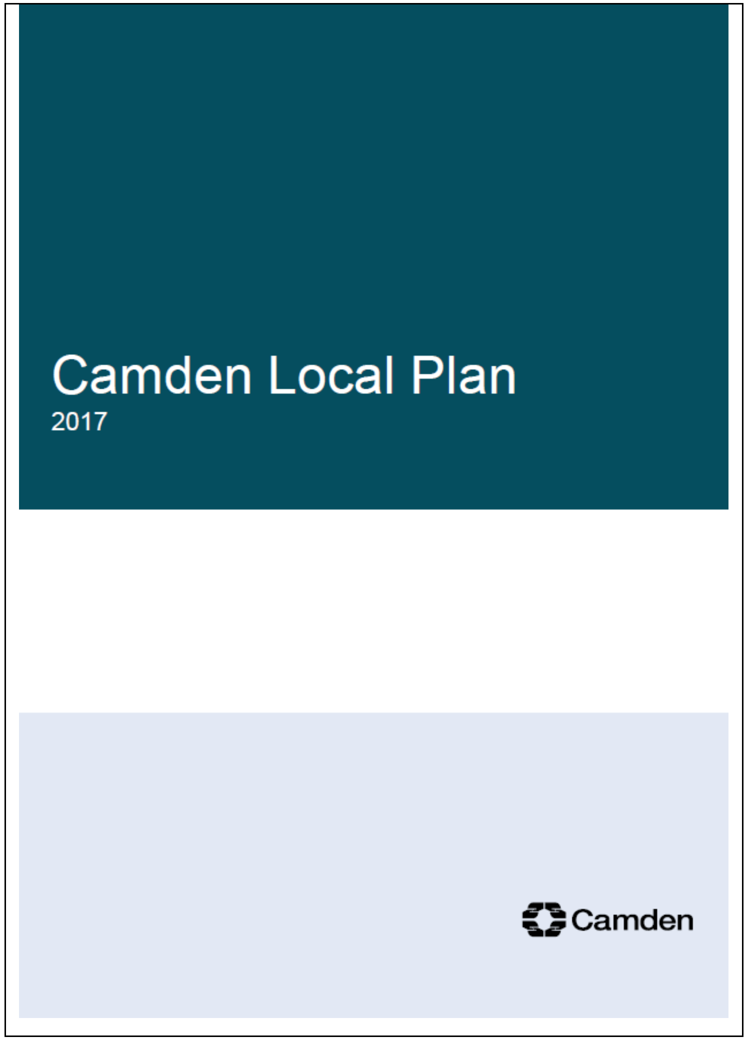
2.3.2 Camden Local Plan

The Brough of Camden has developed The Camden Local Plan which sets out the Council's planning policies. The Camden Local Plan details the borough's planning policies from 2016 to 2031 this is summarised into three objectives.

1. Developing new solutions with partners to reduce inequality and improve health and wellbeing
2. Create conditions for and harnessing the benefits of economic growth
3. Investing in our communities to ensure sustainable neighbourhood

The Camden Local Plan aims to tackle the causes of climate change in the borough by ensuring developments use less energy and assess the feasibility of decentralised energy and renewable energy technologies. Camden Council will require all developments to minimise the effects of climate change by to following:

i. Require all developments to reduce carbon emissions via steps in the energy hierarchy.
ii. Require all development to demonstrate how London Plan targets for carbon emissions have been met
iii. Expect all developments to optimise resource efficiently.



3.0 Be Lean: Reducing Energy Demand

Consideration of energy usage is an integral part of any proposed Accommodation and each aspect of the Low Energy Building Design includes methods of conserving energy and promoting sustainability. This section of the Energy Strategy looks at how demand has been reduced by the minimum required efficiency defined by building regulations, known as the 'limiting parameter'. This minimum efficiency or limiting parameter is then compared with the Low Energy Building Design to assess the energy use of proposed Accommodation development on Stephenson Way in Euston.

3.1 Building Envelope and Fabric

The energy usage of a building is intrinsically linked to the efficiency of the building envelope design, accordingly this section details how energy use is minimised by following energy strategy design principles in Section 1.1 and using a Passivhaus influenced fabric first design philosophy. The reduction of heat loss through the building fabric is the most effective method of passively reducing energy usage. Building services will be replaced multiple times over the life of the building but it is less likely that the building fabric will be upgraded. Therefore, the reduction of u-value and the adoption of the Passivhaus design philosophy is the most effective method of reducing energy usage and carbon emissions over the full life cycle of the building.

In addition to low u-value the development will also incorporate a green roof to minimise heat loss and impact on the environment.

3.1.1 Thermal Properties of Building Fabric

The energy usage of the building services associated with controlling the space temperature is dependent on the building envelope. The efficiency of the building envelope significantly affects energy usage as this is essentially a measure of how efficiently the internal building environment is thermally isolated form the external environment. The more efficient the isolation of internal from external environment, the less energy will be required for use in servicing the internal environment to meet optimum comfort levels. The proposed green roof will also limit heat loss through the roof of the development reducing energy and carbon emissions.

3.1.2 Thermal Bridging

The proposed development had been designed to use accredited construction details ACD which will limit thermal bridging and reduce heat loss through the building envelope.

	Limiting Fabric Parameters $W\ m^{-2}\ k^{-1}$	Low Energy Design Parameters $W\ m^{-2}\ k^{-1}$	Percentage Improvement %
Roof	0.25	0.10	60
External Walls	0.35	0.19	46
Ground Floor	0.25	0.15	40
External Glazing	2.20	1.6	27

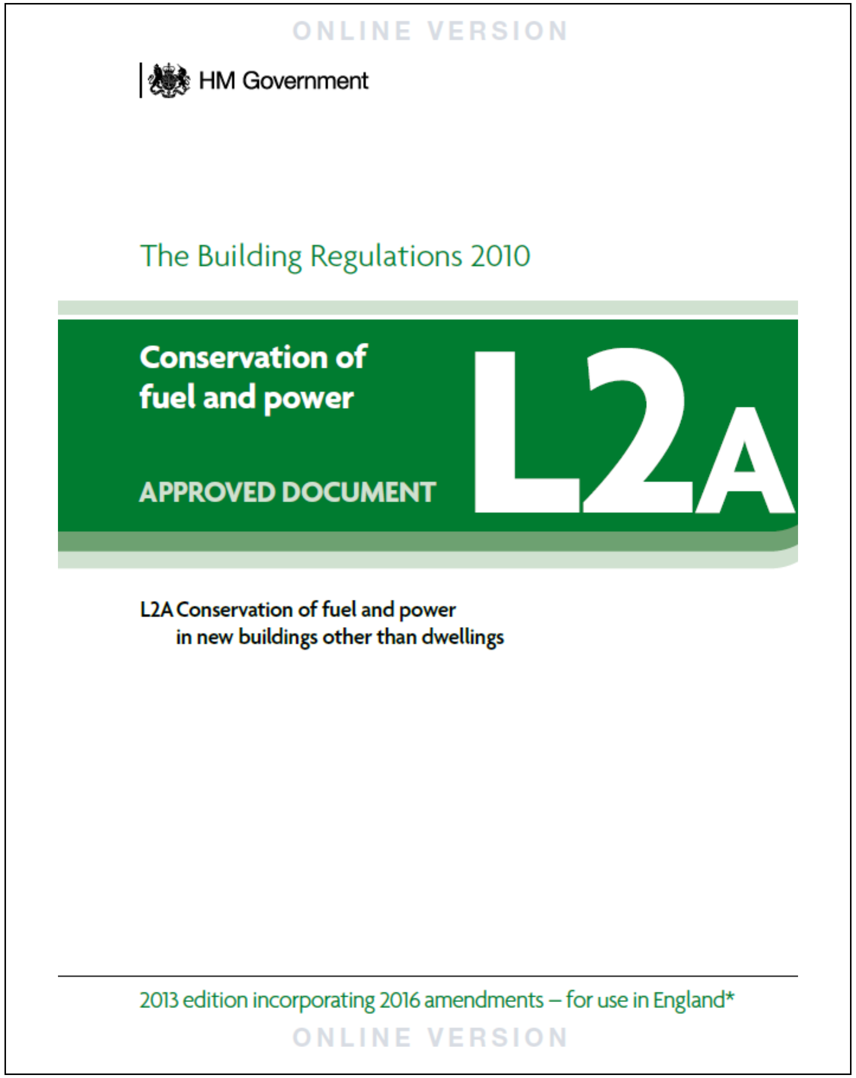
Table 3.1.1: Table comparing the limiting fabric from Part L2A of the building regulations with the proposed Low Energy Design

3.1.3 Air-Tightness of Structure

The energy usage of the building services associated with controlling internal environment are heavily dependent on the air-tightness of the building, which is essentially a measure of how efficient the building envelope is at resisting ingress of air from the external environment. Any ingress of air from the external environment will need to be conditioned by the building services to ensure the internal environment stays at the optimum level of comfort. Accordingly, the reduction in air permeability and thereby external air ingress will reduce the demand upon the building services conditioning the area and proportionally reduce energy usage.

	Limiting Air Permeability $m^3\ hr^{-1}\ m^{-2}$	Low Energy Design Permeability $m^3\ hr^{-1}\ m^{-2}$	Percentage Improvement %
Air Permeability	10.0	3.0	70

Table 3.1.2: Table comparing the limiting air permeability from Part L2A with the proposed Low Energy Design.


ONLINE VERSION

HM Government

The Building Regulations 2010

Conservation of fuel and power

APPROVED DOCUMENT

L2A

L2A Conservation of fuel and power in new buildings other than dwellings

2013 edition incorporating 2016 amendments – for use in England*

ONLINE VERSION

3.1.4 Natural Ventilation

The proposed accommodation development on Stephenson Way in Euston has been designed to use passive natural ventilation to improve Indoor Air Quality IAQ by providing 'fresh' air to occupants.

The openable panel provided for purposes of natural ventilation has been sized to exceed what is required in Building Regulations Part F. The minimum allowed by building regulations is 1/20th (5%) of the floor area of the space. However, the openable panel proposed will exceed this allowing for greater air flow and more flexibility in managing IAQ and internal summer temperatures.

The natural ventilation of the space will ensure the IAQ and summer temperatures are managed passively. The bathroom spaces also have trickle ventilation and a decentralised mechanical ventilation dMEV system which is designed to provide fresh air to the space and ensure occupant comfort throughout the year. The flow rate and SFP of the ventilation system has been selected to minimise energy usage and provide 'background' ventilation to ensure occupant comfort.

	Limiting Specific Fan Power SFP W l^{-1} s^{-1}	Low Energy Design SFP W l^{-1} s^{-1}	Percentage Improvement %
Specific Fan Power SFP	0.5	0.25	50

Table 3.1.3 Table comparing the limiting specific fan power with the proposed Low Energy Design

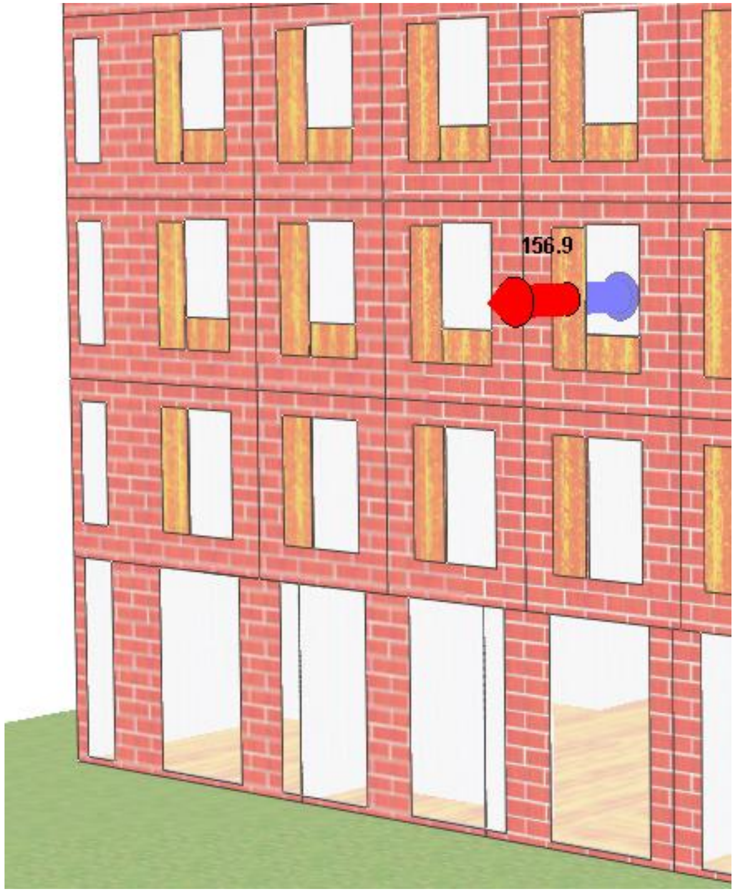


Figure 3.1.3 Figure to show the inlet and outlet flow of naural ventlation for a bedroom

3.2.2 Low Energy Lighting & Control

The energy required to illuminate the spaces of the development can be minimised by using low energy LED light fittings that minimise the energy and carbon emission used in artificial lighting. The artificial lighting has also been designed to incorporate lighting controls which will ensure that no electricity used for artificial lighting is wasted. This will ensure that carbon emissions are not created unnecessarily and that the building is a sustainable development.

The lighting controls

- Bedroom bathrooms – auto on/off control
- Corridor – auto on/off control
- Stairs – auto on/off control
- Laundry – auto on/off control
- Public Toilet – auto on/off control

	Limiting Lumens per Circuit Watt $Lm.W^{-1}$	Low Energy Deign Value $Lm.W^{-1}$	Percentage Improvement %
Lighting Efficiency	60	110	83

Table 3.2.2 Table comparing the limiting lighting efficiency with the proposed Low Energy Design Value

4.0 Overheating Risk Analysis

The potential for over overheating is generally increasing in modern buildings because of a contribution of rising ambient temperatures due to anthropogenic climate change and increased building envelope performance. Accordingly, each new development should be assessed for overheating risk.

The proposed development on Stephenson Way in Euston has been modelled using building physics simulation software IES VE. This is a separate simulation model created specifically for assessing overheating risk. The simulation model shows overheating risk can be mitigated through the application of Passive and Active Measures as detailed below.

Building Fabric Measures

- Low external element u-values preventing excessive heat conduction through the fabric in high ambient temperatures
- Low window g-value of 0.4 which will prevent excessive solar gains

Passive Measures

- Natural ventilation via openable insulated panels
- Internal blinds applied to glazing to minimise solar gains
- Glazing to have fixed panes and insulated openable panels as separate sections, to ensure the blinds do not prevent air movement
- Low internal gains via specification of low energy small power equipment

Active Measures

- The bedrooms have been designed with trickle ventilation and decentralised mechanical ventilation system dMEV to remove excessive internal gains during periods of high ambient temperature.

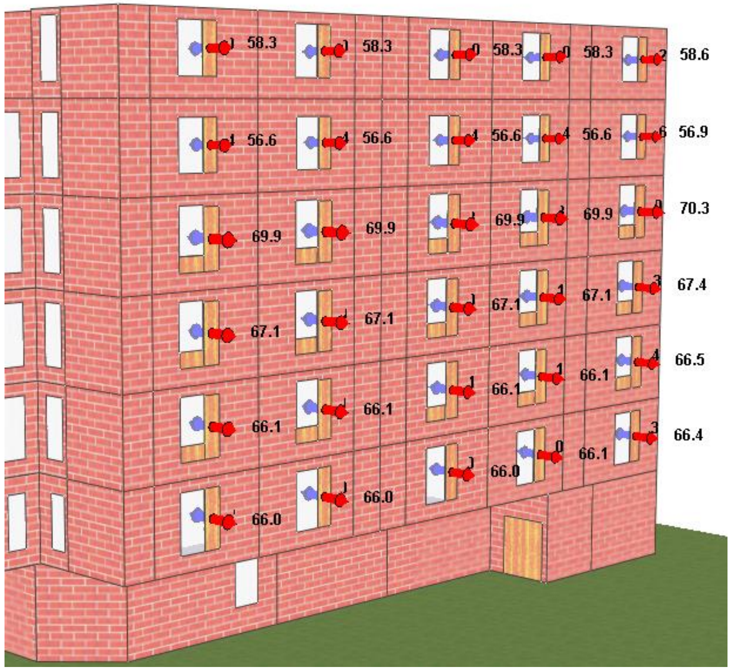


Figure 4.1 to show the air flow rates due to the natural ventilation of bedrooms

4.1 CIBSE TM52 Calculations

The proposed development is required to comply with CIBSE TM52 overheating calculations to determine overheating risk in naturally ventilated buildings. CIBSE TM52 assesses overheating risk using three parameters (as per the below). The building will be assessed using CIBSE DSY for London weather files and Category II normal expectation including people, equipment and lighting gains.

	TM52 Calculation Requirement
Criterion 1 (C1)	The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1 K or more during the occupied hours of a typical non-heating season (1st May to 30th September).
Criterion 2 (C2)	The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration. This criterion sets a daily limit for acceptability.
Criterion 3 (C3)	The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.

The results of the TM52 calculations show that all 78 rooms in the development pass the overheating risk test. The worst-case rooms are given in the table below, these results show that the worst-case rooms all pass the TM52 calculation therefore qualifying the overheating risk.

Room Ref	C1	C2	C3	Result
5F Threedio 01 TH05	1.1	21	3	Pass
5F Threedio 02 TH05	1.5	23	3	Pass
5F Threedio 03 TH05	1.4	23	3	Pass
5F Microstudio MS01	0.9	19	3	Pass
5F Microstudio MS02	0.8	15	3	Pass
5F Microstudio MS03	0.8	17	3	Pass
5F Microstudio MS04	1	19	3	Pass
5F Microstudio MS05	0.8	18	3	Pass
5F Microstudio MS06	0.8	17	3	Pass
5F Microstudio MS07	0.9	20	3	Pass
5F Microstudio MS08	0.8	20	3	Pass
5F Microstudio MS09	0.8	20	3	Pass
5F Microstudio MS10	0.8	20	3	Pass
5F Studio UA DS05	0.7	14	2	Pass
6F Microstudio MS01	0.7	17	3	Pass
6F Microstudio MS02	0.8	20	3	Pass
6F Microstudio MS03	0.8	20	3	Pass
6F Microstudio MS04	0.8	20	3	Pass
6F Microstudio MS05	0.8	20	3	Pass
6F Studio MS01	0.7	15	3	Pass

5.0 Be Clean: Analysis of Decentralised Energy

The London Plan details the Mayor's expectation that 25% of the future heat and power will be provided by decentralised systems by 2025. Decentralising the energy supply will improve the robustness of the power to the city by placing less reliance on the grid. As the carbon factor of grid electricity decreases an increased demand will be placed on the grid for low carbon electricity. This could potentially cause issues with supply and as such the Mayors expectation is designed to future proof the City's supply.

5.1 Heat Distribution Network

The proposed student accommodation development will have an energy demand for hot water services throughout the year. This consistent requirement for thermal energy for hot water services could be supplied by a heat network. The Figure 5.1 is taken from The London Heat Map which details potential heat networks around the city. The London Heat Map does identify a potential network 'Euston Road' running from St Pancreas down past Euston station along Euston Road.

Given that there is potential for a district heating network in the area the proposed accommodation development on Stephenson Way in Euston will provide provision for a future connection, this will enable the space heating and hot water services to be connected to a future heat network.

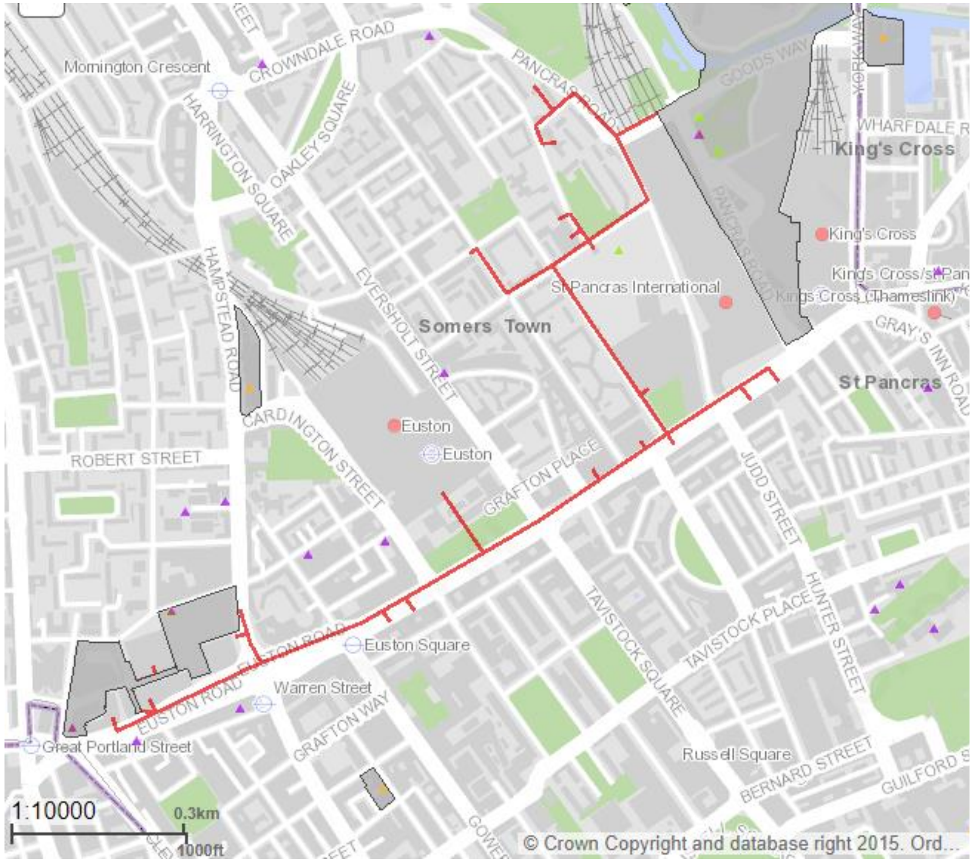


Figure 5.1 to show the proposed heat networks in the area

5.2 Existing Heat Network

The proposed development is in a prime central location in London City Centre near Euston Road however when looking at the London Heat Map no current existing heat networks are operating in the area.

The nearest heat networks to the site are the Citigen network operated by EON which is a significant distance from the site, however EON have been contacted to confirm the feasibility of a connection to the Citigen network.

The financial viability of a connection to the network is directly related to the distance the heat pipes must run on order to provide the proposed development with thermal energy generated by the centralised plant. The heat network to the South is the Existing Whitehall network which is currently 3 km from the proposed development on Stephenson Way in Euston. This would require an investment of £1.0M to £1.5M which will not be finically viable for the District Energy Network Operator.

Similarly, the connection to the Citigen network is approximately 4 km distance from the proposed development on Stephenson Way. The Citigen network would need an investment of 1.5M to 2.0M to supply the proposed development which is again unfortunately not financially viable for this project.

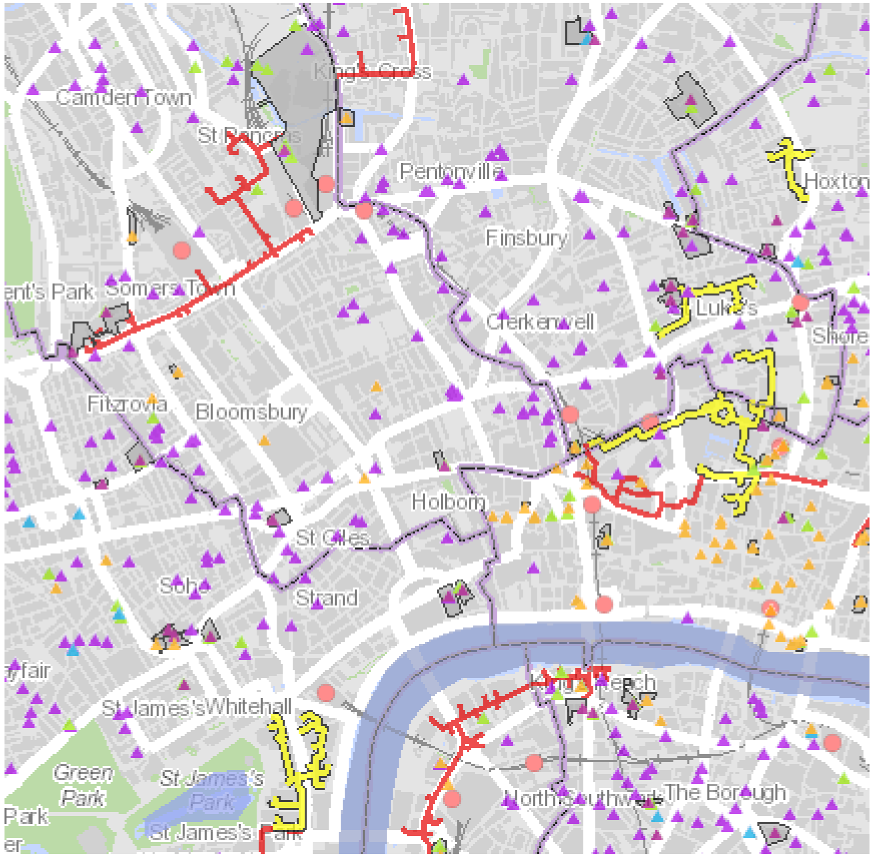
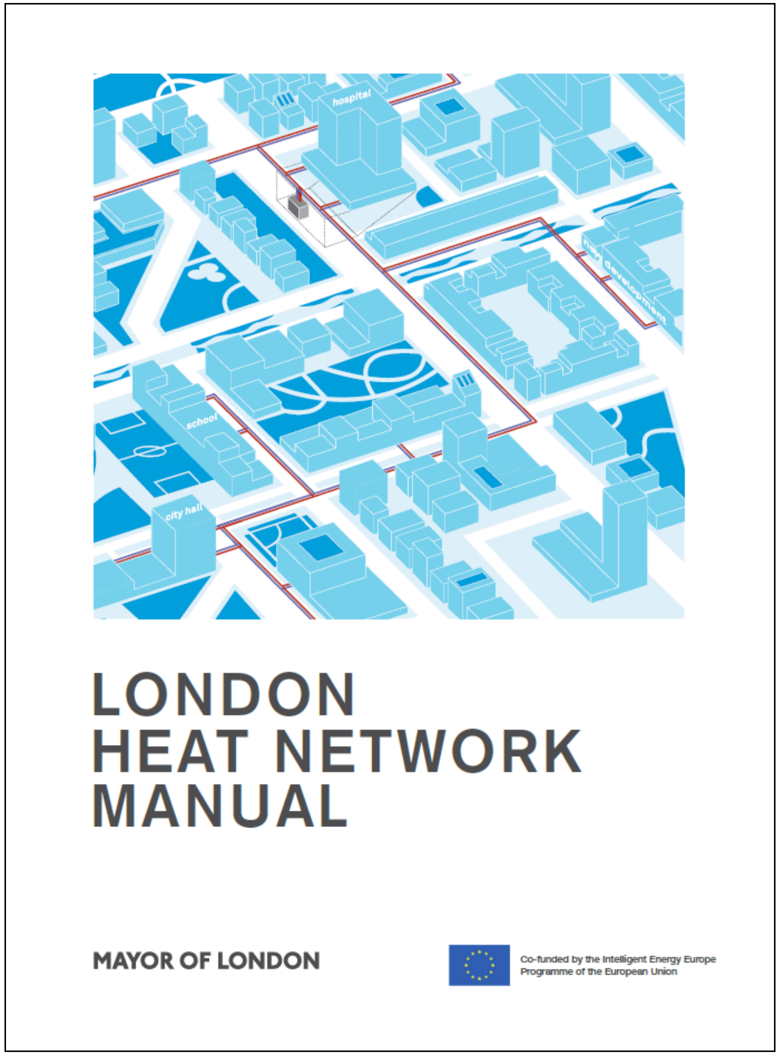


Figure 5.2 tob show the location of the existing heat netwroks in the area

5.3 Future Heat Network

The proposed development will facilitate future connection to a heat network by incorporating architectural and building services strategy design improvements. The design improvements will minimise the impact of a future heat network connection works required in the existing building, thereby making the switch to a district heating network less costly and less disruptive.

- The trigger for a new district heating network will be when one is available in the local area.
- The future heat network will supply heating energy to the development via district heating mains pipes. These pipes will need to be brought into the existing plant room and utilising connection points installed as part of initial design, the new plate heat exchanger will enable the space heating and HWS to be provided via the district heating network.
- Isolation valves will be designed into the space heating and HWS to enable future connection to a DH network.
- The future routes of the heat network mains will be brought in to the development will be safeguarded. This will ensure that when a heat network is available that the works required to install the heat network do not clash with the existing development.
- The London Heat Network Manual will be used as a design guide at Stage 4 to facilitate the future connection to a heat network.



6.0 Be Clean: Analysis of Renewable Technology

6.1 Analysis of Available Renewable Technology

The available renewable technology which will be considered for the proposed accommodation development on Stephenson Way in Euston is detailed in the table below, along with potential benefits and any foreseeable issues. The table is provided to give a visual overview of the appropriate renewable technology and hence determine suitable renewable technology.

Technology Type	Description of Technology	Potential Benefits	Potential Issues	Valid for Application
PV Panels (Photovoltaic)	Photovoltaic solar arrays use solar radiation to create electricity, using a similar process to photosynthesis. Electrons are freed from atoms and the subsequent flow of electrons results in electric current.	Zero carbon emissions, 100% renewable technology Additional income due to government incentives Relatively maintenance free as no moving parts Visual impact can be low as can be placed out of sight. Noise free operation	Panels should face south and have sufficient angle to maximise capture Shadowing and detritus can lower performance over time Structure must be able to accommodate the weight of the panels. Required maintenance for cleaning panels	Yes (valid and recommended)

Technology Type	Description of Technology	Potential Benefits	Potential Issues	Valid for Application
Solar Thermal (Solar water heating)	Soar thermal installations use solar radiation to heat water. Evacuated tubes are installed in an area of maximum solar radiation. The heat is then transferred to the water and the heated water is then used to supplement the hot water requirement of the building.	Zero carbon emissions, 100% renewable technology Additional income due to government RHI scheme Relatively low maintenance as few moving parts Visual impact can be low as can be placed out of sight. Noise free operation	Tubes should face south and have sufficient angle to maximise capture Shadowing can affect energy generation performance The structure of the building must be able to accommodate the weight of the filled tubes. More benefit seen during the summer months	Yes (valid but not recommended due to area required to achieve required carbon reduction)

Technology Type	Description of Technology	Potential Benefits	Potential Issues	Valid for Application
Air Source Heat Pump ASHP (Space Heating)	Air source heat pumps transfer low grade thermal energy in the atmosphere for use in heating spaces or water heating.	RHI available for each kWh of energy generated Efficient operation utilising the low grade heat in the atmosphere. Proven and reliable technology	Potential for leak of refrigerant with high GWP relative to CO2 Specialist maintained due to refrigerant handling laws External condenser fans create noise.	Yes (valid and recommended)
Ground Source Heat Pump GSHP	Ground source heat pumps use the Earth as a heat sink and transfer low grade thermal energy from the ground for use in the building. This energy can then be used for space heating/cooling or water heating.	Additional income generated due to RHI government incentives Efficient operation utilising low grade heat in the ground Noise free operation	Not 100% renewable as electricity creates carbon emissions Ground survey required to determine feasibility of installation. Carbon emissions due to electricity as fuel	No (not valid for this site)

Technology Type	Description of Technology	Potential Benefits	Potential Issues	Valid for Application
Air Source Heat Pump ASHP (Hot Water Heating)	Air source heat pumps transfer low grade thermal energy in the atmosphere for use in heating spaces or water heating.	RHI available for each kWh of energy generated Efficient operation utilising the low grade heat in the atmosphere. Proven and reliable technology	Potential for leak of refrigerant with high GWP relative to CO2 Specialist maintained due to refrigerant handling laws External condenser fans create noise.	Yes (valid and recommended)
CHP (Cogeneration)	A cogeneration plant is a combustion engine using natural gas or biogas fuel to drive an alternator which produces electricity. The combustion process is cooled using water as a refrigerant. This low-grade heat can then be transferred for use in building services.	Income generated by RHI (if served by renewable gas) Efficient generation of energy, minimising losses. Potential to export Electricity	Need to have sufficient heat and electrical load Needs to operate for a majority percentage of the year	Yes (valid but not recommended due to NOx emissions and effect on air quality)

Table 6.1 Detailing the Low and Zero carbon technology options available for the proposed development on Stephenson Way in Euston.

7.0 Carbon Emissions Reductions Energy

7.1 Low Energy Building Design and Energy Hierarchy

The Low Energy Building Design building and services design process uses the design principles outlined in Section 1.1 to ensure the energy use of the proposed development is as low as possible and that where energy is used, as little as possible is wasted. The design concepts used in the Low Energy Building Design has taken elements of the Passivhaus fabric first approach to the building design process. This approach significantly lowers the energy demand before the building services are considered in the design process. Once the energy use of the building is sufficiently minimised, low energy building services and LZC technology are then utilised in the design. This ensures the carbon targets can be met and that energy needed to provide services and control the building internal environment is minimised.

The energy strategy has shown passive and active carbon reduction measures as part of the Low Energy Building Design. The carbon reductions for these measures will now be illustrated using the Energy Hierarchy. This is a carbon reduction methodology consisting of three main stages: Be Lean, Be Clean, Be Green.

Be Lean

The first stage in the energy hierarchy is 'Be Lean' which includes demand reduction measures designed to reduce energy usage passively.

Be Clean

The second stage in the energy hierarchy is 'Be Clean' assessment of clean energy sources district heating and CHP.

Be Green

The third and final stage is the application of renewable energy technologies.

7.2 Establishing Baseline Emissions

The baseline carbon emissions are determined by assessing the proposed development against the building regulations Part L compliance software. The regulated carbon emissions for this project have been calculated using Part L compliance software IES VE 2018 VE Compliance DSM.

This software uses the design information for the proposed development to create a notional 'target building' development. The carbon emissions for the notional building are then compared with the actual building's carbon emissions. Accordingly, a compliant development is then deemed to be one which the actual emissions BER is less than or equal to the notional 'target building' carbon emissions TER.

The regulated carbon emissions are calculated for Part L compliance while unregulated carbon emissions for small power items like laptops, televisions and chargers are not currently assessed for Part L building regulations compliance.

The baseline carbon emissions are qualified by multiplying the TER generated using Part L compliance software and the floor area of the development. The TER has been calculated using a notional baseline development which includes heating provided by gas boilers. This will provide the baseline metric, for which all additional carbon emissions reductions are calculated against.

The proposed baseline carbon emissions

The baseline carbon emission are 90.4 tonnes per annum

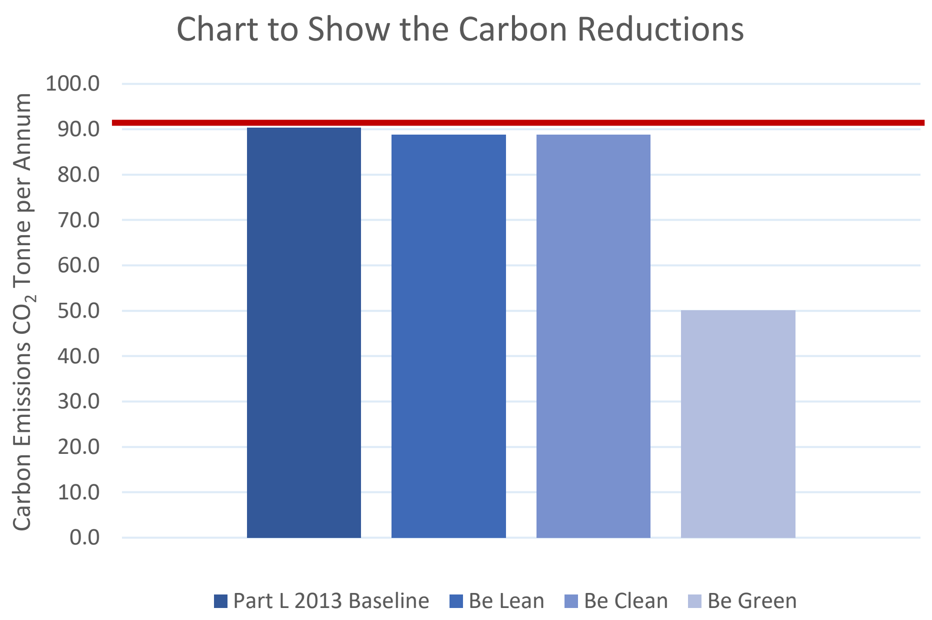


Chart to show the baseline carbon emissions of the proposed development

The red line shows the baseline building carbon emissions TER

7.3 Be Lean

The carbon emissions baseline has been calculated as detailed in Section 7.2. The Demand reduction phase of the energy hierarchy now uses the measures discussed in Section 3.0 to illustrate the passive measures which have enabled the development to reduce carbon emissions.
The passive measures used in the proposed development are designed to reduce energy demand without using fuel in the process.

The Passive Measures included in the development design are summarised below

- Low external element u-values with green roof
- Low air permeability
- Natural Ventilation
- Low energy LED lighting with lighting controls
- Metering & BMS with auto monitoring and targeting of energy for post-occupancy evaluation POE
- Low energy bathroom ventilation system dMEV with trickle ventilation

The carbon reductions due to the Be Lean measures

The Be Lean measures achieve a carbon reduction of 2%

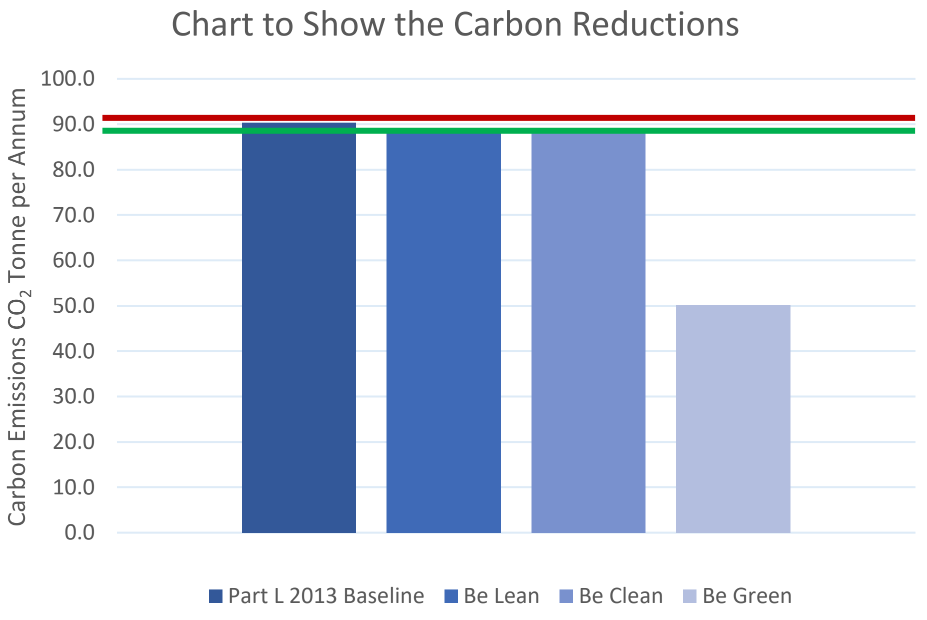


Chart to show the Be Lean carbon emissions reductions of the proposed development

The red line shows the baseline building carbon emissions TER

The green line shows the actual building carbon emissions BER

7.4 Be Clean

The analysis presented in Section 5.0 detailed the availability of heat networks which are currently in the vicinity of the proposed development on Stephenson Way in Euston. In addition, the details of potential heat networks were discussed and given that the development will be in an area which is likely to have a heat network in the future, provision will be made in the building services design to allow a connection to the network in the future. This building services design strategy will allow space heating and hot water services to be provided by a district heating network in the future.

The feasibility of utilising CHP for providing the hot water services in the proposed development has been assessed at part of the preliminary building services design. However, this option for reducing carbon emissions was not deemed to be the most appropriate method of meeting the carbon reduction targets, due to the adverse effect on NOx emissions and hence air quality in the area.

The application of a district heating network will have no effect on local air quality and such, the space heating and hot water services design will enable provision for a connection to a district heat network in the future. This will allow the dominant energy demands of the building both the space heating and hot water services to be provided by a district heating network once one is available in the local area.

The carbon reductions due to the Be Clean measures

The Be Clean carbon emissions are constant at 2% reduction

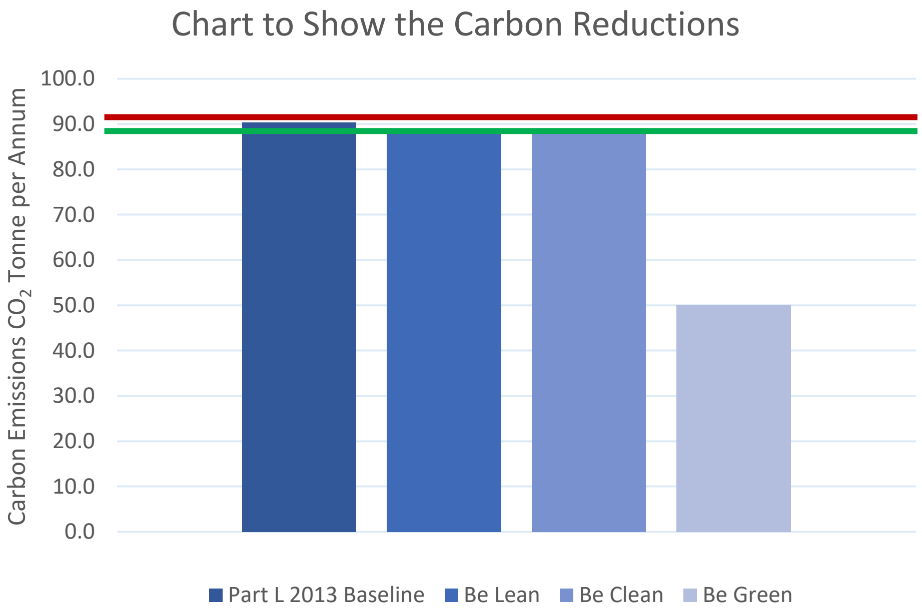


Chart to show the Be Clean carbon emissions reductions of the proposed development

The red line shows the baseline building carbon emissions TER

The green line shows the actual building carbon emissions BER

7.5 Be Green

The final stage of the energy hierarchy utilises renewable technology to further lower the carbon emissions of the development. Given that the measures in the Be Clean stage are unfeasible or would have an adverse effect on the air quality in the area, the carbon emissions reductions have been achieved using measures detailed as part of the Be Green stage of the energy hierarchy.

The building services design for the proposed development on Stephenson Way in Euston enables a significant reduction in carbon emissions by utilising solar PV and Heat pumps for HWS and space heating.

A CO_2 refrigeration cycle air source heat pump ASHP to provide 100% of the hot water services, this enables an SCOP of 4.4 using bin weather data for London.

The HWS ASHP uses 10,216 kWh of electricity to provide 44,950 kWh of energy

The heating ASHP uses 9,952 kWh of electricity to provide 32,843 kWh of energy

The seasonal efficiency of the heat pumps illustrate that these are the lowest carbon method of heating space/HWS this is exemplified by using current carbon factors. The development has also been designed to utilise renewable zero carbon electric for the ASHP by on site solar PV electricity generation. The development will incorporate 9.75 kW of solar PV to generate electricity which will power the ASHPs providing renewable and zero carbon space heating and hot water services. The carbon saved from solar PV is 0.519 $kgCO_2.kWh^{-1}$ * 9,786 kWh = 5,079 kg of CO_2.

The Be Green stage of the Energy Hierarchy enable the development to meet the carbon reduction targets and as such provides a low carbon development.

The carbon reductions due to the Be Green measures

The Be Green measures achieve a carbon reduction of 43%

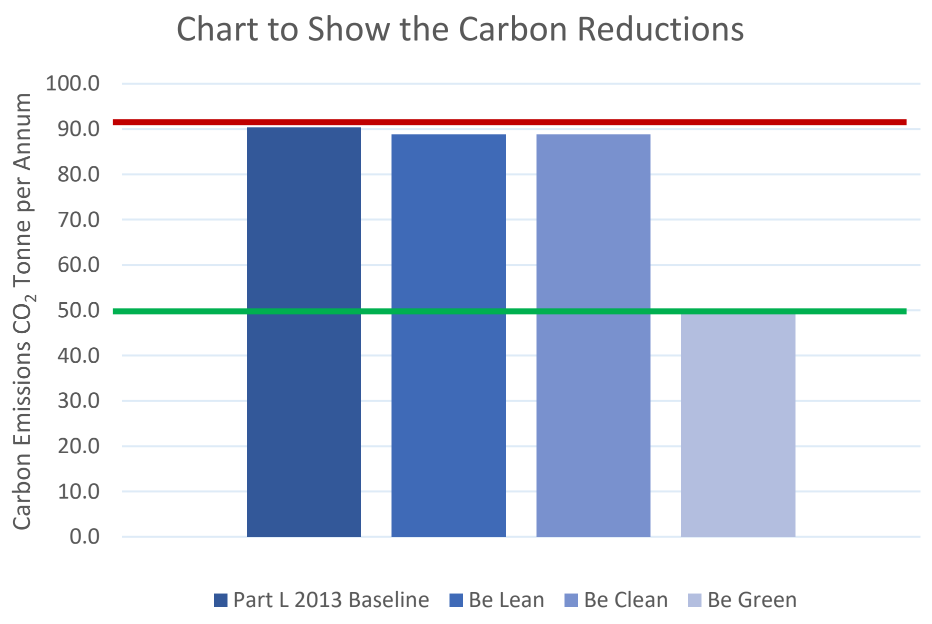


Chart to show the Be Green carbon emissions reductions of the proposed development

The red line shows the baseline building carbon emissions TER

The green line shows the actual building carbon emissions BER

7.6 Overall Carbon Reductions

Carbon Dioxide Emissions Per Annum for non-domestic Buildings

	Regulated CO_2 Tonnes CO_2 per annum	Unregulated CO_2 Tonnes CO_2 per annum
Baseline Part L (2013)	90.4	51.9
Including Be Lean Measures	88.8	51.9
Including Be Clean Measures	88.8	51.9
Including Be Green Measures	50.1	51.9

Figure 7.6.1 to show the carbon emissions of the proposed development

Regulated Carbon Dioxide Savings Per Annum for non-domestic Buildings

	Tonnes CO_2 Per annum	Percentage Reduction %
Savings from Be Lean Measures	1.5	1.7%
Savings from Be Clean Measures	0.0	0.0
Savings from Be Green Measures	38.7	43.6%
Reduction Compared to Baseline	40.3	44.6%
Annual Deficit / Contribution £	0.0	£0

Figure 7.6.2 to show the carbon emissions reductions of the proposed development

8.0 Conclusion

The proposed development on Stephenson Way in Euston has followed the GLA's energy hierarchy to qualify the carbon emissions reduction targets have been met. This process has involved calculation of carbon emissions at each stage of the hierarchy using IES VE Compliance DSM.

The First Stage Be Lean of the energy hierarchy incorporates the below measures

- Low external element u-values with green roof
- Low air permeability
- Natural Ventilation to bedrooms
- Low energy LED lighting with lighting controls
- Low energy bathroom ventilation system dMEV with trickle ventilation

The Be Lean measures facilitate a carbon reduction of 2%

The Second stage is detailed in Section 7.4 allowing provision for future connection to a heat network to provide space heating and hot water services.

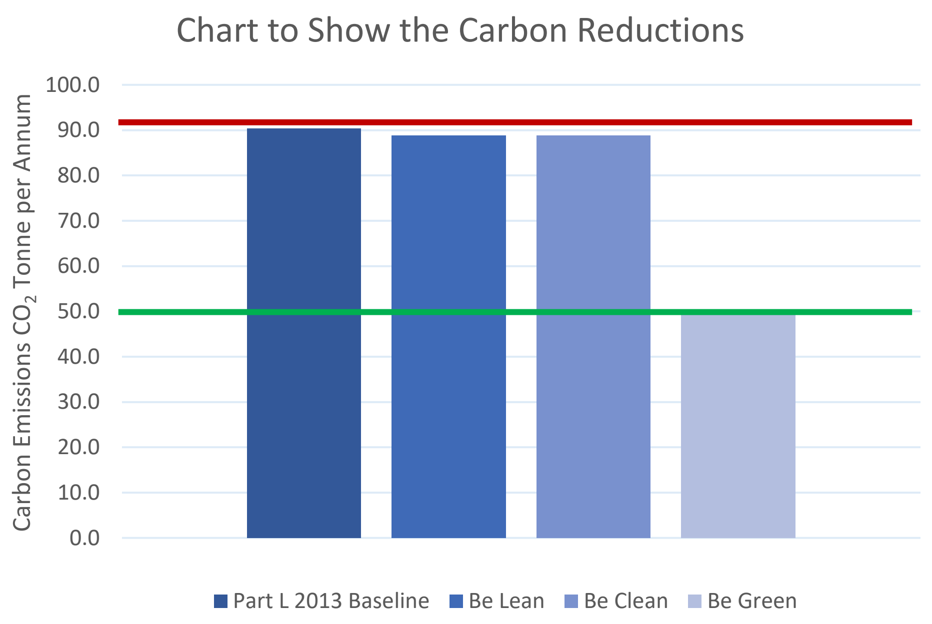
Third Stage of the energy hierarchy includes

- Air Source Heat Pump ASHP hot water services HWS
- Solar PV on site renewable electricity generation 9.75 kW

The Be Green measures facilitate a carbon reduction of 43%

This Energy Strategy therefore confirms that the overall development's carbon emissions will be reduced 44% below the Part L 2013 baseline.

The energy hierarchy carbon reduction methodology has minimised energy usage and carbon emissions of the development on Stephenson Way in Euston to provide a sustainable low energy building. (it should be noted that the carbon reduction will increase to 71% when assessed using SAP 10 carbon factors as per the Draft London Plan which better reflect realistic carbon emissions of electricity)



Appendix

Appendix 1 Part L brukl report 2013 Baseline

Appendix 2 Part L brukl report Be Green

Appendix 3 Carbon Emissions Reductions Using SAP10 Carbon Factors

Appendix 4 Details of Solar PV

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Stephenson Way Euston

As designed

Date: Fri Feb 22 13:40:35 2019

Administrative information

Building Details

Address: Stephenson Way, Euston, NW1 2HX

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.10

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.10

BRUKL compliance check version: v5.4.b.0

Owner Details

Name: Churchgate

Telephone number:

Address: , ,

Certifier details

Name: Nikolas Sotnyk

Telephone number: 01274 687755

Address: Century House, 257 Cutler Heights Lane, Bradford, BD4 9JG

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	41.3
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	41.3
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	40.6
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.19	0.29	RM00000B:Surf[0]
Floor	0.25	0.15	0.15	RM000000:Surf[0]
Roof	0.25	0.1	0.1	RM000004:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.6	1.6	RM000006:Surf[1]
Personnel doors	2.2	2.2	2.2	RM000003:Surf[1]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	2188.3	2188.3
External area [m^2]	2432.6	2432.6
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	757.45	1507
Average U-value [W/m^2K]	0.31	0.62
Alpha value* [%]	10	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
100	**C2 Residential Institutions: Universities and colleges**
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	47.63	66.01
Cooling	0	0
Auxiliary	3.35	1.87
Lighting	10.35	13.32
Hot water	108.33	89.69
Equipment*	23.73	23.73
TOTAL**	**169.65**	**170.89**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	146.55	204.88
Primary energy* [kWh/m^2]	231.27	235.43
Total emissions [kg/m^2]	40.6	41.3

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

BRUKL Output Document

Compliance with England Building Regulations Part L 2013

Project name

Stephenson Way Euston

As designed

Date: Thu Feb 21 10:36:07 2019

Administrative information

Building Details

Address: Stephenson Way, Euston, NW1 2HX

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.10

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.10

BRUKL compliance check version: v5.4.b.0

Owner Details

Name: Churchgate

Telephone number:

Address: , ,

Certifier details

Name: Nikolas Sotnyk

Telephone number: 01274 687755

Address: Century House, 257 Cutler Heights Lane, Bradford, BD4 9JG

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	34.6
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	34.6
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	22.9
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.19	0.29	RM00000B:Surf[0]
Floor	0.25	0.15	0.15	RM000000:Surf[0]
Roof	0.25	0.1	0.1	RM000004:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.6	1.6	RM000006:Surf[1]
Personnel doors	2.2	2.2	2.2	RM000003:Surf[1]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	2188.3	2188.3
External area [m²]	2432.6	2432.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	757.45	1507
Average U-value [W/m²K]	0.31	0.62
Alpha value* [%]	10	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
100	**C2 Residential Institutions: Universities and colleges**
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	15.01	24.28
Cooling	0	0
Auxiliary	3.35	1.75
Lighting	10.35	13.32
Hot water	20.54	30.23
Equipment*	23.73	23.73
TOTAL**	**49.25**	**69.57**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	3.81	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	146.55	204.88
Primary energy* [kWh/m²]	247.72	356.45
Total emissions [kg/m²]	22.9	34.6

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

NON-DOMESTIC

Table 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 Development	91	52
After energy demand reduction	89	52
After heat network / CHP	89	52
After renewable energy	52	52

Table 4: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

	Regulated non-domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	2	2%
Savings from heat network / CHP	0	0%
Savings from renewable energy	38	41%
Total Cumulative Savings	**39**	**43%**

Table 5: Shortfall in regulated carbon dioxide savings

	Annual Shortfall (Tonnes CO_2)	Cumulative Shortfall (Tonnes CO_2)
Total Target Savings	**32**	-
Shortfall	-7	-223
Cash in-lieu contribution (£)	**-13,403**	-

Table 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 Development	79	52
After energy demand reduction	79	52
After heat network / CHP	79	52
After renewable energy	23	52

Table 4: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

	Regulated non-domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	1	1%
Savings from heat network / CHP	0	0%
Savings from renewable energy	55	70%
Total Cumulative Savings	**56**	**71%**

Table 5: Shortfall in regulated carbon dioxide savings

	Annual Shortfall (Tonnes CO_2)	Cumulative Shortfall (Tonnes CO_2)
Total Target Savings	28	-
Shortfall	-28	-851
Cash in-lieu contribution (£)	**-51,078**	-

solaredge

Project:

Stephenson Way London

Thursday, November 15, 2018 9:24 AM

Location:

London, United Kingdom

System data:

Installed power: 9.75 kWp

Max achieved DC power: 9.58 kW

Inverter active power: 9.00 kW

Maximum apparent power: 9.00 kVA

PV Array # 1: PV Array # 1

Tilt	Azimuth
15°	149°
Q-Cells, Q Plus 325 W, 325.00 W	

Inverter design

Inverter 1: SE9k

String 1: PV Array # 1: 30 x P370

Power optimizer extreme operating conditions

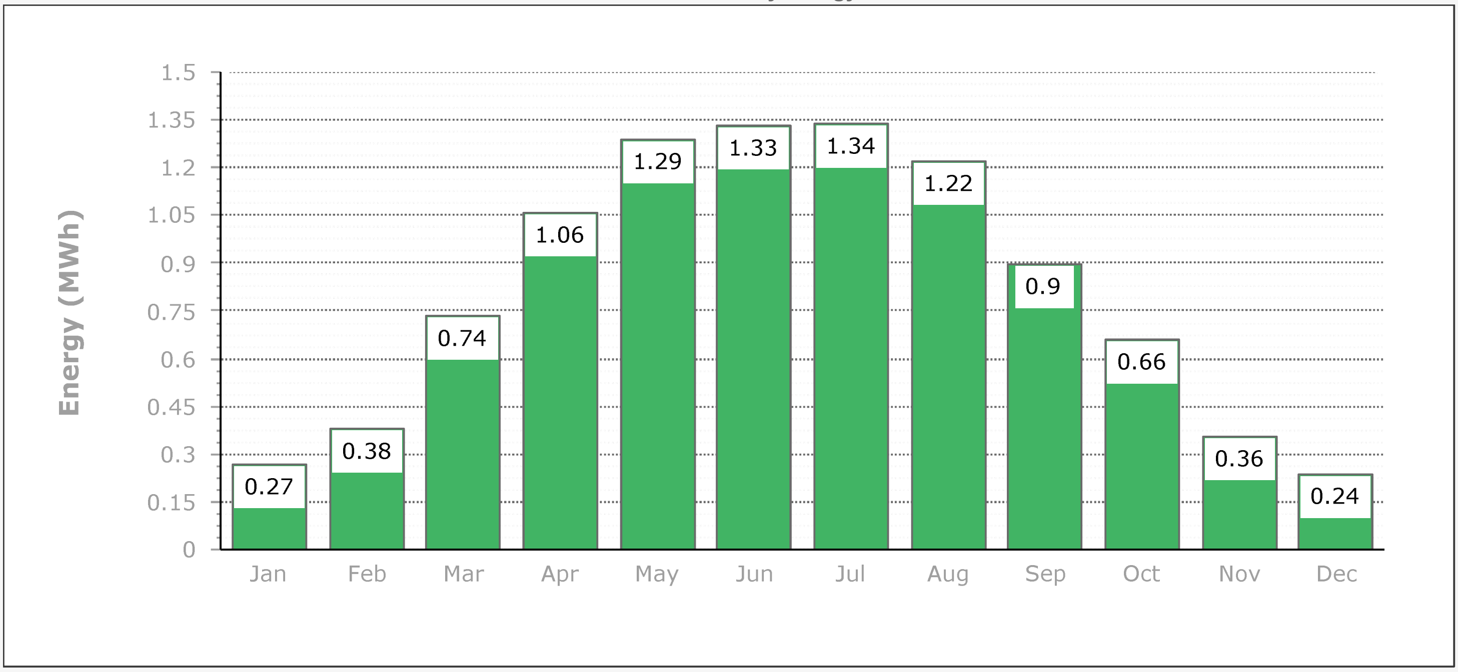
P370

	Calculated	Limit	
Max input power	325 W	370 W	✔
Min input voltage	39 V	8 V	✔
Max input voltage	52 V	60 V	✔
Max input current	10 A	11 A	✔
Max output current	13 A	15 A	✔

* Calculated values are the absolute min/max of all arrays using this power optimizer configuration.

Energy estimation

Estimated monthly energy



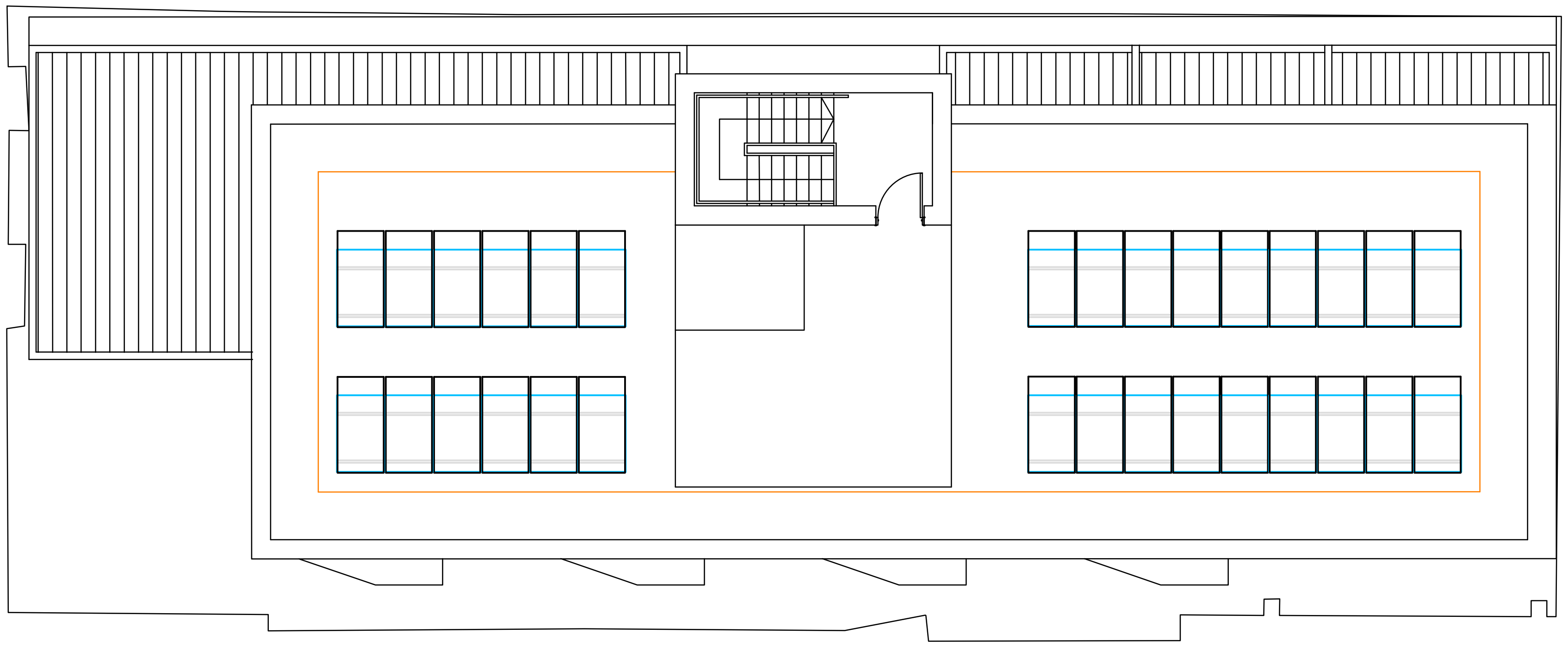
Estimated yearly energy: 9.786 MWh

Energy yields are an approximation; they are not guaranteed by SolarEdge.

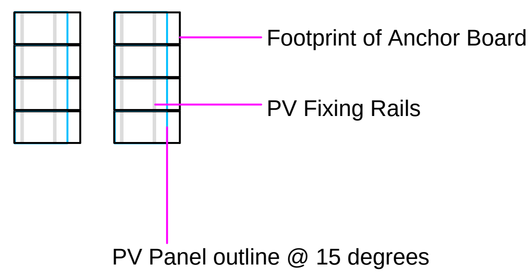
Bill of Materials

Inverters:	SE9k, quantity: 1
Optimizers:	P370-5RM4MRM, quantity: 30

1	2	3	4	5	6	7	8	9



Bauder Bio Solar - Q Cells module



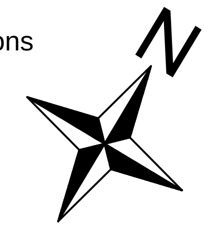
Blue Outline denotes Panel
Black Outline denotes Anchor Board

Design Information

No. Achor Boards:	30
Rail Length Required:	66.00 lm
Type of Inverter:	Solaredge SE9k x1
Type of Optimizer:	P370 x30
Type of Panel:	Monocrystalline
Area of PV Panels:	50.55m2

Wind suction areas (Structural analysis)

- Northern Sections
- East & West Sections
- South Section



General Information

Total power DC	9.75 kWp
BAUDER System type	Bauder Bio Solar
Module type	Q Cells Duo G5 (325wp)
Module amount	30 Units
Azimuth	31 Degrees SE

This Layout is based on the given information. For a more detailed engineering, more information about the roof and nearby objects are necessary.

BAUDER Ltd.
70 Landseer Road
Ipswich, IP3 0DH

BAUDER

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Drawn	14.11.18	Darren Mitchell
Changed	15.11.18	Darren Mitchell
Checked		

Drawing No.: B183967PV - 20181115

Scale:

Client: TP Bennett

Project: Stephenson Way Euston Street, London

Drawing Title: PV Layout Plan
PV Design Layout

Planning Period:

Format: A

Sheet

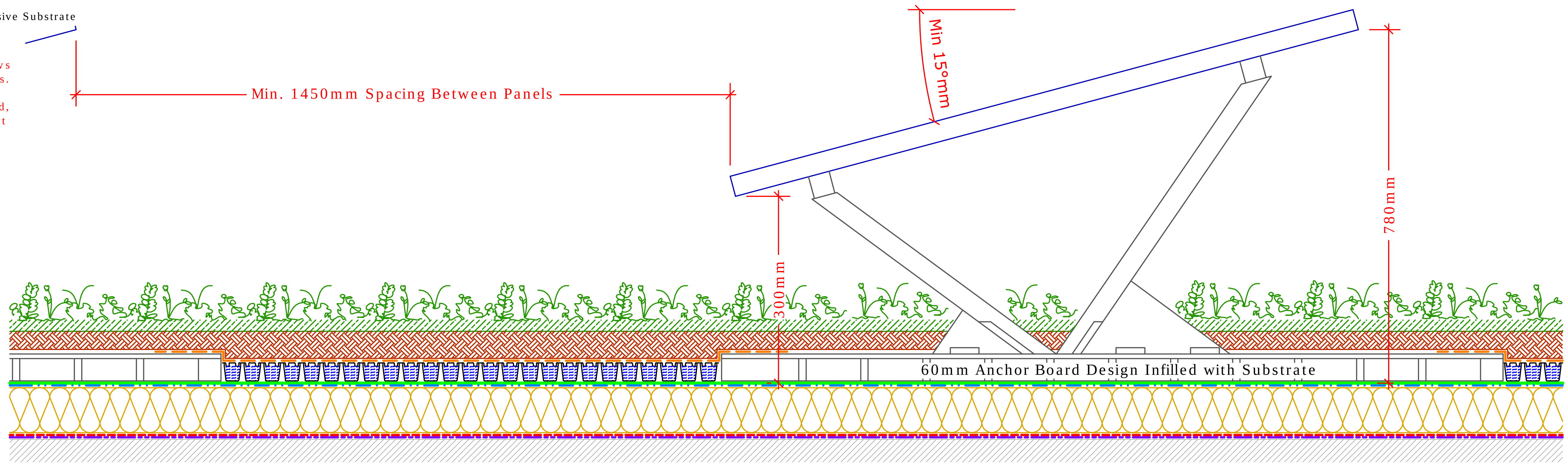
File Name: B183967PV - 20181115.dwg

1	2	3	4	5	6	7	8	9

Key

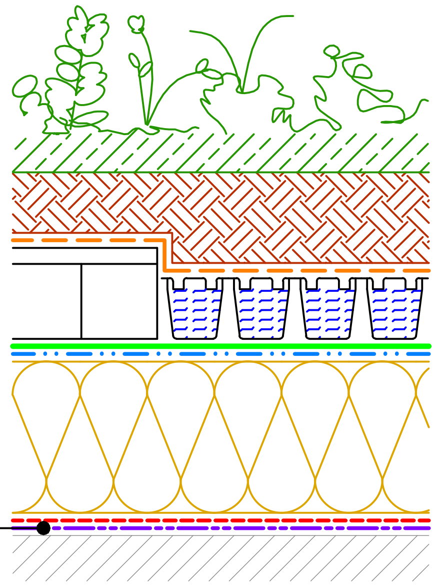
- Bauder Capping Sheet
- Bauder Underlayer
- Bauder Insulation
- Bauder Vapour Control Layer
- Bauder Random Nailed Layer used on TIMBER BOARDED DECKS ONLY
- Bauder Filter Fleece
- Unknown Deck / Substrate
- Extensive Substrate

IMPORTANT NOTE:
This Drawing Shows Alternative Options. For the Correct Solution to be Used, Refer to the Project Specific Specification.

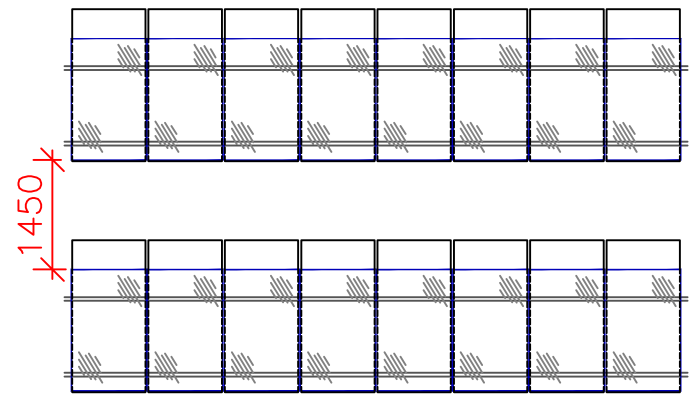


Bauder BioSolar Module Section - Scale 1:10

TIMBER BOARDED DECKS ONLY:
Additional Bauder Random Nailed Layer to be Installed Beneath the Vapour Control Layer on the Horizontal Only



Layer Build Up - Scale 1:5



Grid Arrangement 1:100

PV - BioSolar

IMPORTANT NOTES:
1. This detail is suitable for the following Bauder Systems: Bauder Total Roof System, Bauderflex, Airtech
2. Do not scale to ascertain dimensions.
3. All dimensions are in Millimetres and are to be checked and verified on site prior to commencement of work.
4. This drawing is to be read in conjunction with the specification and associated drawings.
5. This detail is a guideline only, representing typical detailing conditions and illustrate the correct application of the above Bauder System. It may be necessary to modify this detail to suit specific project design constraints and conditions.
6. Refer to the Bauder Specification for the deck type, product description and method of application. For clarity the method of attachment has not been shown.
7. Provision should be made by the installer for mechanically fixing the top leading edge of all upstand details in excess of 250mm in height using appropriate fasteners.

BITUMINOUS STANDARD DETAIL

Scale:	Drawing Number	Issue.
1:5 @ A3	D0100-00W_011-002	01

Drawn By:	Checked By:	Approved By:	Date:
KM	PCH		

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BAUDER FLORA 3 SEED MIX

The Bauder Flora 3 Seed Mix is a blend of seed, tackifier and additives developed to maximise diversity of vegetation on green roofs. Bauder FLora 3 has all the components required to improve the germination and the successful establishment of vegetation for a variety of rooftop conditions: light and shade; exposed and sheltered. The varied mix of species is designed to deliver the British native, biodiverse species required for BREEAM compliance.

Bauder Flora 3 contains a broad range of wildflowers chosen to give an extended flowering season providing nectar and pollen rich habitat for priority pollinators, larval food plants for butterflies and seed sources for birds.

Mix details:

- **UK Native British Provenance Seed Mix** (certification on request)
- **52 Species**
  - 42 Wildflowers of which nine are annuals
  - 8 Grasses/Sedge
  - 2 Sedum species
- **35 of the wildflowers are classed as RHS Perfect for Pollinators**
- 15 Butterfly and moth larval food plants
- Shade tolerant species
- Low growing to medium height
- **Mix percentages; 65% perennial wildflowers, 20% annuals & 15% grasses**

RHS PERFECT FOR POLLINATORS

Ecological Value

This Flora 3 plant mix has a high ecological value providing a long flowering period and nectar sources for a wide variety of pollinators. Plants with long flower tubes such as Wild Red Clover and Vetch species will provide valuable nectar sources for Long-tongued Bumblebee species including the priority species Brown-banded Carder Bee.

Bird's-foot Trefoil and Kidney Vetch make up 20% of the mix, which are important larval food plants for ten butterfly and moth species, including common and small blue priority species. Plant seed heads provide refuge and overwintering sites for invertebrates and our mix includes Black Knapweed and Common Toadflax, which provide valuable seed sources for birds.

The yellow composite flowers such as Rough Hawkbit and Mousear Hawkweed in this mix provide good nectar sources for generalist pollinators including hoverflies and beetles. The mix also contains native and or naturalised sedums that will provide evergreen ground cover in sunny areas and can support specialist invertebrates such as the notable bug species *Chlamydatus evanescens.*

BAUDER FLORA 3 SEED MIX

Establishment and Growth

Typically the mix will produce flowers from April to October starting with species Wild Strawberry and Cowslip, through the summer with Yarrow and Black Knapweed with Lady's Bedstraw flowering later into the autumn. The annuals, biennials and grasses will provide cover and colour in the first season allowing time for the slower growing perennials to establish in later years. The mix has been specified to be drought tolerant with sedum species and low growing perennials. Plants are chosen that do not exceed 40 cm in height to avoid problems with shading of solar panels when the vegetation is used in conjunction with Bauder BioSOLAR. Shade tolerant ground cover plants were specified that will occupy semi-shade microclimates under the panels.

Green roofs are exposed environments subject to wind erosion therefore the mix contains pioneer and ephemeral species such as annuals, biennials and short perennials, which establish quickly from seed and help to stabilise the substrate and prevent wind erosion prior to perennial root systems getting established. A small percentage (typically <15%) of the mix contains non-aggressive grass and sedge species, which will also help to establish and stabilise the substrate.

The seed source is British Provenance (with the exception of sedum species) and suppliers of the mix adopt the Flora Locale Code of Practice for collectors, growers and suppliers of native flora.

flora LOCALE

(Flora locale is an independent charity. Promoting and advancing the conservation and enhancement of native wild plant populations)

Bauder's Unique Additive Mix

Establishing seed at roof level is difficult, to maximise the germination and establishment of the diverse range of seed used, Bauder has developed a unique blend of seed adhesive, organic nutrients and mycorrhizal fungi to encourage water and nutrient uptake by the developing seedlings.

The seed mix and additives are combined with a bulking agent which enable the correct sowing rate to be achieved, the adhesive binds the seed to the substrate preventing it from being blown away in windy conditions or washed deep into the substrate and failing to germinate.

A small quantity of organic slow release fertiliser gives the seed a gentle boost as it establishes. Mycorrhizal fungi increases the root surface area helping the transfer of water and nutrients from the substrate to the developing root system of the plant, enabling the plants to establish quickly.

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SPECIFICATION SUPPORT

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BAUDER

GENERAL MAINTENANCE

PHOTOVOLTAIC SYSTEMS

Bauder BioSOLAR

BioSolar Maintenance Recommendations

The BioSOLAR array should be maintained by trained professionals at fixed intervals (it is recommended that this inspection is carried out annually). The following points should be checked in the process:

- Dirt on the modules: Type and degree of dirt
- Security of the anchoring system including fixings and ballast
- Condition of visible cable connectors
- Establishment of vegetation

Maintaining the solar modules

Module maintenance

Please follow module manufacturer's guidelines for specific maintenance requirements. If you are unsure regarding any aspect of maintenance please contact the Bauder technical office to discuss requirements.

Module cleaning

Please note that cleaning the modules can increase yield. This particularly applies to dirt caused by fallen leaves or bird droppings, which could lead to partial shading. Yield decreases due to snow are negligible since these take place during seasons of lowest yield.

The tilt and self-cleaning glass nature of the solar modules ensures that dust and dirt are generally adequately removed by rain. Snow will also slide off. If the modules should become particularly dirty they should be cleaned using warm water (not exceeding 40°C) and a soft cleaning device.

Upon request we are happy to advise on suitable cleaning agents that we have found to perform exceptionally well against streaking and fingerprints.

Caution!
Never use abrasive cleaners, such as pad brushes when cleaning the modules. When using high pressure washers ensure to keep a minimum distance of 50cm from the surface of the module. Use a cleaning agent with a concentration of no more than 20% glass cleaner.

Maintaining the mounting system

The Biosolar mounting system requires minimal maintenance although a visual inspection should be carried out to ensure the following:

- Bauder extensive substrate has not eroded and correct depth of ballast is in place
- All visible fixings are secure and there has been no movement of mounts/modules
- No vegetation is growing around/through mount fixings

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Maintaining the vegetation - XF118 Wildfower Blanket, Bio-SOLAR seed mix and wildflower plug plants

The following is a guide to the maintenance necessary to keep a biodiverse green roof in good condition. The information relates to installations that have been completed for one full growing season and where establishment maintenance has been effective.

Establishment maintenance relates to the surface watering and weeding required for the first 10-12 weeks after installation is required until the planting has rooted into the growing medium, adapted to its location and can be considered established.

What to Expect from a Bauder Biodiverse Green Roof System

There is a common misconception that extensive green roofs, and sedum plants in particular, are always green and that from ground level they resemble grass. This is misleading, as they consist mainly of low growing, drought tolerant sedums, wild flowers, grasses, moss and herbs. . Where XF118 wildflower blanket is used it is likely to change over time as the planting adapts to the new growing environment.

A variation in type and density of vegetation growth is expected beneath the BioSolar modules due to the shading impact of the panels. Our BioSolar planting mix is chosen specifically to allow the vegetation to adapt and thrive in these varying conditions.

For a complete copy of our Biodiverse green roof maintenance guidelines please visit www.bauder.co.uk/technical-centre

General Vegetation Maintenance

The Bauder biodiversity green roofs meet designed to meet BREEAM requirements will include a species mix selected to provide a balanced plant community on the roof and will require basic maintenance if this is to be sustained in the long term.

Maintenance is best carried out annually, during spring and autumn. Some deposited leaf litter may be considered as contributory to the bio-diverse environment, which is acceptable so long as provision is made to ensure that this has no negative effect on other plants or the PV array.

Note - Specifically designated biodiversity areas should be disturbed as little as possible during maintenance so as not to upset any micro-habitats that may have colonised.

Preliminary Maintenance Procedures

- In the late autumn the vegetation is to be strimmed back to a 50-70mm height and the unwanted waste matter removed and lowered to ground level for composting/disposal. **Care must be taken to ensure that any solar cables are moved out of the way before any strimming/cutting takes place**
- In the spring apply an 80g/m2 dressing of Bauder slow release organic fertiliser to the vegetated surface.

- We recommend removing unwanted leaf litter that has fallen onto the roof surface in the spring and autumn, to ensure that this does not smother the vegetation beneath.
- Open the lids of all inspection chambers and ensure they are free from blockage and water can flow freely.
- Any vegetation which has encroached into drainage outlets, Inspection chambers, walkways and the vegetation barriers (pebbles) should be removed. If movement/settlement of the pebble vegetation barrier has occurred, additional washed stone pebbles similar to the existing should be added.
- Remove any weed growth that will exceed 30mm in height, is invasive or undesirable (if necessary this can be sprayed with a Glyphosate based herbicide). Any vegetation that shades the modules, however thin **will** have an impact on PV output and must be cropped
- Damage to the landscaping should be reported to the building owner.

BAUDER GREEN ROOF MAINTENANCE SERVICE

With over 30 years' experience in the design and supply of green roofs throughout the UK and Ireland Bauder can offer unparalleled experience and expertise in green roof maintenance including sedum, biodiverse and wildflower.

Our Service

Bauder's experienced team will provide you with a tailor-made maintenance programme for your green roof. A typical Bauder Maintenance Programme Includes:

- Full inspection and evaluation of your green roof
- Application of organic slow release granular fertilizer
- Removal of leaves and debris
- Removal of unwanted vegetation
- Inspection and clearance of outlets
- Examination and testing of irrigation

This work is undertaken by Bauder's experienced maintenance engineers who will carry out the necessary risk assessments and comply with all current health and safety legislation throughout the duration of the work. Finally, you will be provided with a bespoke report with photographic verification outlining the condition of the planting and any areas requiring on going treatment.

To discuss your specific requirements, please call our green roof service team for a no obligation quote.

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