The Hall School

Energy Strategy Report

December 2020

ELEMENTA

Document Control

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1 Executive Summary

1.1 Introduction and site description

This document details the proposed energy strategy for the development at the Hall School, Crossfield Road. Originally issued in December 2020, the report has been updated to address feedback received from the Local Authority.

The key updates included within this revision of the report are:

- Clarification that all emissions rates are calculated using SAP 2012 emissions factors, as calculated using the Compliance module of IES VE
- Extent of areas assessed – within the report the "building area" is quoted as 2191sqm; this refers to the area of the major renovation works that is assessed under Part L2A of the Building regulations. As stated in the DAS, the actual areas of the development are as stated in Section 2.1
- Clarification of the proposals for consequential improvements, required as the works are larger than 100sqm and greater than 25% of the existing building as detailed in Section 157
- Addition of PV panels into the scheme, as detailed in Section 6

The proposed development is an extensive redevelopment of a boy's prep school in Belsize Park, a conservation area. The redevelopment will include the demolition and rebuild of Wathen Hall to incorporate a new hall and gymnasium. The works will also include the refurbishment of the street facing elevation and an extension in order to enhance the school's contribution to the conservation area.

1.2 Proposed Energy strategy

The development incorporates the following strategies to reduce the emissions:

- Energy efficient fabric and building services design, the proposal achieves a 12% improvement over the baseline target of the existing building, through energy efficiency alone
- Air Source Heat Pumps (ASHP) serving the space heating and cooling for the school, as well as the DHW.
- Use of photovoltaic panels on the roof to provide onsite generation of 19.4% of the annual energy load

1.3 Carbon emissions and savings

The calculated carbon emissions and regulated savings at each stage of the energy hierarchy of the site are outlined in Table 1.1 below.

	Total regulated emissions (tCO_2/year)	**CO_2 savings (tCO_2/year)**	**Percentage Savings (%)**
Baseline	39.3		
Be Lean	34.6	-4.8	12%
Be Clean	34.6	0.0	0%
Be Green	23.3	-11.3	29%
Baseline to Be Green		16.1	41%

	Total regulated emissions (kg CO_2/m^2 /year)	**CO_2 savings (tCO_2/yea)**	**Percentage Savings (%)**
Baseline	18.1		
Be Lean	15.9	2.2	12%
Be Clean	15.9	0	0%
Be Green	10.7	5.2	29%
Total		7.4	41%

Table 1.1: Carbon Emissions after demand reduction – Absolute & kg CO_2/m^2

The site-wide results indicate a regulated carbon saving of 16.1 tCO_2/year, which is a 41% reduction of the baseline site regulated carbon emissions of 39.3 tCO_2/year.

2 Introduction

Elementa Consulting have been commissioned by The Hall School ('the client') to produce an energy strategy in support of the planning submission for the new school building ('the proposed development'). This report sets out how the proposed development will meet the school's energy aspirations, through energy efficient measures, low carbon energy supply from decentralised sources and the integration of renewable energy technologies.

2.1 The Development

The project consists of the redevelopment of the Hall School on Crossfield Road in Camden, London. The works consist of three elements:

- Demolition of parts of the existing building, and replacement of this with new accommodation
- Extensive refurbishment of art teaching facilities in the retained building (2nd floor)
- Light touch refurbishment of the accommodation within the retained building.

Floor	Light Refurb	Extensive Refurb	Existing Building Retained	New Build
Basement	345m^2		67m^2	130m^2
Lower Ground	356m^2		170m^2	585m^2
Ground Floor	255m^2		158m^2	615m^2
Mezzanine	77m^2		15m^2	
First Floor	80m^2		124m^2	385m^2
Second floor	96m^2	115m^2	51m^2	361m^2
Total	**1209m^2**	**115m^2**	**585m^2**	**2076m^2**
Total Area	**3985m^2**			

Of the proposed scheme, the "Extensive Refurb" and "New Build" areas have been assessed using Part L2A of the Building Regulations, which this energy strategy details: these areas are the new building and the 2nd floor art area within the retained building. The "light refurb" areas are not included in this assessment as there is no increase in installed building services provision. The scheme also attracts consequential improvements under Part L2B, as the new build element is an extension larger than 100 m^2 and greater than 25% of the existing building area. The demolition plans are included within the Architectural Design & Access Statement

2.2 Policy requirements

The proposed development was assessed in accordance to the following policies;

- London Borough of Camden
- National Planning Policy Framework (2018)

2.3 Building Regulations and SAP10

Part L of the Building Regulations in England sets standards for the energy performance of new and existing buildings; the current version is Part L 2013 with 2016 amendments.

At the end of November 2016 BEIS published a consultation on proposed changes to SAP 2012. On 24th July 2018 BRE published SAP 10 which provides an indication of the expected future carbon emission factors that will inform and potentially be adopted in any future update to Building Regulations. One of the key changes was the adjustment of the carbon factors of electricity and (to a lesser extent) natural gas, as shown in Table 2.1 below:

Table 2.1, Sap 2012 and SAP 10 Carbon factors

	SAP 2012 / Part L 2013	SAP 10
Grid Electricity ($kgCO_2/kWh$)	0.519	**0.233**
Natural Gas ($kgCO_2/kWh$)	0.216	**0.210**

The results in this report will present the CO_2 emissions based on SAP 12 carbon factors, however the GLA SAP 10 Spreadsheet is provided for comparison

2.4 Energy targets

The London Borough of Camden Local Plan refers to the following Energy Hierarchy; with non-domestic buildings over 500m^2 required to demonstrate how the energy hierarchy has been applied to make the fullest contribution to CO_2 reduction.

- Be Lean: Use Less Energy
- Be Clean: Supply Energy Efficiency
- Be Green: Use Renewable Energy

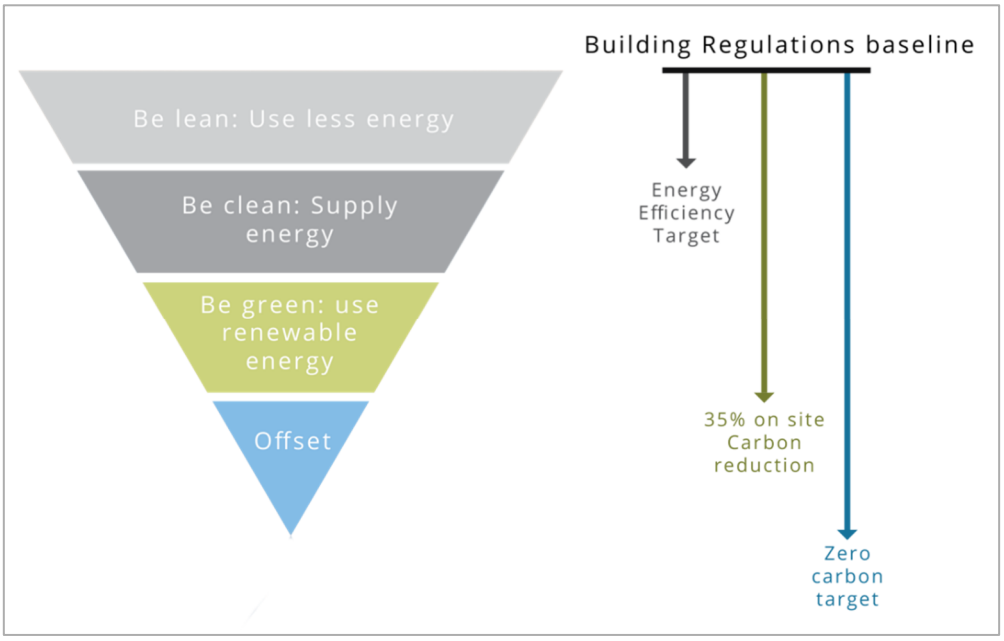


Figure 2.1, Energy Hierarchy diagram

Under the emerging local planning requirements, new build developments are expected to reduce carbon emissions by 35% against part L2A target emission rate.

The London Borough of Camden planning policy also expects developments with over 500m^2 of any gross internal floor space to achieve a 20% reduction in carbon emissions via renewables.

3 Baseline Building

The proposed development of the school was modelled to establish the baseline regulated emissions. This was determined by the Target Emission Rate (TER), calculated from the notional results of the compliance assessment.

To determine the baseline condition, a gas boiler has been used for all spaces of the baseline, in order to meet the heating and hot water demands.

The VE compliance module of IES Virtual Environment version 2019 was used to model the existing building and establish the regulated Buildings Energy Rate (BER), which is used as the baseline. Unregulated emissions from electricity use were estimated from the BRUKL output sheet, using the equipment load prediction.

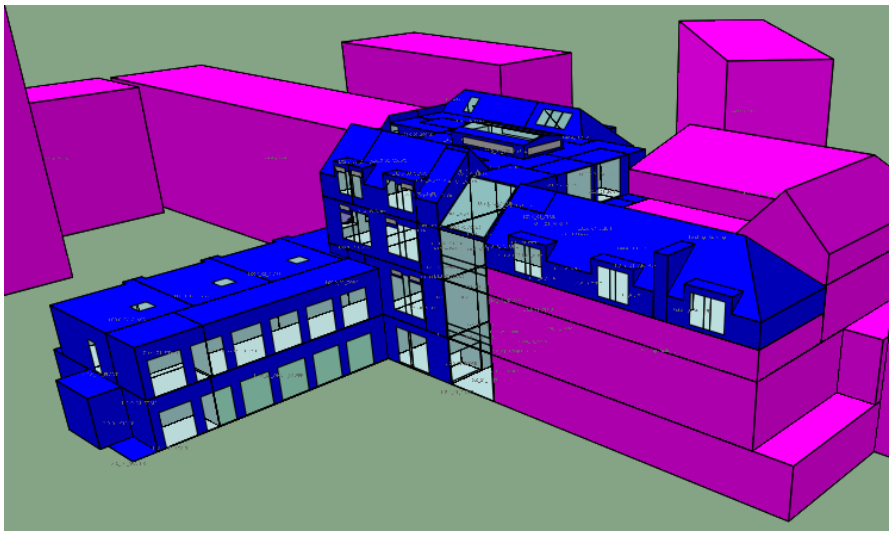


Figure 3.1: 3D view of IES energy model indicating the new build and art department in blue

3.1 Inputs and Assumptions

The building fabric for the baseline building is set by the inputs automatically assigned to the notional buildings of the model. Table 3.1 highlights the Part L2A limiting values and the Part L2A notional values.

	Elements	Part L2A limiting values	Part L2A notional values
Opaque	Wall U-Value (W/m^2.K)	**0.35**	**0.26**
	Ground/ Exposed Floor U-Value (W/m^2.K)	**0.25**	**0.22**
	Flat Roof U-Value (W/m^2.K)	**0.25**	**0.18**
	Pitched roof insulated at ceiling U-values (W/m^2.K)	**0.25**	**0.18**
	External Door U-Value (W/m^2.K)	**2.20**	**2.20**
Glazing	Window / Glazed Door U-Value U-Value (W/m^2.K)	**2.20**	**1.60**
	Glazing G-Value	**-**	**0.40**
	Building Air Permeability (m^3/(h.m^2) at 50 Pa)	**10**	**3**

Table 3.1: Building Part L2A limiting fabric and inputs for the baseline building

The building services automatically assigned for the baseline model are listed in Table 3.2 below.

		Baseline (notional values)
Ventilation	Ventilation	**Mechanical Ventilation with Heat Recovery (MVHR) units**
	Specific Fan Power (SFP)	**1.8 W/l/s**
	Heat Recovery	**70%**
Heating	Heating System	**Gas Boiler**
	Heating efficiency (as per lean case of ES)	**91%**
	Distribution Efficiency for Heting system	**5% losses Included in efficiency**
Cooling	Cooling System	**Electric VRV with MVHR**
	Cooling Efficiency (EER)	**5.00**
	Distribution Efficiency for Cooling system	**10% losses Included in efficiency**
DHW	DHW type	**Gas Boiler**
	DHW Efficiency	**91%**
	Distribution Efficiency for DHW system	**5% losses Included in efficiency**
Lighting	Lighting efficacy	**60 lm/cw**
	Daylight areas - Dimming	**Photo-electric dimming**
	Daylight areas - Sensor controls	**No back-sensor**
	Occupancy sensing	**Manual on – Auto off**

Table 3.2: Building systems for the existing building

3.2 Carbon Emissions

The regulated carbon emissions for the baseline of the school was calculated to be, 39.3 tCO_2/year using the SAP 2012 carbon factors, as shown in Table 3.3.

Unregulated emissions from small power and equipment are calculated to be 13 tCO_2/year

Carbon dioxide emissions (tonnes CO_2 per annum)	**Regulated tCO_2/year**	**Regulated kg CO_2/m^2 /year**
Baseline	39.3	18.1

Table 3.3: Baseline Carbon Emissions

4 Be Lean

The London Borough of Camden Local Plan does not set any targets for CO_2 reductions through energy efficiency alone. However, it mentions that the proposals should demonstrate how passive design measures including the development orientation, form, mass and window sizes and positions have been taken into consideration to reduce energy demand.

A target of 10% reduction is recommended with a consideration to passive measures and energy efficient equipment, including energy efficient lighting and ventilation systems, as outlined the London Plan. The BRUKL input document can be found in Appendix A.

4.1 Target U-Values

The full fabric specification used when modelling the savings from energy efficiency, under the 'Be Lean' case, is listed in Table 4.1 below. The proposed fabric energy efficiency for the school gives an overall specification that meets Criterion 1 of Building Regulations Part L through energy efficiency alone.

	Elements	Proposed values
Opaque	Wall U-Value (W/m^2.K)	**0.13**
	Ground/ Exposed Floor U-Value (W/m^2.K)	**0.12**
	Roof U-Value (W/m^2.K)	**0.10**
	External Door U-Value (W/m^2.K)	**1.40**
Glazing	Frame factor	**10%**
	Window / Glazed Door / Glazing Screen U-Value (W/m^2.K)	**1.20**
	Window Glazing G-Value	**0.40 (N/E/S) 0.3 (W)**
	Glazing Screen G-Value	**0.2**
	Roofights U-Value (W/m^2.K)	**1.20**
	Rooflight - G-Value	**0.40 (All spaces except Atrium – 0.18)**
	Building Air Permeability (m^3/(h.m^2) at 50 Pa)	**3**
	Shading	**Internal blinds have been used**

Table 4.1: Building fabric inputs for the "Be Lean" case

4.2 Building systems

The full building systems specification used when modelling the savings from energy efficiency, under the 'Be Lean' case, is listed in Table 4.2 below.

Ventilation	Ventilation	**Mechanical Ventilation with Heat Recovery (MVHR) units**
	Specific Fan Power (SFP)	**Ground and First Floor: 1.3 W/l/s Second Floor: 1.0 W/l/s**
	Heat Recovery	**80%**
Heating	Heating System	**Gas Boiler**
	Heating efficiency (as per lean case of ES)	**91%**
	Distribution Efficiency for Heating system	**95%**
Cooling	Cooling System	**ASHP (VRF Condenser)**
	Cooling Efficiency	**3.93**
	Distribution Efficiency for Cooling system	**95%**
DHW	DHW type	**Gas Boiler**
	DHW Efficiency	**91%**
	Distribution Efficiency for DHW system	**95%**
Lighting	Lighting efficacy	**90 lm/cw in Classrooms and Offices 75 lm/cw in Atrium, Storage spaces and Circulation**
	Daylight areas - Dimming	**Daylight Dimming in all classrooms, office, meeting rooms, communal study spaces, atrium.**
	Daylight areas - Sensor controls	**No back-sensor**
	Non-Daylight areas – Controls	**Local manual switch**
	Occupancy sensing	**Presence Detection throughout**

Table 4.2: Building systems for the "Be Lean" case

4.3 Carbon Emissions

The regulated carbon emissions for the proposed development, including the energy efficient measures listed above, for the 'Be Lean' case are calculated to be 22 tCO_2/year using the SAP 12 carbon factors, as shown in Table 4.3.

Carbon dioxide emissions (tonnes CO_2 per annum)	**Regulated**	**Regulated kg CO_2/m^2 /year**
Baseline	39.3	18.1
After energy demand reduciton	34.6	15.9
Emissions Reduction	4.8	2.2

Table 4.3: Carbon Emissions after demand reduction

This represents a saving of 4.7 tCO_2/year or 12% of baseline regulated emissions achieved by improving on Building Regulations emissions rate targets through energy efficiency alone

4.4 Cooling demand

The school will have mixed mode ventilation with VRF coils and floor mounted VRF convectors providing the cooling. The chilled beams will be connected to the Air Source Heat Pump (ASHP), which will deliver heating and cooling loads. The cooling hierarchy considers the following measures:

- efficient lighting and dimming where possible
- high solar control glazing with a solar transmittance (g-value) of 0.4 for all glazing type, except West facing windows with a g-value of 0.3 and atrium rooflight with a g-value of 0.18
- mechanical ventilation

Despite using very good solar controlled glazing, the cooling load of the building has increased in respect to the notional building, as shown in Table 4.3 below.

	Building cooling demand (area weighted) (MJ/m^2)
Notional	**6.5**
Actual	**7.9**

Table 4.3, Carbon Emissions after demand reduction

5 Be Clean

The availability of district heat and electricity networks within the local areas was investigated using the London heat map and it was identified that there are no viable/planned local networks in the vicinity (within 500 meters) for this development to derive heat from.

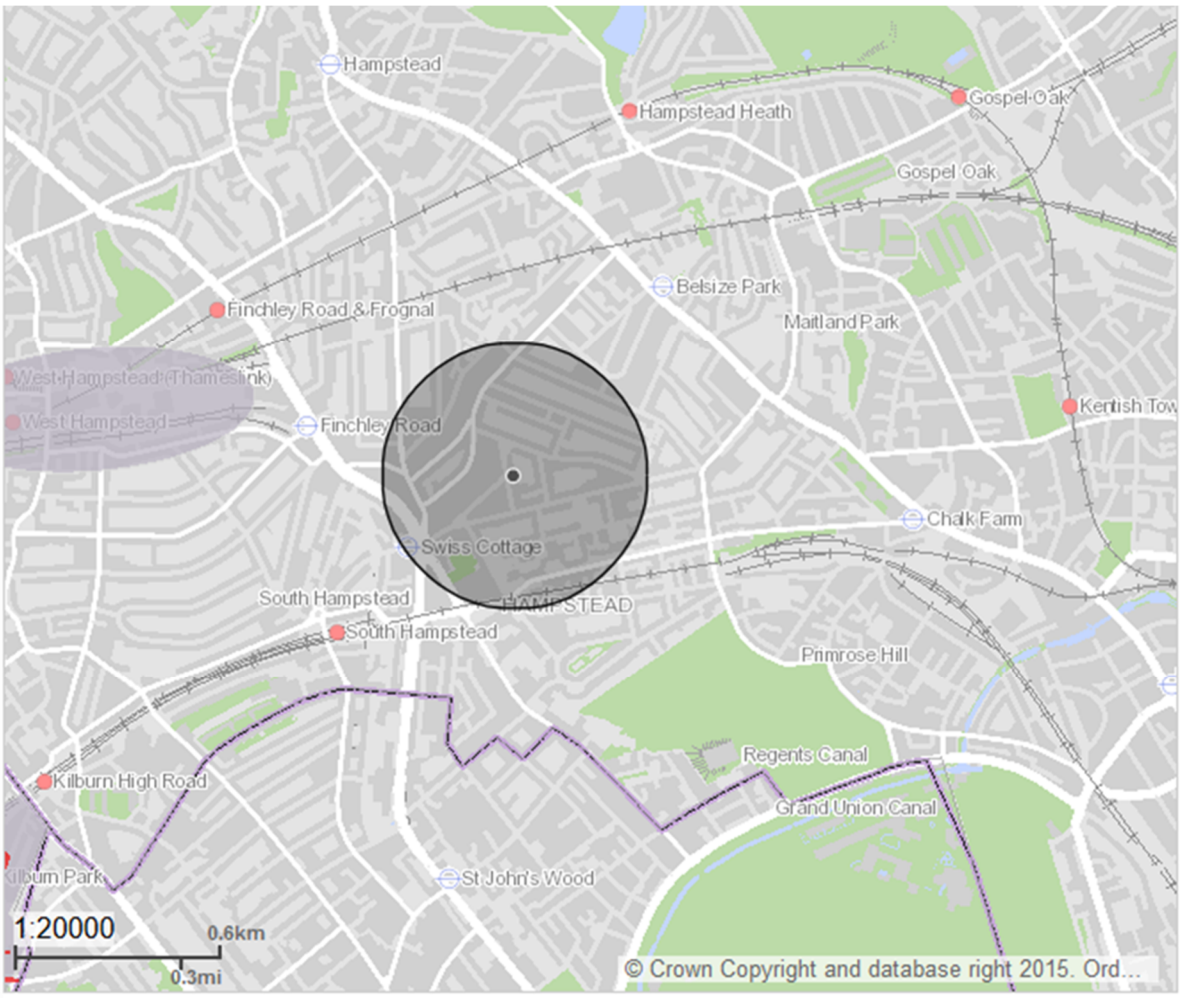


Figure 5.1: Local network map

The heating and hot water annual energy graphs are shown below. This development is not near an existing district heating network, and has a low demand for hot water that is intermittent throughout the year, therefore there is insufficient demand to make a CHP system a viable option.

6 Be Green

This section includes the energy reduction through the use of low and zero carbon technologies incorporated into the proposed development.

6.1 Air Source Heat Pumps

Air source heat pumps (ASHPs) will be used to provide heating, cooling and hot water to the proposed development. The SEER and SCOP values used in the modelling of the heat pump system is shown in Table 6.1 below.

	Kitchen/Café Areas
ASHP Heating SCOP	3.93
ASHP Cooling SEER	3.77

Table 6.1, ASHP efficiencies

6.2 Photovoltaic Panels

It is proposed to provide the following areas of PV panels:

Orientation	Number of panels	PV area m2 (1.5m2/panel)	PV model efficiency	Panels tilt	Shading factor
West	22	33	18%	45°	90%
East	52	78	18%	45°	90%

Table 6.2, PV Provision

The area has been rationalised compared to that previously shown, following a review of the actual available area that is available to safely install the panels on.

This is shown in figure 6.1. During the next stage this array will be optimised , with detail design being undertaken to verify the proposals. The extents are limited due to plant coordination on new roofs and capacity on existing roofs

6.3 Carbon Emissions

The regulated carbon emissions for the proposed development, including the low zero carbon technology listed above, for the 'Be Green' case of the energy hierarchy are calculated to be 13 tCO_2/year using the SAP 10 carbon factors, as shown in Table 6.3.

Carbon dioxide emissions (tonnes CO_2 per annum)	**Regulated**	**Regulated kg CO_2/m^2 /year**
Baseline	39.3	18.1
Be Lean	34.6	15.9
Be Clean	34.6	15.9
Be Green	23.3	10.7

Table 6.3 Carbon Emissions reduction

This represents a saving of 16 tCO_2/year or 41% of baseline regulated emissions achieved by improving on Building Regulations emissions rate targets through low zero carbon technologies, as shown in Table 6.4.

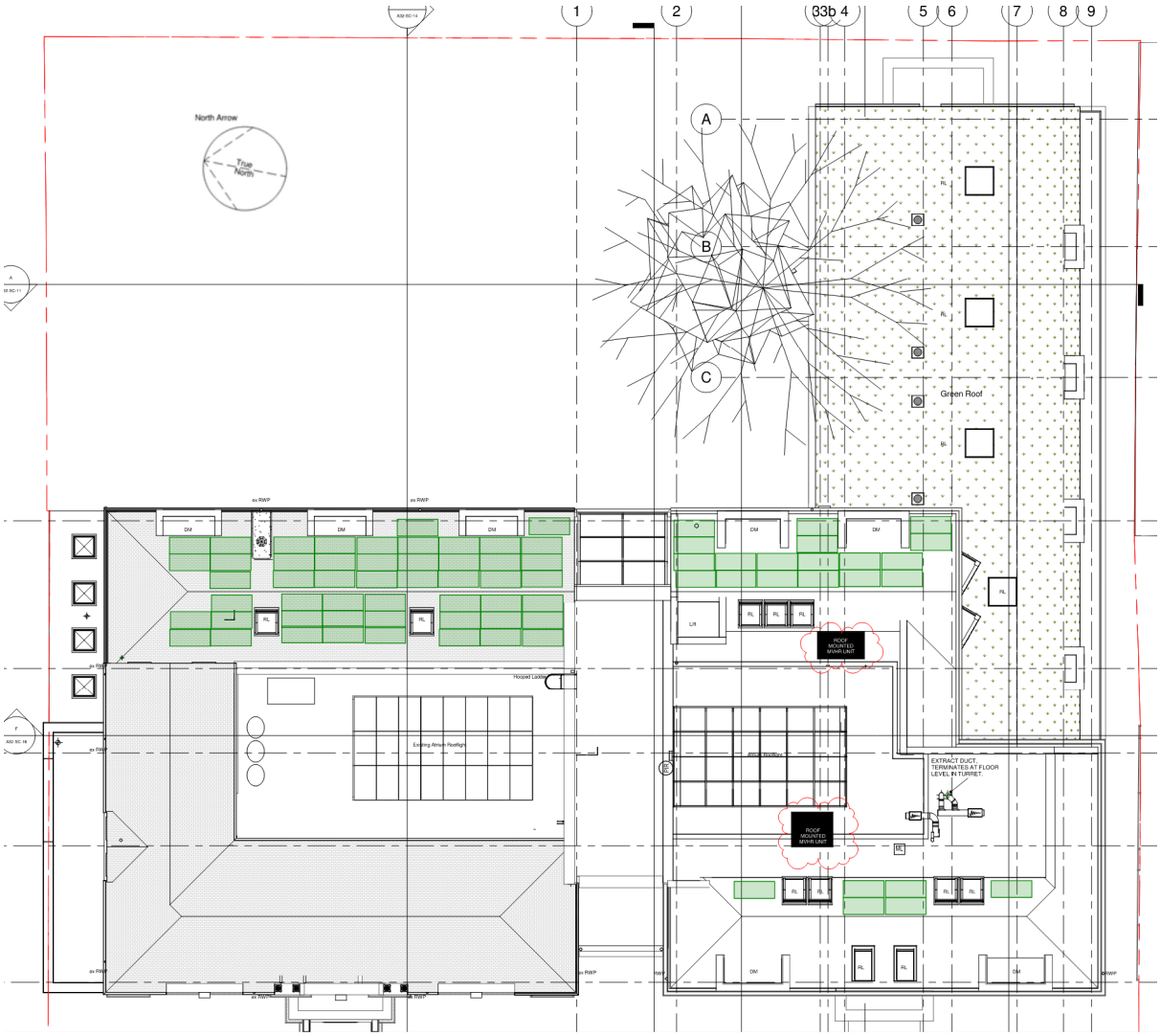


Figure 6.1: Proposed PV panel Array

Regulated carbon dioxide savings	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	4.8	**10%**
Saving from renewable technology	11.6	**29%**
Total Reduction	16.1	**41%**

Table 6.4, Carbon Emissions after demand reduction

7 Consequential Improvements

Under the requirements of Part L2B of the building regulations, it is necessary that developments larger than 100sqm and greater than 25% of the existing building incorporate consequential improvements into the design.

The requirements of consequential improvements are that 10% of the value of the principal works shall be used to provide enhancements to the existing building, subject to being technically, functionally and economically feasible – typically defined by an action having a simple payback of less than15 years.
Consequential improvements might include:

- Upgrading heating, cooling or air handling systems.
- Upgrading lighting systems.
- Installing energy metering.
- Upgrading thermal elements.
- Replacing windows.
- On-site energy generation.
- Applying measures proposed in a recommendations report accompanying an Energy Performance Certificate.

7.1 Proposals for Consequential Improvements

The following elements are proposed to meet with the requirements of consequential improvements:

7.1.1 Replacement Gas Boilers & Controls

The school is currently served by two boiler houses, one of which serves that area due to be demolished; the other boiler house serves the retained building. It is proposed to replace the boilers in this area.

The existing boilers have a 160kW capacity and are to be replaced with more modern condensing boilers with higher efficiency, and enhanced BMS/controls providing weather compensation and plant optimisation algorithms to increase system efficiency.

Additional metering will be provided as part of the control package

7.1.2 Lighting

Within the “light touch” refurbishment areas, lighting is being replaced with high efficiency LED lighting and associated controls

7.1.3 Other measures

Upgrades to the existing building fabric have been considered but are not viable due to the cost associated with the works. Onsite renewables have been maximised with the proposals for PV installations.

8 BREEAM

8.1 ENE 01 Energy Performance

The energy performance of the proposed development has been checked against the BREEAM New Construction (NC) 2018, ENE01 credit. The Energy Performance Ratio (EPR_{ED}) for the buildings heating and cooling demand is calculated and compared against the Energy Performance Ratio (EPR_{NC}) benchmark scale.

The '_brukl.inp' file for the proposed building has been uploaded on the BREEAM online tool. A screenshot of the BREEAM online calculation tool with the generated outputs is provided in the appendix.

Table 7.1, Ene 01 BREEAM Output

Key Performance Indicator	Ene 01 Output
Building Floor Area (m2)	2174
Notional Building Energy Demand (MJ/m2/yr)	50.37
Actual Building Energy Demand (MJ/m2/yr)	43.45
Notional Building Primary Consumption (kWh/m2/yr)	33.37
Actual Building Primary Consumption (kWh/m2/yr)	26.45
Target Emissions Rate, TER (kgCO2/m2.yr)	16.9
Building Emissions Rate, BER (kgCO2/m2.yr)	10.7
Building Improvement over TER %	36.7
Heating and Cooling Demand Energy Performance Ratio, EPRed	0.197
Primary Consumption Energy Performance Ratio, EPRpc	0.292
Overall Energy Performance Ratio, EPRnc	0.817
Total BREEAM 'Ene 1' Credits Achievable	10

8.2 ENE 04 Low zero carbon (LZC) feasibility study

The ENE04 credit covers Passive Design Analysis, Free Cooling and the Low and Zero Carbon (LZC) feasibility study. However, as the two first credits were previously not targeted, this section is only focusing on the Low and Zero Carbon (LZC) feasibility study. This was carried out at RIBA Stage 2 by a suitably qualified energy specialist and establish the most appropriate recognised local low or zero carbon energy sources for the development. The Low Zero Carbon technologies assessed are outlined in Table 8.1 below.

Local LZC technologies will be specified for the development in line with the recommendations of this feasibility study, and this method of supply will result in a meaningful reduction in regulated carbon dioxide emissions (i.e. minimum of 5% reduction).

Table 8.1, Low Zero Carbon technologies assessed

Technology	Technically Feasible	Recommended	Notes
Hydrogen technology	No	No	Technology not yet technically viable at this scale
Tri-Generation	No	No	Limited cooling demand and structural issues
CHP	No	No	A sufficient year round hot water base load is required therefore it is not recommended for this site.
ASHP	Yes	Yes	ASHP (VRF Condensers) have been used to provide heating and cooling.
PV	Yes	Yes	Proposed on site
GSHP	No	No	Technically viable, however, may not be the most cost effective solution due to the need for an underfloor heating system.
Wind power	No	No	Not viable due to the urban nature of the development.
Solar thermal	Yes	No	Could be used on the southern roofs. However, the DHW load is low and PVs would provide greater carbon savings.
Biomass	Yes	No	Biomass heating requires additional plant and storage space, with fuel delivery logistics and local air pollution issues to consider.

The following table demonstrates a 29% reduction in regulated carbon emissions through the use of renewables.

Table 8.2, Ene 04 Carbon emissions improvement

Carbon Factors	**Carbon emissions of Actual Building (Be Green) (kgCO2/m2)**	**Carbon emissions of Actual Building (Be Lean) (kgCO2/m2)**	**Percentage Improvement (%)**
SAP2012	10.7	15.9	**29%**

9 Conclusions

9.1 Baseline

Energy demand and carbon emissions associated with the proposed development were calculated using the VE Compliance module of IES Virtual Environment version 2019. The regulated Target Emission Rate (TER) was calculated to determine the base case used in this Energy Strategy. Gas boilers were assumed as the heating system for the baseline case to permit comparison. An estimate of unregulated electricity and gas use and the associated carbon emissions was also made.

- The school's regulated baseline carbon emissions were calculated to be 39.3tCO_2/year.
- The site-wide unregulated emissions were calculated to be 18.1 tCO_2/year.

9.2 Be Lean

The proposed design approach is to minimise the energy consumption through passive design, fabric performance and energy efficiency alone. Internal heat gains will be limited through the use of energy efficient lighting, plant and appliances.

Based on the proposed fabric and energy efficiency measures, the buildings regulated carbon emissions were calculated to be 34.6 tCO_2/year. Carbon savings from the "be lean" stage of the energy hierarchy are calculated to be 4.8 tCO_2/year, 12% of the regulated baseline emissions.

9.3 Be Green

The use of low and zero carbon technologies have been incorporated into the proposed development, for further energy reductions. Air source heat pumps (ASHPs) will be used to provide heating, cooling and part of the hot water to the proposed development.

After the use of renewable technology, the buildings regulated carbon emissions were calculated to be 23.3 tCO_2/year. Carbon savings from the "be green" stage of the energy hierarchy is calculated to be 11.3tCO_2/year, 29% of the regulated baseline emissions.

9.4 Carbon emissions and savings

The carbon emissions for the 'Be Lean' and 'Be Green' stages of the energy hierarchy are summarised in the tables below. The calculated carbon emissions and regulated savings at each of these stages of the energy hierarchy of the site are outlined in Table 9.1 and Table 9.2 below.

This represents a saving of a total of 13 tCO_2/year or 47% of baseline regulated emissions achieved by improving on the Baselines emissions rate targets through energy efficiency and low zero carbon technologies, as shown in Table 9.2.

Carbon dioxide emissions (tonnes CO_2 per annum)	**Regulated**	**Unregulated**
Baseline	39.3	18.1
After energy demand reduciton	34.6	18.1
After heat networks/CHP	34.6	18.1
After renewable technology	23.3	18.1

Table 9.1, Carbon Emissions after demand reduction

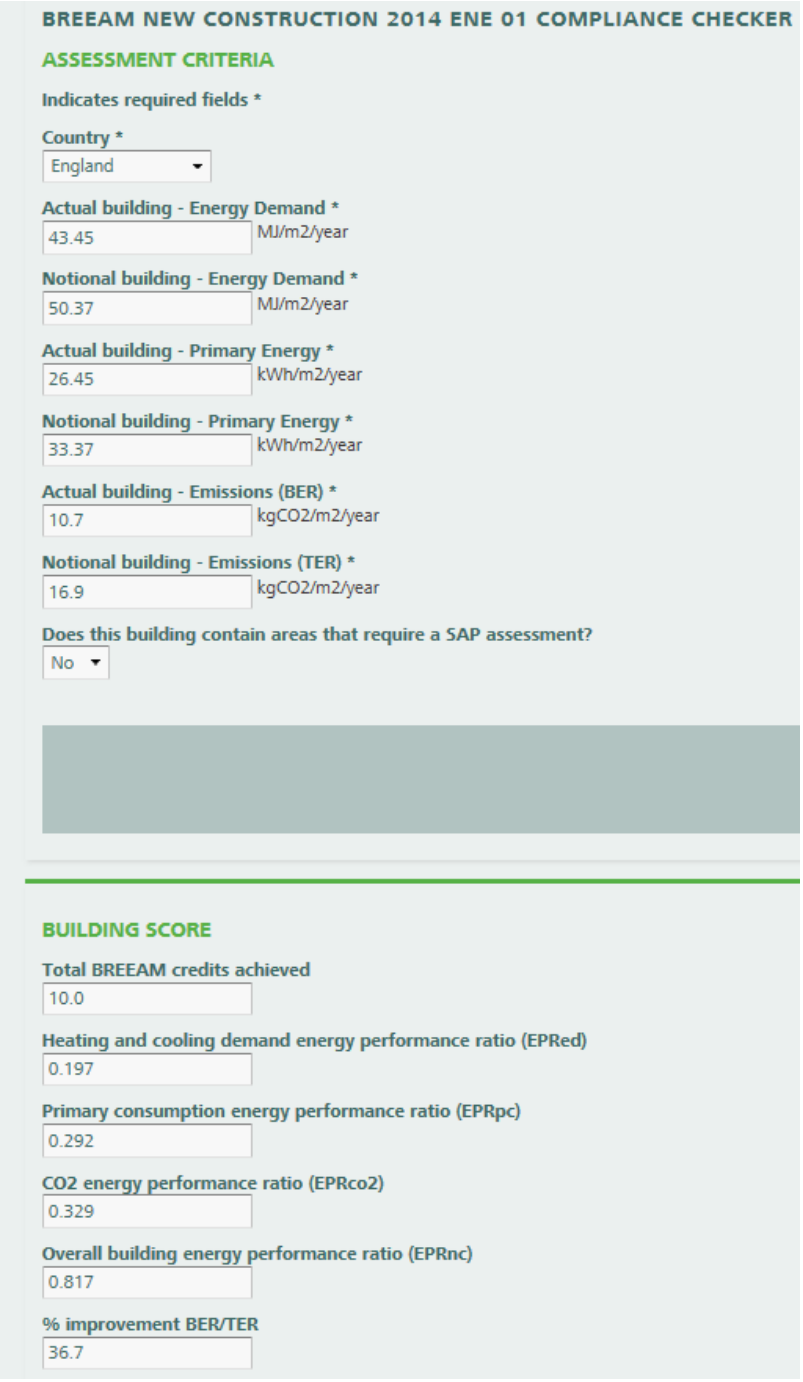
Regulated carbon dioxide savings	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	4.8	**12%**
Savings from heat networks/CHP	0	**0%**
Saving from renewable technology	11.3	**29%**
Total	16.1	**41%**

Table 9.2, Regulated carbon dioxide savings from the Be Lean and Be Green stages and the total cumulative savings.

10 APPENDICES

10.1 ENE01 Calculation

The BREEAM online calculation tool was used to determine the number of ENE01 credits awarded to this project. Figure 10.1 shows a screenshot of the results, with the project achieving 10 credits.



BREEAM NEW CONSTRUCTION 2014 ENE 01 COMPLIANCE CHECKER

ASSESSMENT CRITERIA

Indicates required fields *

Country *
England

Actual building - Energy Demand *
43.45 MJ/m2/year

Notional building - Energy Demand *
50.37 MJ/m2/year

Actual building - Primary Energy *
26.45 kWh/m2/year

Notional building - Primary Energy *
33.37 kWh/m2/year

Actual building - Emissions (BER) *
10.7 kgCO2/m2/year

Notional building - Emissions (TER) *
16.9 kgCO2/m2/year

Does this building contain areas that require a SAP assessment?
No

BUILDING SCORE

Total BREEAM credits achieved
10.0

Heating and cooling demand energy performance ratio (EPRed)
0.197

Primary consumption energy performance ratio (EPRpc)
0.292

CO2 energy performance ratio (EPRco2)
0.329

Overall building energy performance ratio (EPRnc)
0.817

% improvement BER/TER
36.7

Figure 10.1, ENE01 Credit

10.2Appendix 1 - Hall School - Be Lean_brukl

10.3Appendix 2 - Hall School - Be Green_brukl