ENERGY ASSESSMENT

FOR

SELWYN SCHOOL
WALTHAM FOREST

VERSION 3.0

Issued by:-

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Revision	Date	Issue Purpose	Author	Reviewer
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V3.0	9 Dec 2015	Planning	A Sturt	C Smart

EXECUTIVE SUMMARY

Silcock Dawson and Partners have been appointed by Galliford Try to provide an Energy Assessment for the proposed new primary School to be constructed on the site of the existing primary buildings on Cavendish Road. The building comprises around 2966m² of usable floor space over ground and second floors. The building is classified as D1, Education.

The aim of this report is to document the findings of the investigation into energy efficiency measures and the feasibility of on-site decentralised and renewable or low carbon energy sources. The report makes recommendations as to the best means of incorporating low and zero carbon technologies into the development.

Energy efficiency measures will be implemented to provide carbon saving of 23.7% in comparison to the Target Emission Rate regulated emissions. The energy efficiency measures include: improved fabric insulation; improved air tightness; high efficiency ventilation systems, high efficiency heating and cooling, and low energy lighting with daylight diming.

The London Heat Map has been utilised to check if the development can connect into an existing distribution network. Currently there are no existing heat distribution networks in the vicinity of the site. The site will include the potential for future connection into a district heating system should one become available. Combined heat and power engines are not viable for this development due to its heat demand profile.

Photovoltaic panels are a viable renewable energy source for the site and an installation of approximately 67m2 will generate 7668kWh of electricity per year. The corresponding CO2 reduction is 3980kgCO2, resulting in an additional reduction of 14.9%.

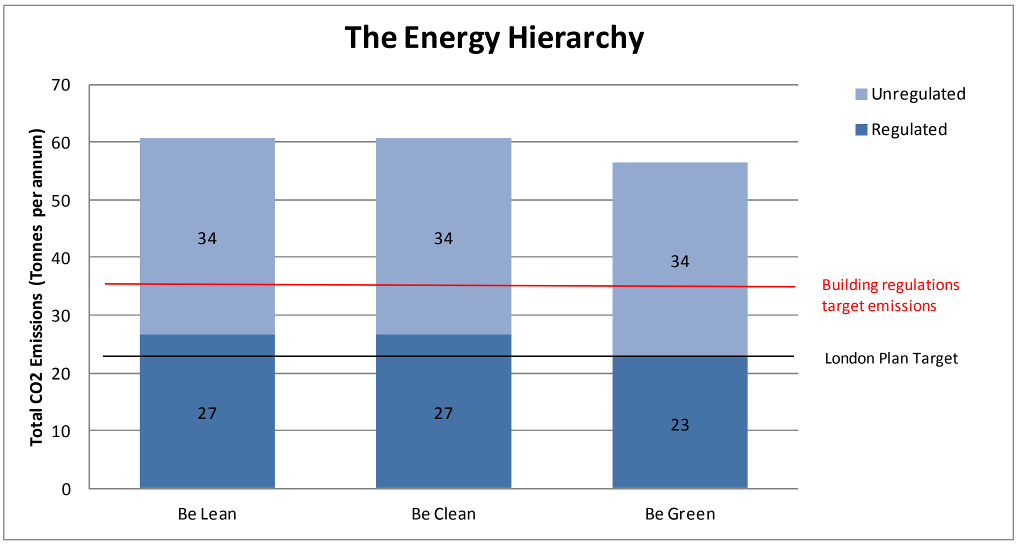
The total carbon savings are summarized in the tables below.

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy

	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2013 Part L compliant	35.0	33.9	68.9
After energy demand reduction	26.7	33.9	60.6
After CHP	26.7	33.9	60.6
After Renewable Energy	22.7	33.9	56.6

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy

	Regulated Carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	8.3	23.7
Savings from CHP	0.0	0.0
Savings from renewable energy	4.0	14.9
Total cumulative savings	12.3	35.1



The total carbon saving through the combination of energy efficient design, and renewable energy against the building regulation target emissions will be 35.1%.

1 INTRODUCTION

The aim of this report is to document the findings of the investigation into energy efficiency measures and the feasibility of on-site decentralised and renewable or low carbon energy sources. The report makes recommendations as to the best means of incorporating low and zero carbon technologies into the development.

1.1 Background

Silcock Dawson and Partners have been appointed by Galliford Try to provide an Energy Assessment for the proposed new primary school to be constructed on the site of the existing Selwyn Primary School.

1.2 Description of the Site and Building

The building comprises around 3100m² of usable floor space over ground and first floors. The building is classified as D1, Education.

Ground Floor Plan

First Floor Plan

1.3 Structure of the Energy Assessment

This statement is structured to respond to the Energy Hierarchy following the GLA's guidance. The statement includes:

- An assessment of the baseline carbon emissions based on the target emission rate.
- A review of the energy efficient features incorporated into the design.
- An assessment of the feasibility of incorporating a combined heat and power system.
- A review of renewable energy technologies and their application for this development.
- Recommendations and commitments

1.4 Contact Details

The report author is Andrew Sturt of the Silcock Dawson & Partners Energy and Sustainable Design Group.

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2 RELEVANT PLANNING POLICIES

This Energy Strategy responds to the broader set of National, and Regional policies outlined below.

2.1 National Planning Policy

The Government has set out planning policy guidance in the National Planning Policy Framework (NPPF). Fundamental to this guidance is the requirement to meet sustainable development objectives. These policy guidelines and statements are used to influence the preparation of the development plans by planning authorities.

The NPPF covers a wide range of planning issues from promoting sustainable transport to facilitating the sustainable use of minerals. Climate change is covered in section 10 ‘Meeting the challenge of climate change, flooding and coastal change. In summary the framework advises:

To support the move to a low carbon future, local planning authorities should:

- plan for new development in locations and ways which reduce greenhouse gas emissions;
- actively support energy efficiency improvements to existing buildings; and
- when setting any local requirement for a building’s sustainability do so in a way consistent with the Government’s zero carbon buildings, policy and adopt nationally described standards.

In determining planning applications, local planning authorities should expect new development to:

- comply with adopted Local Plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and

- take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

Refer to APPENDIX 1 – National Planning Policy Framework for further details.

2.2 Regional Policy – The London Plan

Policy 5.2 of the London Plan requires that the energy strategy needs to follow the given hierarchy

- using less energy, in particular by adopting sustainable design and construction measures (Policy 5.3)
- supplying energy efficiently, in particular by prioritising decentralised energy generation (Policy 5.5 and 5.6), and
- using renewable energy (Policy 5.7).

Policy 5.2A states carbon dioxide emissions in accordance with the following energy hierarchy:

Be lean: use less energy
Be clean: supply energy efficiently
Be green: use renewable energy

Policy 5.2B stipulates that the emissions from the development are reduced by 40% against 2010 building regulations Target Emission Rates. This has been updated within Supplementary

Planning Guidance Sustainable Design and Construction April 2014 to 35% below 2013 building regulations.

2.2.1 Policy 5.6, Decentralised Energy: Heating, cooling and Power

According to Policy 5.6, the proposed heating and cooling systems have to be selected *"in accordance with the following order of preference:*

- *connection to existing CCHP/CHP distribution networks*
- *site-wide CCHP/CHP powered by renewable energy*
- *gas-fired CCHP/CHP or hydrogen fuel cells, both accompanied by renewables*

2.2.2 Policy 5.7 Renewable Energy

Policy 5.7 states that "major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible" although no specific targets are detailed.

2.2.3 Policy 5.9 Overheating and Cooling

Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:

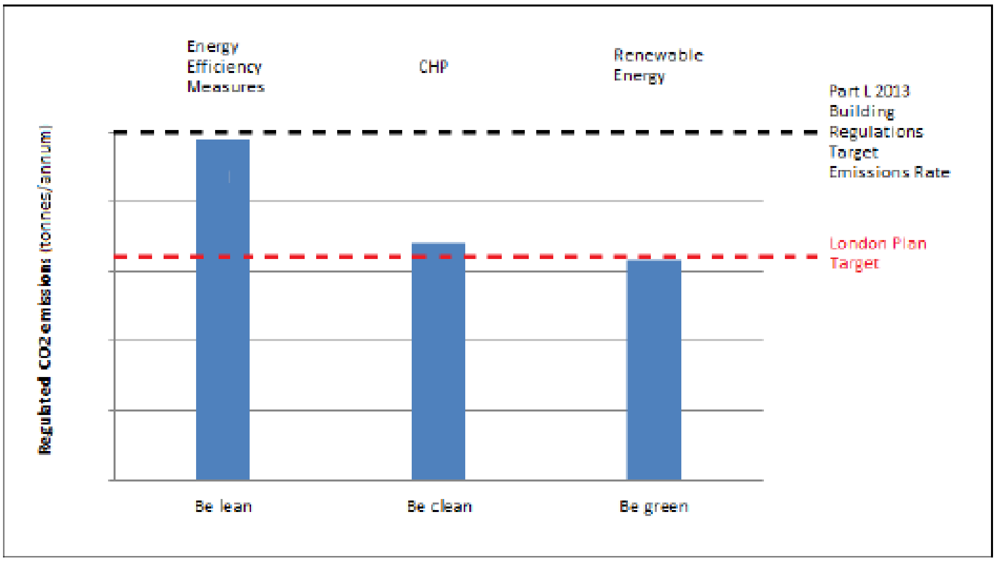
Minimise internal heat generation through energy efficient design

- Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
- Manage the heat within the building through exposed internal thermal mass and high ceilings
- Passive ventilation
- Mechanical ventilation
- Active cooling systems (ensuring they are the lowest carbon options).

2.2.4 Commentary

Chapter 5 of the London Plan sets out a hierarchy for the approach that should be taken to reduce carbon emissions from developments. This hierarchy states that a decentralised energy system, which can include gas fired CHP, should be installed before the provision of renewable technologies.

The GLA Energy Team Guidance on Planning Energy Assessments, April 2015, includes the following figure to illustrate the hierarchy.



2.3 Local Policy – London Borough of Waltham Forest

The local policies reflect the requirements of the London Plan

3 ENERGY DEMAND ASSESSMENT

3.1 National Calculation Methodology (NCM)

Before energy efficiency measures are investigated, it is necessary to establish the baseline energy consumption of the scheme, for comparison and evaluation of the proposed carbon reduction measures.

The baseline case against which carbon savings are assessed is a new development designed to achieve the target emission rate (TER) calculated in accordance with Part L (2013) of the Building Regulations. This baseline case represents a typical new build arrangement; where electricity for the development is imported from the grid and space and heating water are provided by non-renewable energy sources.

The onsite energy consumption associated with non regulated uses (e.g. lifts, small power, information technology) is included in the baseline carbon emission rate.

The following 'regulated' energy uses are considered in the baseline energy analysis:

- Space Heating/Cooling
- Water Heating
- Ventilation
- Fans, Pumps and Controls
- Lighting (internal)

3.2 Regulated loads

CO2 Emissions related to regulated energy use in the residential element of the scheme have been established by a dynamic thermal model using EDSL TAS.

Heating and Cooling	Radiator and radiant panels using gas fired boilers. Cooling by natural ventilation.
Ventilation	Mixed mode ventilation, with additional heat recovery where external noise imposes limits on opening windows. Local extract fans for WCs.

3.3 Non-Regulated Loads

Emissions associated with non-regulated energy consumption (e.g. small power use and equipment) have been calculated by the TAS thermal model.

The on-site energy consumption associated with non regulated uses (e.g. lifts, small power, information technology) is included in the baseline carbon emission rate.

3.4 Carbon Factors

Emissions within this report are based on the following CO2 emission rates.

Natural Gas	0.216 $kgCO_2/kWh$
Grid electricity	0.519. $kgCO_2/kWh$
Grid displaced electricity	0.519 $kgCO_2/kWh$

4 ENERGY EFFICIENT DESIGN

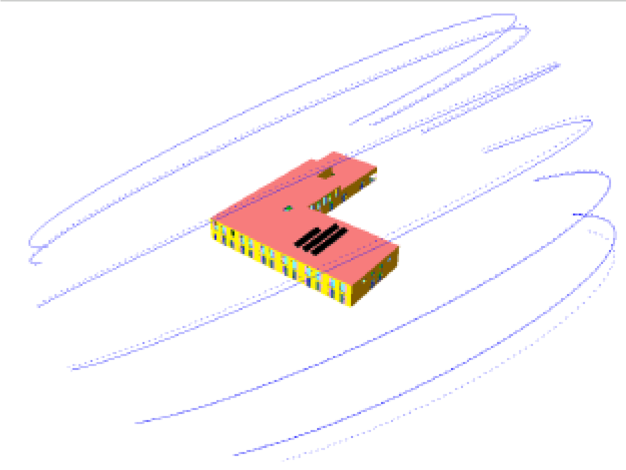
Compliance with the building regulations is achieved through energy efficiency measures alone.

The proposed energy strategy has, as its first priority, minimised energy consumption through suitable orientation and the exemplar performance of the building envelope, facades and plant. The following sections detail the energy efficiency features of the development.

4.1 Physical Form and Orientation of the Building

The building envelope and fenestration has been designed to achieve a balance between the daylight requirements, the need to reduce solar gain during the summer, and limiting heat loss during the winter.

The building will be constructed to provide insulation values in excess of the building regulations requirements and a good level of air tightness to prevent unwanted heat loss. The air permeability target will be 4 $m^3/hr/m^2$ at 50Pa. Due to the constraints of the site the building has approximately the same exposed facades on all elevations. To help reduce solar gain high performance glazing will be used with a good light transfer and thermal insulation properties.



Building with Solar Track

4.2 Building Envelope Specification and Thermal Performance

The fabric of the building has been used to help control the overheating by exposing the concrete slabs. The concrete soffit will absorb heat during the day, providing a cooler feeling in the classrooms, similar to that experienced on a warm day in an old church. During warm periods the heat that has been absorbed by the concrete will be removed over night by ventilating the classrooms with cooler night time air.

The design will target highly efficient U-values and air tightness, better than those used within the notional building calculation, as shown in the table below:

	Notional Building Building Regulations, Part L1A 2013	Proposed Measures
Air Tightness	5 m^3/hr per m²	4 m^3/hr per m²
Wall U-Value	0.18 W/m²°C	0.14 W/m²°C
Roof U-Value	0.13 W/m²°C	0.14 W/m²°C
Floor U-Value	0.13 W/m²°C	0.15 W/m²°C
Glazing U-Value	1.4 W/m²°C	1.36 W/m²°C
Glazing G-Value		0.42
Glazing Light Transmittance		0.78

4.2.1 Heating

The school will be served by condensing boilers, with variable flow variable temperature controls to promote low return water temperatures ensuring maximum efficiencies from the boilers throughout the heating season.

4.2.2 Ventilation

The school is ventilated by two variants of mixed mode systems. Mechanical systems will be employed to ensure that good air quality is achieved within the classrooms and other teaching spaces. Traffic noise along the elevation facing Selwyn Avenue is a level where it is not possible to have permanent untreated openings throughout the year. Spaces along this elevation will ventilated by systems with forced supply and extract fans with heat recovery. It will be possible to open windows during warmer summer days.

Noise levels on other elevations are lower, and it possible to have permanent openings. Within these rooms it is proposed to install a room / outside air mixing system. Opening vents will also be provided to allow higher ventilation rates in the summer.

All rooms and ventilation systems will be controlled via air quality sensors to match the ventilation rates to the room occupancies.

4.2.3 Domestic Hot Water

Domestic hot water is responsible for 24% of regulated emissions, and in order to reduce these emissions, the following measures will be implemented:

1. Dedicated high efficiency gas fired water heaters will be used to generate and store domestic hot water. The use of dedicated water heaters allows the boilers to remain isolated when there is no heating demand.
2. Insulate all domestic hot water flow and return distribution pipe work.

4.2.4 Lighting

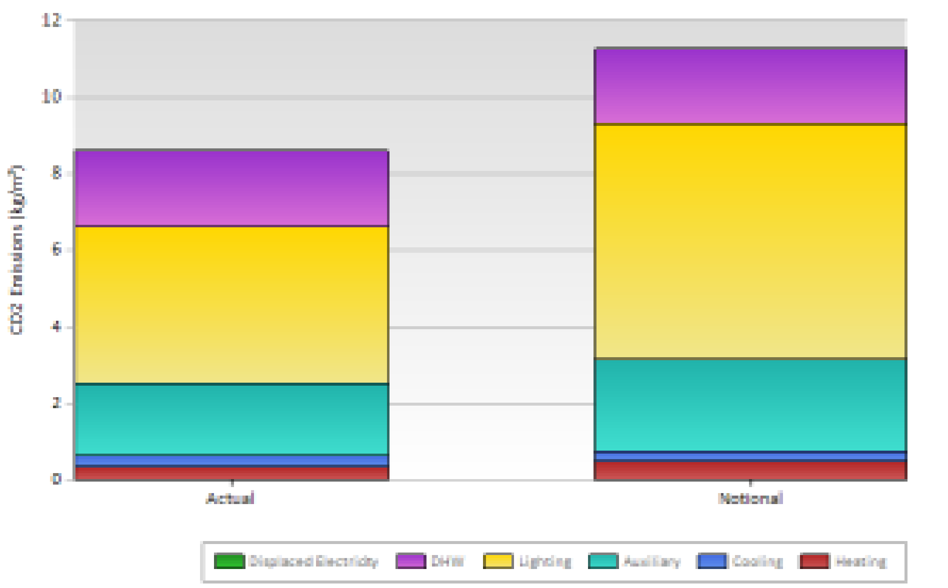
High efficiency light fittings will be used in all areas. Class rooms lighting installations will have an efficacy of no less than 75 luminare lumens / circuit Watt. Absence lighting controls will be employed where practical with photo cell dimming to ensure lighting power consumption is kept to a minimum. Good day lighting is provided to all class rooms and has been assessed using Climate Based Daylight Modelling, which also takes into account the effect of direct sun light in addition to diffuse daylight used when daylight actors alone are assessed.

4.2.5 Equipment

Equipment energy use includes all the appliances, computers, and any electrical devices, their energy use is not related to the energy performance of the buildings. It is beyond the scope of this report to include measures to decrease the emissions linked with the use of equipment used as a function of the building use. Emissions for equipment are assumed to be as the NCM profiles.

4.2.6 Summary of Carbon Emissions Following Energy Demand Reduction

The annual energy consumption for the development incorporating the energy efficiency measures described above is as shown in the tables below:



4.2.7 Conclusion - Be Lean

The energy efficiency strategy for the scheme has been developed following a hierarchical approach. The strategy aims to reduce energy demands by first incorporating suitable passive design measures, followed by proposed enhancements to provide an efficient building fabric, and highly efficient heating and ventilation systems. Energy efficiency features have led to an overall projected improvement over Part L of 24%.

The annual carbon emissions for the building incorporating the energy efficiency measures described above is as shown in the tables below:

Energy demand for energy efficient Building				
Item	**kWhrs/m²/ Year**	**Total kWhrs/ Year**	**Kg CO_2 /year**	**% CO_2**
Htg	1.5	4,762	1,029	2%
DHW	9.2	28,717	6,203	10%
Cooling	0.6	1,741.7	903.9	1%
Auxiliary Energy	3.7	11,471	5,953	10%
Lighting	7.8	24,323	12,624	21%
Equipment	20.9	65,223	33,851	56%
Total	**44**	**136,238**	**60,563**	
Total no Equip	**23**	**71,015**	**26,713**	

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy			
	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2013 Part L compliant	35.0	33.9	68.9
After energy demand reduction	26.7	33.9	60.6

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy		
	Regulated Carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	8.3	23.7

5 HEATING INFRASTUCTURE

Local heat and power sources minimise distribution losses and achieve greater efficiencies when compared to separate energy systems, thus reducing CO2 emissions.

In accordance with Policy 5.6 of the London Plan, the energy systems for the site have been determined in accordance with the following hierarchy:

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

In a communal energy system, energy in the form of heat, cooling, and/or electricity is generated from a central source and distributed via a network of insulated pipes to surrounding residencies and commercial units.

5.1.1 Connection to Existing or Proposed Networks

Connection to a decentralised energy network and the use of combined heat and power is a recognised method of generating energy more efficiently. The London Plan and the London Borough of Waltham Forest policies require development proposals to explore the opportunities to link into an existing or planned decentralised energy network using the London Heat Map tool.

The London Heat Map shows that the site lies to the north outside of the district heating opportunity area...There are no existing or proposed networks identified local to the site. Nonetheless, the site will include the potential for future connection into a district heating system should one become available.

The development will be provided with adequate distribution and plant space to house the district heating heat exchange and metering equipment. The heating system will allow the future connection to a district heating network.

5.1.2 Site Wide Heating Network and CHP

The potential integration of conventional combined heat and power (CHP) plant has been evaluated for the development in compliance with appropriate planning policies including the London Plan Policy 5.6 ‘Decentralised Energy in Development Proposals’.

Combined Heat and Power (CHP) is the simultaneous generation of both electricity and heat in the same process. The CHP process can be applied to both renewable and fossil fuels. Sizing a CHP system is a complex undertaking and viability is largely dependent upon a development’s heat demand and usage profile. Typically a CHP system would be sized to the base heat load (the heat load present all year round) in order to maximise the running time, and therefore the efficiency of the system. A further consideration is that small CHP units tend to be less efficient than large system, and the operating and maintenance costs of small units can outweigh the financial benefit provided by the electricity produced.

The school does not have sufficient base load to justify the installation of a combined heat and power unit. The partial occupancy for 25% of the year in particular militates against the cost effective operating of CHP.

5.2.1 Conclusion

The development will not be provided with a CHP engine as it is not technically viable.

The carbon emissions at the end of the ‘be clean’ stage are identical to those at the end of the ‘be lean’.

6 LOW AND ZERO CARBON TECHNOLOGIES FOR ENERGY PRODUCTION

This section of the report responds to London Plan Policy 5.7.

The school will be served by a gas fired heating system, therefore, the options available for renewable energy are considered, to meet the remaining carbon emissions reduction to satisfy national and local planning policies.

The use of energy conversion technologies using renewable energies must be analyzed. The main technologies available for on-site renewable energy generation are:

- Biomass
- Ground Source Heat Pumps
- Air Source Heat Pumps
- Photovoltaics
- Solar thermal hot water generation
- Wind

Refer to appendix 4 for the more details and a brief explanation of renewable energy technologies.

6.1 Preliminary Technology Appraisal

Technology	Feasibility*			Comments
	H	M	L	
Biomass			✓	The combustion of wood pellets or chips creates heat for space heating and domestic hot water. This technology is not suitable for this development due to the low heat demand and the urban location. A large area for fuel storage is required, which is not available on this city centre constricted site. In addition, the site is within a densely occupied area and biomass boilers generate high levels of particulate material and NO_2.
Ground Source heat pumps			✓	Ground source heat pumps extract heat from the ground, and convert it to low grade heat for space heating and hot water. Due to the compact nature of the site and the relatively small amount of heat that could be withdrawn. The integration of a complicated technology is not appropriate for such a low potential CO_2 reduction.
Air Source Heat Pumps			✓	Air source heat pumps extract heat from air and convert it low grade heat for space heating and hot water. The temperatures at which the heat pump will operate will reduce the plant effectiveness, to the point where little or no CO_2 reductions can be realized when compared to condensing gas fired boilers.

Technology	Feasibility*			Comments
	H	M	L	
Photovoltaic Panels	✓			Photovoltaic modules convert daylight directly into DC electricity and can be integrated into buildings. Space is available at roof level to install a PV array, which would contribute to the overall emissions reduction for the site.
Solar Hot water			✓	Solar thermal installations are a well established renewable energy system and can be one of the most cost-effective renewable energy systems available. Solar thermal panels are technically viable and could work well with the domestic hot water demands from a school. However, PV panels offer a lower maintenance and more cost effective means of reducing carbon emissions. The absence of pupils from the school over the summer break also works against the effective use of solar thermal hot water generation.
Wind			✓	The urban environment and the close proximity of dwellings are not favourable conditions for the installation of wind turbines. The uneven air flow caused by surrounding buildings and the potential negative impact on the visual and noise amenity of the area militate against the use of wind turbines for this development.

H - High Feasibility - No obvious restrictions

M - Medium feasibility - Significant issues that need to be addressed

L - Low feasibility – Site unlikely to support technology

Based on this preliminary evaluation, the following technology will be assessed:

- Photovoltaics (PV)

6.2 Photovoltaic Panels

6.2.1 Application

Photovoltaic modules convert daylight directly into DC electricity and can be integrated into buildings. Photovoltaics (PVs) are distinct from other renewable energy technologies since they have no moving parts to be maintained and are silent. PV systems can be incorporated into buildings in various ways: on sloped roofs and flat roofs, in facades, atria and shading devices. Modules can be mounted using frames or they can be fully incorporated into the actual building fabric; for example, PV roof tiles are now available which can be fitted in place of standard tiles. Since PVs generate DC output, an inverter and other equipment is needed to deliver the power to a building or the grid in an acceptable AC form.

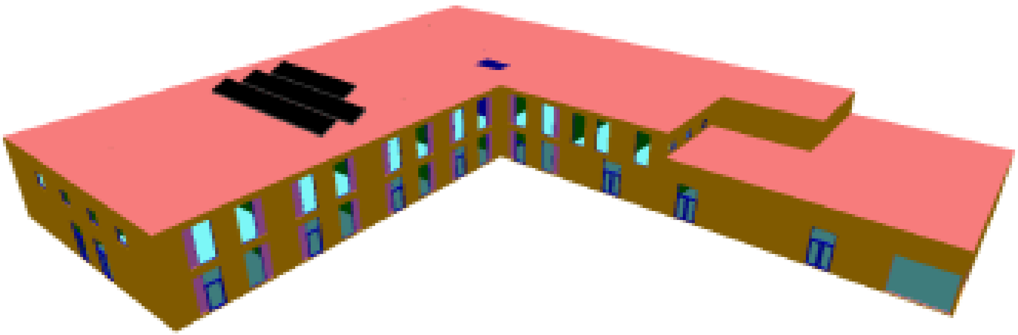


Illustration of PV panels mounted at roof level.

6.2.2 Constraints

The following constraints have been identified for the application of the PV technology at the site.

1. Consideration will need to be given to the effect of over shading to parts or the whole roof, and potential glare issues if tenants over look any PV panels.

2. Connection points into the LV distribution system.

3. Installation cost.

6.2.3 Emissions Reduction

A 10kWp peak installation distributed as the above illustration will have a total area of approximately 67m2.

The final area will determined as part of the detailed design, following final selection of all plant and PV panels selected.

Electricity Generated (kWh/yr)	CO_2 reduction (kgCO_2/yr)	CO_2 reduction % after Energy Efficiency measures
7668	3980	14.9%

6.2.4 Conclusion

PV panels are technically viable and an installation of 67m^2 could be installed on the roof, however, at a cost of £11,500.

7 OVERHEATING AND COOLING

7.1 Background

Policy 5.9: Overheating and Cooling

Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy.

1. Minimise internal heat generation through energy efficient design;

2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;

3. Manage the heat within the building through exposed internal thermal mass and high ceilings;

4. Passive ventilation;

5. Mechanical ventilation;

6. Active cooling systems (ensuring they are the lowest carbon options).

Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible.

7.2 Adaptive Thermal Comfort

The FOS requires that an overheating risk assessment be undertaken for buildings that are not mechanically cooled. The assessment is based on the adaptive comfort model following the methodology and recommendations from EN 15251, and modelling has been undertaken following the procedure set out in CIBSE TM52.

The thermal modelling has been carried out using EDSL TAS v9.2.1.6. software. This modelling software is approved by 2013 Building Regulations and is also compliant with CIBSE AM11 requirements. This modelling has been used to test various strategies for ventilation, solar gain reduction, and the use of building's structure to absorb heat, in order to arrive at a solution that meets the FOS criteria in a cost effective way and allows the other key environmental criteria relating to daylight and acoustics to be satisfied.

The modelling has been undertaken using the guidance provided in the EFA's Energy Efficiency Guide, June 2014.

Three criteria are tested to assess overheating risk; all are defined in terms of the difference between the actual operative temperature in the room at any time (T_{op}) and the limiting maximum acceptable temperature (T_{max}). The difference between these temperature values is the 'delta T' (ΔT). The criteria are tested for the summer period of May to September only, and it is assumed that the school is occupied throughout that period. i.e. half terms and the summer holiday are considered to be occupied periods.

DEFINITIONS

Operative Temperature

$T_{OP} = 0.5\ T_{air}$ (AirTemp) + $0.5\ T_{mrt}$ (Mean Radiant Temp)

Maximum acceptable temperature

TMAX = 0.33Trm + 21.8

where:

Running Mean Temperature, Trm, is the running average of recent external temperatures. The running mean is calculated using a complicated equation that weights the significance of external temperatures according how recently they occurred. This weighting gives a greater influence for recent days, reducing with time passed as people "forget

Criterion 1 – Hours of Exceedance (He): The number of hours that the actual operative temperature in the room (T_{op}) exceeds the limiting maximum acceptable temperature (T_{max}) by one degree (K) or more, must be less than 40.

This criterion provides an understanding of how often a rooms likely to exceed its comfort range and can provide a good first assessment of acceptability.

Criterion 2 - Weighted Exceedance (We): The sum of the weighted hours that T_{op} is above T_{max} must be less than or equal to 6 on each day.

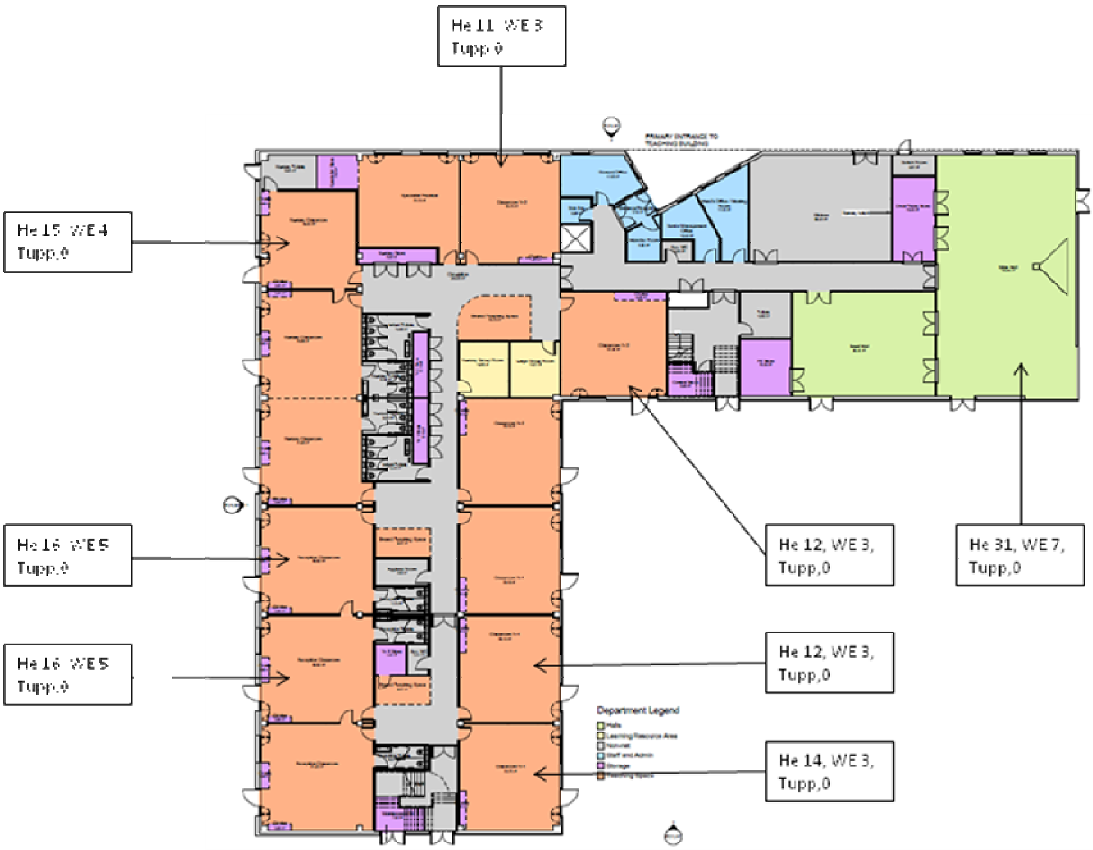
This criterion covers the severity of overheating and considers that, for example, 3 hours with an exceedance of 2 degrees is equivalent to 6 hours with an exceedance of 1 degree. Since this tests the severity of overheating it could be considered to be more important than frequency, and sets a daily limit of acceptability.

Criterion 3 - Threshold/Upper Limit Temperature (Tupp): The predicted operative temperature should not exceed the Tmax by 4 degrees or more at any time.

This sets a limit beyond which normal adaptive actions will be insufficient to restore personal comfort and the vast majority of occupants will complain of being ‘too hot’. This criterion covers the extremes of hot weather conditions and future climate scenarios

Each room will be deemed to have an unacceptable risk of overheating if any two of the three criteria are exceeded.

The teaching areas have been modelled to assess their risk of overheating and the results of a sample number of rooms is presented below:



Ground Floor – Overheating Risk

First Floor – Overheating Risk

Assumptions:

- Each system will be sized to provide a minimum of 5 litres per second per person to each of the areas provided with mechanical ventilation.
- The ventilation unit will operate during the occupied period and over-night when the space requires ventilation to purge the heat.
- The occupied period is 09.00 to 16.00, with a 1 hour break from 12.00 to 13.00.
- Secure manual operation natural ventilation openings are provided and the teaching staff will be expected to leave these open during periods of hot weather.
- The guidance provided in the EFAs Energy Efficiency Guide June 2014 has been followed.
- Light coloured blinds will be fitted to all windows.

Thermal mass will be provided via an exposed concrete slab, to absorb the building heat during the day, and then release at night when the external air temperature cools. The mechanical ventilation will incorporate temperature controls to provide night time purge ventilation, and the secure natural ventilation openings can be left open on occasions of exceptionally hot weather.

Several rooms fail to comply with the criteria, as indicated in the image above. In addition the small group room on the West elevation, first floor north facing class rooms, and large staff room. The natural and mechanical ventilation of these rooms will be reviewed during the next stage to achieve compliance in all relevant spaces.

The simulation was carried out using the current CIBSE design summer year for London The days with highest recorded temperatures are: 19 & 20 June, 5 & 6 July, 20 -25 July, and 6 & 21 August. The highest temperatures were experienced between the 20 – 25 July with temperatures exceeding 30 degrees C for four out of the six days.

7.3 Conclusion

Minimise internal heat generation through energy efficient design;	Low energy luminaires with daylight control
Manage the heat within the building through exposed internal thermal mass and high ceilings;	Concrete soffits are exposed.
Passive ventilation;	Secure natural ventilation provided to all classrooms via fixed louvres.
Mechanical ventilation;	Temperature and CO_2 controlled ventilation to all areas to provide high ventilation rates in the summer and ensure CO2 levels are maintained in the winter at reduced ventilation rates.
Active cooling systems (ensuring they are the lowest carbon options).	High efficiency split air conditioning units will only be provided within the IT Server room.

8 SUMMARY

The table below summarises the emissions reductions available from the various technologies, equipment sizes and approximate cost. The technical viability of the technologies using the renewable energy sources is also considered. The technical viability is intended to include aspects such as maintenance & constructability.

Option	Carbon Saving, (regulated energy) %	Investment costs [£]	Technical Viability (0=not viable, 10=very viable)	Comments
Connection into Local District Heat Network	n/a	n/a	0	Not Viable due to no heat networks available within the area.
Local CHP	n/a	n/a	0	Not Viable due to low heat demand
PV Cells	14.9%	£11,500	9	
Air source heat pumps	Not suitable due to noise and little advantage in carbon savings.			
Ground source heat pumps	Not viable due to high cost and little advantage in carbon savings.			
Biomass heating	Not viable due to broader sustainability issues and urban location			
Solar thermal hot water heating.	PV offers a better solution for use of solar energy			
Wind Turbines	Not viable due to proximity to dwellings and urban location.			

The costs are budget estimates for the system installation only. Additional costs, such as the cost of providing plant rooms etc is not included.

9 RECOMMENDATION

Following a review of the relevant National, Regional and Local planning policies, this Sustainable Energy Strategy proposes a strategy that positively responds to the policy structure that requires developments to *be lean; be clean; be green*. The hierarchy published in the London Plan requires that decentralised energy, including gas fired CHP, should be provided in preference to renewable energy technologies, and that renewable technologies should be used to meet the residual energy demand where feasible.

Energy efficiency measures will be implemented to provide carbon saving of 23.7% in comparison to the Target Emission Rate regulated emissions. The energy efficiency measures include: improved fabric insulation; improved air tightness; high efficiency ventilation systems, high efficiency heating and cooling, and low energy lighting with daylight dimming.

The London Heat Map has been utilised to check if the development can connect into an existing distribution network. Currently there are no existing heat distribution networks in the vicinity, however the site is located adjacent to an opportunity area. The site will include the potential for future connection into a district heating system should one become available. Combined heat and power engines are not viable for this development due to its heat demand profile.

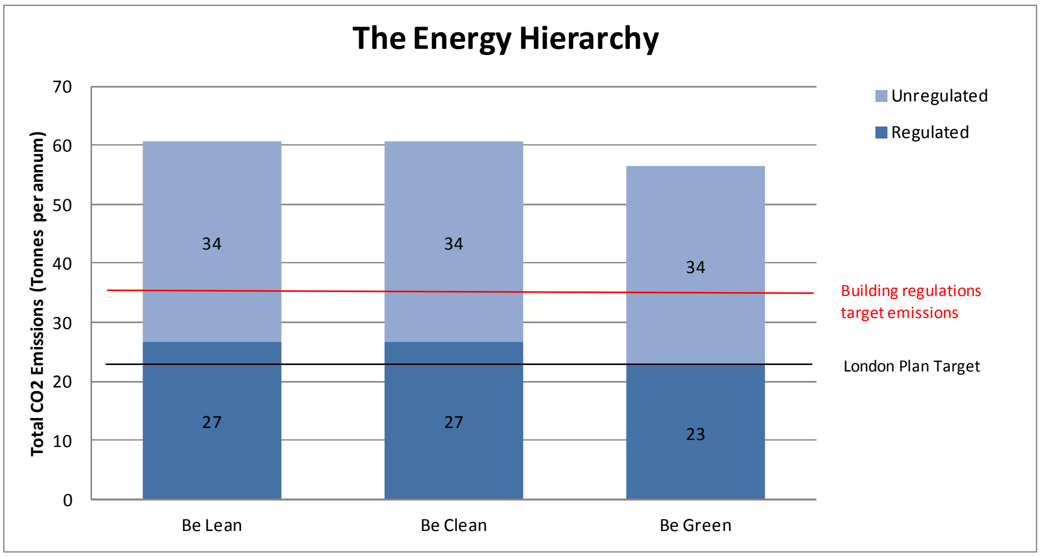
The development will be provided with photovoltaic panels to contribute towards lowering carbon emissions from the proposed development to satisfy the regional and local carbon emission targets. The roof area considered for the proposed installation of photovoltaic panels will be reviewed during the detail design stage.

The total CO2 reduction from the energy efficiency measures and renewable technology is 35.1% as detailed in the tables below.

Energy demand for building with renewable technologies				
Item	**kWhrs/m²/ Year**	**Total kWhrs/ Year**	**Kg CO2 /year**	**% CO2**
Htg (nat. gas)	1.9	6,025	1,029	1.7%
Htg (elec)	0.0	0	0	0.0%
DHW (nat. gas)	10.1	31,342	6,203	10.2%
DHW (elec)	0.0	0	0	0.0%
Cooling	0.6	1,742	904	1.5%
Auxiliary Energy	3.7	11,471	5,953	9.8%
Lighting	7.8	24,323	12,624	20.8%
Equipment	20.9	65,223	33,851	55.9%
CHP gas	0.0	0	0	0.0%
CHP electricity	0.0	0	0	0.0%
PV electricity	-2.5	-7,668	-3,980	-6.6%
Total	**42**	**132,457**	**56,584**	
Total no Equip	**22**	**67,235**	**22,733**	

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy			
	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2013 Part L compliant	35.0	33.9	68.9
After energy demand reduction	26.7	33.9	60.6
After CHP	26.7	33.9	60.6
After Renewable Energy	22.7	33.9	56.6

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy		
	Regulated Carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	8.3	23.7
Savings from CHP	0.0	0.0
Savings from renewable energy	4.0	14.9
Total cumulative savings	12.3	35.1



A1 APPENDIX 1 – National Planning Policy

A1.1 10 - Meeting the challenge of climate change, flooding and coastal change

93. Planning plays a key role in helping shape places to secure radical reductions in greenhouse gas emissions, minimising vulnerability and providing resilience to the impacts of climate change, and supporting the delivery of renewable and low carbon energy and associated infrastructure. This is central to the economic, social and environmental dimensions of sustainable development.

94. Local planning authorities should adopt proactive strategies to mitigate and adapt to climate change, taking full account of flood risk, coastal change and water supply and demand considerations.

95. To support the move to a low carbon future, local planning authorities should:

- plan for new development in locations and ways which reduce greenhouse gas emissions;
- actively support energy efficiency improvements to existing buildings; and
- when setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards.

96. In determining planning applications, local planning authorities should expect new development to:

- comply with adopted Local Plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
- take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

97. To help increase the use and supply of renewable and low carbon energy, local planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low carbon sources. They should:

- have a positive strategy to promote energy from renewable and low carbon sources;
- design their policies to maximise renewable and low carbon energy development while ensuring that adverse impacts are addressed satisfactorily, including cumulative landscape and visual impacts;
- consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources;
- support community-led initiatives for renewable and low carbon energy, including developments outside such areas being taken forward through neighbourhood planning; and
- identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

98. When determining planning applications, local planning authorities should:

- not require applicants for energy development to demonstrate the overall need for renewable or low carbon energy and also recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and
- approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should also expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Selwyn School (Lean)

As designed

Date: Wed Dec 09 16:43:23 2015

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.3.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.3.3

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

Owner Details

Name: Draft

Telephone number:

Address: , ,

Certifier details

Name: Silcock Dawson and Partners

Telephone number:

Address: , ,

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	11.2
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	11.2
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	8.6
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and 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	0.14	0.14	External Wall
Floor	0.25	0.15	0.15	Ground Floor
Roof	0.25	0.14	0.14	Roof
Windows***, roof windows, and rooflights	2.2	1.36	1.6	Classroom door
Personnel doors	2.2	1.78	2.45	Opaque pedestrian door
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	-	-	No high usage entrance doors in project

$U_{a\text{-}Limit}$ = 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
m³/(h.m²) at 50 Pa	10	4.02

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	NO
Whole building electric power factor achieved by power factor correction	0.9 to 0.95

1- Toilet Extract (11 Zones)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	-	-	-
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.					

2- HTM vent (22 Zones)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	-	-	-
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- nat vent

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	-	-	-
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.					

4- MVHR (25 Zones)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	-	-	0.75
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.					

5- Kitchen vent (Kitchen)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	-	-	-	-
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.					

6- Server room (server room)

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0	3.6	-	-	-
Standard value	N/A	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	3118	3118
External area [m²]	5233	5233
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	4	3
Average conductance [W/K]	1780	1762
Average U-value [W/m²K]	0.34	0.34
Alpha value* [%]	7.18	7.18

* 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/m²]

	Actual	Notional
Heating	1.55	2.23
Cooling	0.56	0.48
Auxiliary	3.71	4.76
Lighting	7.88	12.12
Hot water	9.2	9.1
Equipment*	21.13	21.13
TOTAL**	**22.9**	**28.68**

* 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/m²]

	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/m²]	12.74	13.57
Primary energy* [kWh/m²]	50.04	65.77
Total emissions [kg/m²]	8.6	11.2

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

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Selwyn School (Green)

As designed

Date: Wed Dec 09 18:40:26 2015

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.3.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.3.3

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

Owner Details

Name: Draft

Telephone number:

Address: , ,

Certifier details

Name: Silcock Dawson and Partners

Telephone number:

Address: , ,

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	11.2
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	11.2
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	7.3
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	0.14	0.14	External Wall
Floor	0.25	0.15	0.15	Ground Floor
Roof	0.25	0.14	0.14	Roof
Windows***, roof windows, and rooflights	2.2	1.36	1.6	Classroom door
Personnel doors	2.2	1.78	2.45	Opaque pedestrian door
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	-	-	No high usage entrance doors in project

$U_{a\text{-}Limit}$ = 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	4.02

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	NO
Whole building electric power factor achieved by power factor correction	0.9 to 0.95

1- Toilet Extract (11 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	-	-	-
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.

2- HTM vent (22 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	-	-	-
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- nat vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	-	-	-
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.

4- MVHR (25 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	-	-	0.75
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.

5- Kitchen vent (Kitchen)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	-	-	-
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.

6- Server room (server room)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0	3.6	-	-	-
Standard value	N/A	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	3118	3118
External area [m²]	5240	5240
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	4	3
Average conductance [W/K]	1807	1764
Average U-value [W/m²K]	0.34	0.34
Alpha value* [%]	7.19	7.19

* 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/m²]

	Actual	Notional
Heating	1.55	2.23
Cooling	0.56	0.48
Auxiliary	3.71	4.76
Lighting	7.88	12.12
Hot water	9.2	9.1
Equipment*	21.13	21.13
TOTAL**	**22.9**	**28.68**

* 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/m²]

	Actual	Notional
Photovoltaic systems	2.46	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	12.74	13.57
Primary energy* [kWh/m²]	50.04	65.77
Total emissions [kg/m²]	7.3	11.2

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

A3 APPENDIX 3 - RENEWABLE ENERGY OVERVIEW

The information in this appendix is not project specific and is intended to provide an overview of the technologies described.

A3.1 Biofuels

A3.1.1 Background

Biomass is an alternative solid fuel to the conventional fossil fuels and has an impact on carbon emissions that is close to neutral. Various types of biomass fuels are in use, the most common being the woody biomass, which includes forest residues such as tree thinnings, and energy crops such as willow short rotation coppice. The fuel usually takes the form of wood chips, logs and pellets. Supply and storage of the biomass fuel should be carefully considered especially for larger plants. Modern systems can be fed automatically by screw drives from fuel hoppers.

The typical applications are:

a. Biomass boilers replacing standard gas- or oil -fired boilers for space heating and hot water (for individual buildings or district heating systems).

b. Standalone room heaters for space heating.

c. Stoves with back boilers, supplying domestic hot water.

d. Biomass CHP for heat and electricity generation.

Appliances can achieve efficiencies of more than 80%.

The capital cost of automated biomass heating systems is significantly greater than that of conventional heating systems, mainly because of the more complicated feeding mechanisms and the currently smaller market for biomass appliances.

There is an ongoing public debate on the true sustainability of using biofuels. Given the number of differing views expressed by academics and engineers and contradictions in publications issued by the Government the theoretical carbon savings offered by biofuels must be treated with extreme caution. 3.1.2 to 3.1.5 below expands on this.

A3.1.2 Biofuels as a Sustainable Resource

Research undertaken by AEA technology on behalf of the Department for Transport[1] stated that '*Research has shown that biofuels can reduce carbon emissions, yet they are currently a controversial area of science. Insufficient data exists to fully understand the impact of biofuel production on communities and the environment; and, whilst biofuels could be a powerful tool in reducing carbon emissions, they must be produced in a sustainable manner if they are not to do more harm than good' then states that 'biofuels are currently a controversial topic area, and it is difficult to move forward in such circumstances*'. The research paper listed 4 key findings:

- Key finding 1: We need to improve our understanding of the indirect impacts of biofuels, particularly indirect land use change;

- Key finding 2: We need to improve our knowledge of the environmental, socioeconomic and supply-chain impacts of biofuels;

[1] Biofuels Research Gap Analysis, Department for Transport, July 2009

- Key finding 3: There is a need for new research to examine the evolution of the production, infrastructure and vehicle technologies necessary to enable us to meet longer-term biofuels targets for transport and for improving the sustainability of biofuels;

- Key finding 4: There are a number of cross-cutting research gaps that need to be addressed in order to support the development of biofuels policy

According to the Renewable Fuels Agency[2] only 18% of the liquid biofuels consumed in the UK originate in the UK. 30% of liquid biofuels originates in Brazil, and the sustainability of their production and the consequent deforestation are the topic of wider debate.

The carbon emission factor stated in the Standard Assessment Procedure (SAP) 2009 for biodiesel is 0.047kg CO2/kWhr. (The SAP methodology is used to calculate the energy consumption and carbon emissions from dwellings to demonstrate compliance with the Building Regulations and generate Energy Performance Certificates). Data published by the Renewable Fuels Agency[3] shows that the mean carbon emission factor for biodiesel consumed in the UK is 0.148kgCO2/kWhr (41 gCO_2e/MJ), this compares to the carbon emission factor for natural gas of 0.198kgCO2/kWhr. Given that there is a limited supply of biofuel it would be reasonable to use the mean value for the emission factor; this principle is applied to mains electricity where the carbon emissions from all sources of electricity generation are aggregated to arrive at a mean value.

The carbon emission factor stated in the SAP 2009 for wood pellets is 0.028kg CO_2/kWhr. Research by AEA Technology on behalf of the Environment Agency[4] showed that the emissions are actually between 0.050 and 0.140 kg CO_2/kWhr, with 0.1 $kgCO_2$/kWhr being a typical value for good practice. From this it can be concluded that the carbon savings stated when using the SAP values are overstated.

Biodiesel CHP may be technically viable for the development but the lack of certainty over the sustainability of liquid biofuels militates against this. In addition to this, concerns over the future availability of fuel supplies are a consideration. The European Renewable Energy Directive (RED) commits the UK to sourcing 10 percent of its transport energy from renewable sources by 2020[5]. Currently only 3.5% of transport energy is from renewable sources, and 82% of this is imported. It is reasonable to conclude that as the volume of liquid biofuel that is legally required to be used for transport energy increases, the supply of the fuel for other purposes will become more expensive and difficult to procure.

A3.2 Air and Ground Source Heat Pumps

A3.2.1 Background

The technology makes use of the energy available in the ambient air or stored in the Earth's crust, which comes mainly from solar radiation. Essentially, heat pumps take up heat at a certain temperature and release it at a higher temperature. This is achieved by means of a simple heat exchanger in the case of air source heat pumps, or by means of either horizontal or vertical ground collectors, in which a heat exchange fluid circulates and transfers heat via a heat exchanger to the heat pump, in the case of ground source heat pumps. For the latter, when considering buildings with piled foundations, the pipes can be integrated in the design using several piling systems.

The efficiency of any type of heat pump is very much dependent on the temperature level at which it has to provide the heat: the lower the temperature level, the better the coefficient of performance.

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[2] Renewable Fuels Agency Quarterly Report Apr 2010 to October 2010
[3] Renewable Fuels Agency Quarterly Report Apr 2010 to October 2010
[4] Biomass: Carbon sink or carbon sinner?, Environment Agency, April 2009
[5] Department of Energy and Climate Change website.

Almost all heat pumps in operation are based on the vapour compression cycle, which combines efficiency, safety and reasonable cost. The efficiency of heat pumps is measured by the ratio of the heating capacity to the power input, referred to as the Coefficient of Performance (COP). Generally, a COP of around 2.5-3 for air source heat pumps and around 3.5-4 for ground source heat pumps is achievable for heating, assuming low temperature heat emitters such as underfloor heating. When used to generate domestic hot water at 60℃ the COP falls for both types of heat pumps by around 1 point. Therefore, when it comes to domestic hot water, heat pumps can be implemented to pre-heat the water up to a certain temperature, before it enters the boiler, rather than to heat up the domestic hot water entirely up to its final required temperature.

The approximate costs for heat pumps amount to £700 per kW_{th} heat output for an air source heat pump, and £1,200 per kW_{th} heat output for a ground source heat pump with horizontal trenches, and £1,400 per kW_{th} heat output for a ground source heat pump with vertical boreholes (including the cost of bore holes).

A3.3 Solar Water Heating Systems

A3.3.1 Background

Solar thermal and, especially, active Solar Domestic Hot Water (SDHW) heating is a well - established renewable energy system in many countries outside the UK. It can be one of the most cost-effective renewable energy systems available.

It is appropriate for both residential and non-residential applications, and there are currently in the order of 80,000 installations in the UK.

Solar thermal systems in the UK normally operate with a back-up source of heat, such as gas or electricity. The solar system pre-heats the incoming cold water, which is topped up by the back-up heat source when there is insufficient solar energy to reach the chosen target temperature.

Solar collectors are best mounted at an incline with a southerly orientation, although orientations between south-east and south-west are acceptable. The panels can be fixed to the roof or walls. There are three main types of solar collector that can be used in SDHW systems. These are:

a. Evacuated tubes.
b. Glazed selective surfaced flat plate.
c. Glazed non-selective surfaced flat plate.

Evacuated tube collectors are generally more expensive than flat plate type but offer an improved performance, particularly in the winter.

A3.4 Photovoltaics

A3.4.1 Background

Photovoltaic modules convert daylight directly into DC electricity and can be integrated into buildings. Photovoltaics (PVs) are distinct from other renewable energy technologies since they have no moving parts to be maintained and are silent. PV systems can be incorporated into buildings in various ways: on sloped roofs and flat roofs, in facades, atria and shading devices. Modules can be mounted using frames or they can be fully incorporated into the actual building fabric; for example, PV roof tiles are now available which can be fitted in place of standard tiles. Since PVs generate DC output, an inverter and other equipment is needed to deliver the power to a building or the grid in an acceptable AC form. The cost of the inverter and these components can approach 50% of the total cost of a PV system.

For PV to work effectively it should ideally face south and at an incline of 30º to the horizontal, although orientations within 45º of south are acceptable. It is essential that the system is unshaded, as even a small shadow may significantly reduce output.

A3.5 Wind Energy

A3.5.1 Background

Most wind turbines are installed in non-urban areas for environmental and technical reasons. However, it has become more common for smaller devices installed at the point of use, i.e. urban settings. The capacity of wind turbines range from 500W to more than 1.5 MW, but, for practical purposes and in built-up areas in particular, machines of more than 1 kW and below 500kW are likely to be considered. Individual building or community wind projects, although smaller, have the advantage of feeding electricity directly into the building's electricity circuit, thus sparing costly distribution network development and avoiding distribution losses. The downside is the still high capital cost per kW installed for smaller turbines, plus location constraints, such as visual intrusion and noise. The wind regime in urban areas is also a concern owing to higher wind turbulence which reduces the potential electricity output.

In most cases, wind turbines are connected to the electricity grid and all generated energy is used regardless of the building demand fluctuations. The output largely depends on the wind speed and the correlation between the two is a cube function. This means that in short periods of above-average wind speeds the generation increases exponentially. As a result, it is difficult to make precise calculations of the annual output of a turbine, but average figures can provide useful guidance.

The cost per kW installed varies considerably by manufacturer and size of machine with an indicative bracket of £2,500-£5, 000. With a lifespan of more than 20 years, wind turbines can save money if design and planning are carried out in a robust way.

Wind Turbine Options

Wind turbines can be mounted on horizontal or vertical axes. The horizontal mounted turbines are less expensive (around £ 20,000 for a 6 kW turbine) but generate more vibrations. The vertical mounted turbines are more expensive (around £ 22,000 for a 5 kW turbine), but almost vibration free. The table below shows the most relevant figures for both types of turbines.