John Lyon – Oldfield House

Energy Statement

boom collective

Executive Summary and Introduction

This report has been produced by Boom Collective to support the revisions to the planning application for The John Lyon School, Oldfield House, London Borough of Harrow reference P/1813/19.

The proposed scheme is to demolish the existing Oldfield House building (currently two stories) and build a new 4-storey Science, Technology, Engineering, Arts and Maths (STEAM) centre just to the north of the existing site.

The proposals for the Oldfield House site have had full regard to and developed to accord with the London Borough of Harrow policies, the Greater London Plan and all relevant Building Regulations.

The original planning application was submitted in April 2019, upon which Harrow council expressed some concerns with the overall height of the proposed building and its implications on the surrounding area.

These further revisions to the proposal respond to the concerns expressed by the Council and other consultees and presents a reduced height building, principally achieved through the lowering of the building within the topography of the site, creating a lower ground floor level.

It should be noted that the energy strategy for the proposed building remains unchanged from the previous application. With this in mind, and using our professional judgement, it is anticipated that a reduction in the overall height of the building will have a positive affect on the overall carbon emissions of the building.

The energy model will remain unchanged until the next stage of design, at which point the geometry will be updated.

The proposed development is considered to be a major development as defined by the London Plan document.

Therefore the carbon reduction targets for the proposed new development are 35% reduction on Building Regulations 2013, in line with the most up to date Energy Assessment Guidance document dated October 2018.

In regards to meeting London Plan Energy Hierarchy, (lean, clean and green), the development will adapt a fabric first approach.

Lean:

- High Standards of Insulation, targeting 20% improvement on Building Regulations
- High level of air tightness and minimal air leakage.
- High efficiency lighting appliances throughout, adopting LED technology and enhanced lighting controls.

Clean:

- The development will be principally naturally ventilated, with mechanical extract ventilation in WC areas. It is proposed that these units will have efficient performance and controls to minimise energy use.
- Direct point of use electric heating with no distribution losses
- No combustible technologies within the building.

Green:

- A Renewable Appraisal was undertaken at the early stages to establish the most appropriate solution considered in terms of technical, practical and economic viability. The appraisal concluded that a ground source heat pump should be used for heat generation.
- 20m2 of PV panels will be provided on the inner south east facing roof

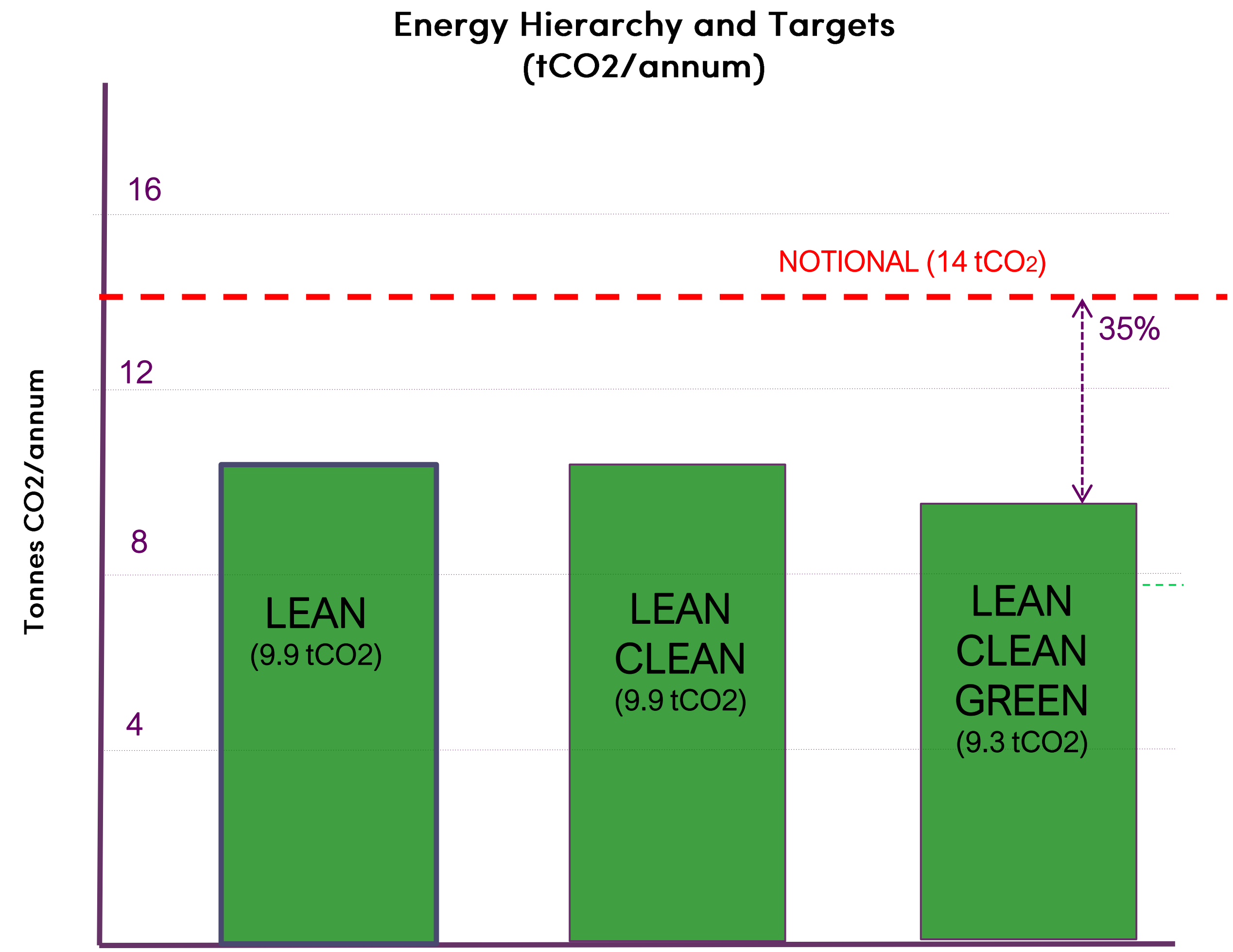
The proposed school development will comply with all criterion on Building Regulations Part L2A and based on the current Building Regulations carbon factors, shows a 35% improvement over the notional building.

The carbon reduction has also been calculated using the new SAP 10 carbon conversion factors and a 50% reduction on Building Regulations 2013 is achieved, as well as 22% reduction in carbon emissions as a result of on-site renewables.

Executive Summary and Introduction

	Regulated Carbon dioxide Savings	
	Tonnes CO2 per annum	% Reductions
Savings from Lean Measures	4.28	30.24%
Savings from Clean Measures	0.00	0%
Savings from Green Measures	0.74	5.22%
Cumulative Savings	5.02	35.47%

	(Tonnes CO2 per annum)	
	Regulated	Unregulated
Notional	14.268	15.85
Be Lean	9.878	15.85
Lean, Clean	9.878	15.85
Lean, Clean, Green	9.270	15.85



Planning Policy & Legislation

National Planning Policy Framework

The National Planning Policy Framework sets out the Government's planning policies for England and details how these are expected to be applied. It sets out a structure for delivering sustainable development with particular relevance for energy and carbon issues.

Building Regulations

Approved documents Part L 2013 (with 2016 amendments) are the most current Building Regulations in relation to Conservation of Power and Fuel. The 2013 revision to Part L of the Building Regulations was a key milestone towards the government's target for all new non-domestic buildings to be zero-carbon by 2019.

NOTE: this government ambition was abandoned in 2015 despite being widely supported by industry.

Following a long consultation period, the new carbon emission targets were published in November 2013 as a 9% aggregate improvement on the 2010 Part L targets for non-housing.

There are 4 parts to the Approved Document L:

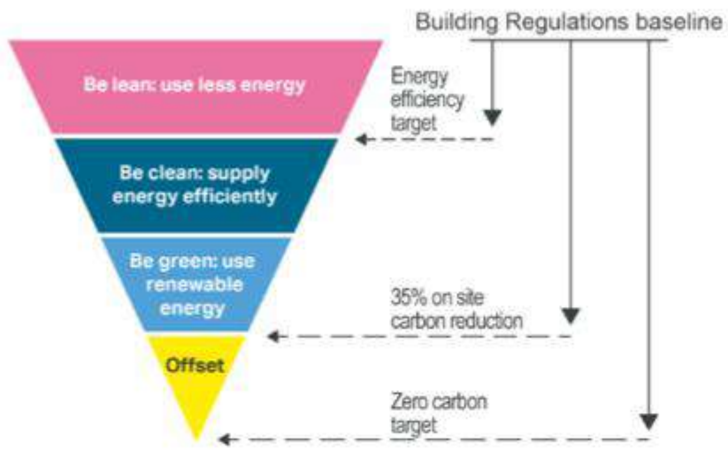
- Part L1A – Conservation of Fuel and Power (New Dwellings)
- Part L1B – Conservation of Fuel and Power (Existing Dwellings)
- Part L2A – Conservation of Fuel and Power (New buildings other than new dwellings)
- Part L1B – Conservation of Fuel and Power (Existing building other than existing dwellings)

The proposed development will be compliant with Building Regulations Part L2A,

The Current London Plan (2017 fix)

Policy 5.2 Minimising Carbon Dioxide Emissions of the London Plan contains an energy hierarchy for minimising carbon dioxide emissions:

Be Lean : use less energy
Be Clean : supply energy efficiently
Be Green : use renewable energy



This hierarchy outlines a framework under which the GLA requires energy efficient building design to be approached. Firstly looking to reduce the energy consumption of a building through passive measures (be Lean), then supplying energy efficiently via building services (be Clean), and finally through the use of renewable energy technologies that supplement conventional fuels (be Green)

Policy 5.2 also outlines specific targets for carbon dioxide reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) calculated under the Building Regulations Part L.

Major development is defined as sites containing 10 or more dwellings, or non-domestic developments with a floor area of 1000m2 or greater.

Non – Residential Buildings:

Year	Improvement on 2010 Building Regulations
2010 – 2013	25%
2013 – 2016	40%
2016 – 2019	As per Building Regulations requirements
2019 – 2031	Zero Carbon

Policy 5.3 states that major development proposals should meet the minimum standards:

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

Planning Policy & Legislation

Policy 5.6 states that major development proposals should select energy systems in accordance with the following hierarchy:

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

Policy 5.7 states that the mayor seeks to increase the proportion of energy generated from renewable sources, and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy Strategy and in supplementary planning guidance will be achieved in London.

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

Policy 5.9 states that 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)

Energy Planning- GLA Guidance
Policy 5.2 of the Current London Plan (2017 fix) requires each major development proposal to submit a detailed energy assessment.

Guidance documents:

- Energy Assessment Guidance (October 2018)
- Carbon Offset Funds (October 2018)
- GLA Carbon Emissions Reporting Spreadsheet (January 2019)

It should be noted that Energy Assessment Guidance document dated October 2018 states:

- **Demonstrate at least a 35% on-site reduction beyond Part L 2013 for non-residential development[4].**

[4] The Mayor intends to introduce the zero carbon target for non-residential development when the new London Plan is published, expected in 2019.

Harrow Core Strategy
Core Policy CS1 – Responding to Climate Change
The Development Management Policies DPD and the Area Action Plan will compliment London Plan policies by establishing requirements for sustainable design and construction techniques that maximise the energy efficiency of new buildings, minimise the use of mains water, minimise carbon dioxide emissions in accordance with the London Plan energy hierarchy, and seek to promote and secure opportunities for decentralised energy, especially within the Harrow and Wealdstone Intensification Area, onsite renewable energy generation and urban greening.

Harrow Development Management Policies
Policy DM12 – Sustainable Design & Layout
The design and layout of development proposals should:

- utilise natural systems such as passive solar design and, wherever possible, incorporate high performing energy retention materials, to supplement the benefits of traditional measures such as insulation and double glazing;
- make provision for natural ventilation and shading to prevent internal overheating;
- incorporate techniques that enhance biodiversity, such as green roofs and green and,
- where relevant, the design and layout of buildings should incorporate measures to mitigate any significant noise or air pollution arising from the future use of the development.

Proposals that fail to take reasonable steps to secure a sustainable design and layout of development will be resisted.

Policy DM13 – Decentralised Energy Systems

- Proposals for decentralised energy networks will be supported.
- Development proposals should connect to existing decentralised energy networks where feasible.

Summary of Target

- 35% reduction on Building Regulations Part L2013

Energy Strategy

The Environmental Engineering strategy options have been developed to provide a quality built environment, focusing on the comfort of the occupants as well as the Whole Life Cost (WLC) considerations of life cycle analysis, value for money, benefits to the environment, and their social impact.

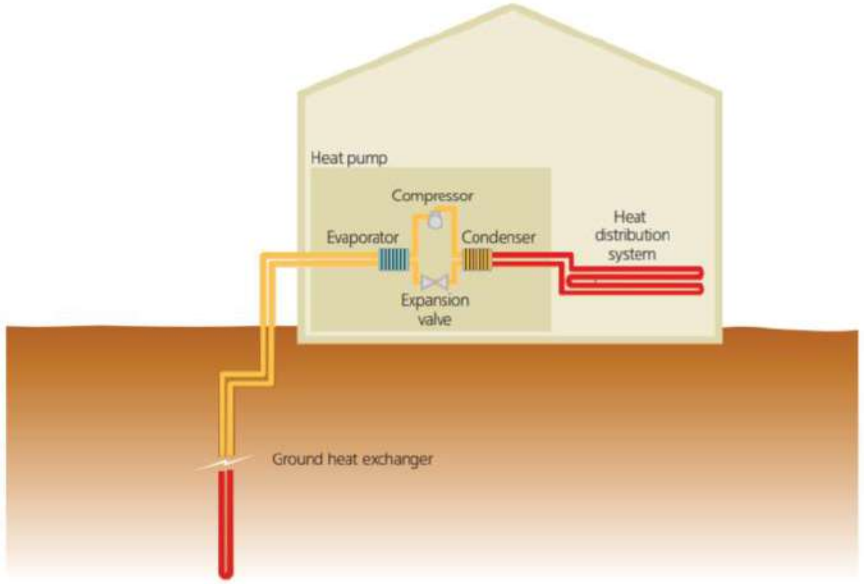
The thermal performance of the building fabric will exceed the current Building Regulations Approval Document Part L2 (2013) and provide an air tightness improvement from 10 to 5.0 m3/hr/m2 of building fabric.

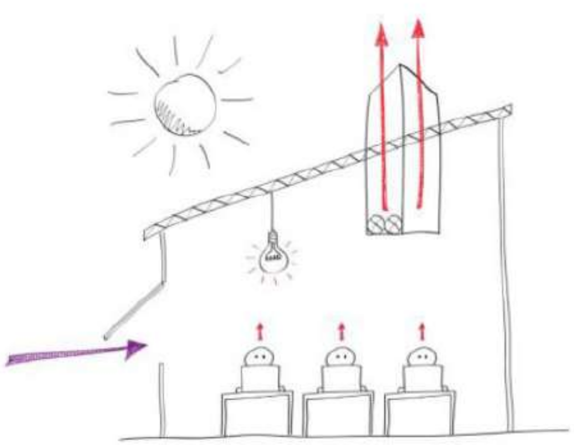
A low energy lighting strategy has been adapted, using light emitting diode (LED) technology and low energy fluorescent fittings. Presence detection control within circulation areas will also contribute to energy savings.

A fully naturally ventilated strategy is proposed, using the breathable building new NVHR 1100 units. This system implements displacement ventilation in summer and mixing ventilation in winter. It has significant energy savings over conventional ventilation approaches. The units are controlled to supply ventilation at the required rate, preventing over ventilation in the winter and encouraging higher ventilation rates in the summer.

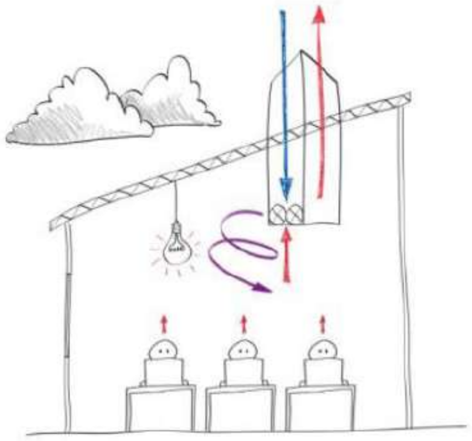
Hot water generation will be electric point of use, while high efficiency heating will be provided by ground source heat pumps located in the basement plant room. Early calculations indicate that approx. 25no. boreholes at 120m deep will be required to meet the heating demand for the school. The boreholes are to be in tandem with the structural piling configuration of the building, optimising cost and time.

Approximately 20m2 of Photovoltaic panels will also be added to south easterly facing pitched roof, generating free electricity and offsetting some of the electrical draw of the heat pump.





Breathing Buildings Summer Strategy
Fans in the e-stack units can be used to boost displacement ventilation in the summer and avoid summer overheating.



Breathing Buildings Winter Strategy
Mixing ventilation strategy used in the winter. E-stack units supply and mix fresh air at high level, to avoid cold draughts and the requirement for preheating.

Demand Reduction - Be Lean

Building Fabric

The thermal performance of the building fabric will exceed the current 2013 Building Regulations Approval Document Part L2A (Non-domestic).

The limiting U values, Notional U values and proposed target U values are detailed in the table adjacent.

Air Permeability

The primary improvements need to be made to the air tightness of the property and the thermal bridging. This will require additional effort in the detailing of typical junctions and interfaces, and addition policing and care taken on site.

Glazing

The notional building against which the design is compared, assumes approx. an area of glazing that is approximately 20% of the floor area. So for a typical 20sqm room, the glazing associated with the apartment would be around 4sqm.

Large glazed modules will help to reduce the U-value of the glazing, as the complexity of the frame and its thermal bridging is the weak spot in the windows performance.

Of the glazing provision approximately 5% of the floor area will need to be openable in order to provide 4 air changes per hour required for purge (rapid) ventilation.

Day lighting and low energy lighting

A low energy lighting strategy has been adapted, using light emitting diode (LED) technology and low energy fluorescent fittings.
Presence detection control will contribute to energy reduction throughout the communal areas.

WCs , store, plant & circulation = 5W/m2
Staff room & classrooms = 6 W/m2,
Stairs = 4 W/m2

	Non-Domestic Part L2A		
Element	Limiting U-values ($W/m^2.K$)	Notional Building U-values ($W/m^2.K$)	Target U-Values (W/m
Walls	0.35	0.26	0.20
Roof	0.25	0.18	0.10
Floor	0.25	0.22	0.13
Windows	2.20	1.6	1.20 G= 0.4
Glazed doors	2.20	2.20	1.20
Opaque doors	2.20	2.20	1.60
Air tightness	10 $m^3/(m^2.h)$ (@ 50 Pa)	5 $m3/(m^2.h)$ (@ 50 Pa)	5 $m3/(m^2.h)$ (@ 50 Pa)

Overheating and Cooling

In line with the Mayor's cooling hierarchy the school development minimises internal heat generation though energy efficient design, for e.g. the use of LED lighting with daylight linking and presence detection will be extensive.

Consideration has been given to the suitable orientation of the building, along with the positioning and sizing of any glazing. Glazing ratios have been developed such that they look to optimise natural daylight without exposing occupied spaces to excessive levels of solar gain.

A fully naturally ventilated strategy is proposed, using the breathable building new NVHR 1100 units.

The window opening area has been carefully sized in line with Breathable buildings NVHR 1100 design criteria.

The e-stack NVHR system provides controlled natural ventilation for the classroom spaces. It implements displacement ventilation in summer and mixing ventilation in winter. This has significant energy savings over conventional ventilation approaches. The units are controlled to supply ventilation at the required rate, preventing over ventilation in the winter and encouraging higher ventilation rates in the summer.

The system installed in each room is designed to meet BB101 2018 summer overheating criteria as well as the BB93 noise limitations.

Heating Infrastructure - Be Clean

The second step of the London Plan's energy hierarchy requires energy systems to be evaluated and designed considering the following:

- Connection to an existing heating or cooling network
- Site wide CHP network
- Communal Heating and Cooling

District Heating networks combine heat demands from different buildings resulting in a more even demand profile, with CHP capacity being shared between heat customers who require heat at different times of the day. This means larger and more efficient plant can run for longer operating hours and generate shorter economic paybacks.

The London Heat Map adjacent shows that there are no potential networks or existing district heating networks. The site is not located in an area identified with opportunity for decentralised energy.

In direct response to London Plan Policy 5.6;

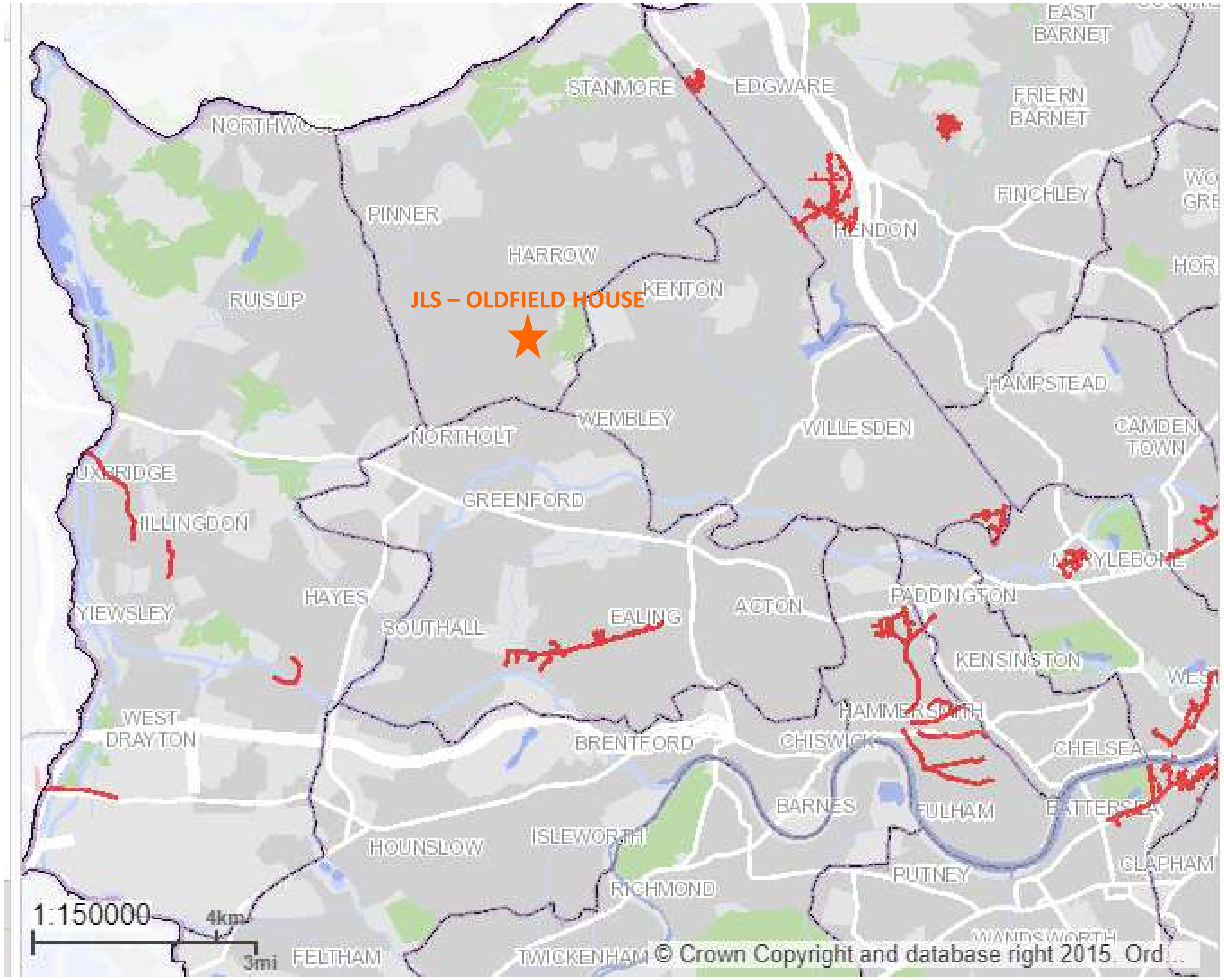
(e) Connect to, or extend, existing decentralised heating, cooling or power networks in the vicinity of the site, unless a feasibility or viability assessment demonstrates that connection is not reasonably possible. - **Not possible at Oldfield House.**

(f) Evaluate the feasibility and viability of Combined Heat and Power (CHP) systems and, where appropriate, examine the feasibility of extending the system beyond the site boundary, where developments cannot immediately connect to an existing heating or cooling network; - **Not possible at Oldfield House.**

Although CHP was given some consideration as a viable solution for the development, the low- carbon technology has been ruled out due to the following reasons;

- Air quality issues; emissions of nitrogen dioxide and particulate matter from a flue would be of local concern
- Site constraints, affordability and size of the plant area required for the CHP.

NOTE: The scheme will include for a heat exchanger in the plant room, allowing for the future connection to a district heating system.



Renewable Energy – Be Green

The utilisation of the Lean and Clean approach allows the project to minimise the reliance on the fossil fueled energy infrastructure. Once the energy use has been minimised, the CO2 emissions can be reduced further through de-carbonised supplies and onsite 'renewable energy' solutions – 'Being Green'.

A LZC technology Appraisal was undertaken and is contained within the Appendix.

In summary, it being an urban site, wind turbines are unlikely to be effective due to poor wind speed. The use of biofuels is prohibitive as London is subject to strict air quality measures. Fuel cells are not technically appropriate as the development will not generate high enough annual energy demand to make the technology feasible, and there is no source of waste heat for absorption chillers to make practical sense. Combined Heat & Power was considered, but again has significant air quality issues and generally works better with higher base loads.

A green approach of incorporating Low and Zero Carbon Technology has then been adopted via ground source heat pumps and PV panels.

Renewable Energy – Be Green

Ground Source Heat Pump (GSHP)
Ground source heat pumps (GSHPs) use pipes which are buried to extract heat from the ground. This heat can then be used to heat radiators, underfloor or warm air heating systems and hot water. For Oldfield House we are looking to use the GSHP for space heating only, this will look to maximise the efficiency of the system.

A ground source heat pump circulates a mixture of water and antifreeze around a loop of pipe, called a ground loop, which is buried in the ground. Heat from the ground is absorbed into the fluid and then passes through a heat exchanger into the heat pump. The ground stays at a fairly constant temperature under the surface, so the heat pump can be used throughout the year. The diagram on the right shows how the ground temperature becomes consistent as the depth increases, this is where the GSHPs will extract and reject heat to.

While GSHP do consume electrical energy, the useful energy output is several times the input. This is dependent on the coefficient of performance (CoP) of the unit and the operating conditions.

Ground source heat pumps are favorable for good localised air quality. The proposed ground source heat pumps will be located in the basement plant room, they run from 'clean' electricity therefore with no flues and no associated localized emissions.

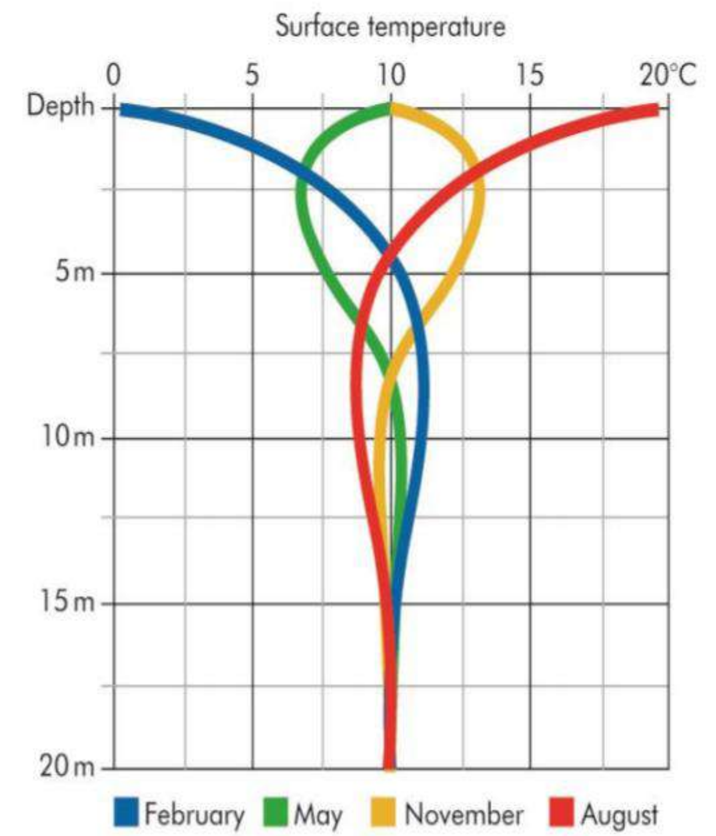
Close Loop Boreholes
It is proposed that closed loop boreholes are utilised. They tend to require between 20 and 40m of pipe per kW. The actual boreholes are usually 100 – 150mm in diameter Each borehole has at least one flow and return pipework, sometimes two.

The table and points below outline the proposed GSHP selection and the system performance expected and assumed modelling criteria.

System Outline
- 70kW GSHP (MSC certified – Space heating only)
- Point of use electric hot water heaters for Domestic Hot Water
- Boreholes / Energy Piles utilised, provision basis of approx. 25No. (150mm dia) 120m deep borehole, based on current geological understand of ground conditions (fairly typical London conditions). This will be developed in further detail going forwards.
- Ground Water Loop Temperatures Design: 0 - 7°C
- LTHW Flow Temperature: 35 °C
- Underfloor Heating throughout.

Modelling Inputs:
SCOP (Heating) = 4.80

Modelling Outputs:
Estimated heating energy = 0.9 kWh/m2



Floor	GSHP Model	Quantity	Peak Heating Output (kW)	Peak Electrical Input (kW)	Primary Input Temperature - Ground Loop (°C)	Primary Output Temperatures – LTHW (°C)
Basement	Vitocal 300-G	2	40.0	8.33	0 – 7	35

Renewable Energy – Be Green

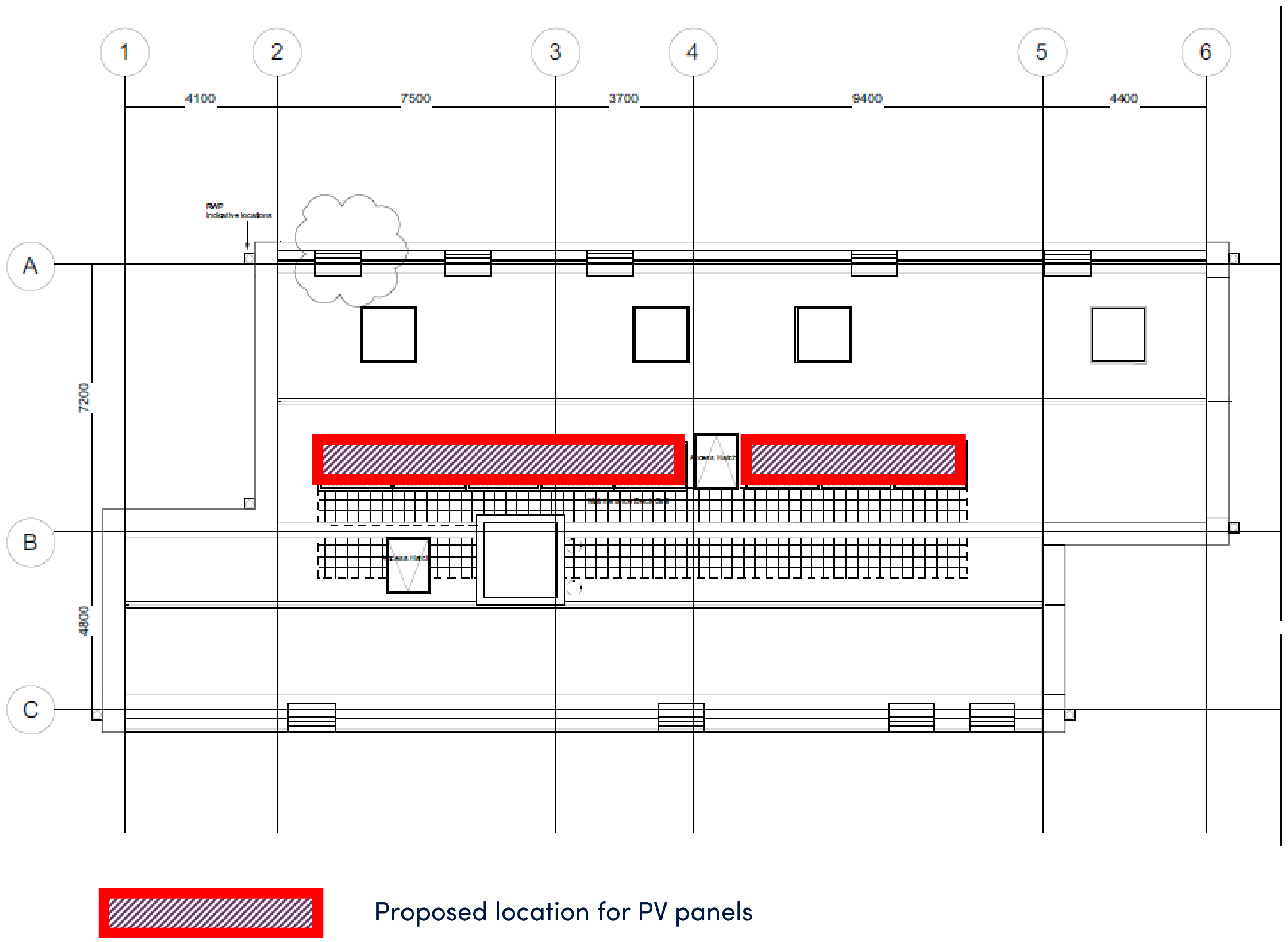
Photovoltic Panels
The proposed system should be on the inner south west facing roof. Whilst there is more south easterly facing roof available, it should be noted that PV panels will not be positioned here in keeping with the conservation area.

System Size = 3.8 kWp
Approximate Output = 3150 kWh
Approximate carbon savings = 1.6tCO_2/annum

The above figures are based on the following assumptions;
- Electricity Carbon Factor = 0.519 kgCO_2/kWh
- Output of PVs (kWh) is based on 850kWh/kWp

Refer to site map in appendix showing that there is no risk of shading from surrounding buildings.

NOTE: Both the PV panels and the Ground Source Heat Pump will be metered by a remote monitoring platform with daily readings for a period of 3 years after installation and when the equipment is turned on.



Carbon Compliance

The calculation methodology for presenting carbon emission reduction draws on the approach set out by Policy 5.2 (Minimising Carbon Dioxide Emissions) of the London Plan and is amplified in the Harrow Development Management Policy.

It is a hierarchical approach with four sequential steps.

- Establish baseline (Part L compliance)
- Evaluate energy efficiency measures ('lean')
- Evaluate heating and cooling systems ('clean')
- Evaluate renewable energy technologies ('green')

SBEM (or Simplified Building Energy Model) is the approved methodology for calculating energy performance in non-domestic buildings. The energy calculations for the non-residential element have been undertaken using TAS software.

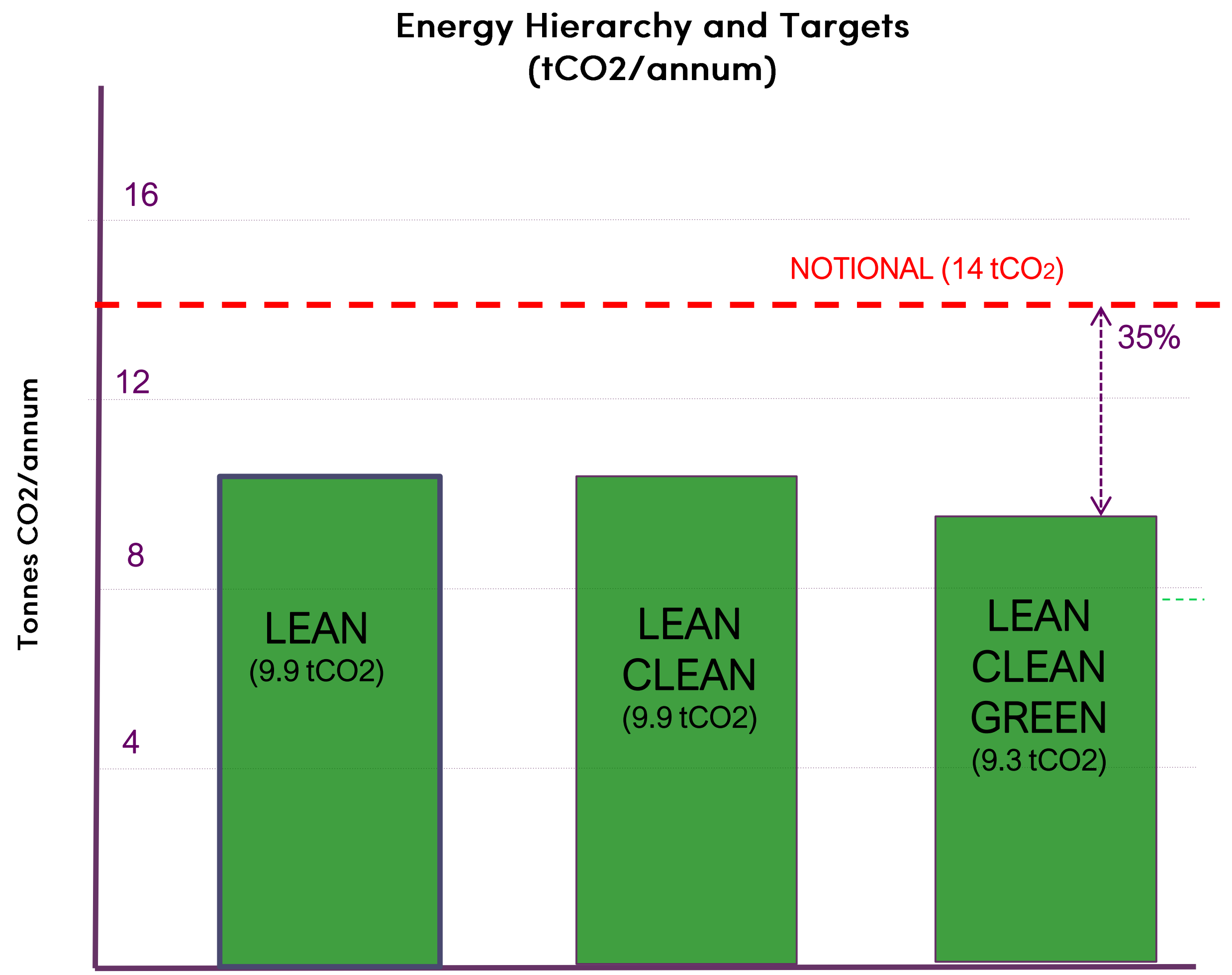
Full modelling report is contained within the Appendix.

A summary of our current proposals to reduce carbon for the development, in line with the calculation methodology outlined in the GLA Preparing Energy Assessments guidance is;

- Improved U values, air permeability = 5m3/m2.h, energy efficient lighting & controls – LEAN
- A fully naturally ventilated strategy is proposed using the breathable building new NVHR 1100 units, and mechanical extract in WC, Kiln/photography rooms, plant room and store – LEAN
- High performing GSHP to provide tempered air in the summer and winter months to all of the spaces. – GREEN
- 20m2 of PV panels (circa. 3.5kWp) will be provided on the inner south east facing roof. – GREEN

The Notional Building changes if the heat source changes. Therefore our proposed strategy shows a 38% improvement over the notional building – which is considered to have Building Regulations compliant U values, air permeability, lighting, ventilation and a gas boiler providing the heat.

NOTE: Energy model and calculations are to be updated at the next stage of design.



	(Tonnes CO2 per annum)	
	Regulated	Unregulated
Notional	14.268	15.85
Be Lean	9.878	15.85
Lean, Clean	9.878	15.85
Lean, Clean, Green	9.270	15.85

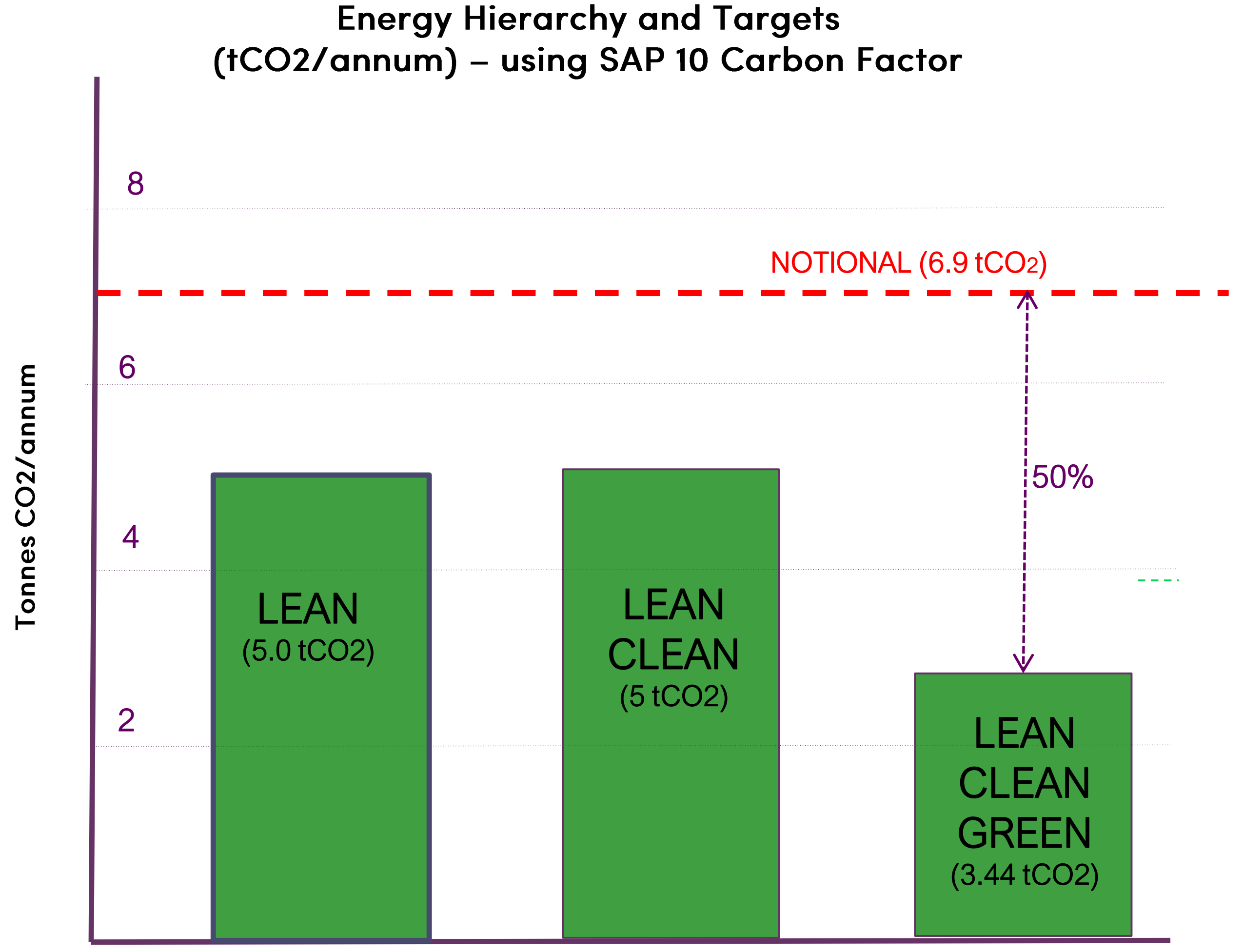
Savings from	Regulated Carbon dioxide Savings	
	Tonnes CO2 per annum	% Reductions
Lean Measures	4.28	30.24%
Clean Measures	0.00	0%
Green Measures	0.74	5.22%
Cumulative Savings	5.02	35.47%

Building Compliance – with SAP 10 Carbon Factors

From January 2019, planning applicants are encouraged to use updated (SAP 10) carbon emission factors to assess the expected carbon performance of a new development. Applicants should continue to use the current Building Regulations methodology for estimating energy performance against Part L 2013 requirements but with the outputs manually converted for the SAP 10 emission factors.

Carbon Factors

	Emissions kgCO$_2$ per kWh	
	SAP 2012	SAP 10
Mains Gas	0.216	0.210
Electricity	0.519	0.233



	(Tonnes CO2 per annum)	
	Regulated	Unregulated
Notional	6.87	15.85
Be Lean	4.96	15.85
Lean, Clean	4.96	15.85
Lean, Clean, Green	3.44	15.85

Savings from	Regulated Carbon dioxide Savings	
	Tonnes CO2 per annum	% Reductions
Lean Measures	1.91	28%
Clean Measures	0.00	0%
Green Measures	1.52	22%
Cumulative Savings	5.02	50%

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Appendix

Natural Ventilation Proposal for New Oldfield House, John Lyon School - Harrow

Project ID: 14675a

22 January 2019

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Powered by 4DFlo
Dynamic thermal mass simulation

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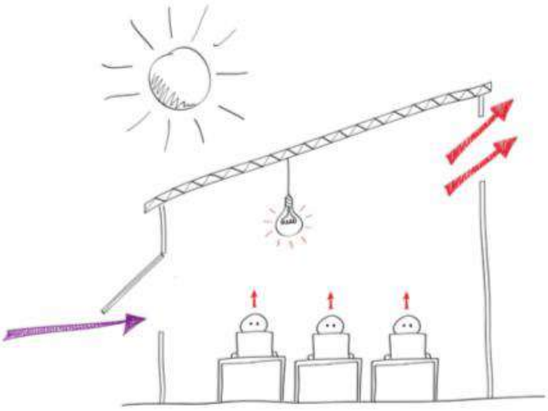
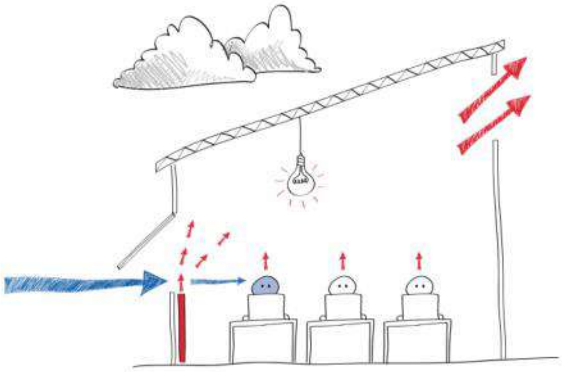
1 Introduction to Breathing Buildings

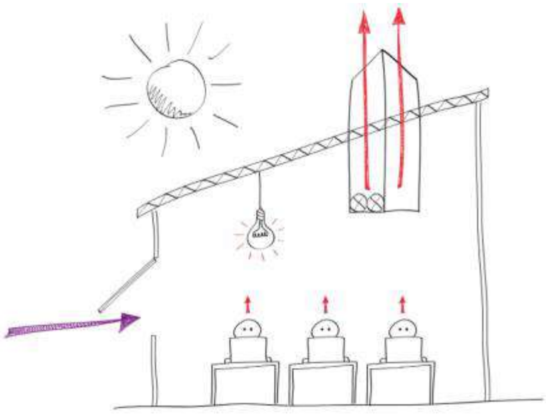
Breathing Buildings Ltd. provides both consultancy and products to enable efficient natural ventilation. Our e-stack ventilation system works in one of two modes: displacement ventilation in summer and mixing ventilation in winter.



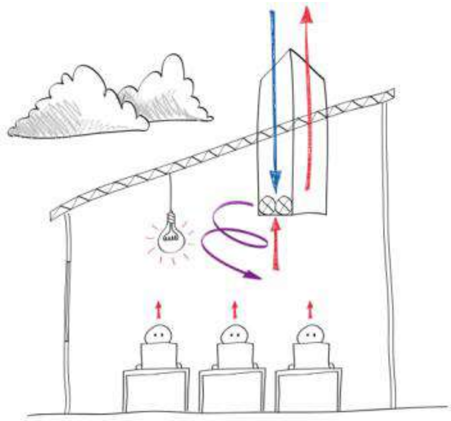
Conventional Summer Strategy
Displacement ventilation is used in the conventional summer strategy when low level openings are available.



Conventional Winter Strategy
Conventional displacement ventilation in the winter requires incoming air to be preheated to prevent cold draughts.



Breathing Buildings Summer Strategy
Fans in the e-stack units can be used to boost displacement ventilation in the summer and avoid summer overheating.



Breathing Buildings Winter Strategy
Mixing ventilation strategy used in the winter. E-stack units supply and mix fresh air at high level, to avoid cold draughts and the requirement for preheating.

Figure 1 – Comparison of conventional and e-stack natural ventilation

In summer, natural ventilation is a lower energy option in comparison with mechanical ventilation or air-conditioning. When low level openings can be used for ventilation, natural upwards displacement ventilation strategy is implemented in the e-stack system (the air flows through the space naturally due to buoyancy forces, rather than using high powered fans). On the warmest days, the low powered

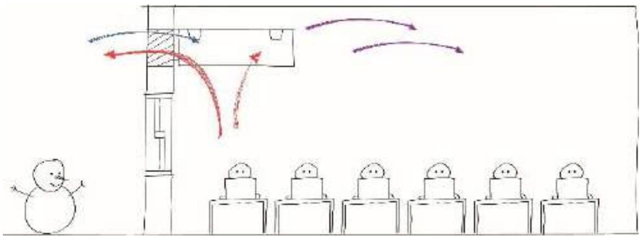
Breathing Buildings

fans present in the units for winter mode are used to increase the airflow further. When low level openings cannot be used for ventilation, the e-stack system is still able to provide ventilation by exchange flow at high level. This strategy can also be assisted by low powered fans present in the units. The rate of ventilation is controlled depending on the temperature in the space.

In winter, our system is unique. Rather than continuing with displacement ventilation (which requires pre-heating at low level to avoid cold draughts) we bring air in at high level, mixing it with the air in the room. This reduces the heating requirement as the fresh air is tempered by the warm room air rather than requiring pre-heating. The room is kept warm during occupation by the heat generated by the occupants and equipment. In well-insulated buildings this is generally sufficient down to external temperatures of 5°C – 10°C. Furthermore, the ventilation rate is controlled by the level of CO_2 in the room, preventing over-ventilation in wintertime.

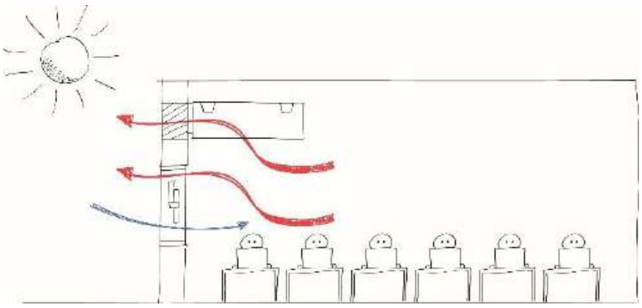
1.1 NVHR system

The NVHR (Natural Ventilation with Heat Recycling) system incorporates the same e-stack technology in a faced mounted unit, allowing single-sided natural and mixing ventilation in deep plan spaces. This system allows buildings with limited roof access to be naturally ventilated and can be installed in almost any building due to its small size.



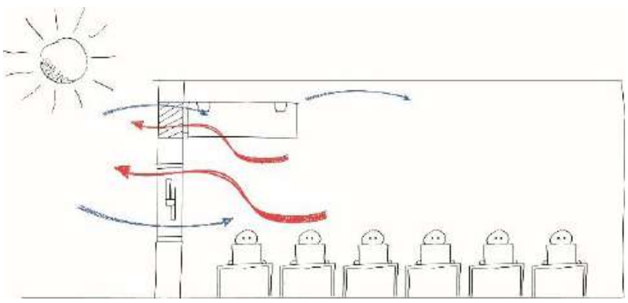
Winter Mixing

- *Draught mitigation strategy*
- *Mixing warm room air with fresh external air*
- *Natural exhaust through the unit*



Summer Natural Ventilation

- *NVHR damper open*
- *Opening windows or low level inlet open*



Summer Boost Ventilation

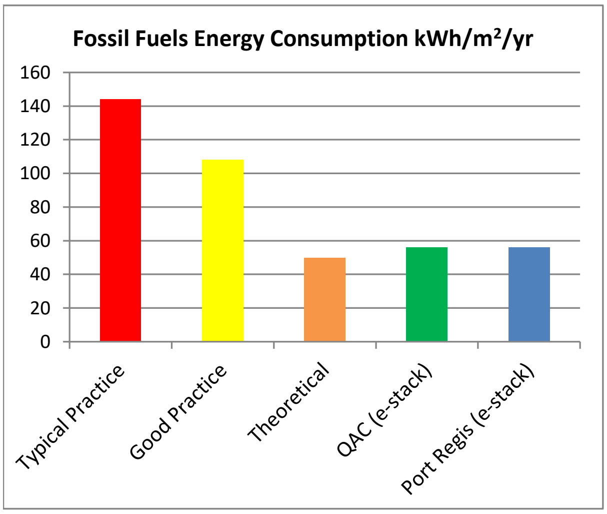
- *NVHR damper open*
- *Inlet fan running to deliver fresh air to space.*
- *Natural exchange flow through opening windows*
- *Also operates automatically for night purge*

A typical school classroom is installed with a pair of units (a 'Parent' and a 'Child'). Each space is controlled by the NVHR Parent unit's on-board controller based on a room temperature and CO_2 sensor, external temperature sensor and duct temperature sensor readings. This allows the system to optimise the ventilation strategy for comfort and energy use. Where required an LED interface panel is provided in each space to indicate when the windows on the facade should be opened.

1.2 Energy savings using e-stack systems

There are two energy savings that the e-stack ventilation system affords. The first is one that applies to all natural systems: the significant reduction in fan power over mechanical systems. The second is one which applies to the e-stack approach and not to traditional natural ventilation techniques: the removal of pre-heating. The second saving is achieved by bringing air in at high level and mixing it with air in the room, rather than passing it over heating batteries. These savings are significant. Below are two example schools which we have worked on in the past few years, Queen Alexandra College and Port Regis School; both of these schools had e-stack units in the majority of classrooms. Figure 3 shows the CIBSE guidelines for fossil fuel usage of secondary schools at good practice and typical practice, followed by the energy usage of Queen Alexandra College and Port Regis School. This shows a very large space heating saving, even over CIBSE good practice guidelines.

Figure 2 – Queen Alexandra College (QAC) and Port Regis School



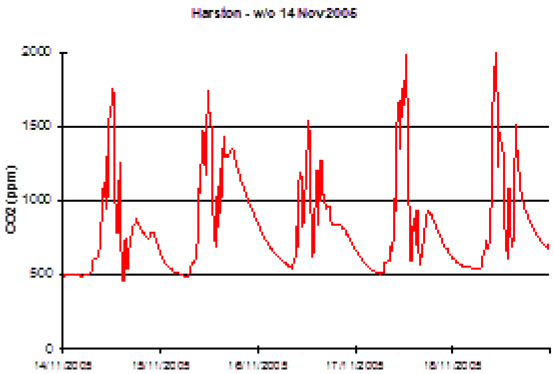
Monitoring at Queen Alexandra College (QAC) and Port Regis School reveal that their energy usage is twice as good as CIBSE 'good practice' guidelines.

Figure 3 – Energy usage at Queen Alexandra College and Port Regis School

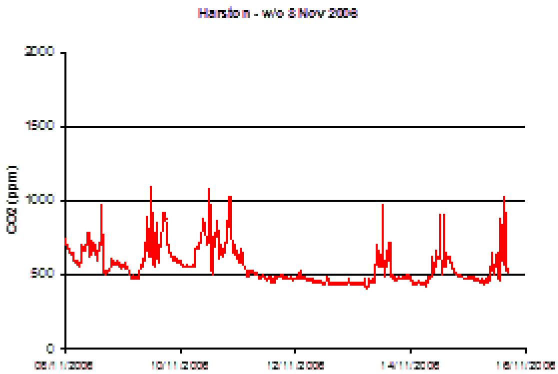
Breathing Buildings

1.3 *Interior Comfort*

Because of the sophisticated control system inside the e-stack units, the internal air is kept fresh, without over ventilating. The graphs below show the CO_2 levels inside a classroom at Harston School, Cambridge, before and after the installation of an e-stack unit.



Pre-installation of e-stack



Post-installation of e-stack

Figure 4 – Internal Comfort

The target CO_2 level set in the controller was 1000 ppm (which is office quality air), and the right hand graph clearly shows the effectiveness of the e-stack system in achieving this. During the summer, the ventilation rate is dependent on temperature. As the temperature inside the classroom increases, the unit is opened up, increasing the rate of displacement ventilation. The low powered fans, used for mixing in winter, are switched on in the hottest parts of the year to drive an even higher rate of ventilation, reducing the internal temperature of the space.

2 Proposal for New Oldfield House, John Lyon School - Harrow

The proposal below is for New Oldfield House, John Lyon School - Harrow and it is based on the drawings received from Daven Masri of Boom Collective on 14th January 2019.

2.1 Design Summary

A new 5 storey school building is proposed for John Lyon School. The scheme requires a natural ventilation strategy to ventilate most of the spaces.

Breathing Buildings propose to use its new NVHR 1100 units to naturally ventilate the school. These offer superior flow rates, lower noise and lower power consumption compared to legacy NVHR 900 system. Each standard classroom will be supplied with 2 units, which will sit exposed in the upper façade of the room above the windows and will be interfaced to external louvres. The exact position of the units is at the discretion of the client but an indicative set up is shown in Figure 5 below. The large ICT/STEM/Computer Science space on the upper ground floor will have 6 units in 3 ventilation zones.

Figure 5 – NVHR 1100 units exposed in a classroom

Breathing Buildings has also modelled the Break Out spaces and Office and can show that they will overheat in summer unless unrealistically large opening areas can be provided, and therefore proposes to place a single NVHR 1100 unit in each of these spaces.

Breathing Buildings' systems use a unique ventilation strategy which varies throughout the year depending on the external environment. In summertime the system typically works in conjunction with low level opening windows to effectively ventilate a room naturally. In winter, a mixing heat recycling strategy operates which is unique to our systems - it eliminates cold draughts without the use of preheating radiators/heating batteries and hence has major energy saving benefits.

2.2 Openings Arrangement

All of the rooms containing NVHR 1100 systems **will meet the minimum BB101 2018 overheating criteria without relying on opening windows** as part of the ventilation strategy. However, as simply achieving overheating compliance does not preclude the classrooms from getting warm in summer, Breathing Buildings **strongly recommends that provision be made for a reasonable area of openings** as good design practice. The recommended *aerodynamic opening areas* (and their corresponding *physical free areas*) are shown in Table 1. These areas have been calculated as the minimum required to pass the optional BB101 2018 Performance in Use Criterion, which is explained in Section 2.4.1.

Floor	Room ID	e-Stack unit	Number of units per room	Recommended low-level aerodynamic area *(m^2)*	Recommended low-level physical free area (assuming C_d = 0.61) *(m^2)*
LG	**DT (North)**	NVHR 1100	2	1.83	3.00
	DT (South)	NVHR 1100	2	1.44	2.36
	Quiet Room 1	NVHR 1100	1	0.09	0.15
UG	**Small Classroom (North)**	NVHR 1100	1	0.03	0.05
	ICT/STEM/Comp Sci	NVHR 1100	6	3.96	6.49
FF	**Art (North)**	NVHR 1100	2	1.62	2.66
	Art (South)	NVHR 1100	2	1.05	1.72
	6th Form Art	NVHR 1100	1	0.18	0.30
SF	**Small Classroom (North)**	NVHR 1100	1	0.03	0.05
	Maths (North)	NVHR 1100	2	1.11	1.82
	Maths (Central)	NVHR 1100	2	0.60	0.98
	Maths (South)	NVHR 1100	2	0.06	0.10
	Staff Office (South)	NVHR 1100	1	0.03	0.05
TF	**Maths (North)**	NVHR 1100	2	0.36	0.59
	Maths (South)	NVHR 1100	2	0.30	0.49
	Break Out (South)	NVHR 1100	1	0.03	0.05

Table 1 - e-stack equipment and openings arrangement

2.3 *Definitions*

The *aerodynamic opening area* refers to the effective opening area of a window once aerodynamic losses have been taken into account. Since there is an aerodynamic loss associated with air passing through a small aperture, the effective area of the opening is smaller than its *physical free area* (the size of the hole). If A is the *physical free area* of the opening, then the *aerodynamic area* A^* would be:

$$A^* = C_d A$$

where C_d is the aerodynamic loss factor of the opening (taken to be 0.61 in this proposal).

Breathing Buildings

2.4 *Regulatory Compliance*

2.4.1 BB101 2018 Overheating Criteria

The system installed in each room is designed to meet BB101 2018 summer overheating criteria, measured against the CIBSE DSY 1 H50 2020 weather file for Heathrow, which is the nearest and most appropriate of the 14 CIBSE/Met Office weather station locations across the UK. DSY (Design Summer Year) consists of a single continuous year of hourly data to represent a year with a hot, but not extreme, summer.

The compliance with the overheating criteria for each room, for the aerodynamic areas recommended in Table 1, is demonstrated in Table 2 - compliance with BB101 2018 overheating criteria

.

Room ID	BB101 2018 overheating criteria				BB101 2018 Pass/Fail
	No. of occupied hours with T_{op}>(T_{accept}+1°C) ≤ 40	Severity of Overheating (Weighted Exceedance ≤ 6)	Upper Limit Temperature (Max T_{op} ≤ (T_{accept}+ 4°C))	Performance in Use (Max ΔT ≤ 5°C)	
LG DT (North)	Pass	Fail	Pass	Pass	**Pass**
LG DT (South)	Pass	Fail	Pass	Pass	**Pass**
LG Quiet Room 1	Pass	Fail	Pass	Pass	**Pass**
UG Small Classroom (North)	Pass	Pass	Pass	Pass	**Pass**
UG ICT/STEM/Comp Sci	Pass	Fail	Pass	Pass	**Pass**
FF Art (North)	Pass	Fail	Pass	Pass	**Pass**
FF Art (South)	Pass	Fail	Pass	Pass	**Pass**
FF 6th Form Art	Pass	Fail	Pass	Pass	**Pass**
SF Small Classroom (North)	Pass	Pass	Pass	Pass	**Pass**
SF Maths (North)	Pass	Fail	Pass	Pass	**Pass**
SF Maths (Central)	Pass	Fail	Pass	Pass	**Pass**
SF Maths (South)	Pass	Fail	Pass	Pass	**Pass**
SF Staff Office (South)	Pass	Fail	Pass	Pass	**Pass**
TF Maths (North)	Pass	Fail	Pass	Pass	**Pass**
TF Maths (South)	Pass	Fail	Pass	Pass	**Pass**
TF Breakout (South)	Pass	Pass	Pass	Pass	**Pass**

Table 2 - compliance with BB101 2018 overheating criteria

The only criterion which MUST be met is Criterion 1, which states that the operative temperature of the room shall not exceed the maximum acceptable temperature by more than 1 degree for more than 40 hours during the period 1st May – 30th September. Criterion 2 (Severity of Overheating) and Criterion 3 (Upper Limit Temperature) are primarily measures of short term discomfort and are reported for information only. Criteria 4 (Performance in Use) is a measure of whether it is possible to demonstrate, post-occupancy, that the average internal air temperature does not exceed the average external air temperature by more than 5°C on days warmer than 20°C.

2.4.2 BB93 noise limits

The system installed in each classroom is designed to comply with the 35dB $L_{aeq,30min}$ upper limit for the indoor ambient noise level. There is the option to throttle back the units in quiet rooms in order to achieve a lower indoor ambient noise level, but this will reduce their flow rates and therefore may result in greater opening areas being required in those rooms to achieve sufficient ventilation.

2.5 Design Assumptions

The design assumptions for this proposal are in-line with BB101 2018 Section 8/ESFA Output Specification Annex 2F Section 11 Guidance. A summary of these assumptions are shown in Appendix A – Design Assumptions. There are a couple of exceptions:

- Typical occupancies are taken to be 25 people per classroom rather than the standard 32 due to John Lyons being a private school.
- Classroom heights are taken from section drawings instead of using the standard 2.7m.

If any of these assumptions are not valid, the proposed solution can be updated by Breathing Buildings accordingly. The spaces were modelled using 4DFlo (see Appendix B – 4DFlo).

2.6 Design Drawings

Figure 6 to Figure 10 show the equipment required on plans of the building. The areas modelled in 4DFlo by Breathing Buildings are shown with a red perimeter.

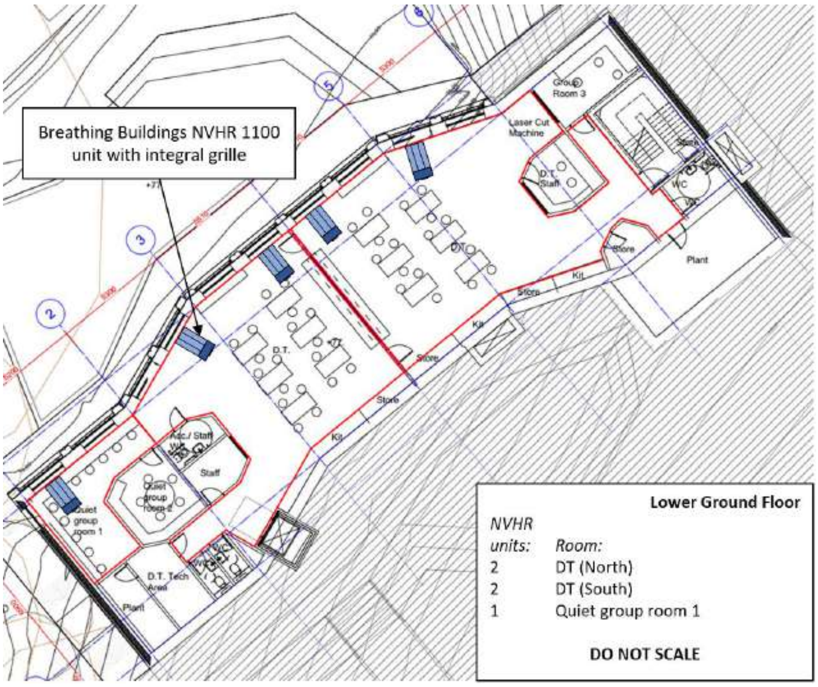


Figure 6 - Lower ground floor e-stack indicative locations

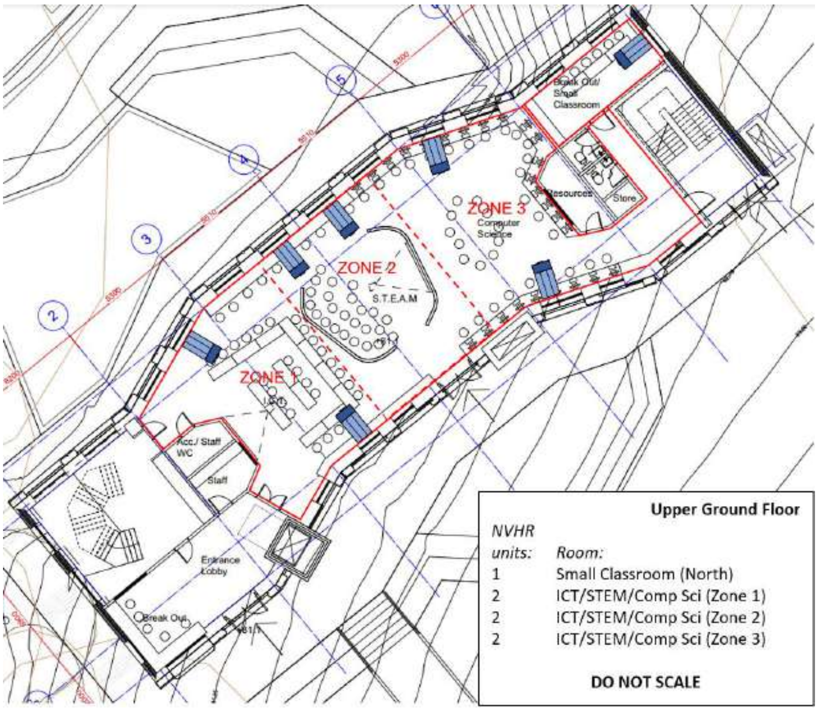


Figure 7 - Upper ground floor e-stack indicative locations

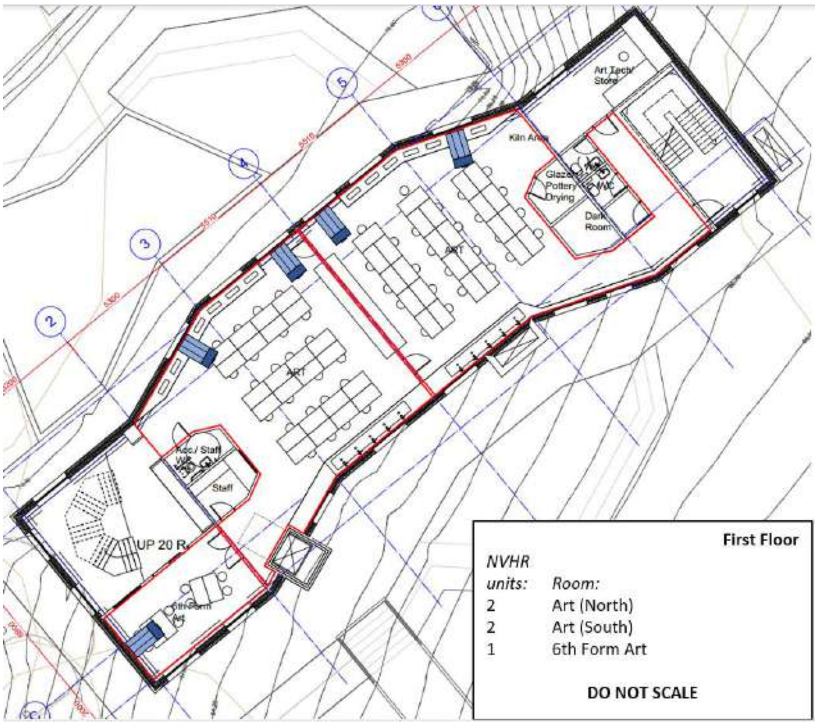


Figure 8 - First floor e-stack indicative locations

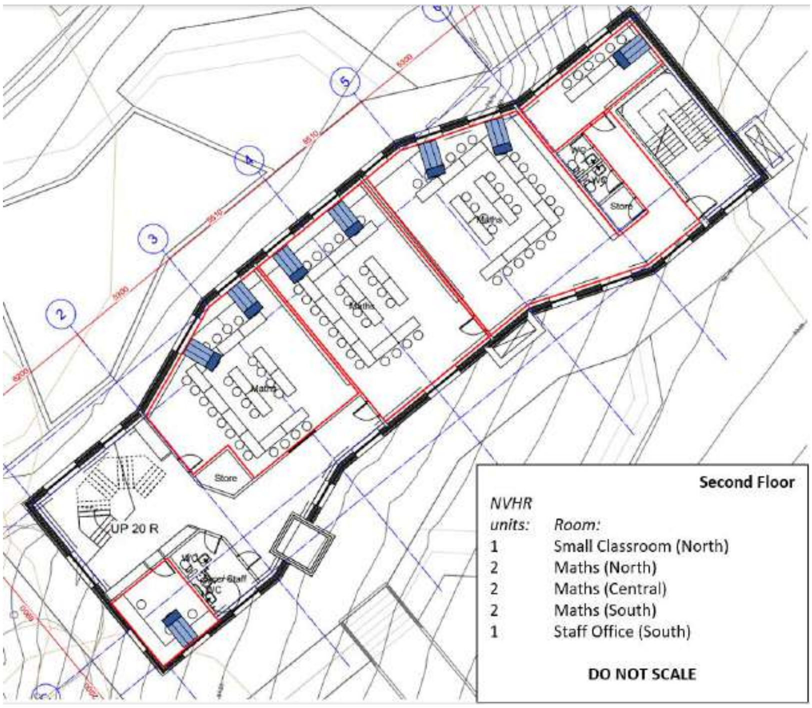


Figure 9 - Second floor e-stack indicative locations

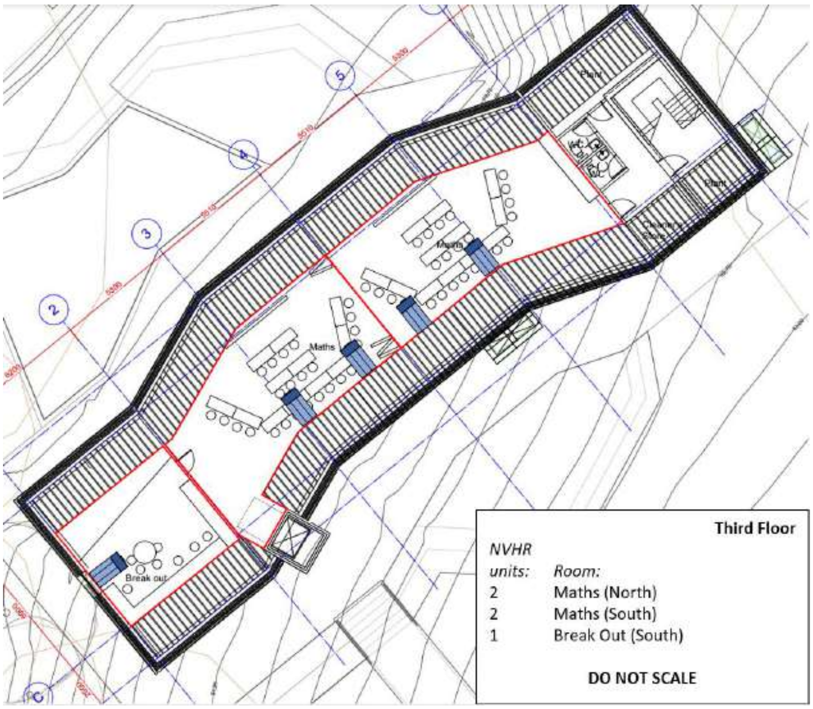


Figure 10 - Third floor e-stack indicative locations

3 Design Responsibility

As part of the submission to Building Control regarding ventilation strategy and area provision, there would generally need to be a document submitted by the design team to address the issues of adequate ventilation provision. Breathing Buildings Ltd. can be appointed as part of the design team to undertake these calculations if desired using 4DFlo (see Appendix B – 4DFlo). If Breathing Buildings Ltd. is not assuming design responsibility, then the appropriate document for Building Control purposes is usually provided by the M&E Engineers for the project.

4 Summary

The e-stack NVHR system provides controlled natural ventilation for the spaces described. It implements displacement ventilation in summer and mixing ventilation in winter. This has significant energy savings over conventional ventilation approaches. The units are controlled to supply ventilation at the required rate, preventing over ventilation in the winter and encouraging higher ventilation rates in the summer.

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5 Appendix A – Design Assumptions

Lower and Upper Ground Floors:

Room ID	Occupied Hours per Day	Max. Occupancy	Sensible Heat Gains			Room Geometry		Thermal mass	Glazing	
			Occupants	Lighting	Additional	Area	Height		Area	G-Value
			W/person	*W/sq. m*	*W/sq. m*	*sq. m*	*m*		*sq. m*	-
LG DT (North)	9:00 - 16:00	25	70	7.2	15	100	3.4	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	12.8 (NW)	0.40
LG DT (South)	9:00 - 16:00	25	70	7.2	15	81.5	3.4	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	12.8 (NW)	0.40
LG Quiet Room 1	9:00 - 16:00	11	70	7.2	10	19	3.4	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	1 (SW) 5.1 (NW)	0.40
UG Small Classroom (North)	9:00 - 16:00	6	70	7.2	10	14.2	3.4	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	3.38 (NW) 1.69 (NE)	0.40
UG ICT/STEM/Comp Sci	9:00 - 16:00	90	70	7.2	15	181.2	3.4	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	12.4 (SE) 13.52 (NW)	0.40

Table 3 – Design Assumptions

Breathing Buildings

First and Second Floors:

Room ID	Occupied Hours per Day	Max. Occupancy	Sensible Heat Gains			Room Geometry		Thermal mass	Glazing	
			Occupants	Lighting	Additional	Area	Height		Area	G-Value
			W/person	*W/sq. m*	*W/sq. m*	*sq. m*	*m*		*sq. m*	-
FF Art (North)	9:00 - 16:00	25	70	7.2	5	102.3	3.2	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	6.94 (SE) 7.68 (NW)	0.40
FF Art (South)	9:00 - 16:00	25	70	7.2	5	87.6	3.2	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	4.25 (SE) 7.68 (NW)	0.40
FF 6th Form Art	9:00 - 16:00	8	70	7.2	5	21.5	3.2	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	4.25 (SE)	0.40
SF Small Classroom (North)	9:00 - 16:00	6	70	7.2	10	14.9	3.1	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	2.69 (NW)	0.40
SF Maths (North)	9:00 - 16:00	25	70	7.2	10	76.3	3.1	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	4.38 (SE) 3.69 (NW)	0.40
SF Maths (Central)	9:00 - 16:00	25	70	7.2	10	53.2	3.1	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	2.56 (SE) 5.38 (NW)	0.40
SF Maths (South)	9:00 - 16:00	25	70	7.2	10	48.4	3.1	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	3.56 (NW)	0.40
SF Staff Office (South)	8:00 - 17:00	3	90	7.2	25	11.5	3.1	Ceiling: Cast concrete (lightweight) Walls: Plasterboard Floor: Screed	1.69 (SE) 1 (SW)	0.40

Table 4 – Design Assumptions

Third Floor:

Room ID	Occupied Hours per Day	Max. Occupancy	Sensible Heat Gains			Room Geometry		Thermal mass	Glazing	
			Occupants	Lighting	Additional	Area	Height		Area	G-Value
			W/person	*W/sq. m*	*W/sq. m*	*sq. m*	*m*		*sq. m*	-
TF Maths (North)	9:00 - 16:00	25	70	7.2	10	56.8	2.75	Ceiling: Timber Walls: Plasterboard Floor: Screed	1.17 (SE) 4.93 (NW)	0.40
TF Maths (South)	9:00 - 16:00	25	70	7.2	10	57.9	2.75	Ceiling: Timber Walls: Plasterboard Floor: Screed	0.81 (SE) 4.93 (NW)	0.40
TF Break Out (South)	9:00 – 16:00	8	70	7.2	5	32.5	2.75	Ceiling: Timber Walls: Plasterboard Floor: Screed	1.0 (SW)	0.40

Table 5 – Design Assumptions

6 Appendix B – 4DFlo

4DFlo Dynamic Thermal Mass Simulation Modelling Software by Breathing Buildings

The 4DFlo modelling uses a dynamic thermal model calculation which can include for the impact of night cooling where such strategies are implemented. The ventilation flows are calculated on an hourly basis in the time-stepped model based on the formulae in CIBSE Applications Manual AM10 “Natural Ventilation in Non-Domestic Buildings”. 4DFlo modelling is also compliant with the requirements of AM11 in terms of being a full dynamic model as described in Table 3.1, and hence appropriate for use in assessment of overheating risks.

By means of these calculations, the model can be used to confirm that the building, when equipped with the proposed Breathing Buildings natural ventilation scheme, complies with the Building Regulations Approved Document F as well as BB101, PSBP FOS or CIBSE Guide A Environmental Design overheating criteria (Table 1.8) as appropriate to the design specification.

Calculations can be carried out in order to show compliance for each room with predicted hourly outputs in terms of summertime internal temperatures. All modelling calculations are carried out using weather data input from the CIBSE TRY or DSY weather years (as appropriate) for the location and project in question.

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7 Appendix C – Control Options

		e-stack Control Options		
		NV Smart	NV Smart +	NV Smart + Connected
Strategy	Summer Boost	●	●	●
	Night Cool	●	●	●
	Winter Mixing	●	●	●
	Draught Mitigation	●	●	●
Integration	BMS Integration			●
	Heating/ Cooling Interlock		●	●
	Window/ Damper Signal		●	●
Ancillaries	LED for Open/ Close Windows		●	●
	Keyswitch	●	●	●
	Room Temp/CO_2 Sensor	●	●	●
	External Temp Sensor	●	●	●
	Wind Sensor Interface			●
	Rain Sensor Interface			●

Table 6 – Control Options

8 Appendix D – Specification Text

8.1 NVHR 1100 unit

The spaces shall be provided with an automatic ventilation system via an NVHR 1100 system, provided by Breathing Buildings Ltd, 15 Sturton Street, Cambridge, CB1 2SN, 01223 450060.

Each space is designed to meet the ventilation and overheating criteria of BB101 2018. The ventilation system is capable of achieving a daily average CO_2 concentration of not more than 1000ppm and has the capability of boosting to 8l/s/person at any time.

The system shall include two ventilation mixing units, each measuring 1500mm(L) by 1078mm(W) by 329mm(H) and incorporating the following; insulated damper; low energy internal mixing fan, with at least two speed settings, and an integral controller. The unit shall be connected to grilles in the room and can be ducted to the rear of a space.

In winter the NVHR units shall be used for fresh air intake and exhaust. The unit shall mix the incoming cold air with sufficient hot interior air, using low energy fans, prior to the fresh air entering the occupied space in order to minimize the risk of cold draughts. Air will be exhausted via a passive section of the insulated damper.

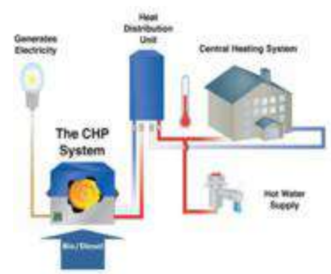
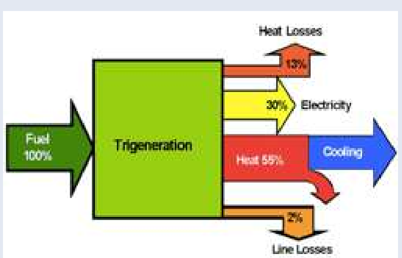
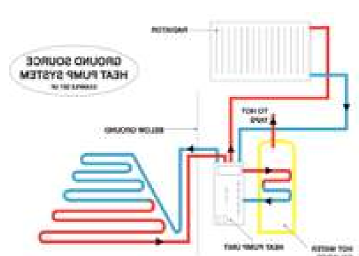
In summer the space will primarily operate as a buoyancy-driven natural ventilation system, with provision for automatic fan assistance to flows when required. If windows are required on the façade, these will be sized to work in conjunction with the NVHR unit for summer operation.

The unit will be capable of automatic, secure night cooling when appropriate, allowing cool air to enter the space via the unit, and using fan assistance if required.

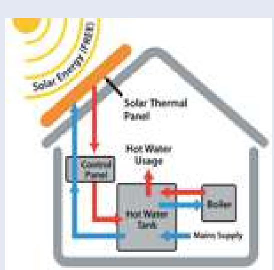
Each unit will be automatically controlled via the NV Smart controller using combined temperature / CO_2 sensor in each room & a common external temperature sensor to determine the operation of the unit. The operation of the internal temperature and CO_2 sensor is based on the infrared principle and a patented auto-calibration procedure compensates for the deterioration of the infrared source and ensures outstanding long-term stability. A key switch with timed override and integrated indicator light to indicate when windows should be open/closed will be located in each room.

For more information, including technical drawings, please visit: www.breathingbuildings.com/products/

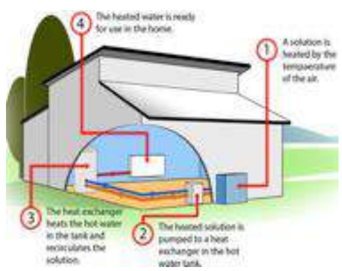
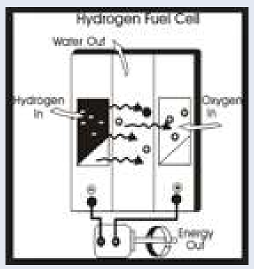
Renewables and LZCT Appraisal

Renewable Technology	Advantages	Disadvantages	Viable Option
Combined Heat and Power (CHP) 	• Heat and power generation – efficient way to generate heat • Tried and tested technology • Suitable for projects with high heating and hot water loads	• Modulating decreases performance • Higher Nox emissions than condensing boiler • No RHI tariff **DECIDING FACTOR:** – Significant impact on the local air quality, in an area where it is already a concern – Flues required – Affordability	N
Tri-generation 	• Waste heat drives absorption chiller in summer months Provides low carbon cooling (depending on source of waste heat) • Chillers are quiet	• Requires source of waste heat usually from industrial process • Large plant space required for absorption chiller • Large amount of heat rejection • Still requires conventional chillers for peak cooling load • No RHI payments	N
Ground Source Heat Pump 	• Can provide steady and consistent heating and cooling • RHI available	• Large area of land required • Run off electricity – high carbon factor • High capital cost • Costs associated with exploratory bore holes required **DECIDING FACTOR:** – Carbon savings	Y
Biomass 	• Carbon neutral • Economic alternative to fossil fuels • RHIs available	• Large storage areas required with access for deliveries • Source of wood pellets • Slower start up time compared with fossil fuels • Reliability of fuel source **DECIDING FACTOR:** **– Not acceptable by Planning**	N

Renewables and LZCT Appraisal

Renewable Technology	Advantages	Disadvantages	Viable Option
Wind Turbine 	• Zero carbon technology • FITs available • Turbulent wind speed at urban sites • Recorded output typically lower than manufacturer's data • Area of natural beauty – Planning permission very unlikely	• Recorded output typically lower than manufacturer's data • Planning permission difficult • Noisy, especially with gearbox **DECIDING FACTOR:** – Not acceptable by Planning	N
Photovoltaics (PV) 	• Zero carbon technology (PV) • Tried and tested technology • Can be integrated/replace building fabric providing cost savings • Simple technology with no moving parts – minimal maintenance • FITs available	• Obstructions (shadowing etc.) effects productivity • Best results produced in direct sunlight mostly over summer, south facing – do we have a south facing roof? • Needs to be carefully integrated amongst rooflights and drainage requirements • Require large areas for significant production	Y
Home PV battery 	• Enhances PV technology and allows greater control, efficiency and reliability • Tried and tested technology • Simple technology with no moving parts – minimal maintenance • Waives the requirement for a G59 connection with the electricity grid	• Requires Space	Y
Solar thermal Panels 	• Tried and tested technology • Can be integrated into the building fabric • RHIs available	• Not compatible with CHP system • Pumps use electricity • Obstructions effect productivity **DECIDING FACTOR:** – More carbon savings from PV panels	Y

Renewables and LZCT Appraisal

Renewable Technology	Advantages	Disadvantages	Viable Option
Air Source Heat Pump 	• RHI available • Minimum maintenance • No deliveries • Underfloor heating is ideal so not to take up floor space • Minimal spatial requirements	• Not a zero carbon technology as it uses some electricity to run the pump • Best matched to underfloor heating • Alternative means of heating water required for summer months • Aesthetics should be considered DECIDING FAACTOR: - No air quality issues	Y
Fuel Cell 	• More efficient cogeneration method than CHP • Research grants may be available	• Newly adopted technology – only two installations in UK • Suited to development with significant heat and electricity demand • Requires large plant space DECIDING FACTOR: - Heating and electricity demand too low	N
Wood burning Stove 	• Carbon neutral • Economic alternative to fossil fuels • Aesthetically pleasing centre point in a living space • Come in various sizes, colours and finishes • Give a warn and cosy atmosphere • RHIs available (only if back boiler)	• Flue/chimney required • Storage areas required • Slower start up time compared with fossil fuels DECIDING FACTOR: - Chimney required – Air Quality	N
Anaerobic Digester 	• It turns waste into a resource • You can use waste by-products to generate energy and reduce your waste disposal costs. • It can be used in combination with a combined heat and power plant to generate both electricity and heat.	• Works best on a larger scale • Requires Planning permission • Would need community buy in DECIDING FACTOR: - Not suited to small scale jobs.	N

JOHN LYON SCHOOL – OLDFIELD HOUSE

PART L2A - ENERGY ASSESSMENT

TABLE OF CONTENTS

It is important to note that with any modelling exercise there are assumptions and approximations that have to be made. As far as possible, details of all assumptions made, and approximations used are supplied as part of the report. These should be read carefully.

All results are based on the output from computer modelling software and should be taken as an indication of the likely final situation, but these conditions cannot be guaranteed.

1. THE MODEL

The building was modelled using TAS 9.4.1 dynamic thermal modelling software written by EDSL Ltd.

1.1. GEOMETRY

The following images are taken of the 3D model and attempt to show the full geometry. As with any modelling exercise, some approximations have to be made, but care has been taken to ensure the scale and internal dimensions of the model are as close as practicable to the design drawings, and that glazing areas etc. are accurately represented.

.

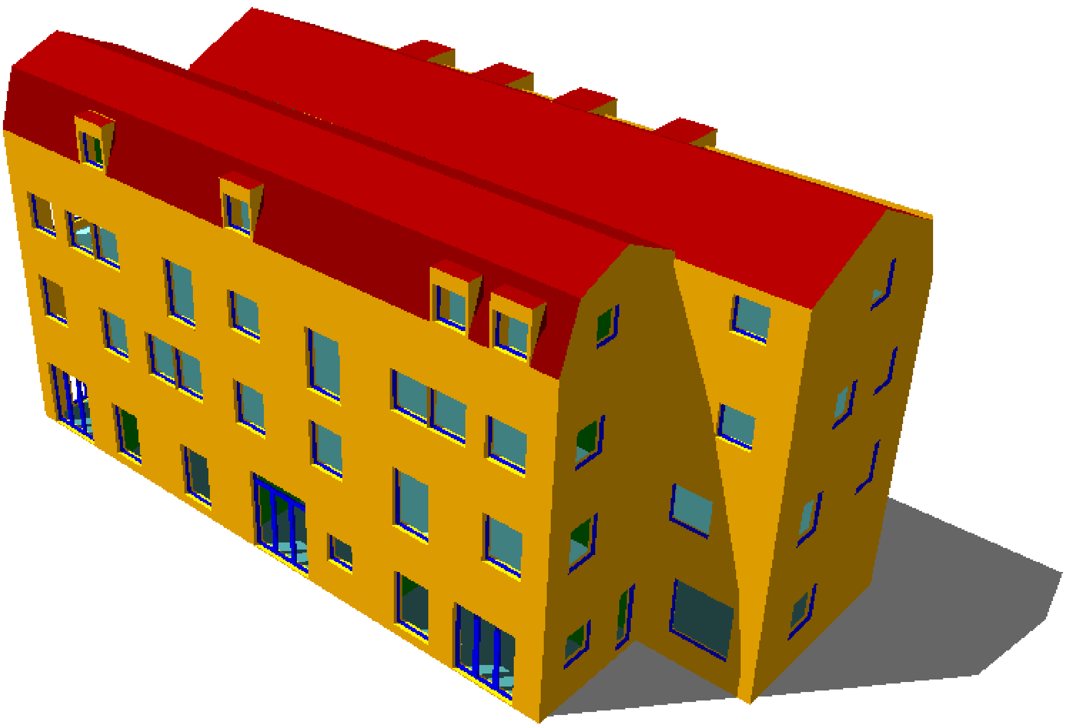


Figure 1. Image of the model from the South-East

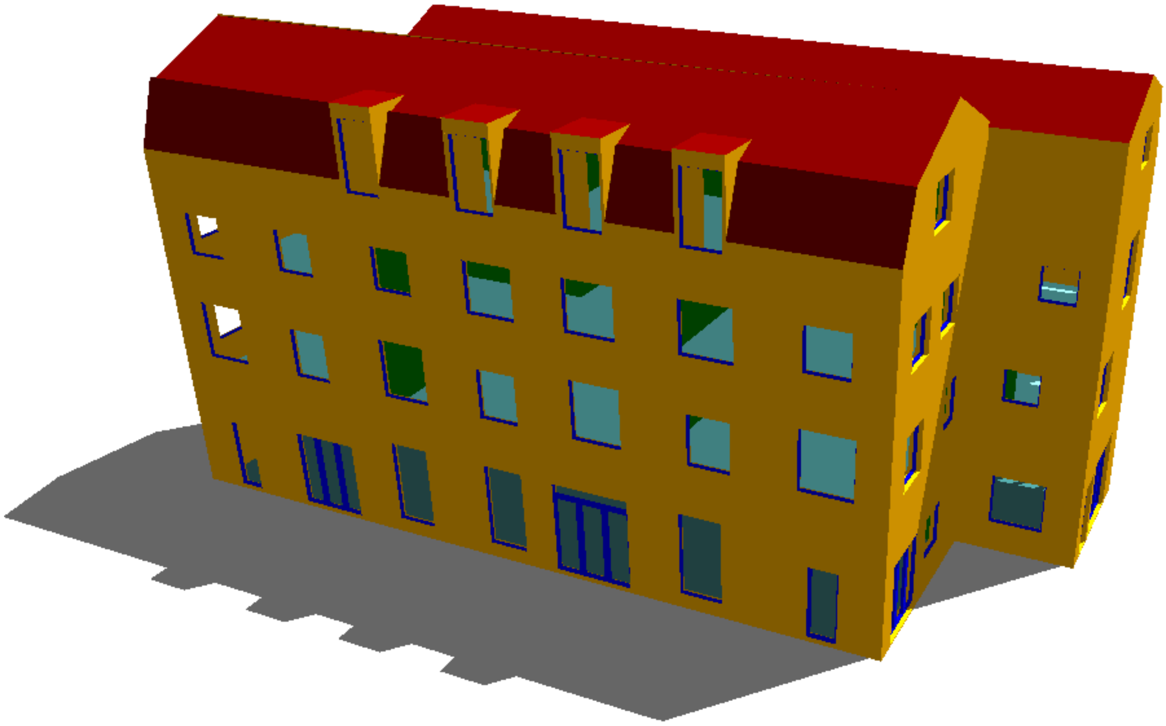


Figure 2. Image of the model from the North-West

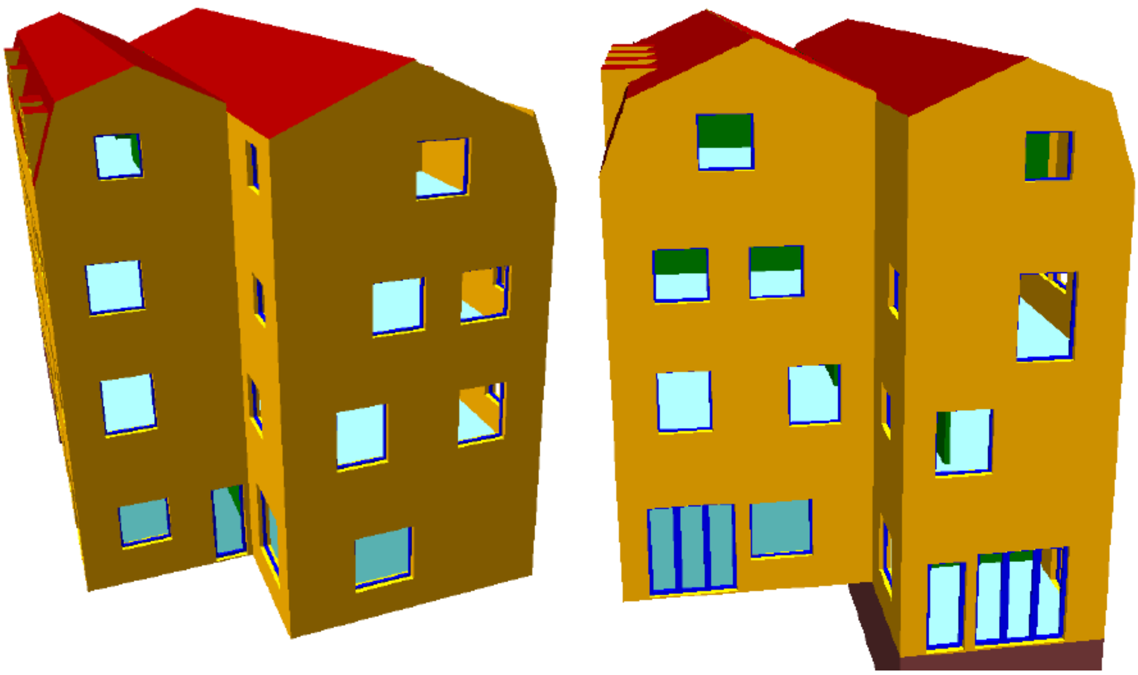


Figure 3. Image of the model from the East and West

1.2. ZONE LAYOUTS

The zoning for this building has been colour coded to reflect the usage assumed for each space:

Colour	NCM Profile	NCM Description
	D1_Edu_Teaching_v5.2.7	Teaching areas which include classrooms and corridors providing access to and between classrooms. People Density 0.55 pers/m2. Lux level 280
	D1_Edu_HighDensIT_v5.2.7	High density desk based work space with correspondingly dense IT. People Density 0.2183099 pers/m2. Lux level 300 Lux.
	D1_Edu_WkshpSS_v5.2.7	A teaching area for practical non-science classes (eg woodwork, metalwork). For practical science based teaching spaces use "laboratory" and for non practical teaching spaces use "classroom/meeting room". People Density 0.06325926 pers/m2. Lux level 500 Lux.
	D1_Edu_Circulation_v5.2.7	For all circulation areas such as corridors and stairways. People Density 0.11 pers/m2. Lux level 100 Lux.
	D1_Edu_Office_v5.2.7	Areas to perform management, office and administration work separated from standard customer/public areas. It can include internal corridors providing access to the office spaces, tea making facilities or kitchenettes within the office space and staff lounges. People Density 0.103 pers/m2. Lux level 400 Lux.
	D1_Edu_Reception_v5.2.7	The area in a building which is used for entry from the outside or other building storeys. People Density 0.1155 pers/m2. Lux level 200 Lux. Display Lighting 9 W/m2.
	D1_Edu_Toilet_v5.2.7	Any toilet areas. People Density 0.11 pers/m2. Lux level 200 Lux.
	D1_Edu_Plant_v5.2.7	Areas containing the main HVAC equipment for the building eg: boilers/air conditioning plant. People Density 0.11 pers/m2. Lux level 200 Lux.

Note the North angle has been taken from the dwg drawings with Elevation 2 facing SE.

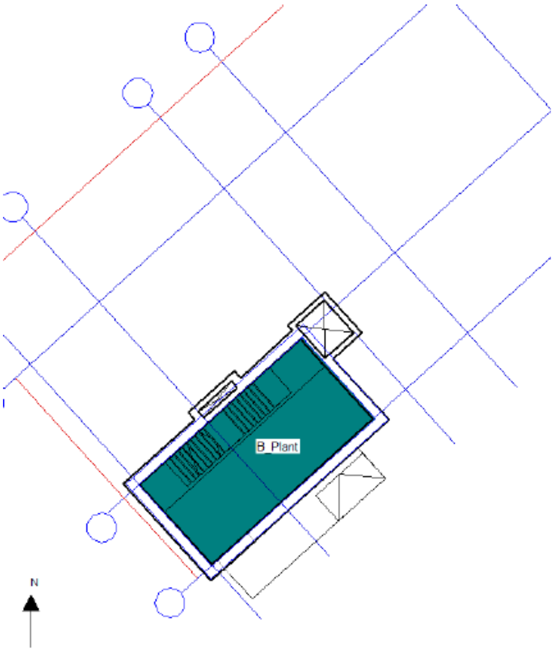


Figure 4. Basement zone layout

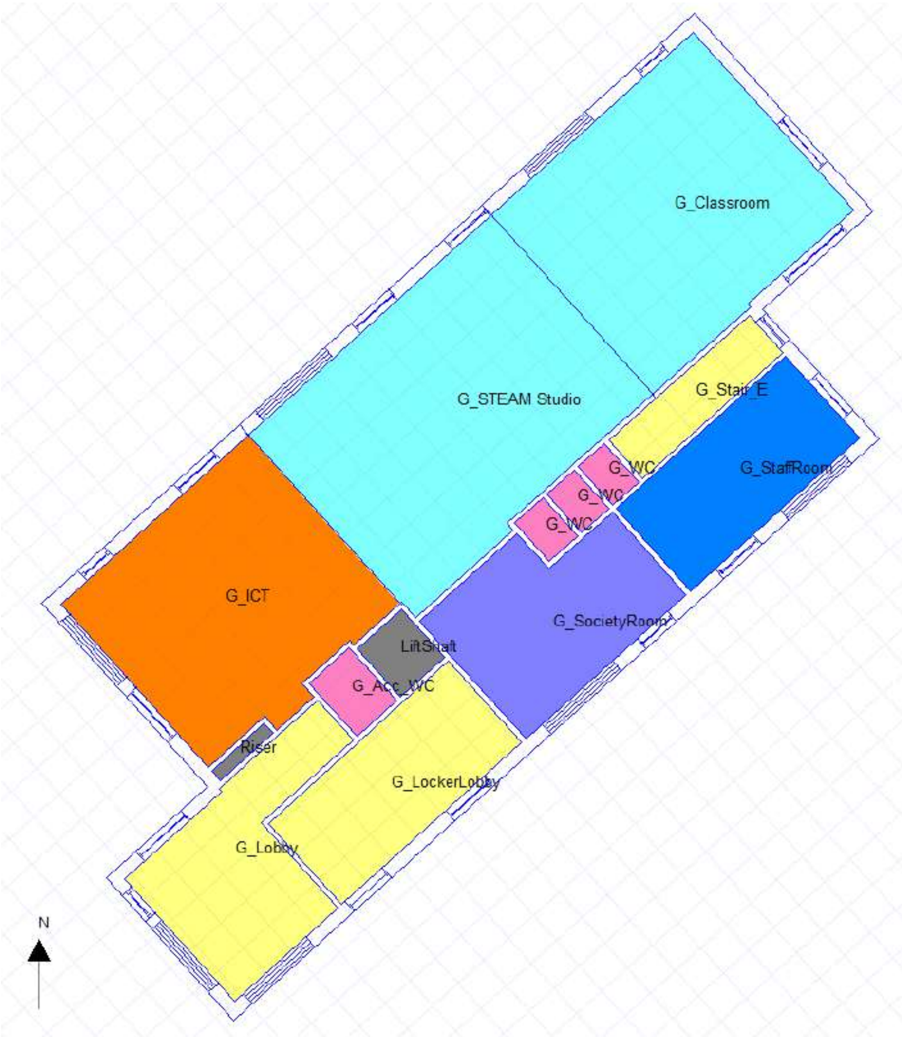


Figure 5. Ground floor zone layout

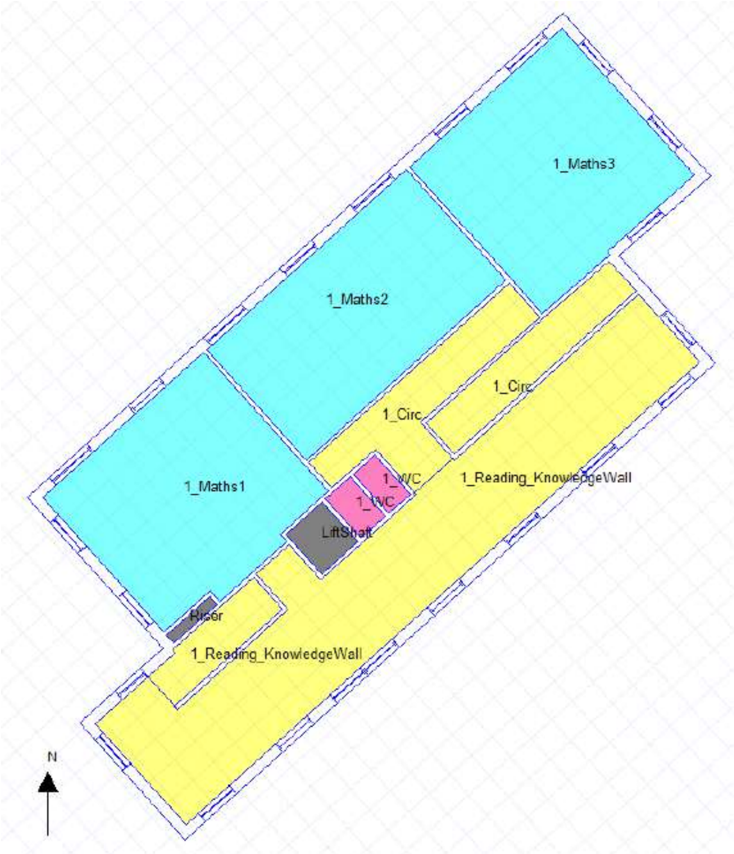


Figure 6. First floor zone layout

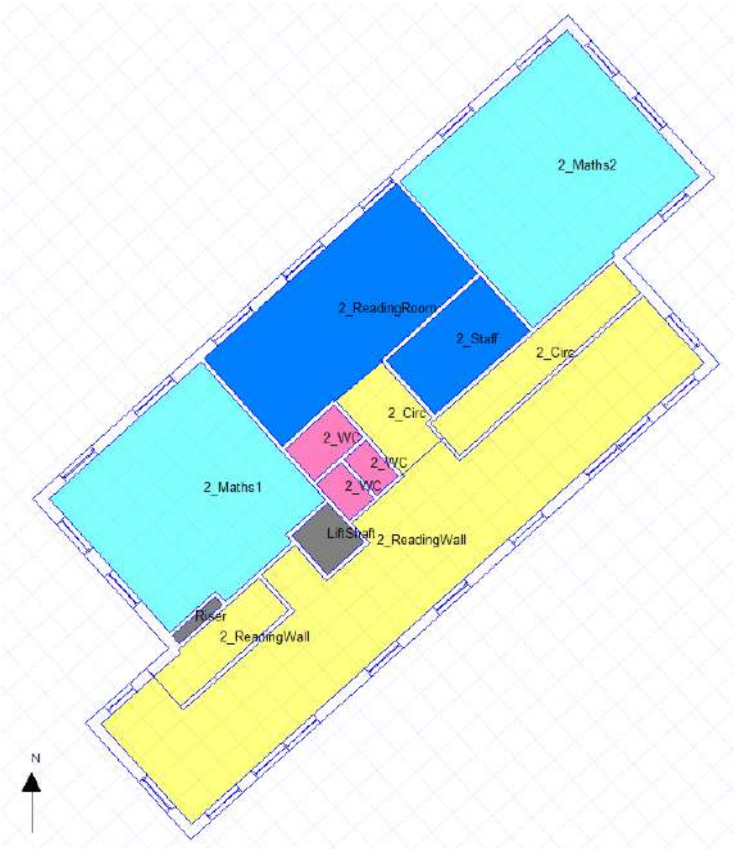


Figure 7. Second floor zone layout

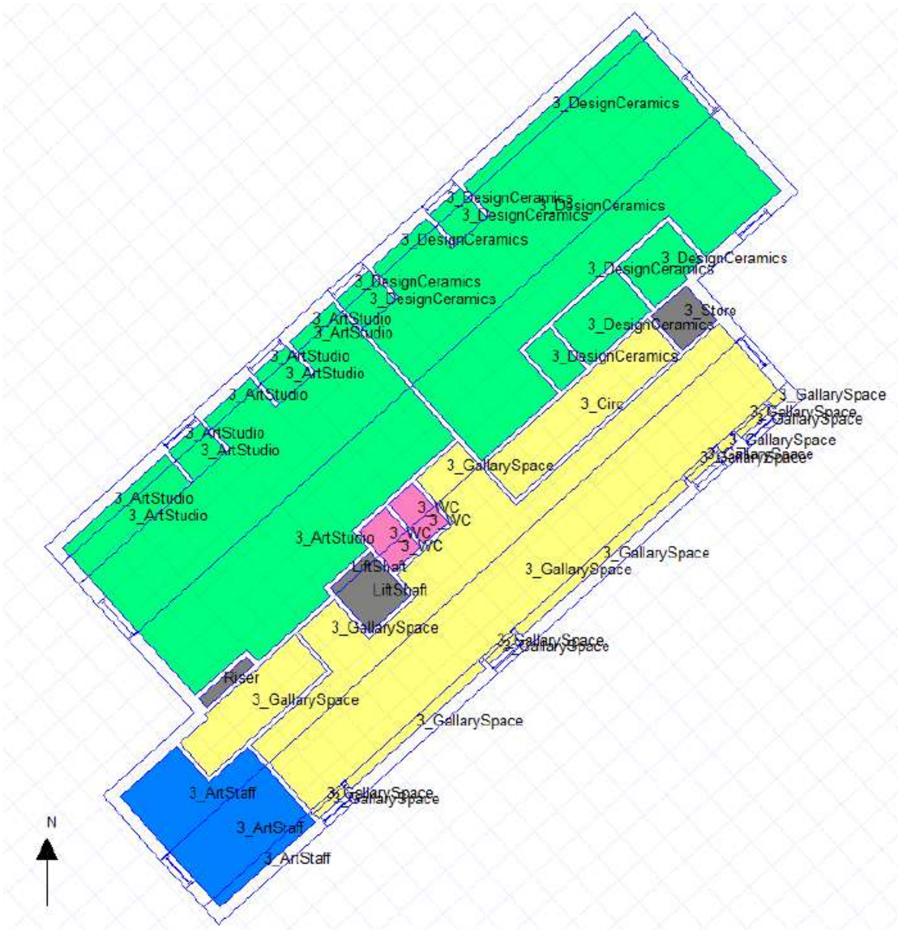


Figure 8. Third floor zone layout

NB this zone layout for the third floor appears to have more divides to the spaces, but these are null lines required to model the roof shapes. The model assumes that there is no loft space about the occupied rooms i.e. the rooms extend up to the roof.

1.3. BUILDING ELEMENTS

Building Element	U-Value (W/m^2 K)	g-value	Notes
External Walls	0.2	n/a	Brick wall with cavity insulation and internally finished with plaster board
Ground floor	0.13	n/a	Concrete ground bearing ground & basement slab
Roof	0.1	n/a	Slate roof with 'traditional build-up'
Windows (inc frame)	1.2	0.4	Double glazing with solar control
Internal floors	n/a	n/a	Concrete slabs between level

INKLING

1.4. INTERNAL GAINS

The weather file used for this exercise CIBSE London TRY

1.4.1 Solar

Solar gains are calculated automatically by the modelling software based on the orientation of the building, the transmission coefficients of the glazing and the solar angles.

1.4.2 Occupancy and Equipment gains

The following gains are provided within the NCM database for use assessing education buildings including schools. These are standard profiles and are not editable. Section 1.2 above indicates which spaces have been allocated to each profile.

	NCM Profile	Peak Occupancy (W/m²)	Peak Equipment (W/m²)	Hours of peak operation (weekdays)
	D1_Edu_Teaching_v5.2.7	38.6	4.7	7am-6pm
	D1_Edu_HighDensIT_v5.2.7	16.0	30	7am-6pm
	D1_Edu_WkshpSS_v5.2.7	4.3	6.2	7am-7pm
	D1_Edu_Circulation_v5.2.7	7.7	2.0	7am-7pm
	D1_Edu_Office_v5.2.7	7.5	11.9	7am-6pm
	D1_Edu_Reception_v5.2.7	9.9	5.6	9am-5pm
	D1_Edu_Toilet_v5.2.7	7.7	5.0	7am-7pm
	D1_Edu_Plant_v5.2.7	0.09	50.5	9am-5pm

1.4.3 Lighting gains and controls

The following information on lighting gains and controls was provided and used for this assessment:

Space Type	lighting power density (W/m²)	Daylight linking and dimming	Occupancy sensing
Circulation / Lobby / Locker Lobby	5	No	AUTO-ON-OFF
Society Room	5	No	AUTO-ON-OFF
Staff Room	6	Yes	AUTO-ON-OFF
ICT	6	Yes	AUTO-ON-OFF
STEAM / Classroom	6	Yes	AUTO-ON-OFF
General Classroom	6	Yes	AUTO-ON-OFF
WCs	5	No	AUTO-ON-OFF
Stairs	4	No	AUTO-ON-OFF
Store	5	No	AUTO-ON-OFF
Kiln + photography	5	No	AUTO-ON-OFF

Gallery	6	Yes	AUTO-ON-OFF
Reading room/walls	6	Yes	AUTO-ON-OFF
Plant	5	No	AUTO-ON-OFF

1.5. HEATING AND VENTILATION

1.5.1 Infiltration

The air tightness target for this project is 5m³/m²/hr@50Pa.
(Note that the Notional building will use 3m³/m²/hr@50Pa)

1.5.2 HVAC Systems

Heating system type and efficiency:
Ground Source Heat Pump system running on grid electricity with

- seasonal COP of **4.8**
- Distribution efficiency **90%**

DHW system type and efficiency:
Direct electric at point of use with

- **100%** generation efficiency
- **100%** distribution efficiency

Ventilation plan:
NVHR – applies to all classroom spaces including ICT and art studios

- Fan power = **0.13 W/l/s**
- No heat recovery
- Demand control based on occupancy

Extract only – applies to all WCs, Kiln/photography rooms, plant room and store

- Fan power = **0.3 W/l/s**

Natural Ventilation – applies to all circulation spaces, staff rooms, reading spaces and gallery plus locker room

2. RESULTS

Part L2A 2013 Lean/Clean/Green

For the GLA the model needs to assess a tiered approach, showing that Part L2A is passed using good passive design in the first instance (Lean), then improving the technology used to meet the buildings demands (Clean), and lastly any renewables are taken into account (Green).

2.1. BE LEAN

The guidance states that the 'Lean' iteration should be run with gas boilers to provide space heating and DHW, with 91% efficiency and 10% distribution losses. See below:

8.8. If the final heating proposal is to be low carbon or renewable energy, gas boilers must still be assumed for the purposes of the 'be lean' element of the hierarchy. In this case the gas boiler performance must be assumed to be equal with Part L notional values for boiler efficiency and controls in order to only show the

[17] The FEES is the maximum energy demand for the dwelling.
[18] From the inside looking out.
[19] The Target CO_2 Emissions Rate is the minimum energy performance requirement for a new dwelling/building. It is expressed in terms of $kgCO_2$ per m^2 of floor area per year.

ENERGY ASSESSMENT GUIDANCE 25

performance of the energy efficiency measures that will be installed. Higher efficiencies should only be used if gas boilers will be part of the final strategy (i.e. after the 'be clean' and 'be green' tiers of the hierarchy have also been addressed), in which case the gross efficiency of the gas boiler model to be specified can be used.

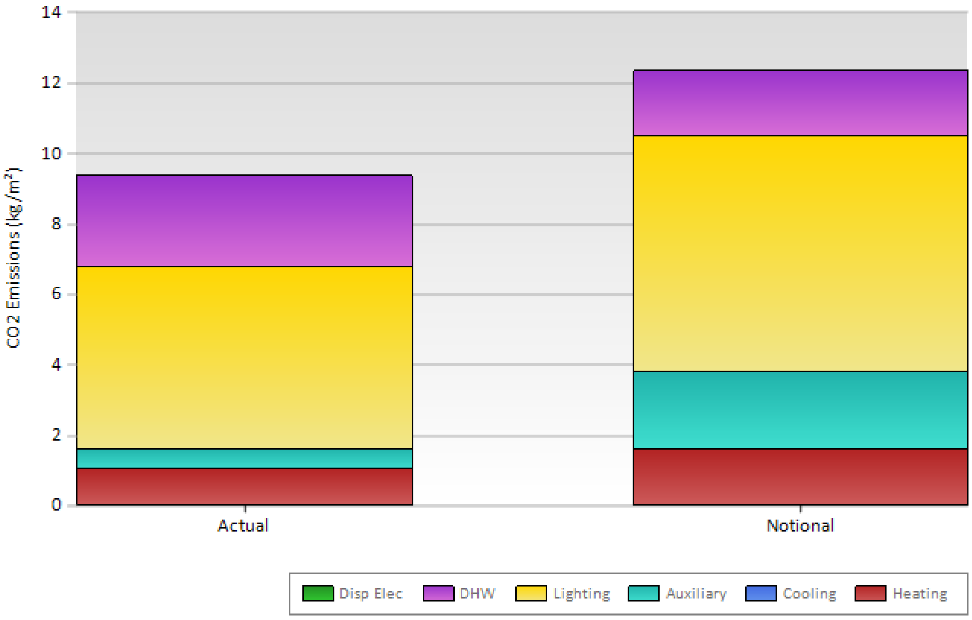
Figure 9. Extract from GLA Energy Assessment Guidance

The Lean case therefore uses gas boilers for space heating and DHW.

The result predicted is a **31%** reduction against the TER as shown below:

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	11.7
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	11.7
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	8.1
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission



	Actual	*Notional*
Heating (kgCO2/m²)	1.02	1.59
Cooling (kgCO2/m²)	0.00	0.00
Auxiliary (kgCO2/m²)	0.58	2.21
Lighting (kgCO2/m²)	5.19	6.67
DHW (kgCO2/m²)	2.57	1.88
Displaced Electricity (kgCO2/m²)	0.00	0.00
*Equipment (kgCO2/m²) **	*12.96*	*12.96*
Total (kgCO2/m²)	9.36	12.34
Total Floor Area (m²)	1192.79	1192.79

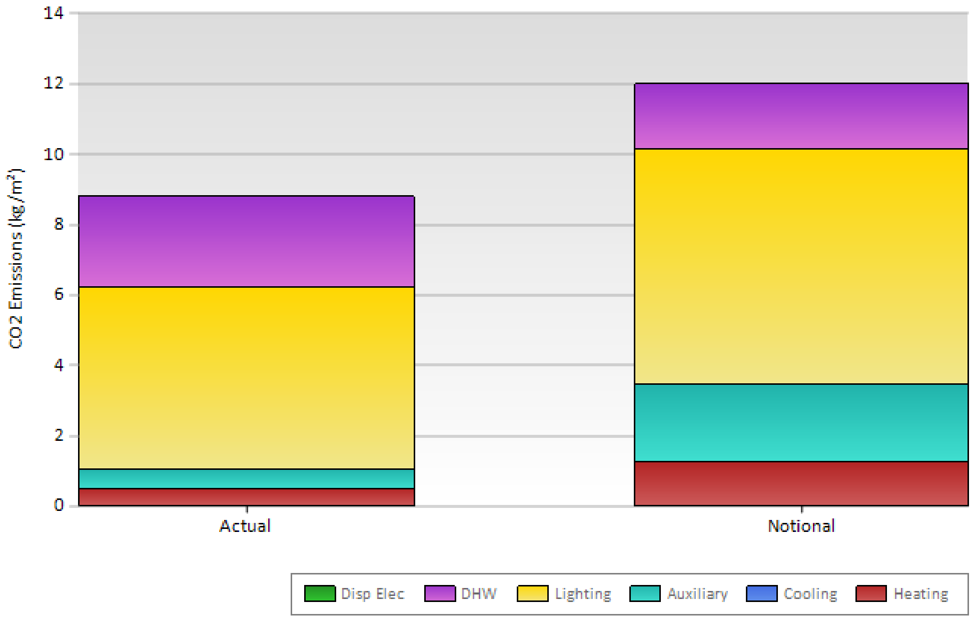
2.2. BE CLEAN

For this case, the Ground Source Heat Pipe (GSHP) system to provide space heating was included.

The result predicted is a **27%** reduction against the TER as shown below:

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	12
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	12
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	8.8
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission



	Actual	*Notional*
Heating ($kgCO2/m^2$)	0.45	1.25
Cooling ($kgCO2/m^2$)	0.00	0.00
Auxiliary ($kgCO2/m^2$)	0.58	2.21
Lighting ($kgCO2/m^2$)	5.19	6.67
DHW ($kgCO2/m^2$)	2.57	1.88
Displaced Electricity ($kgCO2/m^2$)	0.00	0.00
*Equipment ($kgCO2/m^2$) **	*12.96*	*12.96*
Total ($kgCO2/m^2$)	8.80	12.01
Total Floor Area (m^2)	1192.79	1192.79

INKLING

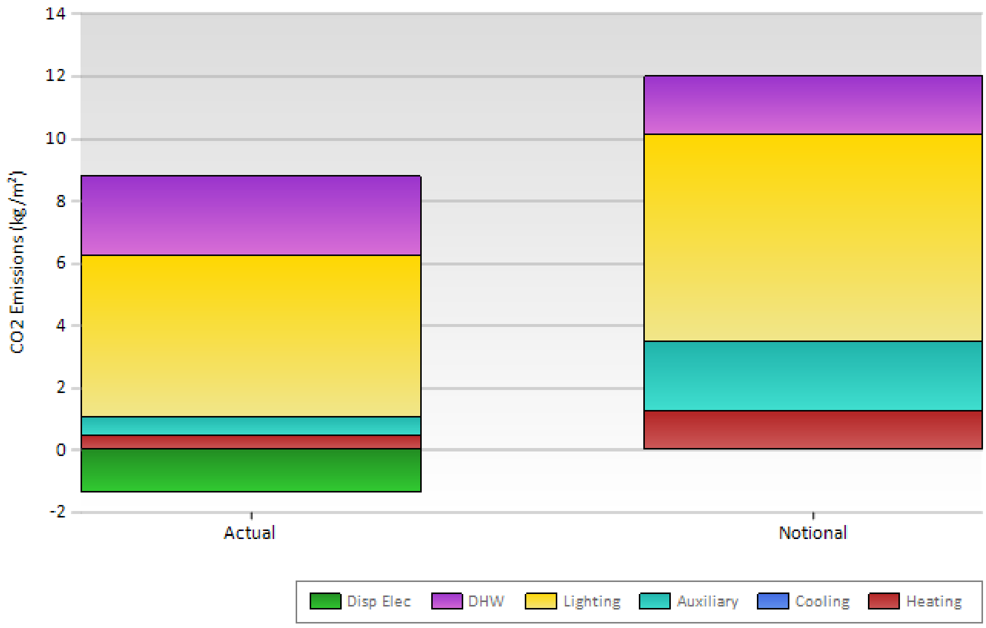
2.3. BE GREEN

For this case **20m²** of PV was added to the SE facing sloped roof with a generation efficiency of **20%**.

The result predicted is a **38%** reduction against the TER as shown below:

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	12
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	12
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	7.4
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



	Actual	Notional
Heating (kgCO2/m²)	0.45	1.25
Cooling (kgCO2/m²)	0.00	0.00
Auxiliary (kgCO2/m²)	0.58	2.21
Lighting (kgCO2/m²)	5.19	6.67
DHW (kgCO2/m²)	2.57	1.88
Displaced Electricity (kgCO2/m²)	-1.37	0.00
*Equipment (kgCO2/m²) **	*12.96*	*12.96*
Total (kgCO2/m²)	7.42	12.01
Total Floor Area (m²)	1192.79	1192.79

2.4. CARBON COMPARISON

Extracting the loads and multiplying by the carbon factors given for each fuel type provides the following analysis:

Fuel type	Fuel Carbon Factor (kgCO2/kWh)	
	SAP 2012	SAP 10
Natural Gas	0.216	0.210
Grid Electricity	0.519	0.233
Fuel oil	0.319	0.298

Energy Use

	Baseline (Notional)	**Lean**	**Clean**	**Green**
Space heating (Kwh)	7.35	4.73	0.9	0.9
Fuel type	Natural Gas	Natural Gas	Electric	Electric
DHW (kWh)	5.88	6.21	5.08	5.08
Fuel Type	Fuel Oil	Electricity	Electricity	Electricity
Lighting (Kwh)	13.18	10.26	10.26	10.26
Auxiliary (kWh)	4.36	1.15	1.15	1.15
PV (kWh)				-2.64

CO2 using SAP 2012 Carbon Factors

	Baseline (Notional)	**Lean**	**Clean**	**Green**
Space heating	1.59	1.02	0.47	0.47
DHW	1.27	1.34	2.64	2.64
Lighting	6.84	5.32	5.32	5.32
Auxiliary	2.26	0.60	0.60	0.60
PV				-1.37
	11.96	**8.28**	**9.03**	**7.66**
		31%	**25%***	**36%***

* These reduction percentages don't exactly match those quoted in the sections above because these are based on the TER for the Lean case, and this target changes for the Clean and Green cases when the DHW changes to direct electric.

CO2 using SAP 10 Carbon Factors

	Baseline (Notional)	**Lean**	**Clean**	**Green**
Space heating	1.54	0.99	0.21	0.21
DHW	1.23	1.30	1.18	1.18
Lighting	3.07	2.39	2.39	2.39
Auxiliary	1.02	0.27	0.27	0.27
PV				-0.62
	6.87	**4.96**	**4.05**	**3.44**
		28%	**41%**	**50%**

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

JLS - Oldfield School

As designed

Date: Thu Apr 11 15:28:19 2019

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.4.4"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.4.4

BRUKL compliance check version: v5.6.a.1

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	11.7
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	11.7
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	8.1
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.26	Basement Walls
Floor	0.25	0.13	0.13	Ground Floor
Roof	0.25	0.1	0.1	Roof
Windows***, roof windows, and rooflights	2.2	1.2	1.2	Door_Triple_2800
Personnel doors	2.2	-	-	No personal doors in project
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	5

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- Extract Only (8 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- 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.					

3- NVHR (10 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	-	0.13	-
Standard value	0.91*	N/A	N/A	1.1^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system	YES				
* 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. ^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

1- Gas boiler

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	0
Standard value	0.9*	N/A
* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.		

Local mechanical ventilation, exhaust, and terminal units

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

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
G_STEAM Studio	-	-	-	-	0.1	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
G_Classroom	-	-	-	-	0.1	-	-	-	-	-	N/A
1_Maths1	-	-	-	-	0.1	-	-	-	-	-	N/A
1_Maths2	-	-	-	-	0.1	-	-	-	-	-	N/A
1_Maths3	-	-	-	-	0.1	-	-	-	-	-	N/A
2_Maths1	-	-	-	-	0.1	-	-	-	-	-	N/A
2_Maths2	-	-	-	-	0.1	-	-	-	-	-	N/A
G_Acc_WC	0.3	-	-	-	-	-	-	-	-	-	N/A
G_WC	0.3	-	-	-	-	-	-	-	-	-	N/A
1_WC	0.3	-	-	-	-	-	-	-	-	-	N/A
2_WC	0.3	-	-	-	-	-	-	-	-	-	N/A
3_WC	0.3	-	-	-	-	-	-	-	-	-	N/A
G_ICT	-	-	-	-	0.1	-	-	-	-	-	N/A
3_Store	0.3	-	-	-	-	-	-	-	-	-	N/A
3_ArtStudio	-	-	-	-	0.1	-	-	-	-	-	N/A
3_DesignCeramics	-	-	-	-	0.1	-	-	-	-	-	N/A
B_Plant	0.3	-	-	-	-	-	-	-	-	-	N/A
3_PhotographyKiln	0.3	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
G_Lobby	-	-	-	128
G_LockerLobby	-	-	-	116
G_Stair_E	-	-	-	33
1_Reading_KnowledgeWall	-	-	-	573
1_Circ	-	-	-	123
2_ReadingWall	-	-	-	596
2_Circ	-	-	-	82
3_GallarySpace	-	-	-	509
3_Circ	-	-	-	43
G_StaffRoom	-	-	-	132
2_Staff	-	-	-	71
2_ReadingRoom	-	-	-	240
3_ArtStaff	-	-	-	104
G_STEAM Studio	-	-	-	413
G_Classroom	-	-	-	341
1_Maths1	-	-	-	315
1_Maths2	-	-	-	308
1_Maths3	-	-	-	314
2_Maths1	-	-	-	298
2_Maths2	-	-	-	344
G_Acc_WC	-	-	-	17
G_WC	-	-	-	25

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
1_WC	-	-	-	21
2_WC	-	-	-	38
3_WC	-	-	-	19
G_ICT	-	-	-	295
3_Store	-	-	-	9
3_ArtStudio	-	-	-	454
3_DesignCeramics	-	-	-	477
G_SocietyRoom	-	-	22	262
B_Plant	-	-	-	236
3_PhotographyKiln	-	-	-	63

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?
G_StaffRoom	NO (-47%)	NO
2_Staff	N/A	N/A
2_ReadingRoom	NO (-67%)	NO
3_ArtStaff	NO (-95%)	NO
G_STEAM Studio	NO (-34%)	NO
G_Classroom	NO (-64%)	NO
1_Maths1	NO (-66%)	NO
1_Maths2	NO (-60%)	NO
1_Maths3	NO (-70%)	NO
2_Maths1	NO (-71%)	NO
2_Maths2	NO (-79%)	NO
G_ICT	NO (-54%)	NO
3_ArtStudio	NO (-81%)	NO
3_DesignCeramics	NO (-83%)	NO
G_SocietyRoom	NO (-30%)	NO
3_PhotographyKiln	N/A	N/A

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m2]	1193	1193
External area [m2]	1907	1907
Weather	LON	LON
Infiltration [m3/hm2@ 50Pa]	5	3
Average conductance [W/K]	584	1005
Average U-value [W/m2K]	0.31	0.53
Alpha value* [%]	14.92	14.92

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

Building Use

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

Energy Consumption by End Use [kWh/m2]

	Actual	Notional
Heating	4.73	7.35
Cooling	0	0
Auxiliary	1.13	4.36
Lighting	10.26	13.18
Hot water	6.21	5.88
Equipment*	25.6	25.6
TOTAL**	**22.33**	**30.77**

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

Energy Production by Technology [kWh/m2]

	Actual	Notional
Photovoltaic systems	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]	14.69	22.82
Primary energy* [kWh/m2]	47.43	68.65
Total emissions [kg/m2]	8.1	11.7

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	4.4	0	1.5	0	1	0.82	0	0.91	0
	Notional	5.2	0	1.8	0	1.2	0.82	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	19.3	0	6.6	0	1.1	0.82	0	0.91	0
	Notional	39.5	0	13.4	0	1.2	0.82	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	12.1	0	4.1	0	1.3	0.82	0	0.91	0
	Notional	10.8	0	3.7	0	8.1	0.82	0	----	----

Key to terms

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

Key Features

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

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.2	External Wall
Floor	0.2	0.13	Ground Floor
Roof	0.15	0.09	PV_panel-pane
Windows, roof windows, and rooflights	1.5	1.2	WinH_1500*3000
Personnel doors	1.5	-	No personal doors in project
Vehicle access & similar large doors	1.5	-	No vehicle doors in project
High usage entrance doors	1.5	-	No high usage entrance doors in project

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

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

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

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

BRUKL Output Document

Compliance with England Building Regulations Part L 2013

Project name

JLS - Oldfield School

As designed

Date: Tue Apr 09 17:55:56 2019

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.4.4"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.4.4

BRUKL compliance check version: v5.6.a.1

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	12
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	12
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	7.4
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	0.2	0.26	Basement Walls
Floor	0.25	0.13	0.13	Ground Floor
Roof	0.25	0.1	0.1	Roof
Windows***, roof windows, and rooflights	2.2	1.2	1.2	Door_Triple_2800
Personnel doors	2.2	-	-	No personal doors in project
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

$U_{a-Limit}$ = 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	5

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- Extract Only (8 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.8	-	-	-	-
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- Nat Vent

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.8	-	-	-	-
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- NVHR (10 Zones)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.8	-	-	0.13	-
Standard value	0.91*	N/A	N/A	1.1^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* 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.

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

1- Direct ELectric

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	0
Standard value	0.9*	N/A

* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.

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

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
G_Lobby	-	-	-	128
G_LockerLobby	-	-	-	116
G_Stair_E	-	-	-	33
1_Reading_KnowledgeWall	-	-	-	573
1_Circ	-	-	-	123
2_ReadingWall	-	-	-	596
2_Circ	-	-	-	82

General lighting and display lighting	**Luminous efficacy [lm/W]**			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
3_GallarySpace	-	-	-	509
3_Circ	-	-	-	43
G_StaffRoom	-	-	-	132
2_Staff	-	-	-	71
2_ReadingRoom	-	-	-	240
3_ArtStaff	-	-	-	104
G_STEAM Studio	-	-	-	413
G_Classroom	-	-	-	341
1_Maths1	-	-	-	315
1_Maths2	-	-	-	308
1_Maths3	-	-	-	314
2_Maths1	-	-	-	298
2_Maths2	-	-	-	344
G_Acc_WC	-	-	-	17
G_WC	-	-	-	25
1_WC	-	-	-	21
2_WC	-	-	-	38
3_WC	-	-	-	19
G_ICT	-	-	-	295
3_Store	-	-	-	9
3_ArtStudio	-	-	-	454
3_DesignCeramics	-	-	-	477
G_SocietyRoom	-	-	22	262
B_Plant	-	-	-	236
3_PhotographyKiln	-	-	-	63

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?**
G_StaffRoom	NO (-47%)	NO
2_Staff	N/A	N/A
2_ReadingRoom	NO (-67%)	NO
3_ArtStaff	NO (-95%)	NO
G_STEAM Studio	NO (-34%)	NO
G_Classroom	NO (-64%)	NO
1_Maths1	NO (-66%)	NO
1_Maths2	NO (-60%)	NO
1_Maths3	NO (-70%)	NO
2_Maths1	NO (-71%)	NO
2_Maths2	NO (-79%)	NO
G_ICT	NO (-54%)	NO
3_ArtStudio	NO (-81%)	NO
3_DesignCeramics	NO (-83%)	NO
G_SocietyRoom	NO (-30%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
3_PhotographyKiln	N/A	N/A

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	1193	1193
External area [m^2]	1907	1907
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	5	3
Average conductance [W/K]	584	1005
Average U-value [W/m^{2}K]	0.31	0.53
Alpha value* [%]	14.92	14.92

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

Building Use

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

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

	Actual	Notional
Heating	0.9	2.48
Cooling	0	0
Auxiliary	1.15	4.36
Lighting	10.26	13.18
Hot water	5.08	5.88
Equipment*	25.6	25.6
TOTAL**	**17.38**	**25.9**

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

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	2.64	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	14.69	22.82
Primary energy* [kWh/m^2]	52.03	66.39
Total emissions [kg/m^2]	7.4	12

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Electricity, [CFT] Electricity										
	Actual	4.4	0	0.3	0	1.2	4.32	0	4.8	0
	Notional	5.2	0	0.6	0	1.2	2.43	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Electricity, [CFT] Electricity										
	Actual	19.3	0	1.2	0	1.1	4.32	0	4.8	0
	Notional	39.5	0	4.5	0	1.2	2.43	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Electricity, [CFT] Electricity										
	Actual	12.1	0	0.8	0	1.3	4.32	0	4.8	0
	Notional	10.8	0	1.2	0	8.1	2.43	0	----	----

Key to terms

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

Key Features

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

Building fabric

Element	**$U_{i\text{-}Typ}$**	**$U_{i\text{-}Min}$**	**Surface where the minimum value occurs***
Wall	0.23	0.2	External Wall
Floor	0.2	0.13	Ground Floor
Roof	0.15	0.09	PV_panel-pane
Windows, roof windows, and rooflights	1.5	1.2	WinH_1500*3000
Personnel doors	1.5	-	No personal doors in project
Vehicle access & similar large doors	1.5	-	No vehicle doors in project
High usage entrance doors	1.5	-	No high usage entrance doors in project

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

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

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