Central Somers Town CIP

Energy and Sustainability Statement – Plot 4 Edith Neville Primary School and Children's Centre

DECEMBER 2015

Somers Town Community Investment Programme

Camden

Energy and Sustainability Statement

Edith Neville School and Children's Centre

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1.0 EXECUTIVE SUMMARY

This report is to demonstrate that Edith Neville Primary School is capable of meeting the requirements of the London Plan Policy 5.2 and is to accompany the planning application for the proposed development. Details on the key measures and CO2 reductions achieved in the energy assessment are set out in this report, as well as the wider sustainability considerations of the proposal.

The school's energy performance is aimed at reaching carbon reduction targets for new buildings, in line with the Greater London Authority (GLA) London Plan and Building Regulations (England) 2013 Part L2A. Policy 5.2 of the London Plan states that development proposals are expected to contribute to meeting their target for 2013-2016 by achieving a BER that is 35% below the Building Regulations 2013 TER. Following the energy assessment, the development proved successful in achieving this target using the London Plan Energy Hierarchy;

The first step in the hierarchy required the application of demand reduction measures (Be Lean). Using the passive design strategies and energy efficient services described in Section 6, the building out-performed the baseline notional building by exceeding Building Regulation requirements for CO2 emissions by 8.1%.

The second step in the hierarchy involved the assessment of heating infrastructure in accordance with Policy 5.6B (Be Clean). By connecting to a local district heat network that will incorporate combined heat and power, the development was able to reduce its emissions by a further 16.3%.

The third and final step in the assessment required the consideration of renewable energy technologies in line with Policy 5.7 of the London Plan (Be Green). Previous analysis concluded that solar photovoltaics are the most feasible technology for this development. Through the addition of PV panels to the available roof area, amounting to approximately 150m^2 of panels, the development was able to exceed the London Plan target of 35% CO2 reductions beyond Part L 2013, achieving an overall 44% reduction in carbon emissions, with a 19.6% reduction via on-site renewables.

Site specific analysis for renewable technologies not considered feasible can be found in Appendix A. The BRUKL output reports for each stage of the hierarchy can be found in Appendix B

A detailed description of the demand reduction measures applied in each step of the hierarchy, together with a breakdown of the building's carbon emissions, can be found in Sections 6, 7 and 8.

Table 1.1: Carbon dioxide emissions after each stage of the Energy Hierarchy

	Carbon dioxide emissions (Tonnes CO2 per annum)	
	Regulated	**Unregulated**
Baseline: Part L 2013 of the Building Regulations Compliant Development	32.4	17.96
After energy demand reduction	29.8	17.96
After CHP	24.5	17.96
After renewable energy	18.2	17.96

Table 1.2: Regulated carbon dioxide savings from each stage of the Energy Hierarchy

	Regulated Carbon dioxide savings	
	(Tonnes CO2 per annum)	**(%)**
Savings from energy demand reduction	2.6	8.1
Savings from CHP	5.3	16.3
Savings from renewable energy	6.3	19.6
Total Cumulative Savings	14.3	44.0
Total Target Savings	11.3	35%
Annual Surplus	2.9	9.0%

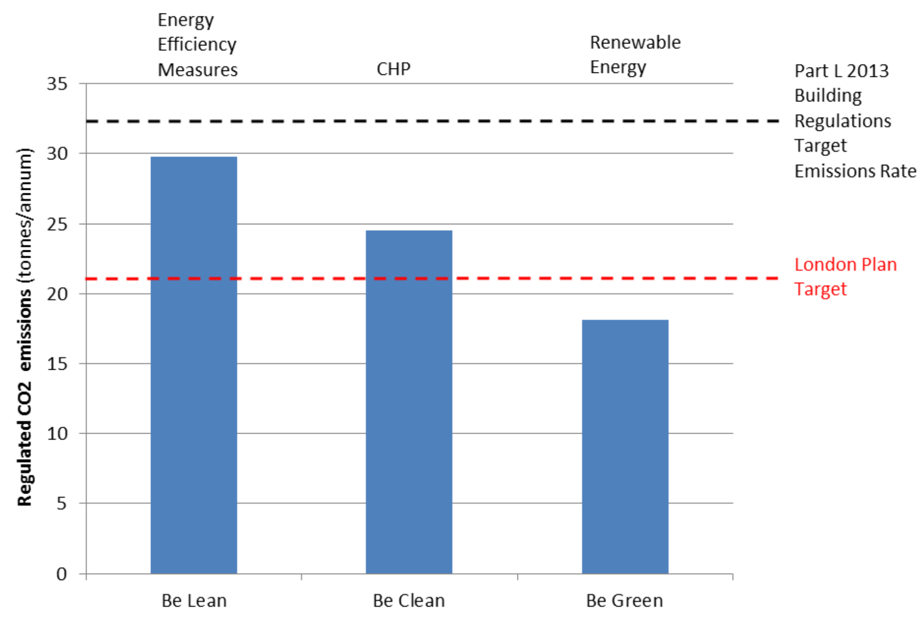


Figure 1.1 – The Energy Hierarchy

2.0 INTRODUCTION

2.1 Scope of Report

This report is intended to describe the sustainability proposals for the redevelopment of Edith Neville Primary. These proposals have been framed in the context of local, regional and national planning policies.

As part of this, an energy assessment is included to quantify the predicted emissions reductions from these measures, and to address the requirements of the London Plan and Camden planning policy.

2.2 Project Background and Masterplan

The redevelopment of Central Somers Town is led by the Department for Children, Schools and Families and will be delivered as part of an approved regeneration strategy to deliver significant improvements to the public realm, provide a replacement primary school, nursery, play facilities and community hall. The development will also provide 136 housing units as well as maximising the amount of affordable housing which can be delivered by the scheme. Central to the development is the provision of public open space across the site. This space will be greatly improved as a result of the proposals and there will be no net loss of area following completion of the scheme.

The Central Somers Town project is self-funding, with the receipts from the private sale housing used to cross subsidise the delivery of the public realm, Edith Neville Primary School, nursery, community play facilities and community hall, in line with the wider vision for the Central Somers Town area.

Central Somers Town CIP
The Council has a significant property portfolio in the Somers Town area. Primarily this is made up of residential stock but also includes schools, a play project, children's centres and nurseries. These facilities provide an important service to children and their families and form an important part of bringing the wider community together. The area also contains two distinctive areas of public open space, these being Polygon Open Space and Purchese Open Space, which are maintained by the Council and provide a key component in how Somers Town functions as a place to live and work.

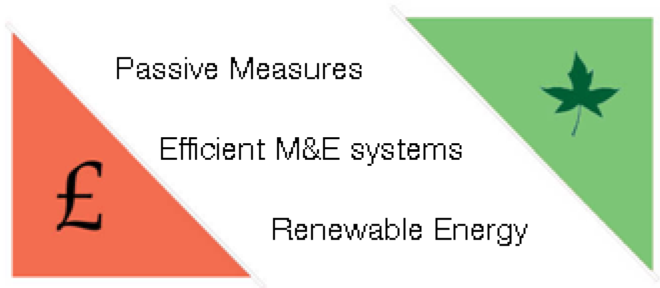
Central to the CIP is the Edith Neville Primary School and Children's Centre which were constructed as buildings with a short life expectancy. Remedial works have been necessary (both planned and unplanned) to keep it in service but the pressing need for replacement has been widely agreed for a considerable period of time.

Central Somers Town area is being addressed strategically as part of the CIP to tackle the significant need for investment. The scheme is intended to be self-funding, with the provision of residential development being utilised to pay for the redevelopment of the primary school and community facilities. It will also be possible to provide wider benefits through the delivery of an element of new affordable housing as well as public realm and public open space improvements.

2.3 General Design Approach

Even before we look at the regulatory and planning policy context of this project as we will in the next section, it is worth outlining our general approach to the environmental design of buildings.

Achieving the balance between sustainability, user comfort and cost is at the heart of our approach. We wish to maintain a comfortable and appropriate internal environment whilst using the minimum amount of energy possible. Our methodology to achieve this is based around the following design hierarchy:



The image above summarises how we go about achieving this – first by the application of passive measures, the form, orientation and fabric of the building; then by selection and design of appropriate and efficient active systems; before finally giving due consideration to renewable technologies that are suitable for the site and building. Moving through this process it can be appreciated how diminishing returns, in terms of energy or CO_2 emissions reduction, are achieved at a greater cost. To put it simply, it is much cheaper and more effective to choose the direction a building faces and what it is built from, than it is to buy and install a high technology renewable system.

3.0 PLANNING POLICY CONTEXT AND DESIGN BRIEF

3.1 Building Regulations – Part L 2013 (England)

CO2 emission rate calculations
Part L of the Building Regulations relates to energy usage and carbon emissions. A Target Emission Rate (TER) is calculated based on a notional building of the exact same size, location and orientation as the proposed building. In order to meet building regulations the calculated actual Building Emissions Rate (BER) for buildings other than dwellings must be lower than the TER.

Refer to Section 5 for details of the compliance calculations addressing this criterion that were carried out.

Consideration of high-efficiency alternative systems
The technical, environmental and economic feasibility of using high-efficiency alternative systems must be taken into account. These systems should include decentralised energy supply based on energy from renewable sources, cogeneration, district heating and heat pumps.

Criterion 3: Limiting the effects of heat gains in summer
This criterion was introduced for the 2013 edition of Approved Document Part L, and is intended to limit summertime solar gains in occupied areas of buildings, through placing a limit on the allowable solar gains. In order to comply, it must be demonstrated that the cumulative solar gains experienced from April to September are lower than those for an equivalent space with a 1m high band of east-facing glazing with a g value of 0.68.

3.2 GLA London Plan

The London Plan (2011) is the overall strategic policy framework for Greater London's development to 2031. It sets out the London-wide policy context within which London boroughs should set their detailed local planning policies. It also forms the policy framework for the Mayor's own decisions on the strategic planning applications referred to the Greater London Authority.

The London Plan Policy 5.2
The Government's Climate Change Act 2008 sets a target of reducing the UK's greenhouse gas emissions by 80% compared to 1990 levels by 2050. In order to help achieve this target the Mayor has set London the target of reducing its carbon dioxide emissions by 60% compared to 1990 levels by 2025. **Policy 5.2** states that development proposals are expected to contribute to meeting this target by achieving a BER that is 35% below the Building Regulations Part L 2013 TER. These targets are broadly equivalent to the target of 40% improvement over Part L 2010 of the Building Regulations, as specified in Policy 5.2 of the London Plan for 2013-2016.

All new developments must consider ways to reduce their carbon emissions. The London Plan requires that the consideration of carbon emissions reducing measures to be used by the development follow their Energy Hierarchy as depicted in Figure 3.1.

Be Lean first encourages a reduction in energy demand. This can be achieved through both passive and active measures. Passive measures include improvements to the building fabric and ensuring the design of the building minimises solar gains and thus reduces the need for cooling. Active measures include using the most efficient building services.

Be Clean ensures energy is supplied efficiently by requiring the consideration of connecting to a district heating network or using cogeneration for efficient on-site energy production.

Finally **Be Green** encourages the use of renewable energy to offset carbon emissions that would otherwise occur from the use of natural gas or electricity from the grid.

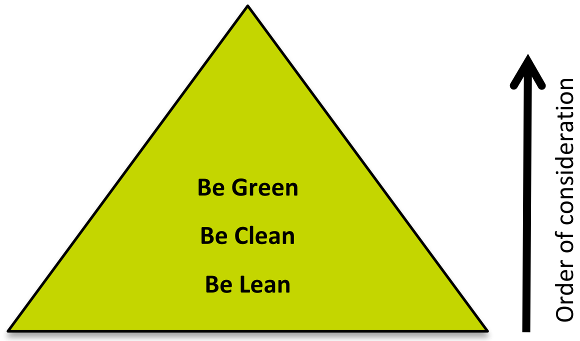


Figure 3.1 The Energy Hierarchy from the London Plan

In line with the London Plan Policy 5.2, this report contains a detailed Energy Assessment that demonstrates how the targets for carbon dioxide emissions reduction are met within the framework of the aforementioned energy hierarchy.

Policy 5.6 Decentralised energy in development proposals
This policy requires developments to assess the feasibility of Combined Heat and Power (CHP) systems. It also states that major developments should consider energy sources in line with the following hierarchy:

1. Connection to existing heating or cooling networks
2. Site wide CHP network
3. Communal heating and cooling

Policy 5.7 Renewable energy
Within the scope of the Energy Hierarchy, it is expected that all major developments reduce carbon emissions through the use of on-site renewable technology. This should be selected, sited and designed to minimise adverse effects on biodiversity and heritage.

There is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20 per cent through on-site renewable energy generation wherever feasible.

Policy 5.9 Overheating and Cooling
Developments should be designed to minimise the risk of overheating, and to minimise their contribution to the urban heat island effect.

For major developments, efforts to minimise overheating risk should follow the following 'cooling hierarchy':

a. minimise internal heat generation through energy efficient design
b. reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
c. manage the heat within the building through exposed internal thermal mass and high ceilings
d. passive ventilation
e. mechanical ventilation
f. active cooling systems (ensuring they are the lowest carbon options).

Policy 5.3 Sustainable Construction
This policy requires that new developments meet the highest standards in sustainable design and construction, and highlights the following key points:

a. minimising carbon dioxide emissions across the site, including the building and services (such as heating and cooling systems)
b. avoiding internal overheating and contributing to the urban heat island effect
c. efficient use of natural resources (including water), including making the most of natural systems both within and around buildings
d. minimising pollution (including noise, air and urban runoff)
e. minimising the generation of waste and maximising reuse or recycling
f. avoiding impacts from natural hazards (including flooding)
g. ensuring developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions
h. securing sustainable procurement of materials, using local supplies where feasible, and
i. promoting and protecting biodiversity and green infrastructure

Other Relevant Policies
Other London Plan policies relevant to sustainable design that have been considered in the design of the buildings include:

5.8	Innovative energy technologies
5.11	Green roofs and development site environs
5.12	Flood risk management
5.13	Sustainable drainage
5.14	Water quality and wastewater infrastructure
5.15	Water use and supplies
5.18	Construction excavation and demolition waste
6.1	Strategic transport approach
6.9	Cycling
6.10	Walking
7.14	Improving air quality

7.15 Reducing noise and enhancing soundscapes
7.19 Biodiversity and access to nature

Supplementary Planning Guidance- Sustainable Construction - April 2014
The Sustainable Design and Construction SPG provides further details and best practice on how to achieve the London Plan's environmental targets in the most efficient and effective way. It also introduces additional requirements and more details on those issues touched upon in the London Plan.

Key Additional Points:
Overheating
Developers should include measures in the design of the schemes in line with the cooling hierarchy set out in London Plan Policy 5.9 to prevent overheating in the schemes lifetime.

To prevent overheating developers should incorporate passive and active measures as appropriate, into their schemes including:

Passive measures:
- appropriate room placement, window sizing, shading devices and solar orientation
- use of thermal mass;
- use green roofs and green walls to keep the heat out, and keep the building and its surroundings cool;
- maximise passive ventilation, including operable windows, a shallow floor plan, high floor to ceiling heights, the stack effect, etc.

Active measures:
- energy efficient lighting and equipment to minimise internal heat generation;

Water
- Residential schemes should be designed to meet 105l or less per person per day.
- New non-residential developments, including refurbishments, should aim to achieve the maximum number of water credits in a BREEAM assessment or the 'best practice' level of the AECB water standards
- All developments should be designed to incorporate rainwater harvesting.
- All residential units including flats/apartments and commercial units, wherever practical, should be metered.

Materials
Design for development should prioritise materials that:
- Have low embodied energy, including those that can be reused intact or recycled.
- At least three of the key elements of the building envelope (external walls, windows, roof, upper floor slabs, internal walls, floor finishes/coverings are to achieve a rating of A+ to D in the BRE's the Green Guide to Specification.
- At least 50% of timber and timber products should be sourced from accredited Forest Stewardship Council.
- Materials should not release toxins to the internal and external environments.
- Design of developments should maximise the potential to use pre-fabricated elements.

Waste
- Developers should provide sufficient internal space for the storage of recyclable and compostable materials and waste in their schemes.
- The design of developments should meet the borough's requirements for the size and location of recycling, composting and refuse storage and its removal.

Nature conservation and Biodiversity
The Mayor's priorities are:
- No net loss in the quality and quantity of biodiversity.
- Developer contributes to biodiversity on their development.

In accordance with London Plan Policy 7.19, developers should adhere to the following hierarchy when considering biodiversity on their development site:
1. Avoid adverse impacts to the biodiversity interest by considering the following factors:
   - identifying the biodiversity interest within the site
   - considering the particular structure of landscape or vegetation required by any important plant or animal species;
   - carefully considering the location, design, form and foundations
   - requirements for the development to protect existing biodiversity as well as the length and timing of the construction phase and the specific processes involved; and
   - considering the implications of the development on changes to the local natural environment over time, for example space required for maturing trees, the impact of additional lighting and noise.
2. Minimise impact and seek mitigation, biodiversity impacts should be reduced as far as reasonably possible.
3. Only in exceptional cases where the benefits of the proposal clearly outweigh the biodiversity impacts, seek appropriate compensation.

3.3 Camden Council

Core Strategy
Camden's Local Development Framework Core Strategy 2010-2015 sets out the council's strategic planning policy.

Key Policies include:
CS11 – Promoting Sustainable Travel

CS13 – Tackling climate change through promoting higher environmental standards

CS14 – Promoting high quality places and conserving our heritage

CS15 – Protecting and improving our parks and open spaces and improving biodiversity

CS16 – Improving Camden's health and well-being

CS18 Dealing with our waste and encouraging recycling

However, the only specific environmental requirement in this document, from CS13, is the expectation that developments will achieve at least a 20% reduction in CO2 emissions through the use of on-site renewable technology.

Development Policies
The Camden Development Policies set out detailed planning criteria that are used to determine applications in the borough. Key sustainability policies include:

DP6 – Lifetime homes and wheelchair housing

DP16 – The transport implications of development

DP17 – Walking, cycling and public transport

DP20 – Movement of goods and materials

DP22 – Promoting sustainable design and construction

DP23 – Water

DP26 – Managing the impact of development on occupiers and neighbours

DP28 – Noise and Vibration

DP32 – Air Quality and Camden's clear zone

The only specific sustainability targets in this document come from DP6 – requiring 10% of new homes to meet wheelchair housing standards or be easily adaptable to them; and DP 22 which expects all new non-residential developments over 500m^2 to achieve at least BREEAM 'Very Good', and BREEAM excellent from 2016.

CPG3 Sustainability
This planning guidance document contains the following key messages:

- Section 2: All developments are to be designed to reduce carbon dioxide emissions in line with the energy hierarchy.
- Section 3: Computer modelling of developments over 500m^2 to be carried out to optimise daylight and solar gain.
- Section 5: Where feasible and viable developments will be required to connect to a decentralised energy network or include CHP.
- Section 6: Developments are to target 20% reduction in carbon dioxide emissions from on-site renewable technologies.
- Section 7: Developments should consider harvesting and recycling of water.
- Section 8: Developments should aim for at least 10% of the value of materials to come from recycled sources
- Section 9: Developments with 500 m^2 or more of non-residential floor space will need to be assessed in line with BREEAM.
- Section 10: All developments are expected to incorporate green or brown roofs where possible and appropriate
- Section 11: Developments must not increase the risk of flooding, with all sites over 10 000m^2 requiring a flood risk assessment.
- Section 13: requires that any loss or damage to an ecosystem or biodiversity must be compensated for with other measures.

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3.4 BREEAM New Construction 2014

BREEAM is the BRE's environmental assessment tool for non-domestic buildings. To achieve a BREEAM 'Excellent' rating under the 2014 scheme the development must obtain a score of over 70%. In addition, an 'Excellent' rating requires the development to gain credits on certain mandatory issues including five credits on Ene 01.

Other key credits relevant to this report include: WAT credits – requiring the development to achieve a maximum calculated water consumption, the implementation of water saving and monitoring measures; LE credits – minimising the impact on existing site ecology; ENE 02 Credit – requiring energy monitoring; and MAN credits – requiring the implementation of good management practice during construction, at commissioning, at handover, and after the building is occupied.

A BREEAM pre-assessment has been carried out by SWEETT, and is included in Appendix C, where further details of the credits targeted can be found.

4.0 SUSTAINABILITY STRATEGY

In this section, the strategies adopted to address the regional and local sustainability planning policies that do not have a direct impact on the Energy Assessment will be described. Where a sustainability strategy has a direct impact on energy consumption, it will be detailed in the following sections as part of the Energy Assessment.

4.1 Water Efficiency

Currently, during dry weather, London's water consumption outstrips available supply. The city's water resources should be used as efficiently and sustainably as possible. The water strategy on site has been designed to minimise water consumption and achieve a 25% reduction over a baseline water consumption. This is in line with legislative requirements from the following documents:

- The London Plan 2011 – Minimising water use and maximising rainwater recycling where possible.
- The BREEAM WAT01 Credit – 2 credits for a 25% improvement.

This requires all fittings to be of a "lower water use" than normal fittings.

Low water demand planting and well-designed, primarily rainwater fed, irrigation systems will also reduce the amount of mains potable water used for external irrigation Refer to the landscaping section of the planning submission for further details of these strategies.

Due to the relatively low water demand, extensive distribution network that would be required and the extensive use of green and brown roofs it has been deemed that a grey or rain water harvesting system for internal use would not be cost effective or practicable for the school. As such, rainwater harvesting has been confined to landscape watering use.

Water efficiency strategies for reducing potable demand and foul flows will be implemented. These will include;

- Leak detection,
- Sub meter, with the output monitored by the BMS
- Occupancy-sensing zonal shut off valves
- Pressure reduction

See the Price and Myers Sustainable Urban Drainage Statement and the site-wide Flood Risk Assessment for full details of the drainage measures to be implemented.

4.2 Pollution

Air Pollution
Given that the school will be deriving its heating from the existing district heat network, it is expected that little change, and if anything a net improvement, in air quality immediately around the new development will be experienced.

A site-wide Air Quality Assessment has been undertaken by Ramboll Environ for the Somers town redevelopment – refer to this document for further information on air quality in the area.

Light Pollution
The full extent and detail of the external lighting installation associated with the school is yet is to be determined. However care will be taken to avoid the risk of increase light pollution or nuisance lighting, with all external lighting designed in accordance with the ILP Guidance for the reduction of Obtrusive Light.

Particular care will be taken over lighting to the external play areas – with all fittings selected to have an upward light ratio of zero and controlled either by a time clock, presence detection or a combination of both. Low energy sources will be used throughout.

4.3 Climate Change Adaptation

As will be described in Section 6, the approach to overheating control has been assessed against a number of weather years that could be representative of frequent warm-weather events in a future climate. However, occupant comfort, and specifically control of internal temperature is not the only measure required for successful adaptation to a warmer climate. Other measures that have been considered by the design team include:

- How the building could be adapted in future to function at lower occupation densities to reduce internal gains.
- Ensuring that the glazing ratio of window to wall area is less than 50%.
- Consideration of how the building form might be arranged to provide solar shading.
- Avoidance of low-level glazing where possible. It increases heat gains and losses without improving daylighting.
- Ensuring that spaces are capable of being naturally ventilated, the vast majority incorporating cross-ventilation and/or stack driven ventilation for high volume summer purge ventilation.
- Consideration of the site-wide vegetation strategy that includes green roofs and shading from deciduous plants. Green roofs combined with wind can cool buildings below by transpiration.
- Ensuring that vents can be left opened in a secure fashion to provide night-time cooling.
- Specify low-flow water fittings to reduce water stress
- Specify planting that can cope well with long periods of dry weather.
- Irrigation of the planting with rainwater.

Refer to the landscaping proposals for further details on the planting proposed, and the SUDs assessment for climate change adaptation measures associated with surface water drainage.

4.4 Monitoring Energy Use

Monitoring and sub-metering of energy use has a number of benefits and can contribute to reducing energy consumption and carbon emissions in a number of ways. As well as helping to identify leaks or problems with the building's systems, it can also be used to identify the major areas of energy consumption, and thus help to target energy saving measures both through retro-fitting equipment and influencing occupant behaviour.

As such, an extensive network of heat, water and electricity meters will be provided throughout the school, monitoring all of the major energy uses so that they are identifiable to the end use. The meters will be linked back to the central BMS from where they can be monitored, with protocols to warn of unusual usage patterns included.

4.5 Materials and Waste

Building and construction activities worldwide consume 3 billion tonnes of raw materials each year, equalling 40% of total global resources; on average 10% of virgin construction materials from building projects go straight to landfill. Reclaiming construction materials and reusing them in a manner that preserves the embodied energy and carbon already invested in the material is therefore environmentally the most advantageous approach.

For the Edith Neville School development, the palette of materials has been chosen for longevity, robustness and low maintenance. The materials used in the design will have Green Guide ratings between A+ and C to achieve the required credits targeted for BREEAM. In terms of the GLA checklist all the Mayor's preferred standards will be achieved if feasible. The aspiration to source 50% of construction materials by mass from a source 35 miles of site may not be feasible due to possible logistic constraints and local market pressures due to the site's city centre location. However, there will be a requirement on the contractor to source local materials wherever possible.

Reuse of materials does not form a significant part of the material criteria of BREEAM, which assumes all projects are new builds. Despite early-stage consideration, the nature of the site and state of the buildings on it makes it impractical to reuse buildings or materials that are found on the site.

Refer to the Architect's Design and Access statement for further details of the materials proposed.

4.6 Ecology and Urban Greening

Biodiversity
The development seeks to maximise opportunities for outdoor space-creating new high quality public realm, private spaces and communal gardens. The design aims to maximise the ecology credits available under BREEAM. An ecology survey has been undertaken on the site in its current

state, and it is anticipated that the proposals will have a net positive effect on biodiversity on the site.

Robustness and maintainability reviews have been considered to ensure a quality landscape for future generations. Native plants will be selected that are suited to their intended location and planting method, and rainwater will be used for irrigation to relieve pressures on water resources.

Full details are in the Ecology Report that accompanies this planning application.

Green Roofs and Brown Roofs
Extensive areas of green and brown roofs are proposed across the site – as well as planted areas on the terraces. As a result the site will experience an increase in green area over the course of the development, along with the other benefits brought by this approach – including the biodiversity benefits, surface water attenuation and passive cooling possibilities.

Local Food Growing
Areas will be provided in the school's landscape for the growing of vegetables and educational activities associated with this. Refer to the Landscape Architect's Design and Access statement for further details.

4.7 Flooding

A site-wide flood risk assessment has been undertaken for the overall Central Somers Town redevelopment masterplan, covering the Edith Neville Primary School site – refer to the Flood Risk Assessment that accompanies this planning application for further details.

5.0 ENERGY STRATEGY

5.1 Establishing CO2 Emissions from Regulated Loads

In order to carry out this assessment, we have used IESVE 2014 (VE Compliance 7.0.2.0) dynamic thermal simulation software to calculate the regulated loads of the building for each stage of the energy hierarchy. Details of fabric and services properties at each stage of the Energy Hierarchy are described in this section. Their respective CO_2 emissions and % savings are presented in Table 1.2, and in graphical form at the end of each section.

A dynamic thermal model of the proposed school building was created, with the geometry based on the architectural proposals. The software was then used to test the building against the requirements of the Building Regulations Part L2 2013 by comparing the model's performance to that of a notional building – one of exactly the same form, location and orientation, serviced by systems of a predefined efficiency.

In this assessment, most variables are defined by the National Calculation Methodology – such as occupancy patterns, internal gains and heating set points – to enable a fair comparison across buildings that may in reality be subject to differing usage patterns. The notional building's emission rate is known as the 'Target emission rate' (TER), and the modelled building's emission rate is known as the 'Building emission rate' (BER).

The TER was used as the 'baseline' emissions rate for the Building Regulations compliant development, with which the school building was compared at each stage – the aim being to achieve a BER of 35% less than the TER at the final stage of the hierarchy.

The output reports from the Building Regulations calculations for each stage of the energy hierarchy, known as BRUKL reports, can be found in appendix B.

5.2 Establishing CO2 Emissions from Unregulated Loads

Unregulated loads are taken from the separated equipment load predictions within the Dynamic Simulation Models. These are drawn from the National Calculation Method space usage templates.

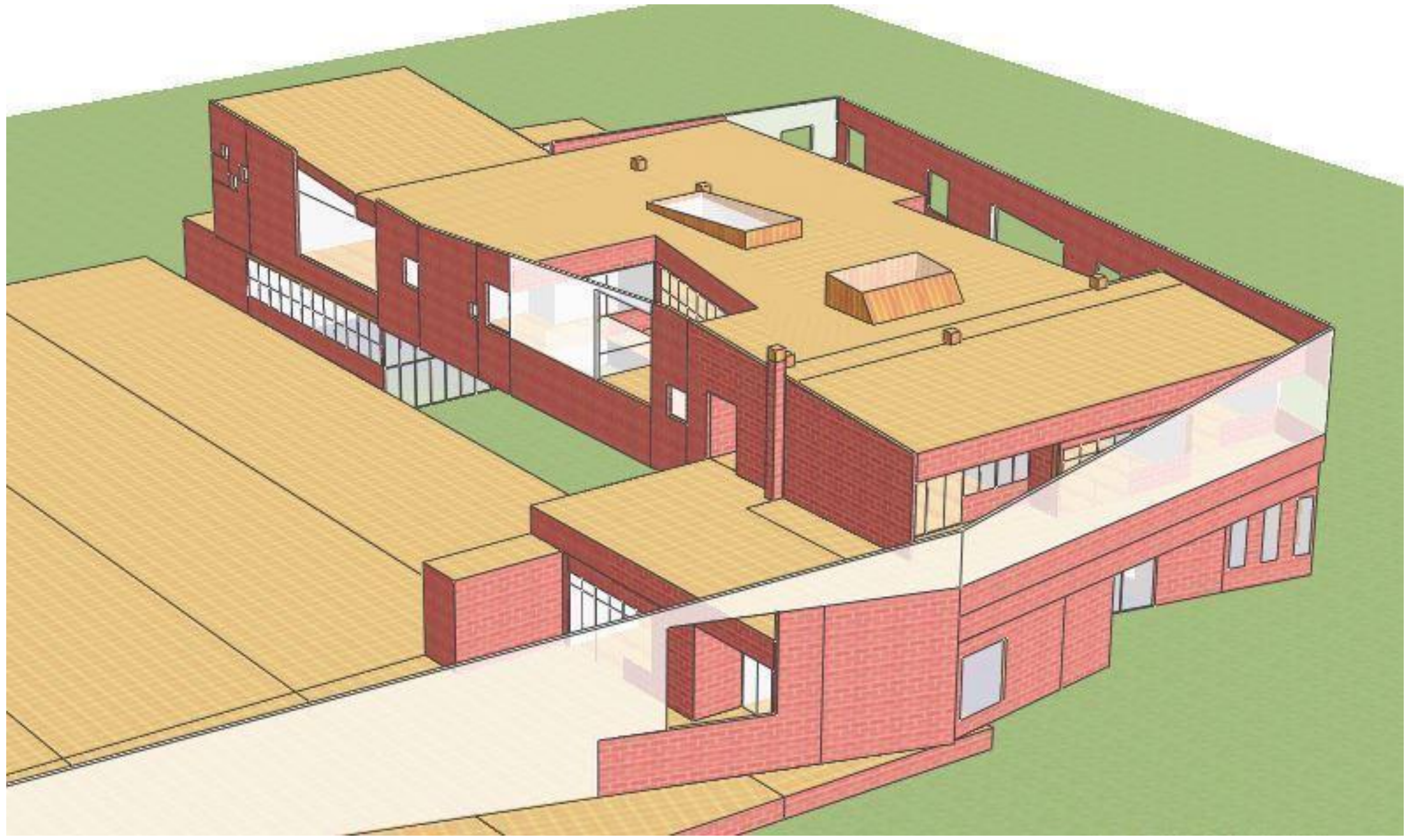


Figure 5.1 – IES dynamic thermal model

6.0 DEMAND REDUCTION: BE LEAN

The ‘Be Lean’ case assumes heating is provided by gas boilers with an efficiency of 91% and that any active cooling is provided by electrically powered equipment. The development was designed to limit its contribution to the heat island effect, as set out in Policy 5.9 for overheating and cooling hierarchy:

1) Minimise heat generation through energy efficient design
2) Reduce the amount of heat entering a building in summer
3) Manage the heat within the building through exposed internal thermal mass and high ceilings
4) Passive ventilation
5) Mechanical ventilation

The passive and active measures adopted at this stage of the hierarchy are described in the following sections.

6.1 Building orientation

Where possible, the orientation and form of the building have been developed to maximise opportunities for daylighting and views out, while minimising the potential for solar gains during summer. Possibilities to optimise the building orientation are to some extent limited by the existing school around which the new building must be designed – thus necessitating a long west-facing façade, however where north or south-facing external facades are available, occupied spaces have been located here and glazing specification and shading have been used to maximise the daylighting potential while minimising the risk of excessive solar gains.

6.2 Building envelope and fabric performance

Air Infiltration

With modern well insulated buildings significant amounts of heat loss is typically caused by unwanted air infiltration through the fabric, and in particular through the points where different building elements meet. This requires good attention to detailing through design and monitoring of the construction process and workmanship on site.

Current Building Regulations 2010 (Approved Document L2A 2013) require that the air permeability of the building fabric does not exceed 10 $m^3/h.m^2$ at an applied pressure difference of 50Pa. This is not a particularly onerous target and in order to minimise the heat losses associated with air infiltration the new school will be designed to a standard of 3 $m^3/h.m^2$.

Air tightness design target
3 $m^3/h/m^2$ at 50 Pa test pressure

Thermal Insulation

The thermal performance of the fabric has been proposed to optimise the balance between energy savings and other considerations such as cost, wall thicknesses and the diminishing returns available from increasing the thermal performance of a building envelope beyond a certain point. As seen in Table 6.1 below, these are significantly better than the Building Regulations minimum (‘Limiting’) and also that of the NCM notional building against which the school is assessed (‘Notional’).

Thermal Bridges

At this stage in the design, with interface details not yet finalised, it has not been possible to accurately assess the impact of thermal bridging. As such, the default thermal bridging parameter has been used throughout the modelling, as this represents a worst case in which little attention is paid to the risk of thermal bridges.

It is however hoped and expected that this will be improved upon – using robust details wherever possible and appropriate, and elsewhere looking in detail and eliminating potential thermal weaknesses. As the design is developed, the details will be carefully monitored and considered in view of thermal bridging, and the assessment updated with a more accurate, and no doubt improved, thermal bridging parameter.

Table 6.1 – Proposed fabric properties

U-Values:	Limiting W/m^2K	Notional W/m^2K	Proposed W/m^2K
Ex wall	0.35	0.26	0.15
Floor	0.25	0.22	0.13
Roof	0.25	0.18	0.13
Door (<50% glazed)	2.2	2.20	1.80
Windows	2.2	1.60	1.40
Roof lights	2.2	1.80	1.40

6.3 Natural Ventilation and Overheating

It is proposed that the majority of spaces in the new school building will be naturally ventilated, with mechanical ventilation only considered for spaces with exceptionally high heat gains, such as high-density IT rooms or server cupboards, and areas where specialist usage conditions demand mechanical extract, such as WCs and kitchens or cooking areas.

The natural ventilation strategy for this development has been designed with specific characteristics of a school environment in mind. Classrooms experience high occupant densities throughout the year for prolonged periods of the day. This means that the natural ventilation strategies employed must be adaptable and flexible, with a high degree of control to respond to potentially rapidly changing external conditions. To this end, the facades have been designed with a mixture of low and high level openings and secure opaque louvres, with ventilation chimneys incorporated to aid buoyancy-driven ventilation and night purging during the warmer months.

We have also designed the various ventilation openings to be flexible in adapting to both summer and winter conditions. Large, sliding windows and doors provide high volume summertime ventilation to offset the heat gains in summer, whilst smaller, high-level opaque openings provide a minimum ventilation rate in winter – offering a well distributed low-volume flow outside of the occupied zone to ensure good mixing and to avoid the risk of cold draughts.

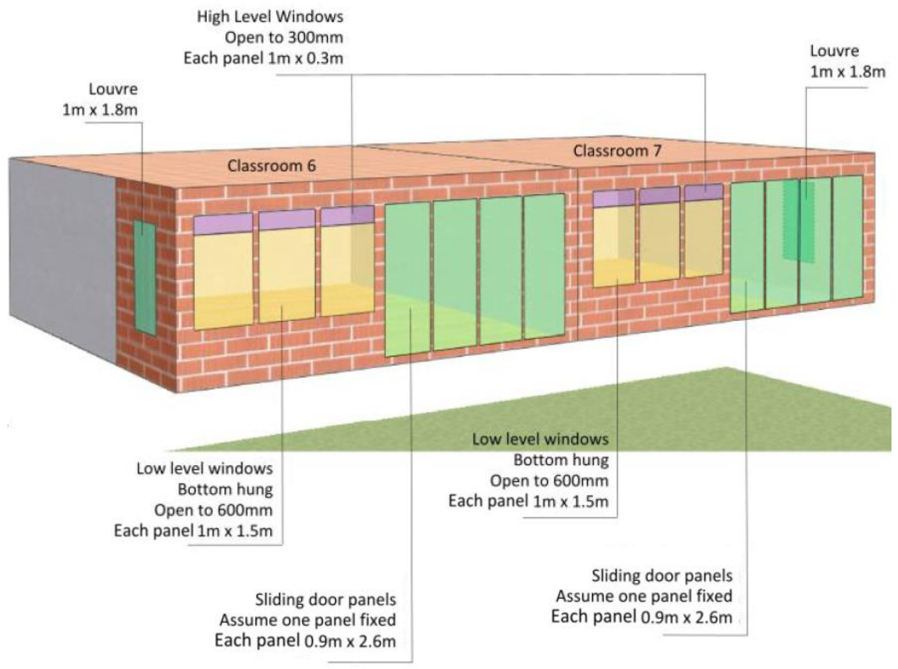


Figure 6.1 – Typical natural ventilation openings in classrooms

Overheating Mitigation

While it is tempting to increase glazing areas to achieve maximum daylighting, care must be taken to minimise the risk of overheating that increased glazing areas are known to bring. External shading, opaque ventilation louvres and enhanced glazing properties are among the measures implemented to control solar gains whilst maintaining adequate daylight and ventilation levels. Figure 6.1 illustrates the ventilation openings and glazing in the east facing classrooms. To further enhance ventilation rates, and provide cross-ventilation to ensure all areas of the room receive fresh air, ventilation chimneys have been included in the classrooms and upstand louvres on the skylights in the circulation areas.

External shading devices have also been incorporated into the design – with overhangs providing protection from the high summer sun for south-facing classrooms; and a perforated metal ‘skin’ cladding the building, and glazing, in areas where west-facing facades were unavoidable. A perforated perimeter wall around the entire development has also been developed to provide further shading where necessary. These measures help to control peak solar gains, and thus minimise overheating risk, while still allowing ample light into the occupied zones to provide good daylighting and minimise the energy use for electric light.

Through such measures, the building was able to achieve compliance with Criterion 3 of the Building Regulations Part L2, Limiting the Effects of Solar Gains.

CIBSE TM52
The latest guidance from CIBSE (Chartered Institute of Building Services Engineers) on the subject of overheating is CIBSE Technical Memorandum 52 (TM52). This sets requirements for modelling overheating in buildings, based on the CIBSE Design Summer Year (DSY) which simulates a typical “hot” year.

TM52 (2013) provides a methodology to assess ‘Adaptive Thermal Comfort’. It is based on the comparison between the predicted room temperature and a maximum acceptable room temperature calculated from the 'running mean' of the outdoor temperature (T_{rm}). The running mean places greater weight on the temperature for days closer to the present as these have more influence on a person’s comfort levels. This means that the overheating threshold is dynamic and is based on the weather file utilised.

TM52 is based on the latest research into the rate at which people adapt to changes in climate. As a result, the temperature criteria vary through time. During a cool spell of weather the acceptable temperature range decreases, whereas in a hotter period, when people are acclimatised, warmer internal temperatures are permitted. The internal target temperature is based on the running mean of the external temperature.

TM52 sets out three criteria, with a 'pass' dependent on meeting two out of the following three criteria:

Criterion 1 - Hours of Exceedance (H_e):
The number of hours the predicted operative temperature exceeds the upper limit of the range of acceptable operative temperatures (T_{max}) by 1K, or more, does not exceed 40 hours, during the five summer months (May-September).

Criterion 2 - Weighted Exceedance (W_e):
The sum of the weighted exceedance for each degree Kelvin above T_{max} (1K, 2K and 3K) is ≤ 6, where:

$W_e = \Sigma H_e$ (1, 2, 3) *(ΔT) (1, 2, 3) and

$\Delta T = (T_{op} – T_{max})$, rounded to a whole number i.e. [0 °C < 0.5 °C ≥ 1 °C].

Therefore, the severity of the instances overheating must be limited with worse instances of overheating occurring much less frequently than minor instances.

Criterion 3 - Threshold/Upper Limit Temperature (T_{upp}):
The measured/predicted operative temperature should not exceed the Tmax by 4K or more at any time, where T_{max} + 4K is called the upper limit (T_{upp}). This means that the temperature shall never be significantly higher than the current expected discomfort temperature.

Weather Data
The external weather data used in the simulations places a significant role in the building’s performance with respect to the above criteria. The current standard weather datasets in the UK are the Test Reference Years (TRYs) and Design Summer Years (DSYs), provided by CIBSE.

They are hourly weather files based on past observations (1981–2012) and are available for 14 locations in the United Kingdom, including London. The TRYs are average years, and so are appropriate for energy performance calculations. The DSYs of an actual 1-year sequence of hourly data selected from the 20-year data sets to represent a year with a hot summer and so are appropriate for thermal comfort assessments.

Urban centres such as London tend to experience more intense and frequent summer hot events, exacerbated by the urban heat island (UHI) effect. The UHI effect is a result of the dense built up of urban centres and the lack of green areas and manifests as a temperature difference between the urban centres and their rural surroundings.

The Greater London Authority - recognising the intensity of the UHI effect in London and its impact on the risk of overheating, especially in dense urban locations - funded a study to address the need to introduce the UHI effect in building design. The results of the study were made available by CIBSE as ‘TM49 Design Summer Years for London’ with the accompanying DSY datasets for building thermal simulation. This means that instead of having a single DSY for London, three DSYs are now available capturing the local climate in three different London sites: London Weather Centre, Heathrow and Gatwick (urban, semi-urban, and rural) and for three years (1976, 1989 and 2003) of varying severity of hot events.

As well as accounting the potential increased risk of overheating due to the urban heat island effect, the use of these weather years will also provide some insight into how a building may perform in a climate where significant warm-weather events become more frequent.

For our overheating assessment, we tested the building under the London Heathrow CIBSE TM49 DSY weather files.

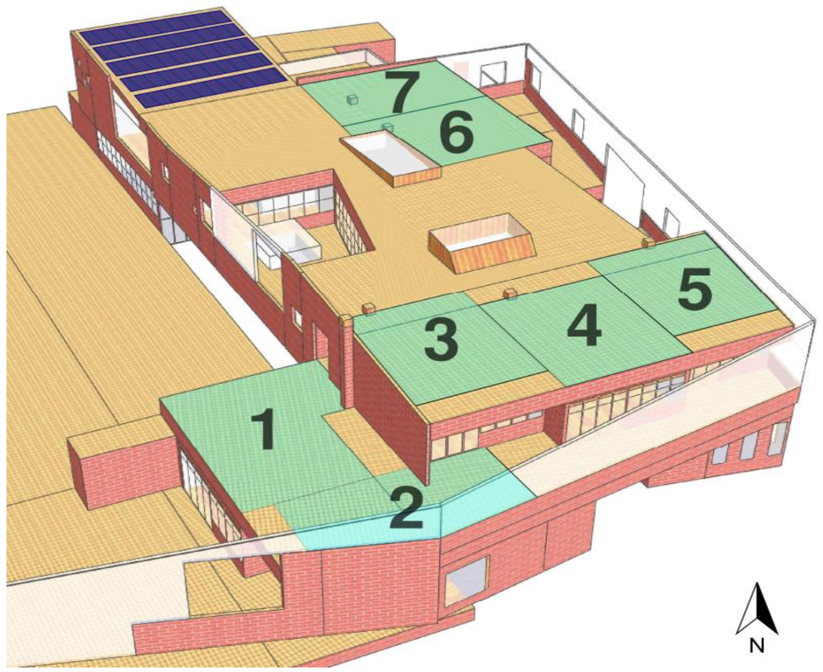


Figure 6.2 – Overheating model and classroom locations

Overheating Modelling Results
The results of our overheating analysis against the TM52 criteria using the TM49 weather data are summarised in Table 6.2.

In all three cases, it can be seen that Criteria 1 is satisfied. This means that the indoor temperature exceeds the T_{max} (by at least 1K) for less than 40 hours during the summer months. Under the earlier DSYs, Criteria 3 was satisfied throughout, which means that the indoor temperature does not exceed the upper limit (T_{upp}) at any point.

However, under the 2003 DSY, it was found that all teaching spaces fail Criteria 2 and 3. Further investigation into the results showed that although the upper limit temperature (T_{upp}) was exceeded, it was only during the times when this threshold was particularly onerous. Figures 6.3 and 6.4 overleaf look at these instances in more detail.

Table 6.2 Overheating TM52 results

	1976			1989			2003		
	1	2	3	1	2	3	1	2	3
Classroom 1	✓	✗	✓	✓	✗	✓	✓	✗	✗
Classroom 2	✓	✗	✓	✓	✓	✓	✓	✗	✗
Classroom 3	✓	✗	✓	✓	✗	✓	✓	✗	✗
Classroom 4	✓	✗	✓	✓	✗	✓	✓	✗	✗
Classroom 5	✓	✗	✓	✓	✓	✓	✓	✗	✗
Classroom 6	✓	✗	✓	✓	✗	✓	✓	✗	✗
Classroom 7	✓	✗	✓	✓	✓	✓	✓	✗	✗

Evaluation of Results
While the classrooms perform well against the 1976 and 1989 weather years, their failure against the 2003 weather year could give some cause for concern.

As a result, we have looked in detail at the buildings performance in this year, both in the hope of highlighting potential areas for improvement, but also to understand what coincidence of circumstance has led to this failure.

The key temperature variables used by TM52 to assess overheating can be summarised as follows:

- T_{od}: daily mean temperature.
- T_{rm}: the exponentially weighted running mean of the daily mean outdoor air temperature.
- T_{comf}: comfort temperature – this is based on T_{rm}, with more recent experiences being more influential.
- T_{max}: maximum acceptable temperature, calculated by adding a fixed ΔT to T_{comf} depending on the building type.
- T_{upp}: absolute upper limit, which is 4K above T_{max}.

The profiles for these variables over the summer of the 2003 weather year are illustrated in figure 6.3.

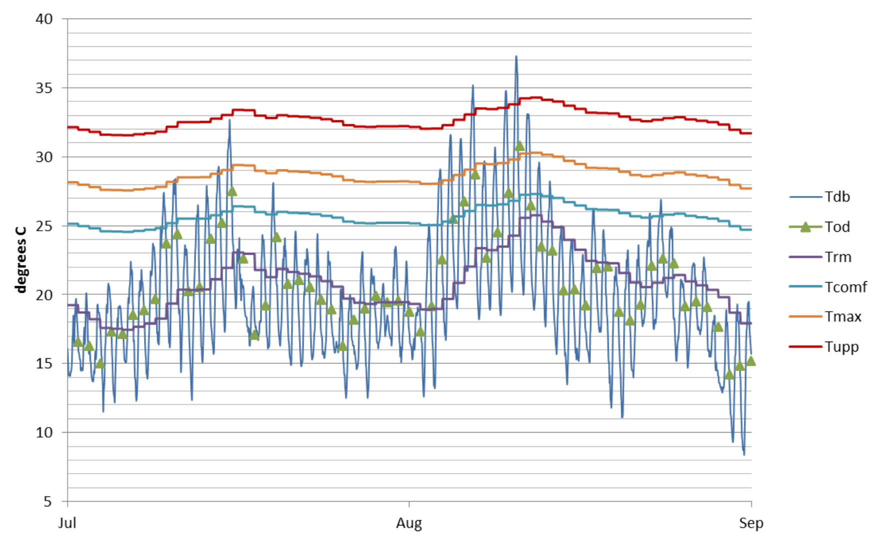


Figure 6.3 – Graph of outdoor dry bulb temperature (T_{db}) with CIBSE TM52 parameters (2003 DSY)

As can be seen from the graph illustrated in Figure 6.3, there are instances when the upper limit temperature (T_{upp}) is significantly lower than the outdoor dry bulb temperature – this can be seen in the graph around August, where the maximum temperature limit is 3°C lower than the outdoor dry bulb temperature. This means that in these instances, one would have to maintain an indoor temperature of at least 3°C below the external temperature in order to pass Criterion 3 of the TM52. In addition, failure of criterion 3 makes passing criterion 2 extremely difficult to pass – for a W_e of at least 4K has already been accrued from that one single hour.

Since the teaching spaces are naturally ventilated, maintaining air temperatures significantly below the external on these exceptionally warm days is extremely difficult.

Figure 6.4 illustrates the indoor and outdoor temperature profile for a typical classroom on the hottest day of the 2003 DSY. Despite the indoor temperature being hotter than the threshold (T_{upp}), and thus failing criterion 3 of TM52, it is still lower than the outdoor temperature for most of the occupied hours. Therefore, in the event that an exceptionally hot day does fall under school term dates, during school hours, these naturally ventilated spaces are still capable of maintaining relatively low - in many cases below external - internal temperatures.

The ventilation rate shown on the graph should also be noted – as can be seen, rates between 800 and 2000 l/s are achieved throughout the occupied hours, equivalent to between 16 and 40 ACH. This level of ventilation will result in a significant reduction in perceived temperature due to air speed, and furthermore, with a relatively thermally light building construction allows the rooms to rapidly reduce their temperatures once the outdoor temperature starts to decrease – this is evident in Figure 6.4 after 19:00.

It is felt that failure on this criterion, in this particular weather year, does not represent an overheating risk for a naturally ventilated classroom when full occupancy throughout the summer is assumed, given that school buildings rarely experience this level of use outside of term time when the hottest weather occurs. It is felt that the performance of the natural ventilation system demonstrated should ensure that in all realistic situations temperatures will be maintained within reasonable limits.

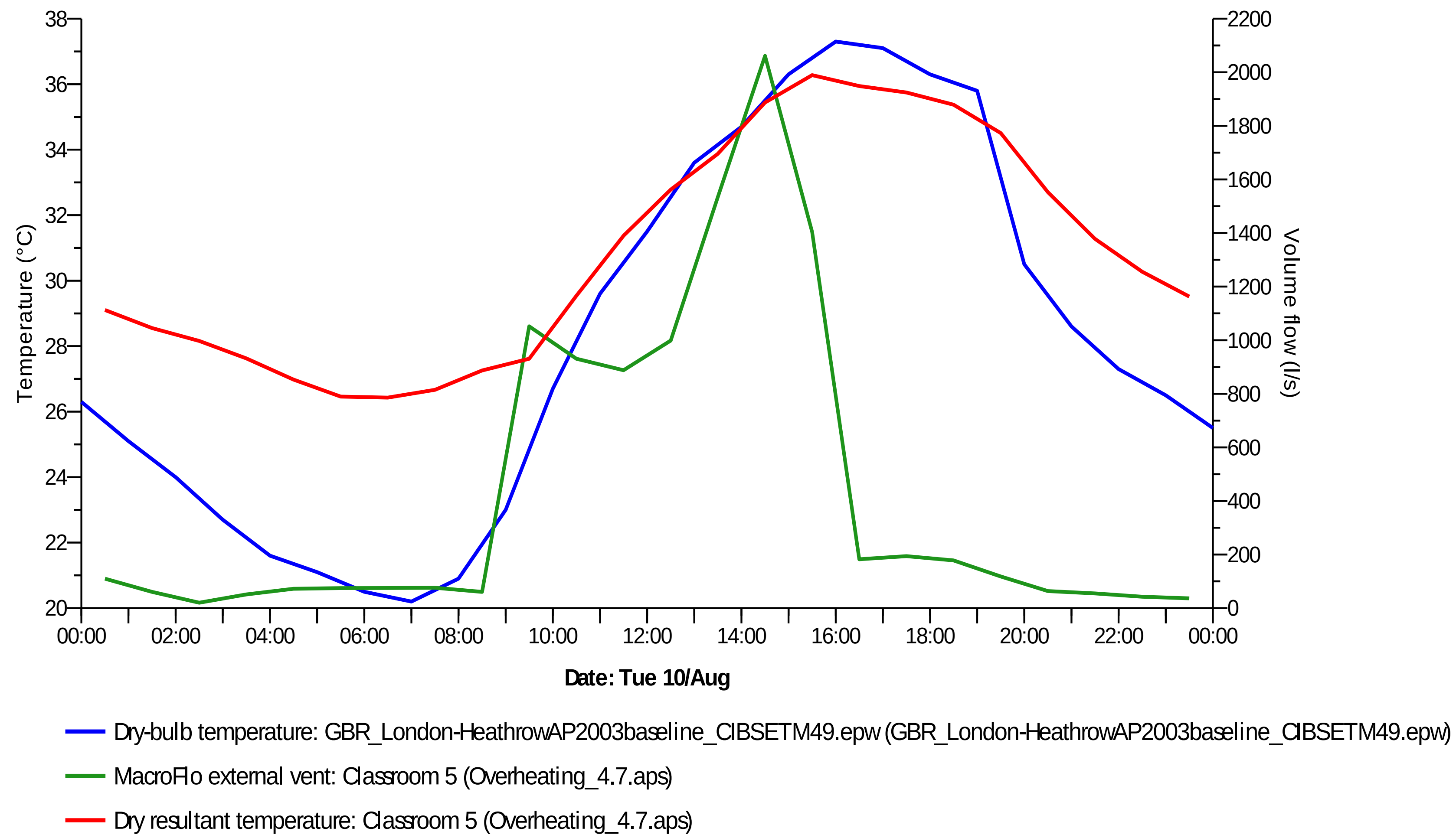


Figure 6.4 – Peak Day Graph. Outdoor dry bulb temperature (T_{db} in blue) with indoor dry resultant temperature (T_{op} in red) and external ventilation flow rate (in green) - Classroom 5 on August 10th (2003 DSY)

6.4 Daylighting

Orientation of the glazing and provision of shading devices where appropriate is key to an effective daylighting strategy. For example, north facing glazing can be extremely useful for providing daylight as there is no direct sunlight incident on this orientation, and thus shading is only required when necessary to reduce internal light levels. On the other hand, west-facing glazing needs to be carefully selected to ensure the thermal performance is adequate, and consideration given to the shading provisions as this is critical to limiting solar gains in the afternoon – the time of highest air temperatures – as well as providing glare control.

As such, we have been looking in detail at glazing areas, specifications and locations on each façade, as well as potential shading options, to develop an elevation scheme which will maximise the passive benefits of daylight and winter-time solar gain; while minimising the risks of excessive solar gain and ensuring compliance with Criterion 3 of the Building Regulations part L2.

In order to enhance daylighting in the main areas, the school features full height glazing on the exposed classroom walls, as well as significant glazing in the halls, studios and foyer spaces. Early modelling indicated that the south facing classrooms on the first floor experienced higher levels of solar gain in the summer. To counteract this, a small overhang was incorporated – shading the rooms from the high summer sun, while still allowing wintertime passive solar heating and having a minimal impact on daylight levels. The overhanging offices on the first floor provide significant shading to the hall and ground floor foyer. Other architectural features, such as the external perimeter wall and the perforated metal facade, have also helped maintain good daylight while controlling solar gains and glare.

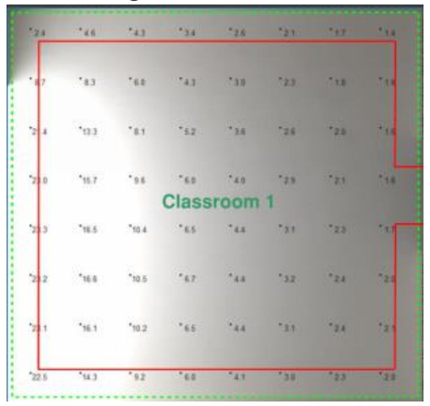
Since the building is slightly offset to the west, it was immediately apparent that shading from the lower afternoon sun would be critical in order to avoid summertime overheating. For this reason, it has been proposed that exposed west facades make use of vertical shading fins, particularly the studio on the first floor. This aesthetically favourable shading device restricts the solar energy incident on the glazing. The surrounding perimeter border of the school has been designed using a mixture of opaque shading, perforated metal sheeting and large openings. These features have been strategically positioned around the development in order to provide shading were required, while still admitting daylight.

The building model used in the energy assessment features an average glazing area of 30% of the façade area, which reflects the proposed glazing strategy used for early stage daylighting calculations and provides a balance between adequate daylight and controlled solar gains, as well as remaining within the planning guidance.

Results

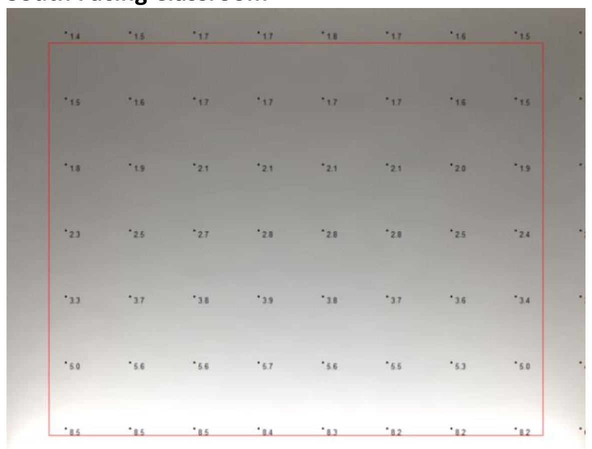
'Building Bulletin 90: Lighting Design in Schools' states that interiors with an average daylight factor of 5% or more may be considered day lit rooms and will not normally require electric lighting. Those below 2% will require frequent use of electric lighting, whilst interiors between 2% and 5% will require some electric lighting between October and March.

West Facing Classroom



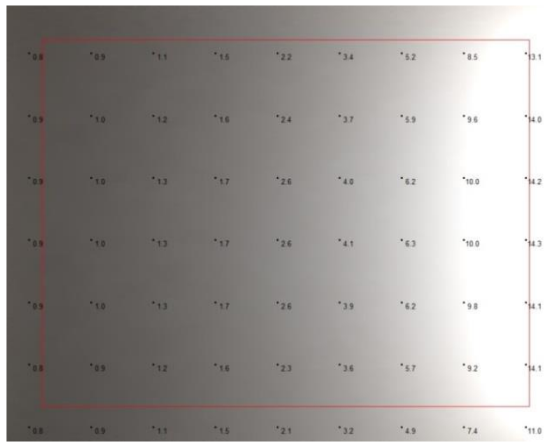
Average DF: 5.97

South Facing Classroom



Average DF: 3.47

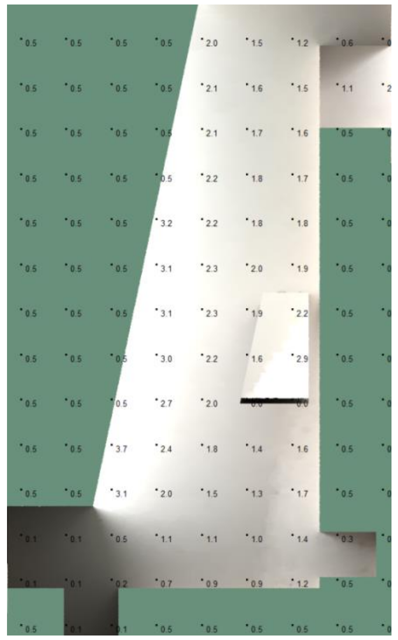
East Facing Classroom



Average DF: 4.23

Figure 6.5 – Daylighting results for classrooms

Ground floor Foyer



Average DF: 1.13

Figure 6.6 – Daylight factors in the circulation space

Average DF: 7.98

Figure 6.6 – Daylight factors in the hall

Classrooms
The results from our early stage daylighting simulations highlight the effect of building orientation on the daylight factors. East and west facing classrooms boast higher average daylight factors, whilst the south facing classrooms display more evenly distributed daylight levels.

Circulation Spaces
Despite having a more complex geometry than the teaching spaces, these areas display generous daylight levels, as seen in Figure 6.6. This is thanks to the full height glazing spread across the west façade. It can also be noted, however, that daylight does not reach certain areas, particularly the SW end of the foyer. It is for this reason that the average daylight factor is slightly lower than other rooms.

We have since added skylights in strategic areas in order to tackle the daylight limitations highlighted in the early stage simulations. Through this addition we expect to improve the overall daylight factor of the foyer, whilst enhancing the uniformity of daylight distribution across these circulation spaces.

Halls
A mixture of glazing and louvred openings has proved successful in providing excellent daylight levels in the ground floor hall space. The daylight factor averages at 7.98 and is seen to be evenly distributed across the entire floor space.

6.5 Active measures

Mechanical ventilation with heat recovery
Where mechanical ventilation is required – such as WCs – fans will be local to the areas served to minimise specific fan power; and will incorporate heat recovery, so that heat is transferred from the warm extract air to the cold supply air during the heating season.

Mechanical ventilation will be demand and occupancy controlled, with background and boost modes.

Energy efficient lighting
Where daylight is not sufficient, lighting will be provided by high efficiency LED sources. Linear LED is proposed in the teaching spaces and occupied areas, with some allowance for feature lighting in the active circulation and school entrance. Classrooms will be equipped with daylight dimming controls and the main spaces within the school will have zonal lighting control and occupancy sensors.

The lighting control strategy will be developed with due consideration to BREEAM zoning requirements, to maximise the use of daylighting and to avoid the unnecessary use of lights when spaces are unoccupied. A networked lighting control system is to be provided.

Control is proposed generally as follows:

- Classrooms: Luminaires circuited in rows parallel to the external façade. Manual on with auto-off absence detection and daylight dimming.
- Circulation: Manual-on auto-off occupancy detection
- WCs: Auto-on Auto-off occupancy detection
- Stores and plant: Manual control

Controls
A central BMS will be provided to monitor system alarms, log energy use data, and control the HVAC systems. This coordinated and coherent control approach will ensure systems operate most efficiently and their operation is coordinated with each other to avoid opposing systems 'fighting' each other.

This approach will also enable other energy-saving strategies to be employed, such as weather compensation and optimised start stop heating control.

6.6 Carbon Breakdown – Be Lean

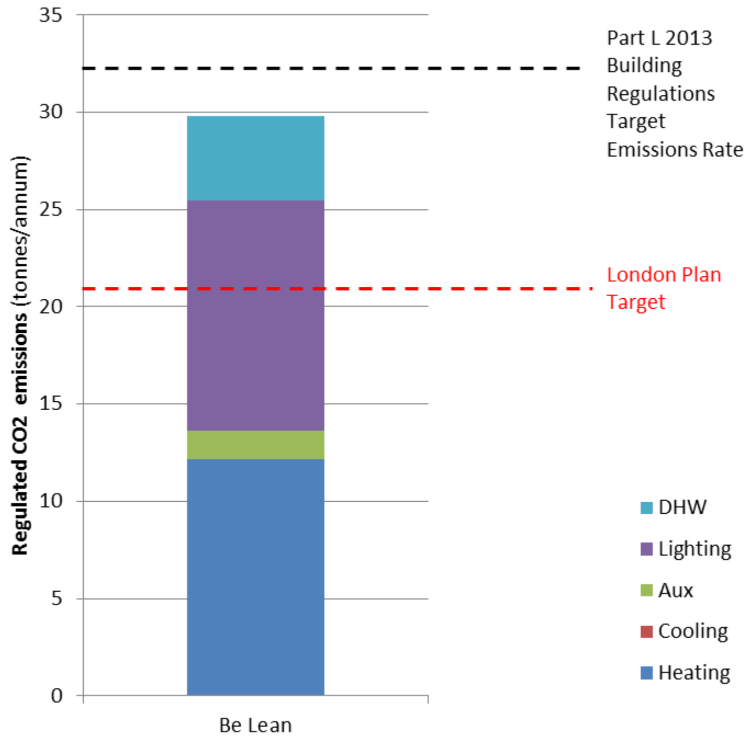


Figure 6.7 – 'Be Lean' Carbon Breakdown

The results for the 'Be Lean' strategy are shown in Table 1.1 and Table 1.2. The figures demonstrate compliance with the Building Regulations part L2A 2013 simply from the passive and active sustainability measures proposed. This puts the development in an excellent position to achieve compliance with the London Plan at the second and third stages of the energy hierarchy.

7.0 EFFICIENT ENERGY SUPPLY: BE CLEAN

As part of the second stage of the energy hierarchy, Policy 5.6 of the London Plan states that proposals should select energy systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks
2. Site wide CHP network
3. Communal heating and cooling

7.1 District Heating

For this development, we are proposing to connect to an existing nearby district heating network. In this way, heat energy is generated at a central location and then supplied to end users in the surrounding area. The aim is to minimise the amount of plant required for individual end users whilst improving system efficiency by generating heat on a large scale at one location. All pipework and equipment required for this system will also be sized accordingly in order to cater for future 2FE expansion.

7.2 Combined Heat and Power

A Combined Heat and Power (CHP) involves the cogeneration of heat and electricity, typically by recovering the waste heat generated in the production electricity, and using it for space heating and hot water.

An assessment of the district heat network and its potential expansion to cover the Central Somers Town masterplan development has been undertaken by Arup. The fact that the existing district heating network expansion will not only cater for the primary school development, but also a number of new developments in the vicinity, as well as its existing load, will provide the base load heating demand necessary to make a CHP system economical.

Arup have estimated that the CHP engines would provide approximately 60% of the network's heat, and has suggested that the CHP would have a power efficiency of 35.7% and thermal efficiency of 39.5%. These figures have been used to calculate the carbon dioxide emissions factors and primary energy factors used in the energy assessment, calculated in conjunction with the factors for electricity and gas in Part L 2013 of the Building Regulations, as set out in the NCM 2013 guidance.

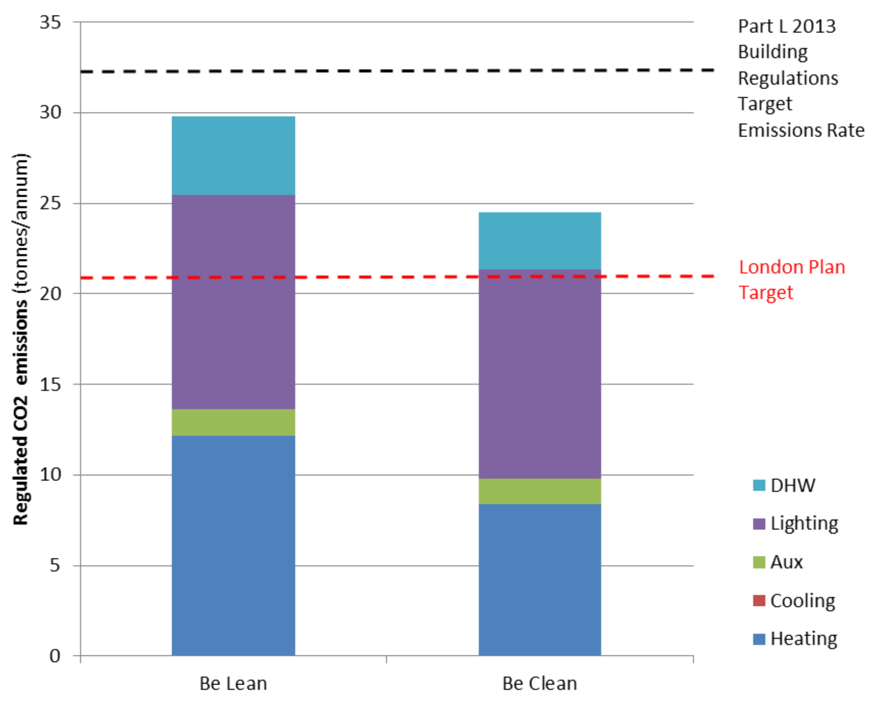


Figure 7.1 – 'Be Clean' Carbon Breakdown

By connecting to a District Heating network that will incorporate CHP, the CO_2 emissions were further reduced by 16.3% when compared to the Part L 2013 baseline TER.

MAX FORDHAM

8.0 RENEWABLE ENERGY: BE GREEN

Within the framework of the energy hierarchy, proposals should provide a reduction in expected CO_2 emissions through the use of on-site renewable energy generation. A study was undertaken to investigate which renewable technologies were most suitable for the development. This assessment concluded that the most appropriate and effective way to deliver the renewable energy target on this development would be through the addition of solar photovoltaic (PV) panels. A summary of those renewable technologies deemed unfeasible for this development can be found in Appendix A.

8.1 Solar Photovoltaic (PV) Panels

PVs convert energy from sunlight directly into electricity. The main advantage, particularly over solar thermal, is that the generated electricity can be used for a wider range of applications than hot water and can also be exported to the National Grid. Furthermore, electricity can be considered a more valuable energy source than heat in terms of CO_2 emissions. For these reasons, PVs can be easily integrated into most schemes.

Current 'feed-in-tariff' rates and decreasing costs of PV cells for on-site electrical generation mean that PV installations are currently a relatively economic renewable energy technology.

The development has $200m^2$ of roof area allocated to PV panels. This roof space - above the studio – was designed to have a slope of around 6°. We've assumed that the panels will be mounted to this inclination, in order to avoid self-shading. Since the building is oriented slightly South-West, an azimuth of 150° from horizontal was calculated.

Using polycrystalline panels with a nominal efficiency of 11% and a total area of $150m^2$ – allowing 25% of the roof space for access and maintenance –the emissions are reduced against the Baseline TER by a further 19.6%, resulting in a cumulative offset of 38.5% from the Building Regulations TER, and compliance with the planning requirement for a 20% contribution from on-site renewable technology. This area of PV modules is estimated to generate 12.22MWh/year.

Providing $150m^2$ of PV panel leaves an additional $50m^2$ of free roof space to allow for access and maintenance around the panels. An indicative layout is illustrated in Figure 8.1.

Considerations have been made regarding the future proofing of the renewable energy system, in the event that the school development undergoes extension to 2FE. While we cannot predict the regulations and energy targets that will be in place in the future, we are confident that the 2^{nd} storey will provide the roof space required for any additional PV panels required.

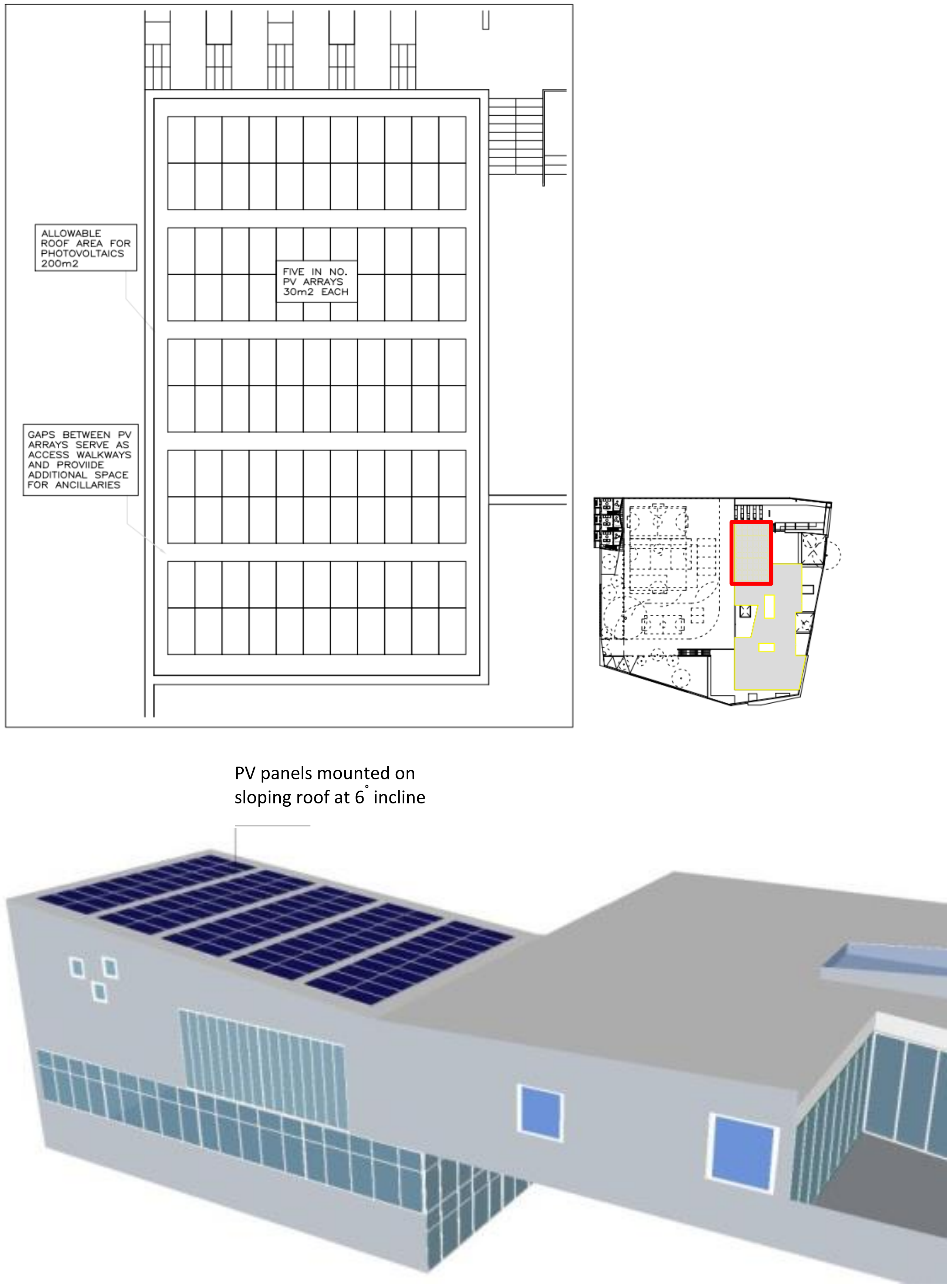


Figure 8.1– PV panel layout

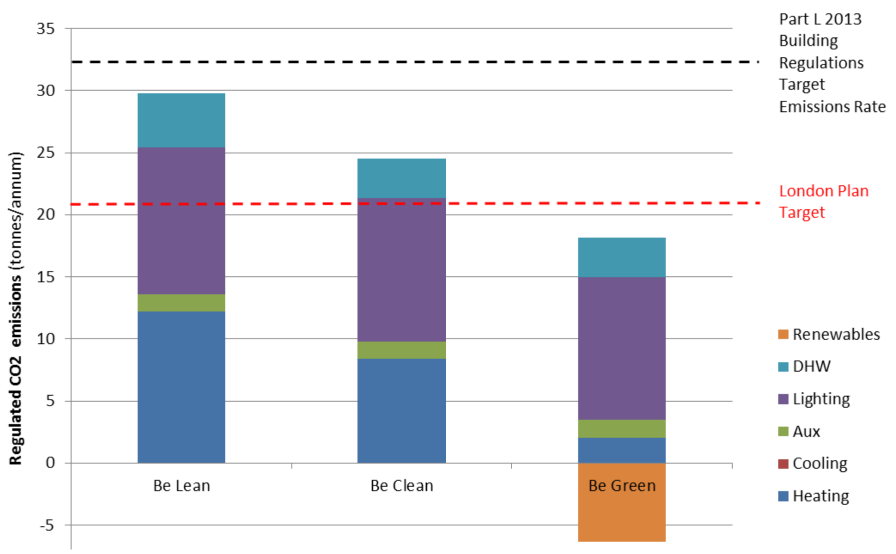


Figure 8.2 – 'Be Green' Carbon Breakdown

Using 150m[2] of photovoltaic modules, CO_2 emissions of the development were reduced by a further 19.6%, resulting in an overall reduction compared to the Part L baseline TER of 44% - thus achieving London Plan targets and providing a surplus of 9%.

8.2 Assessment of Suitability of Different Green Technologies

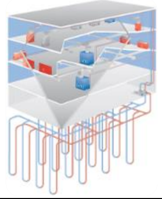
During initial stages of energy modelling, various low-to-zero carbon technologies (LZCTs) were assessed in order to compare their specific strengths and weaknesses and finally select the most feasible technology.

The initial energy model was created using estimated annual hourly demand profiles. As this work was undertaken prior to the development of architectural plans, figures typical to the building type were used, and consequently the results should be viewed as most valuable in relative terms to each other, rather than as absolute accurate predictions of energy consumption or reduction.

Results and a summary of those technologies deemed suitable for this development are presented in Table 8.1. Other green technologies were considered, but were not deemed feasible. These are summarised in Appendix A.

Heat Pumps
From our early stage assessment, heat pumps were found to be a potentially feasible form of green technology. Heat pumps can be used to extract heat from a heat source at one temperature and provide heat to a heat sink at a different temperature.

Despite performing well in this initial assessment, it was decided not to propose the use of heat pumps primarily due to the availability of a district heating network in the vicinity. As well as being more compliant with the requirements of the London Plan, connection to this network was selected for a number of reasons: It was an existing network – therefore much of the infrastructure and plant was already manufactured and operational, thus reducing the embodied energy of the heating solution. In addition, an assessment of the network and its suitability for CHP was already underway – by connecting to the network it provided a greater baseline heat load for the network, thus more justification for the installation of CHP and the consequent carbon emissions savings this would provide across all the buildings already on the network. This approach has been borne out in that it has now been confirmed that CHP technology will be installed in the energy centre for the network prior to the completion of the Somers Town redevelopment.

	 Solar PV	 GAHP	 GSHP
Input	Solar radiation	Gas and heat from air	Electricity and heat from the ground
Efficiency	~15% of incident solar radiation converted to electricity	GUE ~1.5	COP ~4 1 $kWh_{elec\ in} \rightarrow$ 4 $kWh_{heat\ out}$
Output	Electricity	Heat	Heat
Renewable	Yes	Depends on source of gas	Depends on source of electricity
Carbon emissions	None [1]	0.216 kg $CO_2/kWh_{gas\ in}$ [2]	0.519 kg $CO_2/kWh_{elec\ in}$ [2]
Location	External, mounted on roof or sides of building	External, roof	Internal, plant room
Approx. capital costs	~£350/m²	£800/kW	~£800/kW (HP) ~£2200/kW (borehole)
Uses	Electricity can be either used by the building or sold to the grid	Heat used for space heating and/or domestic hot water pre-heat	Heat used for space heating and/or domestic hot water pre-heat
Advantages	• Easy to install • Easy to connect services • Light-weight, low plant space requirement • Zero carbon electricity • Easy "bolt-on" renewable technology • Modular, additional modules can be added in the future	• Heat extracted from renewable source (air) • Low running cost • Reduced capital cost compared to GSHP as no boreholes required	• Heat extracted from renewable source (ground) • Low running cost • Low plant space requirement • Low maintenance • Suitable for low temperature heating • No loss of efficiency in cold weather
Disadvantages	• Relatively low efficiency compared to solar thermal • High capital cost • Large area of panels required to generate meaningful amount of electricity • Requires direct sunshine to function efficiently	• Efficiency falls in cold weather when heating demand peaks • Large heating emitters required for low temperature heat, or • Efficiency reduces as flow temperature increases.	• Boreholes have high capital cost • Risk as to whether can achieve predicted yield from ground • Or, collector loop requires large site area • Large heat emitters required for low temperature heating

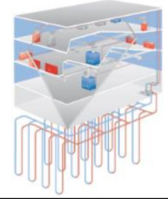
	 Solar PV	 GAHP	 GSHP
Issues	If placed on roof of school may be visible from taller residential development	May have visual impact if placed on school roof because will be visible from dwellings. Noise from GAHP also needs to be considered.	Hydro-geologist survey required. Abstraction rate may vary. Boreholes very expensive.
CO_2 savings	12%	16%	15%
Energy generated from LZCT per year	27,445 kWh	207,434 kWh	207,434 kWh
Energy used	19,325 kWh	207,434 kWh	207,434 kWh
Energy exported	8120 kWh	none	none
Size	216 m² of PV covering ~400 m² of roof area 40 kW_{peak}	2nr x 40 kW ~10 m² roof area	60 kW Heat pump in basement
Annual saving	£6030	£9282	£21,431
Capital cost	£75,600	£64,000	£180,000
Simple payback	18 years	7 years	9 years
Suitable for development	**Yes**	**Yes** – could be used for space heating	**Yes** – could be used for space heating

Table 8.1 – Summary of suitable LZCTs and results of the initial energy modelling

[1] If carbon emissions from manufacturing are ignored
[2] Values for emissions factors taken from National Calculation Methodology 2013

9.0 WHOLE SCHEME ENERGY PERFORMANCE

By incorporating the strategies outlined in this report it is expected that the whole scheme's regulated carbon performance will be 44% below the 2013 Part L target. This gives an 9% annual surplus on the London Plan requirement for a 35% reduction in carbon emissions.

Table 9.1: Carbon dioxide emissions after each stage of the Energy Hierarchy

	Carbon dioxide emissions (Tonnes CO2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	32.4	17.96
After energy demand reduction	29.8	17.96
After CHP	24.5	17.96
After renewable energy	18.2	17.96

Table 9.2: Regulated carbon dioxide savings from each stage of the Energy Hierarchy

	Regulated Carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	2.6	8.1
Savings from CHP	5.3	16.3
Savings from renewable energy	6.3	19.6
Total Cumulative Savings	14.3	44.0
Total Target Savings	11.3	35%
Annual Surplus	2.9	9.0 %

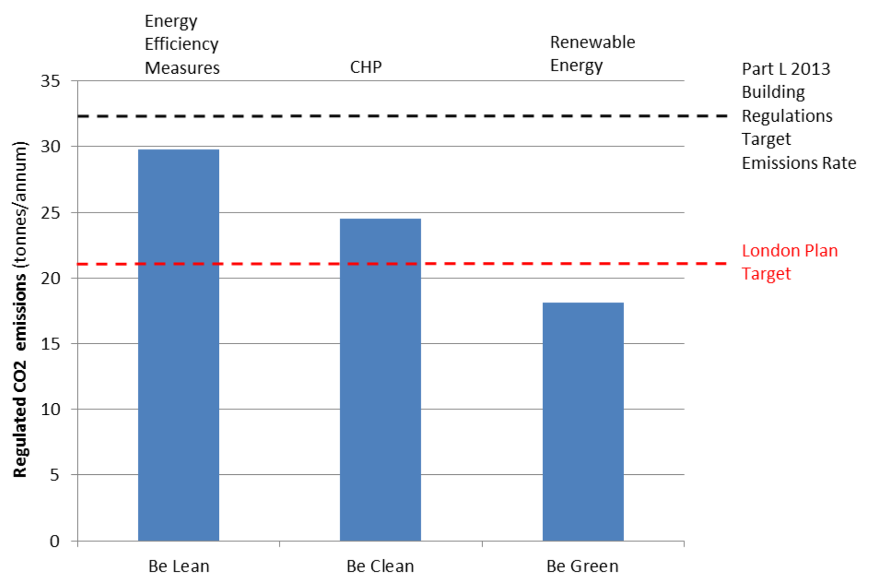


Figure 9.1 – The Energy Hierarchy

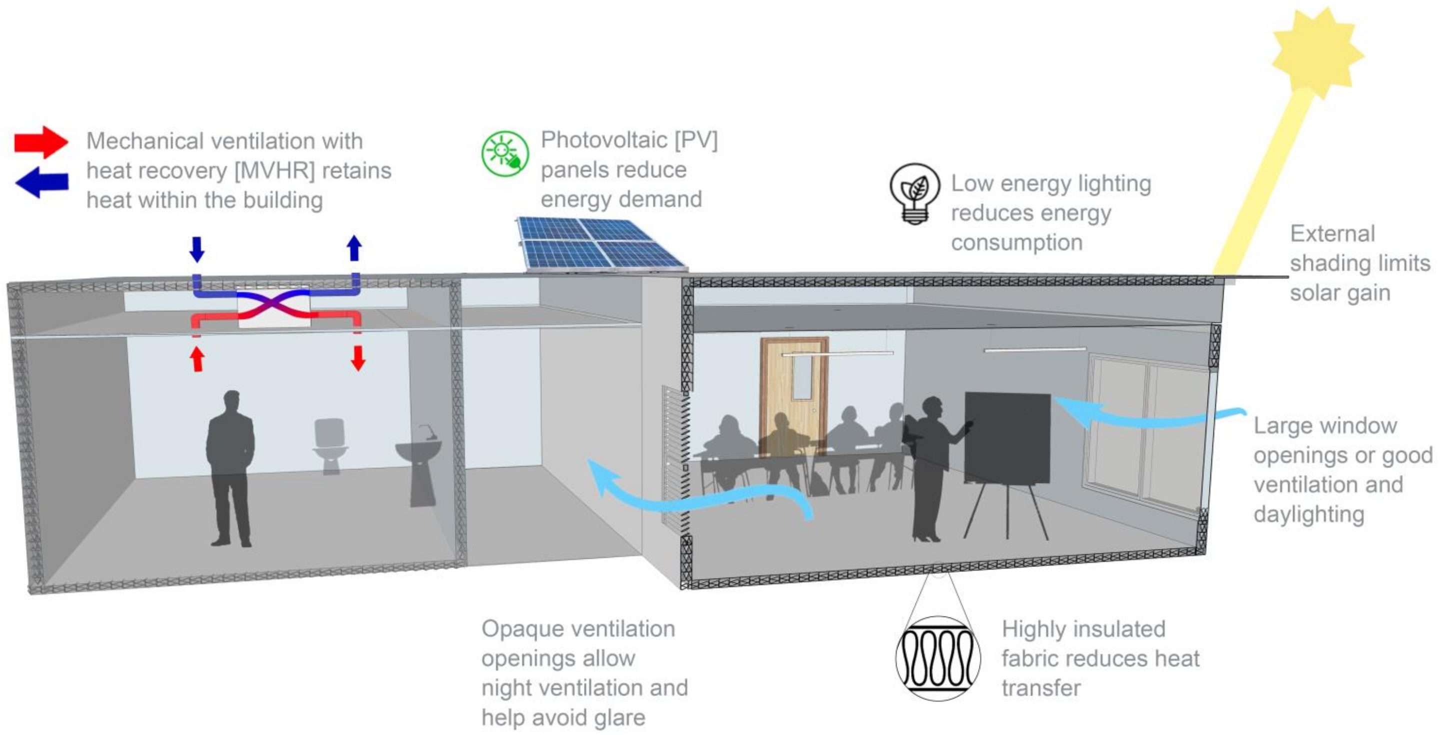


Figure 9.2 – Sustainability strategy for Edith Neville Primary School

10.0 APPENDIX A - UNFEASIBLE RENEWABLE TECHNOLOGIES

Solar Thermal
Solar energy can be used to heat water to be used for domestic hot water purposes. There are two general types of collector – flat plate collectors (FPC) and evacuated tube collectors. Evacuated tube collectors are more efficient than FPC due to heat loss by convection reduced by the vacuum inside the collector.

Solar thermal collectors are usually mounted on the roof of a building. A pump circulates fluid through the collector to either a heat exchanger, a coil in a hot water cylinder or a separate tank. The fluid heats up in the solar collector and the heat is transferred to water through the heat exchanger or coil in the cylinder.

As well as the obvious financial benefit of reducing heat energy bills, the government provides a Renewable Heat Incentive (RHI) which is a tariff paid for every unit of heat used from solar thermal technology.

Solar thermal systems are most suited to developments that have a large domestic hot water demand all year round. This suggests solar thermal collectors may not be suitable for the school which has a low hot water demand, especially so during the summer holidays when it is likely to be unoccupied.

Wind
A wind turbine extracts energy from the wind. The rotary motion of the turbine is used to drive an electrical generator. Electricity can then be either exported to the grid or used directly onsite. In addition, a FIT is available for all electricity generated from wind energy. Broadly, wind technology can be divided into two types – large scale and small scale.

Large scale wind turbines with blade diameters on the order of 10 to 100 m and generators up to 10 MW must be sited in open, non-urban areas where average wind speeds are high. This technology is not suitable for integration into and urban development and is deemed not feasible for Edith Neville Primary School.

It is possible for smaller wind turbines with generators on the order of kilowatts to be situated in urban areas and even mounted on buildings. However, installing wind turbines on buildings can lead to problems with vibrations from the WTG and require that the structure of the building be reinforced to cope with the added physical loads produced as the WTG harvests energy from the wind.

Water
There are various places where the movement of water can be used to generate electricity either by using turbines to extract energy from the flow of water or otherwise. These include wave, tidal and hydroelectric generation from the flow of water from one location to another. However, Edith Neville Primary School is not situated in a location where the flow of water is accessible. Therefore this technology is not feasible

Biomass
Biomass boilers involve the combustion of organic materials to produce heat. Such organic material used for fuel may include woodchips or pellets. To run a biomass boiler requires the regular delivery of fuel and suitable provision on-site to store the fuel. As the client seeks to "maximise the net sellable area of the development" where possible, biomass technology is deemed un-feasible due to the storage requirements and potential for impact on the local air quality.

Low or Zero Carbon Category	Low or Zero Carbon Technology	Feasibility
Solar	Solar photovoltaics	**Yes**
	Solar thermal	**No**
Wind		**No**
Water		**No –** There are no local water sources that can be used to generate hydro, tidal or wave power.
Heat pumps	Ground source heat pump	**Yes**
	Water source heat pump	**No –** There are no local water sources that can be used to extract heat from or reject heat to.
	Air source heat pump	**Yes**
Biomass	Woodchip fired boiler Pellet fired boiler	**No –** Reasons for discounting these technologies are two-fold: • The logistical inconvenience of delivering the fuels to a city centre location and • Space constraints make use of significant area for fuel storage undesirable.
CHP	Natural gas	**Yes**
	Biomass	**No** – see category Biomass
District heating	Natural gas	**Yes**
	CHP	**Yes**
	Biomass	**No** – see category Biomass

Table4.1 List of possible LZCTs

			
	Solar Thermal (ST)	**Wind**	**ASHP**
Input	Solar radiation	Wind	Electricity and heat from the air
Output	Heat	Electricity	Heat
Efficiency	~40-80% of incident solar radiation converted to heat	~30% of wind through turbine swept area converted to electricity	COP ~2 to 5
Renewable	Yes	Yes	Depends on source of electricity
Carbon emissions	None[1]	None[1]	0.519 kg CO_2/kWh$_{elec\ in}$[2]
Approx. capital costs	~£625/m²	~£5000/kW	~£800/kW
Location	External, mounted on roof or sides of building	External, mounted on roof	External
Uses	Heat used for space heating and/or domestic hot water	Electricity can be either used by the building or sold to the grid	Heat used for space heating and/or domestic hot water pre-heat
Advantages	• Zero carbon heat generated • Light-weight • More efficient than PV	• Zero carbon electricity • Low plant space requirement	• Heat extracted from renewable source (air) • Low running cost • Reduced capital cost compared to GSHP as no boreholes required
Disadvantages	• Requires more maintenance than PV • No way to sell surplus energy like PV or wind	• Zero carbon electricity • Acoustics • Structural requirements for wind loadings • Structural requirements for anti-vibration • Supply may not match demand	• Efficiency falls in cold weather when heating demand peaks • Large heating emitters required for low temperature heat, or • Efficiency reduces as flow temperature increases.

			
	Solar Thermal (ST)	**Wind**	**ASHP**
Issues	If placed on roof of school may be visible from taller residential development. May need to have method of heat rejection to avoid over-heating. Will be periods during summer when there is no demand due to school holidays.	May have visual impact if placed on school roof because will be visible from dwellings. Tall building may affect local wind speed. Structure of the building must be strong enough to withstand loads from the wind turbine.	May have visual impact if placed on school roof because will be visible from dwellings. Noise from ASHP also needs to be considered.
CO_2 savings	8%	4%	11%
Energy generated from LZCT per year	91,484 kWh	8184 kWh	207,434 kWh
Energy used	39,292 kWh	6686 kWh	207,434 kWh
Energy exported	52,188 kWh (rejected)	1498 kWh	none
Size	216 m² solar collector covering ~400 m² of roof area	10 kW 6 m diameter 9 m height	2nr x 30 kW ~10 m² roof area
Annual saving	£5887	£1980	£7303
Capital cost	£135,000	£50,000	£60,000
Simple payback	23 years	25 years	9 years
Suitable for development	**No –** using the same roof space, solar PV can reduce CO_2 emissions by 25% compared to 11% from solar thermal	**No –** The issues with noise from the WTG, the effect on the structure of the building and the low carbon reduction potential make this LZCT unsuitable.	**No** – more expensive and lower carbon savings than GAHP when used for space heating

Table A2 – Summary of LZCTs that were not deemed feasible for this development and results of the initial energy modelling

[1] If carbon emissions from manufacturing are ignored
[2] Values for emissions factors taken from National Calculation Methodology 2013

11.0 APPENDIX B: BRUKL OUTPUT REPORTS

11.1 Be Lean

11.0 APPENDIX B: BRUKL OUTPUT REPORTS

11.1 Be Lean

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Edith Neville Primary School

As designed

Date: Thu Nov 05 12:44:45 2015

Administrative information

Building Details

Address: 174 Ossulsten Street
London NW1 1DN

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.4

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.4

BRUKL compliance check version: v5.2.d.2

Owner Details

Name: London Borough of Camden

Telephone number: 020 7974 2986/4903

Address: 5 Pancreas Square
London, N1C 4AG

Certifier details

Name: Max Fordham LLP

Telephone number: 020 7267 5161

Address: 42-43 Gloucester Crescent
London, NW1 7PE

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	14.2
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	14.2
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	13.1
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 the building services should achieve reasonable overall standards of energy efficiency

Values not achieving 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	0.15	0.15	KT000000:Surf[2]
Floor	0.25	0.13	0.13	KT000000:Surf[0]
Roof	0.25	0.13	0.13	KT000000:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.41	2.97	HD000000:Surf[22]
Personnel doors	2.2	1.8	1.8	LR000000:Surf[32]
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

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Kitchen

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	1.1	-
Standard value	0.91	N/A	N/A	1.1^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

^ Allowed SFP may be increased by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

2- Teaching Spaces

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

3- Toilets

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.7
Standard value	0.91*	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

4- Interview+Front Office

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

5- Server+Sickbay

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.5	3.2	0	0	0.7
Standard value	2.5*	3.2	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

"No HWS in project, or hot water is provided by HVAC system"

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting	**Luminous efficacy [lm/W]**			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Kitchen	-	72	-	1766

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Corridor	-	133	-	165
Acc WC	-	174	-	65
Staging	120	-	-	12
PE Equipment	102	-	-	23
Tables + Chairs Store	67	-	-	53
Large Hall	80	-	-	746
Small Hall	80	-	-	670
WC	-	174	-	35
WC	-	174	-	29
Nursery Group	80	-	-	137
Nursery	80	-	-	527
Kitchen	120	-	-	101
WC Wash	-	174	-	52
Utility	-	174	-	75
Buggy Store	120	-	-	12
2 YO	80	-	-	332
2 YO Corridor	-	174	-	67
Corridor	-	241	-	22
Hygiene	-	118	-	134
Caretaker	80	-	-	116
Lift	120	-	-	9
Wellbeing	80	-	-	107
Staff PPA	80	-	-	176
Shower	-	174	-	41
Acc WC	-	122	-	125
WC	-	174	-	51
Parents Room	80	-	-	197
Drop In	80	-	-	470
Office	80	-	-	174
Corridor	-	241	-	20
Buggy Store	93	-	-	19
Interview	94	-	-	99
Deputy Head	80	-	-	174
Group 1	80	-	-	102
WC	-	145	-	95
Ext Store	95	-	-	22
Classroom 1	80	-	-	435
Store	116	-	-	14
WC	-	137	-	103
Classroom 2	80	-	-	451
Group 2	80	-	-	90
BM	80	-	-	169
Front Office	66	-	-	268

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Stock	120	-	-	12
Sick Bay	117	-	-	109
Foyer/Lobby	-	100	-	611
Foyer/Lobby	-	87	-	393
Foyer/Lobby	-	110	-	168
Studio	80	-	-	495
Studio	80	-	-	402
Acc WC	-	118	-	52
SEN	80	-	-	86
Cleaner	94	-	-	8
WC	-	74	-	185
Headteachers Office	80	-	-	280
Classroom 7	80	-	-	375
Classroom 6	80	-	-	375
Staff Room	80	-	-	372
Server	87	-	-	34
Lift	82	-	-	9
WC	-	75	-	166
Classroom 5	80	-	-	375
Classroom 4	80	-	-	368
Classroom 3	80	-	-	372
Foyer	-	83	-	885
Studio2	80	-	-	58
Studio2	80	-	-	0
CHP	80	-	-	35
Plant Room	62	-	-	73
Table Store	69	-	-	15

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?
Large Hall	NO (-30.9%)	YES
Small Hall	NO (-66.8%)	YES
Nursery Group	N/A	N/A
Nursery	NO (-97%)	YES
Kitchen	N/A	N/A
2 YO	NO (-53.9%)	YES
Caretaker	N/A	N/A
Wellbeing	NO (-56.1%)	YES
Staff PPA	NO (-70.5%)	YES
Parents Room	NO (-83.2%)	YES
Drop In	NO (-54%)	YES
Office	N/A	N/A
Interview	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Deputy Head	NO (-21.4%)	YES
Group 1	NO (-18.6%)	YES
Classroom 1	NO (-20.7%)	YES
Classroom 2	NO (-56.7%)	YES
Group 2	NO (-94.9%)	NO
BM	N/A	N/A
Front Office	N/A	N/A
Sick Bay	N/A	N/A
Studio	NO (-69.3%)	YES
Studio	NO (-56.3%)	YES
SEN	NO (-82.5%)	YES
Headteachers Office	NO (-55.7%)	YES
Classroom 7	NO (-71.9%)	YES
Classroom 6	NO (-52.8%)	YES
Staff Room	NO (-52.4%)	YES
Server	N/A	N/A
Classroom 5	NO (-82.6%)	YES
Classroom 4	NO (-61%)	YES
Classroom 3	NO (-83.8%)	YES
Studio2	NO (-88.3%)	YES
Studio2	NO (-90.8%)	YES

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	2267.4	2267.4
External area [m^2]	4167.6	4167.6
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	1428.97	1842.7
Average U-value [W/m^2K]	0.34	0.44
Alpha value* [%]	9.82	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 Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
100	**D1 Non-residential Inst.: Education**
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: 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	24.65	29.53
Cooling	0.01	0.01
Auxiliary	1.24	1.04
Lighting	10.25	11.23
Hot water	8.8	7.37
Equipment*	15.65	15.65
TOTAL**	**44.95**	**49.18**

* Energy used by equipment does not count towards the total for 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]	76.41	92.2
Primary energy* [kWh/m^2]	75.54	82.15
Total emissions [kg/m^2]	13.1	14.2

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	85.5	0	27.8	0	1.2	0.85	0	0.91	0
	Notional	101.5	0	32.7	0	0.9	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	33.5	0	10.9	0	1.2	0.85	0	0.91	0
	Notional	45.2	0	14.6	0	1.2	0.86	0	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	108.9	10.2	12.3	1.9	0	2.45	1.49	2.5	2
	Notional	140.5	13.8	15.3	1	0	2.56	3.79	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	146.7	0	47.7	0	0.7	0.85	0	0.91	0
	Notional	202.6	0	65.3	0	0.7	0.86	0	----	----
[ST] Central heating using air distribution, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	43.1	0	12.3	0	7.2	0.98	0	0.91	0
	Notional	75.9	0	24.4	0	8.4	0.86	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	**U_{i-Typ}**	**U_{i-Min}**	**Surface where the minimum value occurs***
Wall	0.23	0.15	KT000000:Surf[2]
Floor	0.2	0.13	KT000000:Surf[0]
Roof	0.15	0.13	KT000000:Surf[1]
Windows, roof windows, and rooflights	1.5	1.4	LR000000:Surf[1]
Personnel doors	1.5	1.8	LR000000:Surf[32]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

U_{i-Typ} = Typical individual element U-values [W/(m²K)]

U_{i-Min} = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
m³/(h.m²) at 50 Pa	5	3

11.2 Be Clean

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Edith Neville Primary School

As designed

Date: Thu Nov 05 13:34:30 2015

Administrative information

Building Details

Address: 174 Ossulsten Street
London NW1 1DN

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.4

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.4

BRUKL compliance check version: v5.2.d.2

Owner Details

Name: London Borough of Camden

Telephone number: 020 7974 2986/4903

Address: 5 Pancreas Square
London, N1C 4AG

Certifier details

Name: Max Fordham LLP

Telephone number: 020 7267 5161

Address: 42-43 Gloucester Crescent
London, NW1 7PE

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	11.8
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	11.8
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	10.7
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 the building services should achieve reasonable overall standards of energy efficiency

Values not achieving 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	0.15	0.15	KT000000:Surf[2]
Floor	0.25	0.13	0.13	KT000000:Surf[0]
Roof	0.25	0.13	0.13	KT000000:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.41	2.97	HD000000:Surf[22]
Personnel doors	2.2	1.8	1.8	LR000000:Surf[32]
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

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Kitchen

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	1.1	-
Standard value	0.91	N/A	N/A	1.1^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
^ Allowed SFP may be increased by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

2- Teaching Spaces

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

3- Toilets

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	0	0.7
Standard value	N/A	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

4- Interview+Front Office

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

5- Server+Sickbay

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.5	3.2	0	0	0.7
Standard value	2.5*	3.2	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					

"No HWS in project, or hot water is provided by HVAC system"

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Sick Bay	-	-	-	-	-	0.4	-	-	-	-	N/A
Server	-	-	-	-	-	0.4	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Kitchen	-	72	-	1766
Corridor	-	133	-	165
Acc WC	-	174	-	65
Staging	120	-	-	12
PE Equipment	102	-	-	23
Tables + Chairs Store	67	-	-	53
Large Hall	80	-	-	746
Small Hall	80	-	-	670
WC	-	174	-	35
WC	-	174	-	29
Nursery Group	80	-	-	137
Nursery	80	-	-	527
Kitchen	120	-	-	54
WC Wash	-	174	-	52
Utility	-	174	-	75
Buggy Store	120	-	-	12
2 YO	80	-	-	332
2 YO Corridor	-	174	-	67
Corridor	-	174	-	30
Hygiene	-	118	-	134
Caretaker	80	-	-	116
Lift	120	-	-	9
Wellbeing	80	-	-	107
Staff PPA	80	-	-	176
Shower	-	174	-	41
Acc WC	-	122	-	125
WC	-	174	-	51
Parents Room	80	-	-	197
Drop In	80	-	-	470
Office	80	-	-	174
Corridor	-	174	-	28
Buggy Store	93	-	-	19
Interview	94	-	-	79
Deputy Head	80	-	-	174
Group 1	80	-	-	102
WC	-	145	-	95
Ext Store	95	-	-	22

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Classroom 1	80	-	-	435
Store	116	-	-	14
WC	-	137	-	103
Classroom 2	80	-	-	451
Group 2	80	-	-	90
BM	80	-	-	169
Front Office	66	-	-	214
Stock	120	-	-	12
Sick Bay	117	-	-	58
Foyer/Lobby	-	72	-	847
Foyer/Lobby	-	63	-	545
Foyer/Lobby	-	79	-	233
Studio	80	-	-	495
Studio	80	-	-	402
Acc WC	-	118	-	52
SEN	80	-	-	86
Cleaner	94	-	-	8
WC	-	74	-	185
Headteachers Office	80	-	-	280
Classroom 7	80	-	-	375
Classroom 6	80	-	-	375
Staff Room	80	-	-	372
Server	87	-	-	34
Lift	82	-	-	9
WC	-	75	-	166
Classroom 5	80	-	-	375
Classroom 4	80	-	-	368
Classroom 3	80	-	-	372
Foyer	-	100	-	458
Studio2	80	-	-	58
Studio2	80	-	-	0
CHP	80	-	-	35
Plant Room	62	-	-	73
Table Store	69	-	-	15

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?
Large Hall	NO (-30.9%)	YES
Small Hall	NO (-66.8%)	YES
Nursery Group	N/A	N/A
Nursery	NO (-97%)	YES
Kitchen	N/A	N/A
2 YO	NO (-53.9%)	YES

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Caretaker	N/A	N/A
Wellbeing	NO (-56.1%)	YES
Staff PPA	NO (-70.5%)	YES
Parents Room	NO (-83.2%)	YES
Drop In	NO (-54%)	YES
Office	N/A	N/A
Interview	N/A	N/A
Deputy Head	NO (-21.4%)	YES
Group 1	NO (-18.6%)	YES
Classroom 1	NO (-20.7%)	YES
Classroom 2	NO (-56.7%)	YES
Group 2	NO (-94.9%)	NO
BM	N/A	N/A
Front Office	N/A	N/A
Sick Bay	N/A	N/A
Studio	NO (-69.3%)	YES
Studio	NO (-56.3%)	YES
SEN	NO (-82.5%)	YES
Headteachers Office	NO (-55.7%)	YES
Classroom 7	NO (-71.9%)	YES
Classroom 6	NO (-52.8%)	YES
Staff Room	NO (-52.4%)	YES
Server	N/A	N/A
Classroom 5	NO (-82.6%)	YES
Classroom 4	NO (-61%)	YES
Classroom 3	NO (-83.8%)	YES
Studio2	NO (-88.3%)	YES
Studio2	NO (-90.8%)	YES

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	2267.4	2267.4
External area [m^2]	4167.6	4167.6
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	1428.97	1842.7
Average U-value [W/m^2K]	0.34	0.44
Alpha value* [%]	9.82	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 Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
100	**D1 Non-residential Inst.: Education**
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: 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	21.21	25.45
Cooling	0.01	0.01
Auxiliary	1.25	1.04
Lighting	9.99	11.23
Hot water	8.01	7.06
Equipment*	15.65	15.65
TOTAL**	**40.46**	**44.79**

* Energy used by equipment does not count towards the total for 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]	76.67	92.08
Primary energy* [kWh/m^2]	59.92	66.02
Total emissions [kg/m^2]	10.7	11.8

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: floor heating, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	85.9	0	23.9	0	1.2	1	0	1	0
	Notional	101.4	0	28.2	0	0.9	1	0	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	33.4	0	9.3	0	1.2	1	0	1	0
	Notional	45.1	0	12.5	0	1.2	1	0	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	89.8	8.9	10.2	1.7	0.4	2.45	1.49	2.5	2
	Notional	123.3	14.2	13.4	1	0.8	2.56	3.79	----	----
[ST] Central heating using water: floor heating, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	149.1	0	41.4	0	0.7	1	0	1	0
	Notional	202.6	0	56.3	0	0.7	1	0	----	----
[ST] Central heating using air distribution, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	43.1	0	12	0	7.2	1	0	1	0
	Notional	75.9	0	21.1	0	8.4	1	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	**$U_{i\text{-}Typ}$**	**$U_{i\text{-}Min}$**	**Surface where the minimum value occurs***
Wall	0.23	0.15	KT000000:Surf[2]
Floor	0.2	0.13	KT000000:Surf[0]
Roof	0.15	0.13	KT000000:Surf[1]
Windows, roof windows, and rooflights	1.5	1.4	LR000000:Surf[1]
Personnel doors	1.5	1.8	LR000000:Surf[32]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)]

$U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
m³/(h.m²) at 50 Pa	5	3

12.0 APPENDIX C: BREEAM PRE-ASSESSMENT

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Edith Neville Primary School

As designed

Date: Thu Nov 05 14:36:49 2015

Administrative information

Building Details

Address: 174 Ossulsten Street
London NW1 1DN

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.4

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.4

BRUKL compliance check version: v5.2.d.2

Owner Details

Name: London Borough of Camden

Telephone number: 020 7974 2986/4903

Address: 5 Pancreas Square
London, N1C 4AG

Certifier details

Name: Max Fordham LLP

Telephone number: 020 7267 5161

Address: 42-43 Gloucester Crescent
London, NW1 7PE

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	11.8
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	11.8
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	8
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 the building services should achieve reasonable overall standards of energy efficiency

Values not achieving 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	0.15	0.15	KT000000:Surf[2]
Floor	0.25	0.13	0.13	KT000000:Surf[0]
Roof	0.25	0.13	0.13	KT000000:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.41	2.97	HD000000:Surf[22]
Personnel doors	2.2	1.8	1.8	LR000000:Surf[32]
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

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Kitchen

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	1.1	-
Standard value	0.91	N/A	N/A	1.1^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

^ Allowed SFP may be increased by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

2- Teaching Spaces

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

3- Toilets

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	0	0.7
Standard value	N/A	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

4- Interview+Front Office

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	1	-	0.2	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

5- Server+Sickbay

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.5	3.2	0	0	0.7
Standard value	2.5*	3.2	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

"No HWS in project, or hot water is provided by HVAC system"

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Sick Bay	-	-	-	-	-	0.4	-	-	-	-	N/A
Server	-	-	-	-	-	0.4	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Kitchen	-	72	-	1766
Corridor	-	133	-	165
Acc WC	-	174	-	65
Staging	120	-	-	12
PE Equipment	102	-	-	23
Tables + Chairs Store	67	-	-	53
Large Hall	80	-	-	746
Small Hall	80	-	-	670
WC	-	174	-	35
WC	-	174	-	29
Nursery Group	80	-	-	137
Nursery	80	-	-	527
Kitchen	120	-	-	54
WC Wash	-	174	-	52
Utility	-	174	-	75
Buggy Store	120	-	-	12
2 YO	80	-	-	332
2 YO Corridor	-	174	-	67
Corridor	-	174	-	30
Hygiene	-	118	-	134
Caretaker	80	-	-	116
Lift	120	-	-	9
Wellbeing	80	-	-	107
Staff PPA	80	-	-	176
Shower	-	174	-	41
Acc WC	-	122	-	125
WC	-	174	-	51
Parents Room	80	-	-	197
Drop In	80	-	-	470
Office	80	-	-	174
Corridor	-	174	-	28
Buggy Store	93	-	-	19
Interview	94	-	-	79
Deputy Head	80	-	-	174
Group 1	80	-	-	102
WC	-	145	-	95
Ext Store	95	-	-	22

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Classroom 1	80	-	-	435
Store	116	-	-	14
WC	-	137	-	103
Classroom 2	80	-	-	451
Group 2	80	-	-	90
BM	80	-	-	169
Front Office	66	-	-	214
Stock	120	-	-	12
Sick Bay	117	-	-	58
Foyer/Lobby	-	72	-	847
Foyer/Lobby	-	63	-	545
Foyer/Lobby	-	79	-	233
Studio	80	-	-	495
Studio	80	-	-	402
Acc WC	-	118	-	52
SEN	80	-	-	86
Cleaner	94	-	-	8
WC	-	74	-	185
Headteachers Office	80	-	-	280
Classroom 7	80	-	-	375
Classroom 6	80	-	-	375
Staff Room	80	-	-	372
Server	87	-	-	34
Lift	82	-	-	9
WC	-	75	-	166
Classroom 5	80	-	-	375
Classroom 4	80	-	-	368
Classroom 3	80	-	-	372
Foyer	-	100	-	458
Studio2	80	-	-	58
Studio2	80	-	-	0
CHP	80	-	-	35
Plant Room	62	-	-	73
Table Store	69	-	-	15

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?
Large Hall	NO (-30.9%)	YES
Small Hall	NO (-66.8%)	YES
Nursery Group	N/A	N/A
Nursery	NO (-97%)	YES
Kitchen	N/A	N/A
2 YO	NO (-53.9%)	YES

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Caretaker	N/A	N/A
Wellbeing	NO (-56.1%)	YES
Staff PPA	NO (-70.5%)	YES
Parents Room	NO (-83.2%)	YES
Drop In	NO (-54%)	YES
Office	N/A	N/A
Interview	N/A	N/A
Deputy Head	NO (-21.4%)	YES
Group 1	NO (-18.6%)	YES
Classroom 1	NO (-20.7%)	YES
Classroom 2	NO (-56.7%)	YES
Group 2	NO (-94.9%)	NO
BM	N/A	N/A
Front Office	N/A	N/A
Sick Bay	N/A	N/A
Studio	NO (-69.3%)	YES
Studio	NO (-56.3%)	YES
SEN	NO (-82.5%)	YES
Headteachers Office	NO (-55.7%)	YES
Classroom 7	NO (-71.9%)	YES
Classroom 6	NO (-52.8%)	YES
Staff Room	NO (-52.4%)	YES
Server	N/A	N/A
Classroom 5	NO (-82.6%)	YES
Classroom 4	NO (-61%)	YES
Classroom 3	NO (-83.8%)	YES
Studio2	NO (-88.3%)	YES
Studio2	NO (-90.8%)	YES

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	2267.4	2267.4
External area [m^2]	4167.6	4167.6
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	1428.97	1842.7
Average U-value [W/m^2K]	0.34	0.44
Alpha value* [%]	9.82	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 Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
100	**D1 Non-residential Inst.: Education**
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: 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	21.21	25.45
Cooling	0.01	0.01
Auxiliary	1.25	1.04
Lighting	9.99	11.23
Hot water	8.01	7.06
Equipment*	15.65	15.65
TOTAL**	**40.46**	**44.79**

* Energy used by equipment does not count towards the total for 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	5.36	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]	76.67	92.08
Primary energy* [kWh/m^2]	59.92	66.02
Total emissions [kg/m^2]	8	11.8

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: floor heating, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	85.9	0	23.9	0	1.2	1	0	1	0
	Notional	101.4	0	28.2	0	0.9	1	0	----	----
[ST] Central heating using water: radiators, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	33.4	0	9.3	0	1.2	1	0	1	0
	Notional	45.1	0	12.5	0	1.2	1	0	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	89.8	8.9	10.2	1.7	0.4	2.45	1.49	2.5	2
	Notional	123.3	14.2	13.4	1	0.8	2.56	3.79	----	----
[ST] Central heating using water: floor heating, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	149.1	0	41.4	0	0.7	1	0	1	0
	Notional	202.6	0	56.3	0	0.7	1	0	----	----
[ST] Central heating using air distribution, [HS] District heating, [HFT] District Heating, [CFT] Electricity										
	Actual	43.1	0	12	0	7.2	1	0	1	0
	Notional	75.9	0	21.1	0	8.4	1	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	**U_{i-Typ}**	**U_{i-Min}**	**Surface where the minimum value occurs***
Wall	0.23	0.15	KT000000:Surf[2]
Floor	0.2	0.13	KT000000:Surf[0]
Roof	0.15	0.13	KT000000:Surf[1]
Windows, roof windows, and rooflights	1.5	1.4	LR000000:Surf[1]
Personnel doors	1.5	1.8	LR000000:Surf[32]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

U_{i-Typ} = Typical individual element U-values [W/(m²K)]

U_{i-Min} = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
m³/(h.m²) at 50 Pa	5	3

12.0 APPENDIX C: BREEAM PRE-ASSESSMENT

Central Somers Town - Edith Neville School; BREEAM Tracker

Prepared by: Robin Brylewski
Date: 23/11/2015

BREEAM 2014 Scoring Summary

BREEAM Section	Credits Available	Credits Targeted	% Achieved	Section Weighting	Targeted Score	Potential Additional Credits	Potential Score	Comments
Management	21	19	90.48%	0.12	10.86%	0	10.86%	
Health & Wellbeing	18	14	77.78%	0.15	11.67%	0	11.67%	
Energy	22	15	68.18%	0.15	10.23%	1	10.91%	
Transport	7	5	71.43%	0.09	6.43%	0	6.43%	
Water	9	6	66.67%	0.07	4.67%	1	5.44%	
Materials	14	10	71.43%	0.135	9.64%	1	10.61%	
Waste	8	6	75.00%	0.085	6.38%	0	6.38%	
Land Use & Ecology	10	7	70.00%	0.1	7.00%	0	7.00%	
Pollution	13	7	53.85%	0.1	5.38%	1	6.15%	
Innovation	10	1	10.00%	0.1	1.00%	0	1.00%	
Final BREEAM Score					**73.25%**			
Potential BREEAM Scores							**76.44%**	