

Energy strategy report

1. Introduction

1.1 Project Description

The project consists of a single two storey stand-alone building providing accommodation for two schools, the Orchard Hill Special Free School and the Orchard Hill Alternative Provision Free School. These two schools are covered jointly in the feasibility study FS0637 Orchard Hill Special Free School (Hillingdon Young People's Hub, FS0840 Orchard Hill Alternative Provision Free School (Hillingdon) Young People's Hub, Free Schools Programme, Feasibility Study, July 2018. Within this report the schools are referred to as Orchard Hill SEND and Orchard Hill AP. The site address is known as 71 Falling Ln, West Drayton UB7 8AB.

The schools' capacities are estimated to be as follows:

- Orchard Hill SEND:
 - KS3/4: 80 pupils;
 - Post 16: 30 pupils;
- Orchard Hill AP:
 - KS1/2: 20 pupils;
 - KS3/4: 80 pupils;
 - Post 16: 20 pupils.

This report discusses how the project design has considered building energy use, in particular in the use of passive design features and energy efficient services. Beyond defining the project roadmap on energy efficiency, it also provides the project information to meet the requirements of The ESFA Output Specification Technical Annex 2H Energy.

1.2 Project requirements

The project requirements pertaining to energy efficiency and energy strategy are discussed in this section. These requirements fall into three categories:

- Regulatory requirements associated with planning.
- Building regulations.
- Project specific requirements which form part of the Employers requirements.

1.3 Planning Requirements

The project, postcode EB7 8AB, is located in the London Borough of Hillingdon. The planning requirements associated with the site are nominated in the following documents:

- Hillingdon's Local Plan: Part 1 -Strategic Policies¹, which was adopted on the 8th November 2012 and is due to be reviewed in early 2019;
- Hillingdon's Local Plan: Part 2 – Development Management Policies², which has been revised in 2015 and has been submitted to the Secretary of State on the 18th May 2018 to begin the examination in public phase;
- The London Plan³, issued in March 2016. A draft London Plan was published in December 2018 that is a material consideration in planning decisions. In addition to The London Plan, the Greater London Authority provides guidance⁴ on preparing energy assessment that has been revised in October 2018.

The planning requirements applicable for the project are as follows:

- Reduce regulated CO₂ emissions below those of a development compliant with Part L 2013 of the Building Regulations through energy efficiency measures alone;
- Demonstrate at least a 35% on-site reduction beyond Part L 2013. It is noted that the London Mayor intends to introduce a zero carbon target in the new London Plan;
- Demonstrate that the risk of overheating has been mitigated through the incorporation of passive design measures;
- Demonstrate that connection to existing or planned district heating networks has been prioritised and provide correspondence to support this;
- Commit to a site-wide heat network to allow connection to existing or planned district heating networks identified in the area;
- Commit to a single energy centre to supply the site-wide heat network;
- Investigate suitable low carbon and/or renewable heating plant for installation within the energy centre if connection can't be made to an area wide network;
- Investigate and commit to maximising the installation of renewable technologies (including the potential for storage) on site;
- Include information on how the building's actual energy performance will be monitored post-construction.

SAP10 emissions factors should be used when estimated CO₂ emission performance from January 2019 until Part L is updated with the latest carbon emissions factors.

An Energy Statement is to be submitted at the planning application stage to demonstrate compliance with these planning requirements.

1.4 Building Regulations

The Building Regulations requirements pertaining to energy efficiency and the project are nominated in Approved Document L2A, aka Part L, Conservation of fuel and power in new buildings other than dwellings, 2013 edition. It consists of the following five separate criteria:

- Criterion 1: The calculated CO₂ emission rate for the building, the Building Emission Rate (BER), must not be greater than the Target CO₂ Emission Rate (TER).
- Criterion 2: The performance of individual fabric element and the fixed building services of the building should achieve reasonable standards of energy efficiency.
- Criterion 3: The building should have appropriate passive control measures to limit solar gains;
- Criterion 4: The performance of the building, as-built, should be consistent with the BER.
- Criterion 5: The necessary provisions for enabling energy efficient operation of the building should be put in place.

Compliance with criterion 1, 2 and 3 is based on calculations of the TER using one of the approved calculation tools.

1.5 Employer's Requirements

The Employer's Requirements relevant to the Energy Strategy Report and are included in the Education & Skills Funding Agency (ESFA) Output Specification Technical Annex 2H: Energy, Version 7. This document nominates the requirement for an Energy Strategy Reports, its contents and underpin the delivery of energy efficient schools through setting targets for regulated and unregulated energy use. The document also details the energy modelling requirements that are common to mainstream and SEND schools.

The ESFA Output Specification Technical Annex 2H nominates the following requirements:

³ <https://www.london.gov.uk/what-we-do/planning/london-plan/current-london-plan> accessed 22nd March 2019

⁴ <https://www.london.gov.uk/what-we-do/planning/planning-applications-and-decisions/pre-planning-application-meeting-service-0> accessed 15th March 2019

¹ https://www.hillingdon.gov.uk/media/27633/Hillingdon-Local-Plan-Part-1--Strategic-Policies-Published-version/pdf/Local_Plan_Part_1_Strategic_Policies_15_feb_2013_a.pdf accessed 15th March 2019

² https://www.hillingdon.gov.uk/media/34804/Development-Management-Policies-Oct-2015/pdf/Development_Management_Policies_-_Revised_Proposed_Submission_Version_Oct_2015.pdf accessed 15th March 2019

- An Energy Strategy Report is required;
- Strategies should be implemented following the following energy efficiency hierarchy:
 - Be Lean - use less energy;
 - Be Clean - efficient energy supply;
 - Be Green - renewable energy.
- A Concept Energy Model should be developed at concept stage to compare predicted energy use against energy targets. This energy model should be refined further in the design process;
- Provision of a metering and monitoring system to allow in-use monitoring and targeting and monthly output to the iSERV/K2n services.

2. 4.6b Energy use optimisation

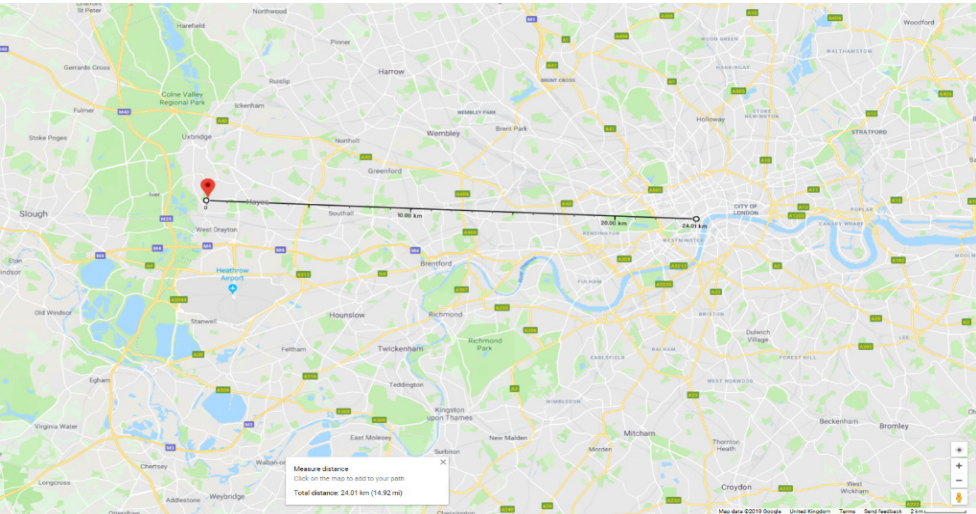
2.1 Model Description

The project energy use optimisation follows the energy hierarchy through reducing the energy demand via improved building fabric, use energy efficiently through energy efficient services and incorporate renewable energy generation to reduce the overall project energy demand.

This optimisation is done in collaborative approach with the design team, in consideration of façade articulation, construction methodology, natural light availability, thermal comfort and acoustic requirements, to derive an optimal solution that balances potentially conflictual requirements.

The energy use is assessed using the dynamic thermal modelling software IES-Virtual Environment version 2018.0.1.0, VE Compliance 7.0.10.0, which is listed⁵ as an approved software for the calculation of energy performance of building. The energy use optimisation is undertaken using the VE Compliance module that is used in assessment of building energy performance for compliance with regulations 24 of the Building Regulations 2010 and Approved Document L2A.

The project site location is shown in **Error! Reference source not found.** and is located west of London. The energy use analysis uses the London TRY05 weather file, which represents a typical year using hourly weather information and is used to demonstrate compliance with Approved Document L2A.



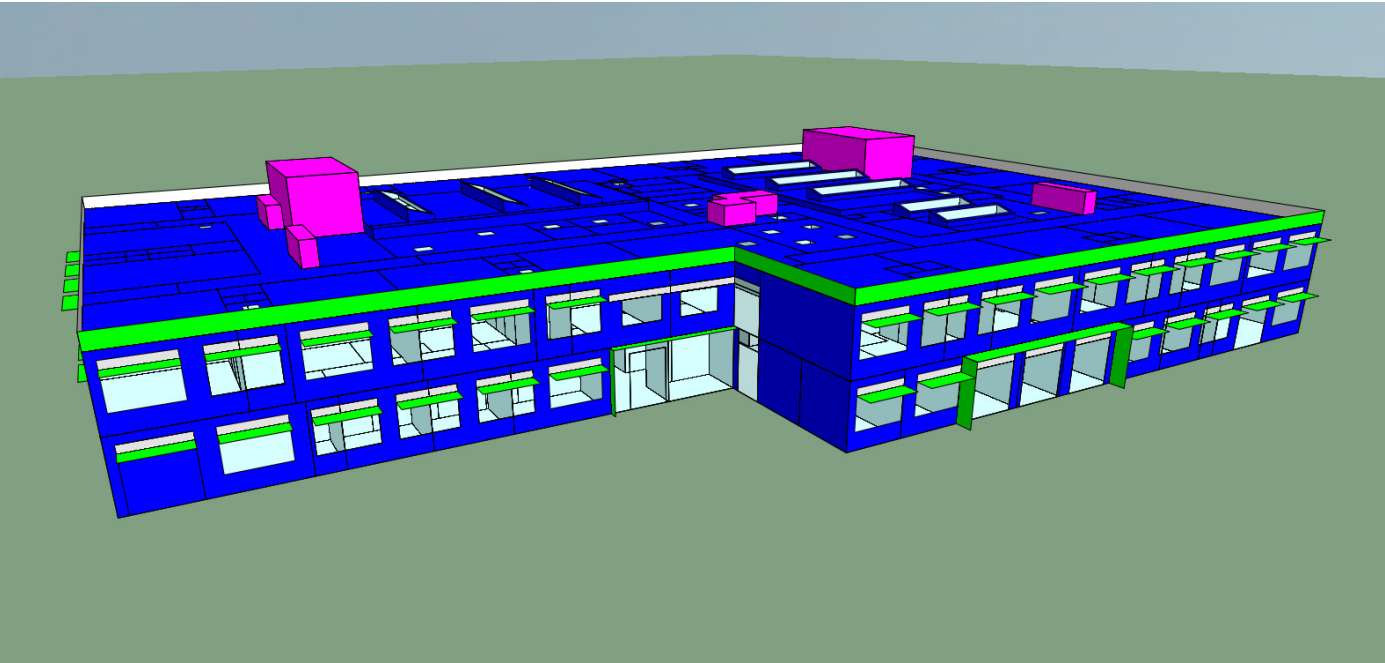
Indicative distance of project site to London

The energy use analysis requires the development of a 3D representation of the project. The 3D representation, which is shown in Figure 1, is based on the architectural drawings and 3D model listed in Table 1 and complemented with discussion with the architectural team. Whilst this information does not incorporate the latest room layout, it provides sufficient accuracy to evaluate the project energy use as a whole and the impact of energy reduction strategies.

Table 1 - 3D model basis of information

Type	Number	Title	Revision	Note
Drawing	2.1_ORC_ALA_Z1_00_DR_A(20)_003	GA Ground Floor Plan	P01	Shared on 2019-03-04
Drawing	2.1_ORC_ALA_Z1_01_DR_A(20)_004	GA First Floor Plan	P01	Shared on 2019-03-04

The building orientation, shown below, is based on the site plan provided by the architect. The building is orientated to have the elongated façades facing North and South directions and minimise East and West facing façades.



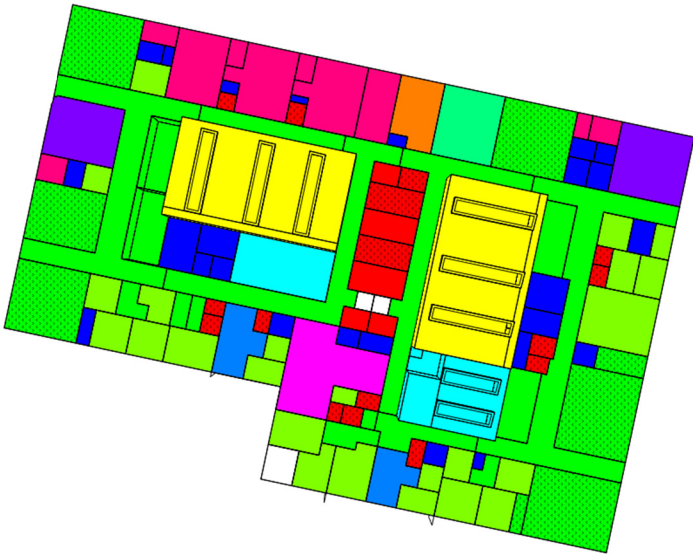
View of the IES-VE 3D representation of the project

The 3D model is complemented by populating each space according to their intended use, which is assigned using the NCM activity, heating, cooling, ventilation, lighting and domestic hot water systems. Figure 3 shows the 3D model representation of the ground and first floor coloured by the assigned NCM activity.

⁵ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/752594/Non-domestic_MHCLG_approved_software.pdf, accessed 22nd March 2019

Ground floor

- NCM Activity
- NCM D1Edu: Changing facilities (SecSchl)
 - NCM D1Edu: Circulation area (SecSchl)
 - NCM D1Edu: Cupboard (SecSchl)
 - NCM D1Edu: Dry sports hall (SecSchl)
 - NCM D1Edu: Eating/drinking area (SecSchl)
 - NCM D1Edu: Food preparation area (SecSchl)
 - NCM D1Edu: Hall/lecture theatre/assembly area
 - NCM D1Edu: High density IT work space
 - NCM D1Edu: Laboratory
 - NCM D1Edu: Office (SecSchl: Common)
 - NCM D1Edu: Reception (SecSchl)
 - NCM D1Edu: Teaching areas (SecSchl)
 - NCM D1Edu: Toilet (SecSchl)
 - NCM D1Edu: Workshop - small scale



First floor

- NCM Activity
- NCM D1Edu: Circulation area (SecSchl)
 - NCM D1Edu: Cupboard (SecSchl)
 - NCM D1Edu: High density IT work space
 - NCM D1Edu: Office (SecSchl: Common)
 - NCM D1Edu: Teaching areas (SecSchl)
 - NCM D1Edu: Toilet (SecSchl)
 - NCM Misc24Hr: Server room (IT)



IES-VE 3D model representation coloured by NCM activity.

The mechanical building services are articulated around natural ventilation boosted using Breathing Building Natural Ventilation with Heat Recycling (NVHR) units for classroom and offices that have façade opening. This ventilation strategy is represented in the energy use analysis using a mechanical ventilation system in accordance with the IES-Virtual Environment user manual related to NVHR and UK NCM analysis (Part L, Section 6, EPCs)6. Sports halls, dining areas and other spaces not connected to the facade are serviced by Mechanical Ventilation with Heat Recovery (MVHR) units. Corridors are provided with supply air only, and toilets and changing areas are provided with extract only.

Heating is provided by two high efficiency condensing boilers and domestic hot water is provided by gas fired water heaters.

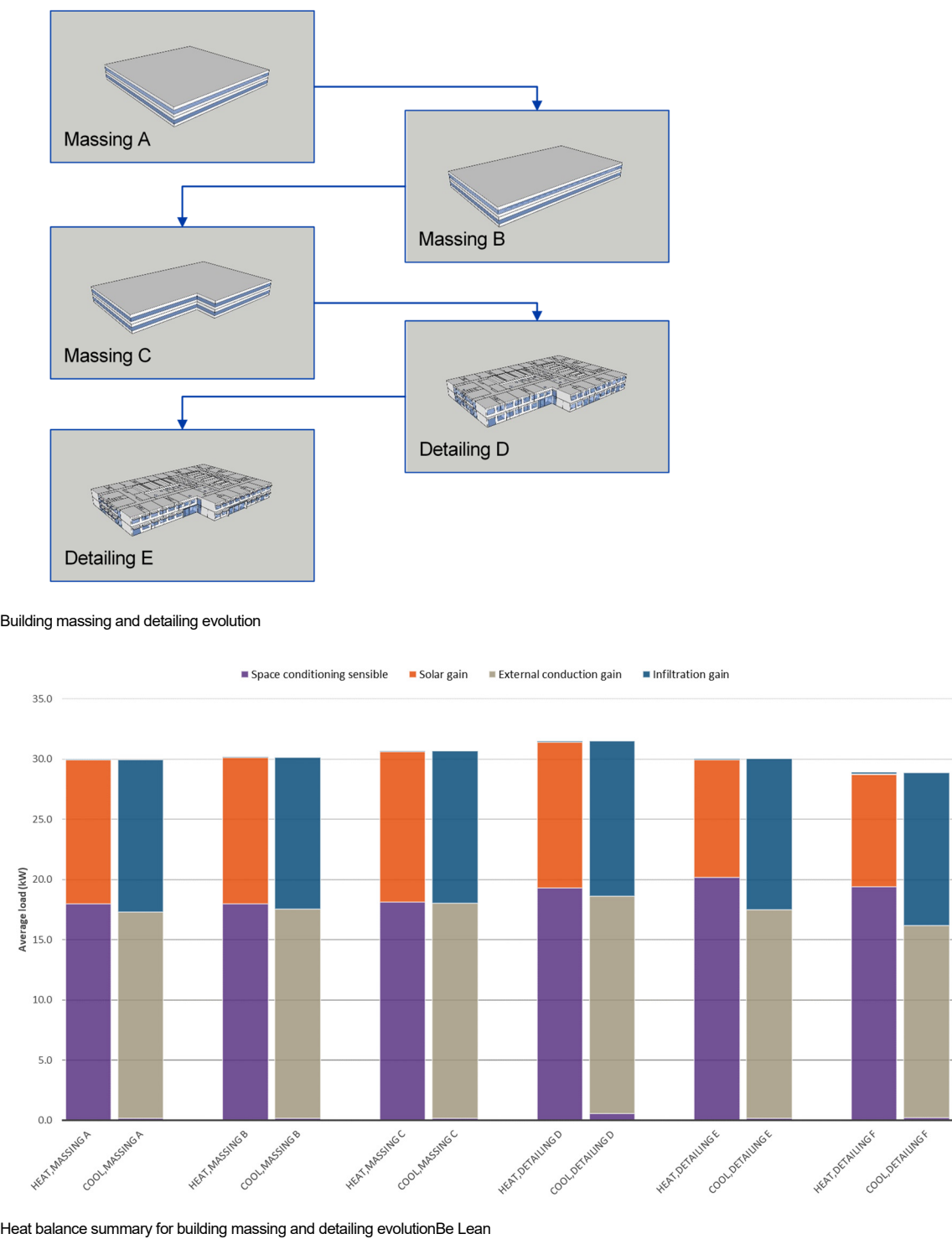
Internal lighting is provided using energy efficiency LED lighting and controlled using the control strategies L0.1 to L0.6 defined in Table 13 of the Output Specification, Technical Annex 2E: Daylight and Electric Lighting, version 7, November 2017 and listed below for ease of reference:

Type of Space	Description	Control method
Admin offices, staff areas, learning resource areas including group rooms, reception areas, primary libraries	Temporary or permanently owned rooms for individuals and small groups	Manual on, absence off
Basic Teaching spaces, including classrooms, staff rooms and admin offices, learning resource areas, study areas	Temporary or permanently owned rooms for larger groups	Manual on, absence off, daylight dimmed (only in a daylight space)
Corridors, stairs and lobbies	Transient spaces	Presence on, absence off, daylight off (only in a daylight space)
Toilets, hygiene rooms, changing rooms, non daylight corridors, stairs and lobbies	Transient spaces	Presence on, absence off
Store rooms, dark rooms, control rooms, sensory rooms, kiln rooms, plant rooms	Infrequently used areas or temporarily owned spaces	Manual on, manual off
Halls, dining and PE spaces, sports halls, dining and social areas, libraries	Spaces where individuals do not expect to control the lighting	Key switch staff control with override on; presence on, daylight dimming (only in a daylight space) and absence off

2.2 Passive Design

The building massing was developed to promote passive design and allow for natural ventilation by reducing solar gain. The development of the massing and detailing model is shown in **Error! Reference source not found.** starting from a square floor plan providing circa 2,740m² of gross floor area over 2 floors (Massing A) to a rectangle with the elongated length facing south to promote passive solar management (Massing B and C). In the detailing, windows on the east and west façade are minimised (Detailing D) and shading is incorporated to manage solar gain (Detailing E). As a final step (Detailing F), improved glazing and wall thermal performance are added to further minimise heat losses and solar gain.

For each evolution of the massing and detailing, an annual dynamic thermal analysis is undertaken to assess the sensible heat balance across the building. The analysis is based on maintaining an indoor temperature of 19°C in winter, with a night-time setback, and 25°C in summer. **Error! Reference source not found.** reports the annual heat gain and losses combined over the whole building. The results indicate that as the building massing evolves from Massing A to Massing C, solar gain and façade heat losses increase by circa 5% due to the alteration of the building volume to façade ratio. This increase is compensated during the detailing by the introduction of external shading that reduces the solar gain by 17% compared to Massing A and the improvement of external wall and glazing U-value that reduces fabric losses by 7%. This approach allows for a gradual assessment of the passive design option through (a) assessment of the positioning of glazing and shading; followed by (b) improvement in building fabric.



2.3 Be Lean

The Be Lean modelling assesses energy efficiency initiatives associated with passive measures: building fabric improvements, shading, air-tightness, glazing percentage area that are reported in Table 2. The building design incorporates

shading on all elevations to reduce summer solar gain and reduce overheating risk. The shading consists of a 1000mm Brize-Soleil preventing sun penetration through window.

Figure 3 compared the proposed building fabric option to the baseline option that consists of the notional building. The improved building fabric U-value performance results in lower conductive heat gains from the building to the outside associated with both summer gain and winter losses.

This model assesses the benefits associated with the use of energy in an efficient manner. The impact of energy efficiency measures is estimated using the building services parameters listed in Table 4, with the key measures summarised below:

Use of energy efficient lighting with local control;

Local delivery of air using highly efficient systems and natural ventilation.

Overall, the energy efficiency initiatives, reported in Table 2 below, associated with passive measures and efficient services results in a slight decrease in energy consumption.



Annualised energy balance comparing be lean approach to the baseline

The following section describes the lean measures included in the proposed design.

Passive Measures

Optimise Daylight

As per the requirements in Annex 2E (Daylight and Electric Lighting), the target daylight levels have been achieved throughout the school. The window design and position has been carefully considered along with the room dimensions and finishes to meet the daylight requirements. By providing good levels of daylight, energy demand for electric lighting will be reduced.

Control Solar gain and optimise the use of shading

Solar gain is controlled to all spaces by providing windows that have been optimally sized to maximise daylight, whilst regulating solar gains. The glazing specification follows the same principals by providing good light transmittance with a g-value of 0.41 to control solar gains in the summer. The g-value and window size are sufficiently sized to enable beneficial solar gains in the winter to reduce heating demand. External shading is provided to areas where enhanced shading is needed to mitigate overheating and prevent over glare for daylight.

Optimise the thermal envelope	The Laing O'Rourke solution offers a concrete façade panel which is designed, manufactured and assembled to ensure that the façade integrity and performance are realised for the building.
Insulate the building	All of the thermal building elements have thermal performance values in exceedance of the minimum values required for Part L (summarised in the final section). However, consideration has also been given to ensuring that the building is not over insulated as this risks trapping heating inside the building in the summer conditions. The proposed u-values for the building elements have been optimally balanced to meet all of the environmental performance criteria.
Eliminate thermal bridging	The design of the thermal bridging details have been fully assessed for the proposed Laing O'Rourke façade panel. We have a full set of details for the proposed facade.
Maximise air tightness	The air tightness assumed in the energy strategy report is 3m3/hr/m2. Our solution of assembled components provides a high level of façade integrity and air tightness. On this basis, and based on projects built elsewhere with the same building elements we can confidently commit to a low air permeability figure.
Optimise the use of thermal mass	The Laing O'Rourke solution provides excellent thermal mass as the building frame comprises of pre-cast concrete slabs with concrete column and beams. This is combined with concrete façade panels to offer a thermally heavy weight solution. Wherever possible the soffits are exposed to offer maximum benefit for the thermal environment.
Maximise potential for natural ventilation	Opening windows are provided across all facades of the buildings. All perimeter rooms benefit from some degree of natural ventilation or hybrid ventilation.
Maximise the efficiency of heating infrastructure	The Laing O'Rourke solution offers a high efficiency modular plantroom solution, manufactured in our facility in Oldbury. The design of these plantrooms has been optimised with energy efficiency at the forefront of the product development. The heating is provided by high efficiency small modular boilers which offer a very low turn down ratio to match the demand load. Domestic hot water is provided by high efficiency water heaters. The external lengths of pipework from the roof to the risers will be minimised to prevent excessive heat loss, and the design will be developed to consider the most efficient pipework routes and optimal levels of insulation. The modular plantrooms offer variable speed pumps and efficient, pre-commissioned controls to improve building performance.

Active Measures

Low Emissions heating systems	Heating is met by high efficiency low NOx modular gas boilers. Domestic hot water is provided by high efficiency gas water heating.
Heat recovery	The proposed breathing buildings units for teaching spaces recovery heat from the exhaust air stream to preheat incoming air. All supply and extract ventilation systems incorporate heat recovery.
Passive cooling and prevention of overheating	There is very little need for cooling in the proposed building. The overheating assessment results in the ventilation and cooling section describe how this is achieved.
Efficient ventilation systems	All ventilation systems will be design and procured to ensure that low specific fan powers, and low energy consumption can be achieved throughout the building. This will be achieved by ensuring that ductwork is appropriately sized and routed.
Energy efficient lighting	Energy efficiency lighting and controls have been proposed for all areas of the school buildings.
Other energy efficient measures	The controls are described in the mechanical and electrical controls sections.

Be Clean

The closest district heating network is located approximately 1.25km away as indicated in Figure 4 and hence is not considered a viable option for this project. Combined Heat and Power (CHP) is not considered for this project as this option is no longer promoted by the GLA and yields little CO₂ emission savings when SAP10 emission factors are employed.



London heat map showing project location and closest district heating network

2.4 Be Green

The Be Lean/Be Clean modelling results indicate that domestic hot water is a dominant energy use. This outcome relates to the NCM modelling protocol employed in this analysis that appear to overestimate annual domestic hot water demand.

The installation of photovoltaic (PV) panels to reduce the project CO₂ emissions through offsetting electrical energy consumption and has been utilized to meet the 35% emission reduction targets

As an alternate or complement to the above, it is also possible to financially contribute to an offset fund managed by the local authority or through an off-site CO₂ reduction alternative subject to approval by the local authority.

This energy strategy report is currently based on option 1, corresponding to the installation of PV panels. To meet the required 35% reduction, PV panels producing circa 67,000 kWh of electrical energy per annum are required, which is estimated to be achievable using a roof mounted PV installation of circa 550m² of inclined high efficiency (15%) PV panels facing south. A copy of the BRUKL certificate based on such installation is provided in appendix.

2.5 Summary

The following table reports on the regulated and unregulated energy use summary for the project. Table 3 reports the CO₂ emissions associated with the energy use calculated using the SAP10 emissions factors, namely:

- Grid electricity: 0.233kgCO₂/kWh
- Natural gas: 0.210kgCO₂/kWh

Table 2 - Energy use summary for non-domestic buildings, option 1 (PV)

	Regulated energy use (kWh/m2)	Unregulated energy use (kWh/m2)
Baseline	64	16.7
After energy demand reduction	63	16.7
After heat network/CHP	63	16.7
After renewable energy	43	16.7

Table 3 - Carbon dioxide emission summary for non-domestic buildings

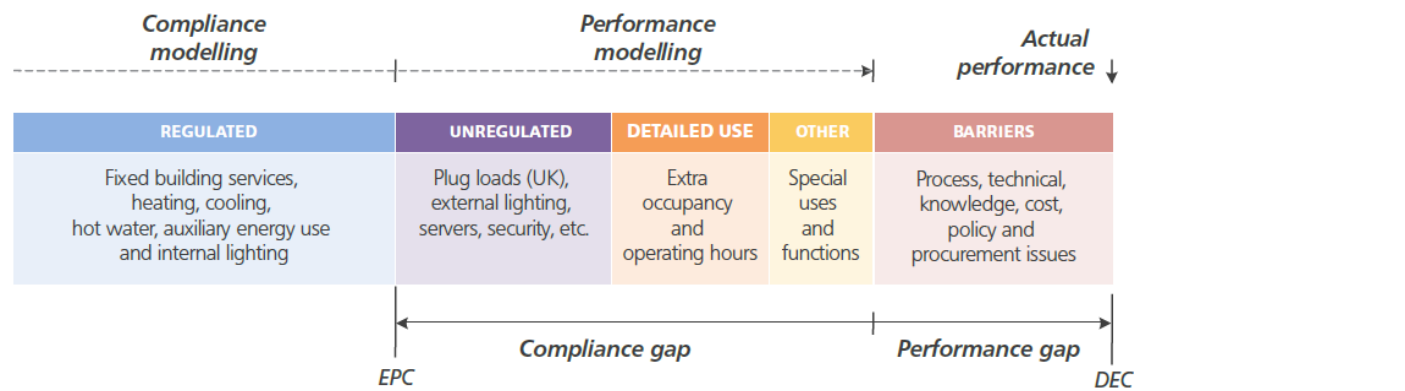
	Regulated (tCO ₂ /annum)	Unregulated (tCO ₂ /annum)	Regulated CO ₂ saving (tCO ₂ /annum)	Regulated CO ₂ saving (%)
Baseline	68	19		
After energy demand reduction	68	19	-1	-1%
After heat network/CHP	66	19	2	3%
After renewable energy	24	19	24	35%

3. Operational modelling

A Concept Energy Model has been developed for the project in accordance with the ESFA Output Specification Technical Annex 2H: Energy, Version 7 to establish the energy performance of the design at the concept design stage. The modelling approach uses the principles described in CIBSE TM54 Evaluating operational energy performance of buildings at the design stage and NABERS Commitment Agreements Handbook for estimating NABERS ratings.

The model consists of a combination of results from a Dynamic Simulation Model (DSM) undertaken using IES-Virtual Environment and calculations undertaken outside of the DSM model. The description of the model is based on the CIBSE TM54 methodology.

The accurate assessment of operational energy is a challenging exercise that requires an in-depth knowledge of not-only the building attribute, but also its intended operation. Another challenge in this assessment lays in the uncertainty in the building operation and the impact that operation can have on the energy consumption. An indication of the differences between compliance modelling, operational modelling and in-use performance is highlighted in Figure 8. The assessment presented in this report is based on an understanding of the school and uses necessarily simplified assumptions and allowance appropriate at this stage of the design. It is intended that the operational modelling is refined in conjunction with building end-users and facility management in subsequent stages of the design process.



Compliance modelling, performance modelling and in-use performance comparison

Step 1 - Establish floor area

The gross floor area is estimated from the DSM model, which is developed on the basis of the information listed in Table 1, and is:

- Estimated gross floor area: 4928m²;

Step 2: Establish operating hours and occupancy factors

The operating hours are nominated as fixed parameters in Annex 2H section 4.2.3.2 as follows:

- Opening timetable: 7:00 - 17:00
 - Dining timetable: 12:00 - 14:00
 - Working week: Monday to Friday during school calendar - estimated 190 opening days
- Occupancy factors are based on a combination of schedule of accommodation and occupancy density nominated in Annex 2H section 4.2.3.5 as follows:
- SoA:
 - Teaching spaces: 8 students + 2 adults;
 - SEN dining area: 55
 - AP dining area: 60
 - Annex 2H section 4.2.3.5
 - Office: 3 people
 - Sports hall: 10m²/person
 - Kitchen: 10m²/person

Step 3: Lighting

Lighting energy uses consists of internal and external lighting. Local task specific lighting and stage lighting is not considered. All lighting is powered using electrical energy.

The internal lighting energy use is estimated on the basis of an average lighting power density of 7.5W/m² applied over the GFA used an average of 7h per days during the occupied period. An allowance of 2.5% of the internal lighting energy use is allocated to the internal security and emergency lighting over a 24 h per day, 7 days a week operation.

The external lighting energy use is estimated using an allowance for external lighting of 2kW operating in average of 8 hours per day, 365 days per annum.

The following table summarises the lighting energy use:

Item	Energy use (kWh/m ²)	Equivalent electrical energy use (kWh/m ²)
External lighting	1.2	1.2
Internal lighting	10	10
Emergency lighting	1.6	1.6
Total	12.8	12.8

Step 4: Lifts and Escalators

Lifts consists of 2 lifts servicing ground and first floor. The lifts energy consumption is estimated using the default approach documented in NABERS Commitment Agreements Handbook for estimating NABERS ratings based on the number of lift floors:

Item	Energy use (kWh/m ²)	Equivalent electrical energy use (kWh/m ²)
Lifts	1.4	1.4
Total	1.4	1.4

Step 5: Small power

The following small power items are being considered:

- IT: Energy use for IT equipment is estimated using the ICT equipment heat gains calculator - classroom provided as part of the Building Bulletin 101: calculation tools as follows:

- General classrooms: standard teaching space with 1 laptop per pupil.
- ICT classroom: specialised IT teaching space.
- Office: 3 laptop per office.
- Other teaching spaces (DT, food tech, etc): teaching space with staff equipment only.
- Server rooms: 2.5kW IT equipment allowance per server room with a full time equivalent operation based on 70% operation over 7hours when school is open;
- DT and food tech equipment: allowance of 3kW equipment per room operating for 1/3 of 7 hours day when school is open;
- Other small power: allowance of 1W/m2 of GFA during 7 hours when school is open.

The following table summarises the lighting energy use:

Item	Energy use (kWh/m2)	Equivalent electrical energy use (kWhe/m2)
IT - General classroom	2.1	2.1
IT - ICT classroom	0.2	0.2
IT - Office	0.2	0.2
IT - DT/Food tech	0.3	0.3
Server room	1.1	1.1
DT/Food tech equipment	1.9	1.9
Other small power	1.3	1.3
Total	7.0	7.0

Step 6: Catering

Kitchen facility energy consumption is estimated using the operational energy usage benchmark for catering facilities documented in CIBSE TM50 and is as follows:

Item	Energy use (kWh/m2)	Equivalent electrical energy use (kWhe/m2)
Electrical	5.0	5.0
Natural gas	1.1	0.4
Total	6.1	5.4

Step 7: Server rooms

Server IT equipment has been considered at step 5. The server cooling system is the only cooling system provided to the school and consists of a DX system. The energy estimation of the cooling system has been estimated on the basis of a COP of 2 or more:

Item	Energy use (kWh/m2)	Equivalent electrical energy use (kWhe/m2)
DX Cooling	0.5	0.5
Total	0.5	0.5

Step 8: Other equipment

An allowance for 2kW of other equipment is included in the analysis for laundry equipment, and other miscellaneous equipment not currently itemised separately:

Item	Energy use (kWh/m2)	Equivalent electrical energy use (kWhe/m2)
Other equipment	1.8	1.8
Total	1.8	1.8

Step 9: Domestic hot water

Domestic hot water is estimated using the following hot water demand nominated in Annex 2H:

- Primary school student (20): 2.3l per day per student;
- Secondary school student (210): 4l per day per student.

The energy used by the domestic hot water demand is estimated on the basis of raising water temperature from 10°C to 60°C using a gas fired boiler with a minimum efficiency of 95% and 190 days of operation. The gas energy usage is converted to equivalent electrical energy using a 0.4 energy weighting factor in accordance with Annex 2H Table 2:

Item	Energy use (kWh/m2)	Equivalent electrical energy use (kWhe/m2)
Domestic Hot Water	2.1	0.8
Total	2.1	0.8

The estimated domestic hot water demand does not take into account hot water demand for kitchen, as this demand is assumed to be already accounted for in the catering demand.

Step 10-12: Dynamics Simulation Model (DSM)

The model is employed to estimate energy consumption used for space heating, fans and pumps as these components of the energy use have a high dependency on ambient conditions such as ambient temperature and solar radiation.

The DSM model employed in this analysis is similar to the one used in the previous section 'Energy use optimisation', but differs in the following aspects:

- Weather file: Use the CIBSE London TRY weather file released in 2016;
- Room conditions: The room conditions, such as heating and cooling set points, occupancy, lighting gains, equipment gain, etc, are as nominated in Annex 2H Table 9 with occupancy for teaching spaces and dining halls as per the project Schedule of Accommodation;
- System efficiencies: The system efficiencies, including heating and cooling efficiency, and auxiliary energy, are as per defined in Annex 2H Table 8.

Spaces provided with natural ventilation boosted by NVHR units are modelled using MacroFlo on the basis of 100mm window opening restrictor on two top-hang window panels, which is estimated to provide 7.6% equivalent free opening. The windows are modelled as manually controlled during opening hours. The NVHR units are modelled as operating up to 130l/s and controlled to operate during day and night-time using an operating profile provided by Breathing Building that account for CO₂ build-up with the room, ambient and room temperature.

Item	Energy use (kWh/m2)	Equivalent electrical energy use (kWhe/m2)
Heating	44.9	18
Fans and pumps	8.1	8.1

Benchmark comparison

The following table reports on the estimated energy usage presented in the previous section against the annual design energy targets for secondary school:

Type	Annual Design Energy Target (kWhe/m2)	Concept Energy Model Predicted (kWhe/m2)	Pass/Fail
Heating	20	18	✓
Hot water	4	0.8	✓
Small power	25	14.2	✓
Lighting	13	12.8	✓
Fans and pumps	7	8.1	✗
Cooling	1	0.5	✓
Lifts	1	1.4	✗
Total	71	55.9	✓

It is noted that the above annual design energy target and concept energy model prediction compare favourably to the CIBSE TM46 Energy Benchmarking for the school on the basis of the Thames Valley location and 1400 hours of operation:

- Benchmark electrical energy consumption: 40kWh/m2
- Benchmark gas energy consumption: 137kWh/m2
- Total benchmark equivalent electrical energy consumption: 94.9kWhe/m2

4. Monitoring and targeting strategy

The monitoring and targeting strategy described in this section is based on the Environmental and Strategy reports covering Mechanical and Electrical services and describes how the project proposal meets the ESFA Output Specification Annex 2H requirements, which are summarised as follows:

- Provide a well-designed, commissioned and fully functioning energy, water and building performance metering system;
- Have a minimum of one temperature and CO₂ sensors in each heating zone and outside air temperature;
- Able to output K2n/iSERV reports on a monthly basis.

The proposed metering system is articulated around the Building Energy Management System (BEMS) documented in the Environmental Controls - Mechanical report. Whilst the BEMS will be detailed further during the design process, the energy metering strategy is aligned with the recommendations of Part L2A, GIL56 'Metering energy use in non-domestic buildings' and CIBSE TM39 'Building energy metering' that will be designed to comply with the requirements for a well-designed energy, water and building performance metering with a minimum of one temperature and CO₂ sensors in each heating zone.

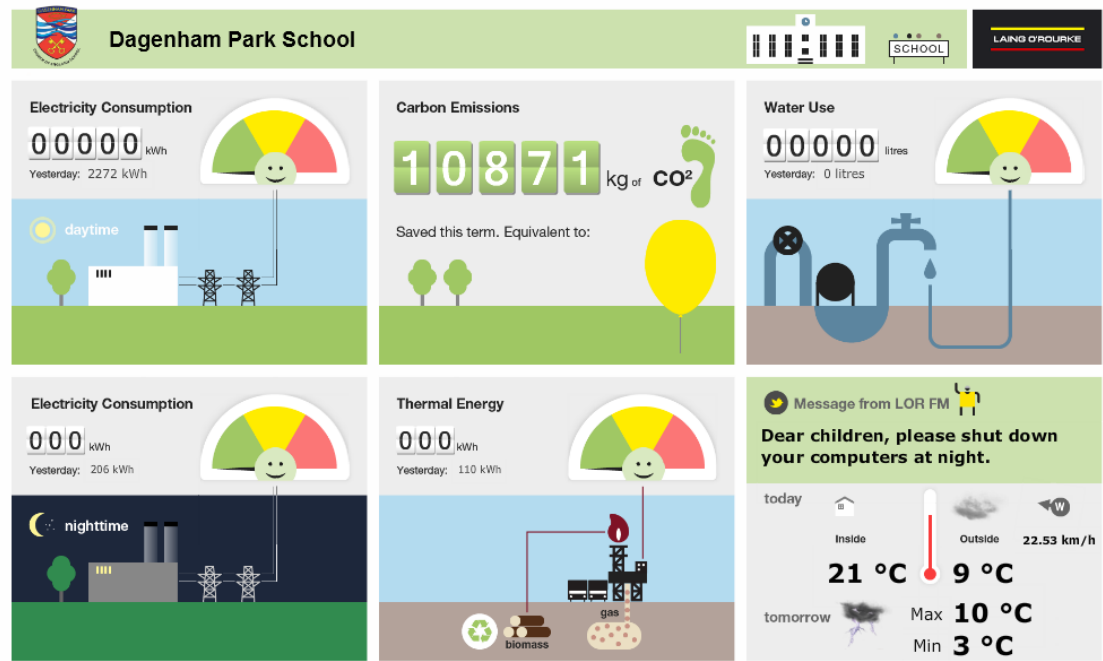
A local building mounted weather station is anticipated, that records outdoor dry bulb temperature, outdoor humidity, wind speed, wind direction, dew point and solar radiation over a maximum of one-hour average.

The controls specialist will demonstrate the system, as required, with a full functionality test on completion of commissioning as well as explain and demonstrate the operation of the building services and BMS and metering controls, thereby ensuring a commissioned and fully functioning metering system.

The design of the BEMS system is considered to be manufactured by a Trend Control System-approved manufacturer and installer, and capable to produce reports in accordance with K2n/iSERV and suitable for upload. It is anticipated that such reports are produced on a monthly basis.

Beyond these requirements that are aligned with the Annex 2H requirements, it is also anticipated to use the BEMS as an education tool. To meet this aim, it is anticipated that selected metering data are linked from the BEMS head end to be

displayed at the school's main entrances to raise awareness of the school energy and water consumption using easy to read and understand graphics. An example of such building dash board that is used at Dagenham Park school is shown below:



5. Incoming Services

The following section describes the assessment of the site peak utility loads including electricity, gas and water.

Please see Drawing;

ORC_ATK_M_58_0005 - Indicative External Works

This drawing indicates the routes of all new incoming services.

5.1 Utility Requirement

The new school is to be a standalone construction to the rear of the existing site.

The new building will be constructed whilst retaining the existing building in operation.

As such it has no connectivity with the existing site and is not reliant on demolition of the existing buildings nor existing utility supplies.

To meet these requirements, the new building will be supplied with new incoming utilities.

Applications have been made to the utility providers and responses have been received from Electricity (SSE) and Gas (1Gas via Cadent).

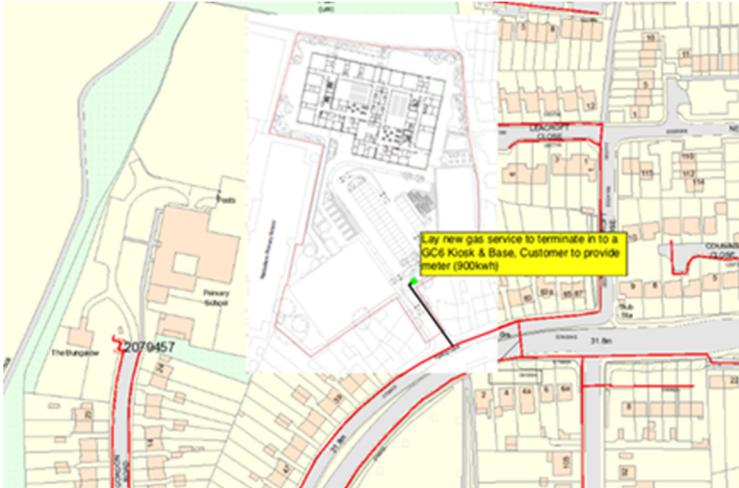
5.2 Natural Gas

Applications were based on the following peak load estimations;

Natural Gas - incoming supply, load Calculation					
School: Orchard Hill		Date:XXXXXX	By: EA	Checked: AB	Rev B
Gas-fitted appliance	Output (kW)	Input (kW)	Notes		
SEN					
LTHW boiler 1:	100	111.11	Efficiency shown on schedules 97.5%, based here conservatively on 90%		
LTHW boiler 2:	100	111.11	Efficiency shown on schedules 97.5%, based here conservatively on 90%		
Gas-fired water htr (school)	50	50	Load due to changing areas/showers		
Gas-fired water htr (Labs)	NA	NA			
Gas-fired water htr (Kitchen)	85	85	sized for a single unit doing both AP & SEN		
Gas Taps (from No. of gas taps)	na	na	electric bunsen burners		
Kitchen		125	2 ovens at 2.1m ³ /hr, 3 gas cookers at 4.3m ³ /hr each, 2 fryers at 2.1m ³ /hr each, 2 hot cupboards a 1m ³ /hr each. Equipment layout still to be finalised by others/ legacy equipment unknowns. Diversity of 50% applied.		
Construction	na	na	No known equipment (1x Brazing Hearth flow rate = 2.18m ³ /hr)		
Food Room	na	na	2 cookers, flow rate per cooker = 5.56x10 ⁻⁴ m ³ /s (from Plumbing Engineering Services Design Guide Table 9). Equipment layout still to be finalised by others/ legacy equipment unknowns.		
Kiln	na	na	Gas fired kiln		
Others (list):	na				
Total:		482.22 kW			
Summary:		Catering equipment loads assumed, however estimated loads included as above with 50% diversity. No.of hot water outlets unknown. Use of gas taps in Science Studios unknown. Hence total load considered to be conservative.			
AP					
LTHW boiler 1:	110	122	Efficiency shown on schedules 97.5%, based here conservatively on 90%		
LTHW boiler 2:	110	122	Efficiency shown on schedules 97.5%, based here conservatively on 90%		
Gas-fired water htr (school)	50	50	Load due to changing areas/showers		
Gas-fired water htr (Labs)	NA	NA			
Gas-fired water htr (Kitchen)	na	na	Kitchen served by single water heater, calculated in SEN total		
Gas Taps (from No. of gas taps)	na	na	electric bunsen burners		
Kitchen	na	na	Single kitchen served, load calculated in SEN total		
DT Workshop	na	na	No known equipment (1x Brazing Hearth flow rate = 2.18m ³ /hr)		
Food Room	20.85	20.85	2 cookers, flow rate per cooker = 5.56x10 ⁻⁴ m ³ /s (from Plumbing Engineering Services Design Guide Table 9). Equipment layout still to be finalised by others/ legacy equipment unknowns.		
Others (list):	na				
Total:		315.29 kW			
Summary:		No.of hot water outlets unknown. Use of gas taps in Science Studios unknown. Use of cookers in Food Room unkown. Hence total load considered to be conservative.			

An application to 1Gas has been made for 900kw.

They have responded with a proposal to route the new supply from the main on Falling Lane along the entrance road.



5.3 Electricity

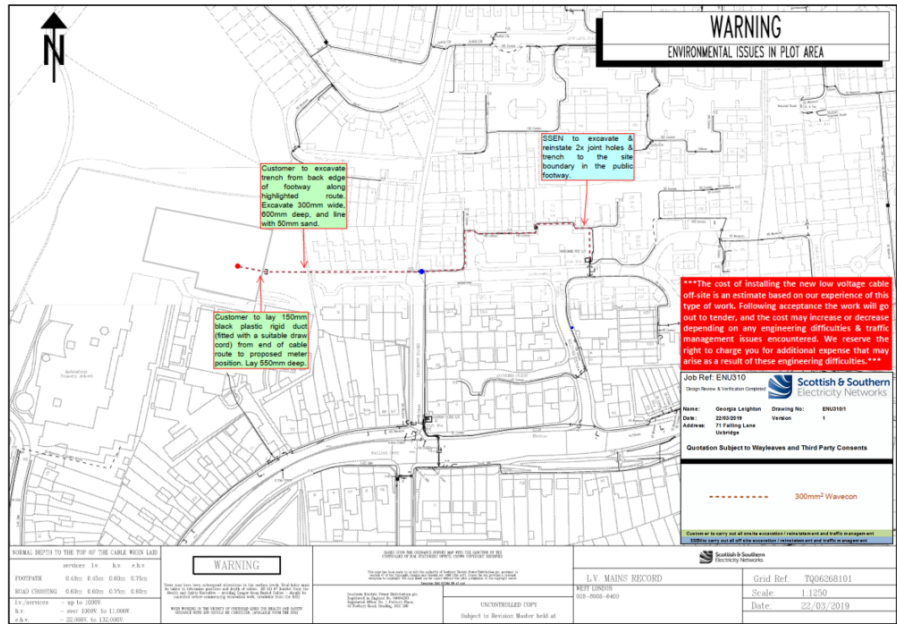
Applications were based on the following peak load estimations;

2. based on gas fired heating & domestic services, mixed mode

		W/m ²	kW	kVA	(inc 20% spare)		
SEN	2649.93 m ²	40	106.00	117.77	141.33	kVA	204
AP	2054.11 m ²	40	82.16	91.29	109.55	kVA	158
Total	4704.03 m ²				250.88		363

An application to SSE has been made for 250KVA, 400a

They have responded with a proposal to route the new supply from the Leacroft Close along the entrance road.



Appendix A - Modelling input summary

Model reference

The following table lists model references:

	Baseline	Be Lean	Be Clean	Be Green	Operational Energy
Model reference	5187523-BP-MR-3032	5187523-BP-MR-3033	-	5187523-BP-MR-3034	5187523-BP-MR-5001

Building Fabric

The following table summarises the building fabric parameters employed in the modelling:

Table 2 - Building fabric modelling parameters

	Baseline	Be Lean	Be Clean	Be Green	Operational Energy
Ground - U-value (W/m2.K)	0.19	0.19	0.19	0.19	0.19
External wall - U-value (W/m2.K)	0.26	0.18	0.18	0.18	0.18
Roof - U-value (W/m2.K)	0.18	0.18	0.18	0.18	0.18
Internal ceiling/floor - U-value (W/m2.K)	1.05	1.05	1.05	1.05	1.05
Internal partition - U-value (W/m2.K)	1.88	1.88	1.88	1.88	1.88
External window - U-value (W/m2.K, glass & frame)	1.57	1.36	1.36	1.36	1.36
External window - G-value	0.40	0.41	0.41	0.41	0.41
Roof lights - U-value (W/m2.K, glass & frame)	2.00	1.64	1.64	1.64	1.64
Roof lights - G-value	0.55	0.41	0.41	0.41	0.41
Air permeability [m3/hm2@50Pa]	3	3	3	3	Infiltration: 0.25ACH
Window (% vertical area)	-	34%	34%	34%	34%
Roof light (% horizontal area)	-	4%	4%	4%	4%

Efficient Services

The following table summarises the building service parameters employed in the modelling:

Table 3 - Building services modelling parameters

	Baseline	Be Lean	Be Clean	Be Green
Power factor correction	Y	Y	Y	Y
NVHR - SFP	0.3	0.3	0.13	0.13
NVHR - Demand control	Gas sensor	Occupancy	Occupancy	Occupancy
Heating - Boiler efficiency	0.9579	0.96	0.96	0.96
Heating - Delivery efficiency	0.9	0.95	0.95	0.95
MVHR - Heat recovery efficiency	0.70	0.75	0.75	0.75

Lighting - Sports hall, dining, kitchen, library	-	Control: Occupancy with daylight dimming and absence off	Control: Occupancy with daylight dimming and absence off	Control: Occupancy with daylight dimming and absence off
Lighting - toilets, changing, corridors, stairs and lobbies		Control: Local manual switching, occupancy control and daylight dimming (if daylit space)	Control: Local manual switching, occupancy control and daylight dimming (if daylit space)	Control: Local manual switching, occupancy control and daylight dimming (if daylit space)
Lighting - Store, plantroom, server room	-	Control: Local manual switching	Control: Local manual switching	Control: Local manual switching
Lighting - Office	-	Control: Local manual switch, occupancy control Power density: 7.5W/m2	Control: Local manual switch, occupancy control Power density: 7.5W/m2	Control: Local manual switch, occupancy control Power density: 7.5W/m2
Lighting - Teaching spaces		Control: Local switching, occupancy control with daylight dimming Power density: 7.5W/m2	Control: Local switching, occupancy control with daylight dimming Power density: 7.5W/m2	Control: Local switching, occupancy control with daylight dimming Power density: 7.5W/m2

Appendix B - Extract of Concept Design BRUKL Output (Be Green with Option 1 - PV panel)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

5187523-BP-MR3001

As designed

Date: Fri Apr 05 14:08:30 2019

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.10

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.10

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

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO₂ emission rate for the building must not exceed the target

CO ₂ emission rate from the notional building, kgCO ₂ /m ² .annum	16.3
Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	16.3
Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	7.5
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	U _a -Limit	U _a -Calc	U _i -Calc	Surface where the maximum value occurs*
Wall**	0.35	0.25	0.25	90000000:Surf[1]
Floor	0.25	0.19	0.19	95000000:Surf[0]
Roof	0.25	0.18	0.18	90000000:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.37	1.4	1300000F:Surf[0]
Personnel doors	2.2	2.2	2.2	90000000:Surf[3]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

U_a-Limit = Limiting area-weighted average U-values [W/(m²K)]

U_a-Calc = Calculated area-weighted average U-values [W/(m²K)]

U_i-Calc = Calculated maximum individual element U-values [W/(m²K)]

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

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

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

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Building services

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

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

1- NVHR Natural ventilation w radiator

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A

Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system

NO

* 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- Extract w radiators

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A

Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system

NO

* 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- Mechanical Ventilation (central AHU) w heat recovery

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	-	0.2	0	0.7
Standard value	0.91*	N/A	N/A	N/A	0.5

Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system

YES

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

4- Supply w radiators

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A

Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system

NO

* 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- FCU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.84	4.74	0	0	-
Standard value	2.5*	3.2	N/A	N/A	N/A

Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system

NO

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

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

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12/16

ESFA Construction Framework | Orchard Hill Special Free School – ITT submission
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Local mechanical ventilation, exhaust, and terminal units

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

Zone name	SFP [W/(l/s)]										HR efficiency	
	ID of system type	A	B	C	D	E	F	G	H	I	Zone	Standard
	Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1		
L1-AP-Classroom		0.1	-	-	-	-	-	-	-	-	-	N/A
L1-AP-Classroom		0.1	-	-	-	-	-	-	-	-	-	N/A
L1-SEN-Classroom		0.1	-	-	-	-	-	-	-	-	-	N/A
L1-AP-Classroom		0.1	-	-	-	-	-	-	-	-	-	N/A
L1-SEN-Classroom		0.1	-	-	-	-	-	-	-	-	-	N/A
L1-SEN-Classroom		0.1	-	-	-	-	-	-	-	-	-	N/A
L1-AP-Post 16 Classroom		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-AP-General office		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-AP-Art room		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-AP-Science prep		0.3	-	-	-	-	-	-	-	-	-	N/A
L0-AP-Science studio		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-AP-DT workshop		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-SEN-ICT rich classroom		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-SEN-Art room		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-SEN-Science studio		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-SEN-Staff room (social)		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-SEN-Construction		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-SEN-Vocational room		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-SEN-General office		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-AP-Fitness studio		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-AP-Dining		-	-	-	1.5	-	-	-	-	-	-	N/A
L0-AP-Office		-	-	-	1.5	-	-	-	-	-	-	N/A
L0-AP-WC		0.3	-	-	-	-	-	-	-	-	-	N/A
L0-AP-Acc WC		0.3	-	-	-	-	-	-	-	-	-	N/A
L1-AP-Acc WC		0.3	-	-	-	-	-	-	-	-	-	N/A
L1-AP-Acc WC		0.3	-	-	-	-	-	-	-	-	-	N/A
L1-AP-Individual learning room		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-AP-Lobby		-	1	-	-	-	-	-	-	-	-	N/A
L0-SEN-Library		0.1	-	-	-	-	-	-	-	-	-	N/A
L0-AP-Lobby		-	1	-	-	-	-	-	-	-	-	N/A
L0-AP-Food room		0.1	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting

Zone name	Luminous efficacy [lm/W]			General lighting [W]
	Luminaire	Lamp	Display lamp	
	Standard value	60	60	22
L1-AP-Classroom	73	-	-	272
L1-AP-Classroom	73	-	-	272
L1-SEN-Classroom	73	-	-	321
L1-AP-Classroom	72	-	-	319
L1-SEN-Classroom	73	-	-	320
L1-SEN-Classroom	61	-	-	423
L1-AP-Post 16 Classroom	73	-	-	274
L0-AP-General office	104	-	-	155
L0-AP-Art room	60	-	-	679
L0-AP-Science prep	70	-	-	88
L0-AP-Science studio	60	-	-	1088
L0-AP-DT workshop	60	-	-	795
L0-SEN-ICT rich classroom	66	-	-	370
L0-SEN-Art room	60	-	-	802
L0-SEN-Science studio	60	-	-	1277
L0-SEN-Staff room (social)	89	-	-	361
L0-SEN-Construction	60	-	-	940
L0-SEN-Vocational room	60	-	-	933
L0-SEN-General office	102	-	-	179
L0-AP-Fitness studio	70	-	-	203
L0-AP-Dining	-	64	-	436
L0-AP-Office	143	-	-	61
L0-AP-Art store	60	-	-	15
L0-AP-Primary store	60	-	-	9
L0-AP-WC	-	120	-	49
L0-AP-Store	60	-	-	5
L0-AP-Acc WC	-	120	-	55
L1-AP-Store	60	-	-	6
L1-AP-Acc WC	-	120	-	47
L1-AP-Acc WC	-	120	-	67
L1-SEN-Store	60	-	-	7
L1-SEN-Store	60	-	-	7
L1-SEN-Store	60	-	-	8
L1-SEN-Store	60	-	-	9
L1-AP-Individual learning room	120	-	-	29
L0-AP-Lobby	-	120	-	361
L0-SEN-Lib store	60	-	-	9
L0-SEN-Library	72	-	-	250
L0-AP-Lobby	-	120	-	122
L0-AP-Food room	60	-	-	795
L0-SEN-Food store	106	-	-	103
L0-SEN-SEN Therapy/MI	112	-	-	117

General lighting and display lighting		Luminous efficacy [lm/W]			General lighting [W]
Zone name	Standard value	Luminaire	Lamp	Display lamp	
		60	60	22	
L1-SEN-Small Group Room	64	-	-	-	110
L1-SEN-Small Group Room	64	-	-	-	110
L1-SEN-Small Group Room	64	-	-	-	111
L1-SEN-Small Group Room	64	-	-	-	111
L1-SEN-Post 16 Social	60	-	-	-	538
L1-AP-Lobby	-		120	-	298
L0-AP-Entrance	-		120	15	190
L0-SEN-Common entrance	-		120	15	156

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

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L1-AP-Classroom	NO (-72.1%)	NO
L1-AP-Classroom	NO (-81.1%)	NO
L1-SEN-Classroom	NO (-80.3%)	NO
L1-AP-Classroom	NO (-45.6%)	NO
L1-SEN-Classroom	NO (-34%)	NO
L1-SEN-Classroom	NO (-63.5%)	NO
L1-AP-Post 16 Classroom	NO (-55.8%)	NO
L0-AP-General office	NO (-40.9%)	NO
L0-AP-Art room	NO (-47.2%)	NO
L0-AP-Science prep	NO (-61.8%)	NO
L0-AP-Science studio	NO (-47.1%)	NO
L0-AP-DT workshop	NO (-74.2%)	NO
L0-SEN-ICT rich classroom	NO (-63.3%)	NO
L0-SEN-Art room	NO (-64.8%)	NO
L0-SEN-Science studio	NO (-74.3%)	NO
L0-SEN-Staff room (social)	NO (-37.1%)	NO
L0-SEN-Construction	NO (-36.4%)	NO
L0-SEN-Vocational room	NO (-61.4%)	NO
L0-SEN-General office	NO (-43.4%)	NO
L0-AP-Fitness studio	NO (-71.8%)	NO
L0-AP-Dining	N/A	N/A
L0-AP-Office	N/A	N/A
L1-AP-Individual learning room	NO (-61.9%)	NO
L0-SEN-Library	NO (-71.1%)	NO
L0-AP-Food room	NO (-84.9%)	NO
L0-SEN-Food store	NO (-52.4%)	NO
L0-SEN-SEN Therapy/MI	NO (-58.4%)	NO
L0-SEN-Hygiene room	N/A	N/A
L0-SEN-Life skills	NO (-36.2%)	NO
L0-SEN-Office	N/A	N/A
L0-SEN-Interview room	N/A	N/A
L0-SEN-Parents room	NO (-41%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L1-SEN-SEN Resources SEN	NO (-53%)	NO
L1-SEN-ICT Tech SEN	NO (-48.5%)	NO
L1-SEN-Server room SEN	N/A	N/A
L1-Control room	NO (-91.8%)	NO
L1-AP-Classroom	NO (-54.3%)	NO
L1-AP-Individual learning room	NO (-74.7%)	NO
L1-AP-Classroom	NO (-59.1%)	NO
L1-AP-Classroom	NO (-56%)	NO
L1-AP-Classroom	NO (-61.1%)	NO
L1-SEN-Classroom	NO (-60.8%)	NO
L1-SEN-Classroom	NO (-60.8%)	NO
L1-SEN-Classroom	NO (-42.8%)	NO
L1-AP-Individual learning room	NO (-70.7%)	NO
L1-AP-Classroom	NO (-60.5%)	NO
L1-SEN-Classroom	NO (-60.8%)	NO
L1-AP-Individual learning room	NO (-57.3%)	NO
L1-AP-Individual learning room	NO (-61.5%)	NO
L1-SEN-Small group room	NO (-56%)	NO
L1-AP-Individual learning room	NO (-61.6%)	NO
L0-AP-School Sports Hall	NO (-33.6%)	NO
L0-SEN-School sports hall	NO (-30.9%)	NO
L0-SEN-Dining	YES (+8.9%)	NO
L1-SEN-Small Group Room	NO (-73.1%)	NO
L1-SEN-Small Group Room	NO (-73.1%)	NO
L1-SEN-Small Group Room	NO (-11.3%)	NO
L1-SEN-Small Group Room	NO (-60%)	NO
L1-SEN-Small Group Room	NO (-60%)	NO
L1-SEN-Post 16 Social	NO (-7.8%)	NO
L0-AP-Entrance	YES (+86.4%)	NO
L0-SEN-Common entrance	NO (-34.1%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

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

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

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric			
Element	U _{i-Typ}	U _{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.25	90000000:Surf[1]
Floor	0.2	0.19	95000000:Surf[0]
Roof	0.15	0.18	90000000:Surf[0]
Windows, roof windows, and rooflights	1.5	1.36	90000000:Surf[2]
Personnel doors	1.5	2.2	90000000:Surf[3]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building
U _{i-Typ} = Typical individual element U-values [W/(m²K)] U _{i-Min} = Minimum individual element U-values [W/(m²K)]			
* There might be more than one surface where the minimum U-value occurs.			

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