

# RIDGE

# PINN RIVER SCHOOL EASTCOTE, PINNER, MIDDLESEX KIER CONSTRUCTION

# ENERGY STRATEGY REPORT

## PM\_40\_20\_26





**PINN RIVER SCHOOL  
EASTCOTE, PINNER, MIDDLESEX  
KIER CONSTRUCTION**

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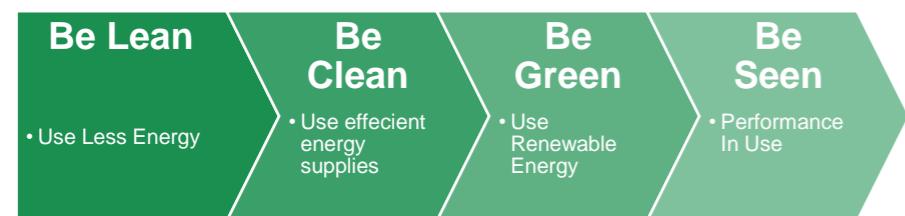
## VERSION CONTROL

## 1. EXECUTIVE SUMMARY

### Approach

The project involves the demolition of life expired school and the construction of a new primary school. The school shall be designed to meet the requirements of the DfE Output Specification and in particular Annex 2H Energy, which requires the project to achieve Net-Zero Carbon in operation.

The Energy Strategy follows the Energy Hierarchy: Be Lean – Be Clean – Be Green- Be Seen approach.



Additionally, the project has been designed in accordance with the Harrow's Local plan (Core Strategy) 2012, Harrow's Local Plan (Development Management Policies) 2013 and London Plan. It is noted that the DfE requirements exceed this requirement considerably.

### Energy Strategy Summary

#### 'Be Lean'

A range of passive design and energy efficiency measures are targeted for the Proposed Development, including:

- Fabric insulation levels achieving improvements over the Building Regulations Part L (2021).
- Suitable glazing ratio and glass g-value to balance heat losses, heat gains and daylight ingress.
- Fabric air permeability improvement upon Building Regulations Part L (2021) requirements
- Insulated pipework and ductwork to minimise heat losses and gains.
- Variable speed pumps to minimise energy consumption for distribution of services.

A range of active design and energy efficiency measures are targeted for the Proposed Development, including:

- Inclusion of mechanical ventilation heat recovery.
- Including of energy saving monitoring equipment including heating controls, PIR's and meters.
- Highly efficient LED lighting.

#### 'Be Clean'

The Proposed Development is not in or near an 'Opportunity Area' for the implementation of a heat network and there are no existing heat networks nearby. Therefore, and due the location and to space constraints, the Proposed Development is not designed to be provided with a means of connection to external networks. Furthermore, the benefit of a CHP engine

is based on the heat carbon factor which is derived from CHP efficiency, gas carbon factor and electricity carbon factor of the national grid. As the electricity grid is expected to be progressively decarbonised, it is likely that the carbon savings from CHP will substantially diminish as time passes.

#### 'Be Green'

A preliminary assessment of incorporating zero carbon energy systems has been undertaken. Solar photovoltaics (PV) was determined to be potentially suitable for the Proposed Development. Therefore, a 1,500m<sup>2</sup> PV array shall be included on the building.

#### 'Be Seen'

Monitor, verify and report on the energy performance of the building when it is finally constructed and occupied.

### Energy Usage Summary

Our estimated EUI is as follows

Loads	Annex 2H EUI Target kWh/ m <sup>2</sup> .year	Our Proposal kWh/ m <sup>2</sup> .year
Space heating	8	7.18
Lighting	8	7.30
Lifts	1	1
Small power	25	Small Power: 10 Server: 7.73
Catering	7	7
Fans and pumps	2	2
Domestic hot water	5	4.90
Building related services	2	2
External lighting	6	6
Cooling	-	1.68
<b>Total Energy Consumption</b>	<b>67</b>	<b>56.79</b>

## 2. INTRODUCTION

### Development Description

The Proposed Development is a new build primary school building to replace the existing life expired school building at Pinn River school, Pinner.

The new school consists of approximately 4,893m<sup>2</sup> of teaching and office areas, over a two-storey layout.

### Energy Strategy Approach

The Energy Strategy follows the energy hierarchy: 'Be Lean, Be Clean, Be Green, Be Seen'



At ITT stage, the energy assessment is based upon estimates developed from the Pinn River school baseline school model. As such, the estimates contained herewith are based upon developed design information and as such, we are confident in their delivery at the next stage.

### Definitions

The following definitions should be understood throughout this strategy:

- Energy demand – the 'room-side' amount of energy which must be input to a space to achieve comfortable conditions. In the context of space heating, this is the amount of heat which is emitted by a radiator, or other heat delivery mechanism.
- Energy requirement – the 'system-side' requirement for energy (fuel).
- Regulated CO<sub>2</sub> emissions – the CO<sub>2</sub> emissions emitted as a result of the combustion of fuel, or 'consumption' of electricity from the grid, associated with regulated sources (those controlled by Part L of the Building Regulations).

### Assessment of Local Planning Requirements

#### Current Policy Framework

The policies considered when preparing this strategy are contained in the National Planning Policy Framework (NPPF, 2012).

#### Local Planning Guidance

The local planning documents "London Borough of Hillingdon Local Plan", including

1. London Borough of Hillingdon Local Plan: Part 1 – Strategic Policies (November 2012)
2. London Borough of Hillingdon Local Plan: Part 2 – Development Management Policies (January 2020); and
- 3.
4. London Borough of Hillingdon Local Plan: Part 2 – Site Allocations and Designations (January 2020).

In particular:

- Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:
  - o Be Lean: use less energy;
  - o Be Clean: supply energy efficiently;
  - o Be Green: use renewable energy;
- 35% improvement over Part L TER
- As a minimum, energy assessments should include the following details
  - o a calculation of the energy demand and carbon dioxide emissions covered by Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations (see paragraph 5.22) at each stage of the energy hierarchy
  - o proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings, and services
  - o proposals to further reduce carbon dioxide emissions through the use of decentralised energy where feasible, such as district heating and cooling and combined heat and power (CHP)
  - o proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.
- The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

### 3. APPROACH TO OPTIMISING ENERGY

#### Be Lean

The following sections detail the passive design and energy efficiency measures that have been considered, and those that will be implemented at the Pinn River school.

#### Passive Design Measures

Passive design measures are those which reduce the energy demand within buildings, without triggering an energy requirement (i.e. no need for fuel) in the process.

These are the most effective and robust measures for reducing CO<sub>2</sub> emissions as the performance of the solutions (e.g. wall insulation), is unlikely to deteriorate significantly with time or be subject to change by future property owners. In this sense, we can be confident that the benefits of these measures will continue at a similar level for the duration of their installation.

#### Building Massing and Orientation

The building has been carefully massed and located on the site to provide the optimum balance between the school's practical requirements, good form factors and the need to prevent excess solar gain, which may lead to overheating.

The orientation of the building is orientated using optimum North/ South layout, which provides the maximum opportunity for passive solar gain in the winter.

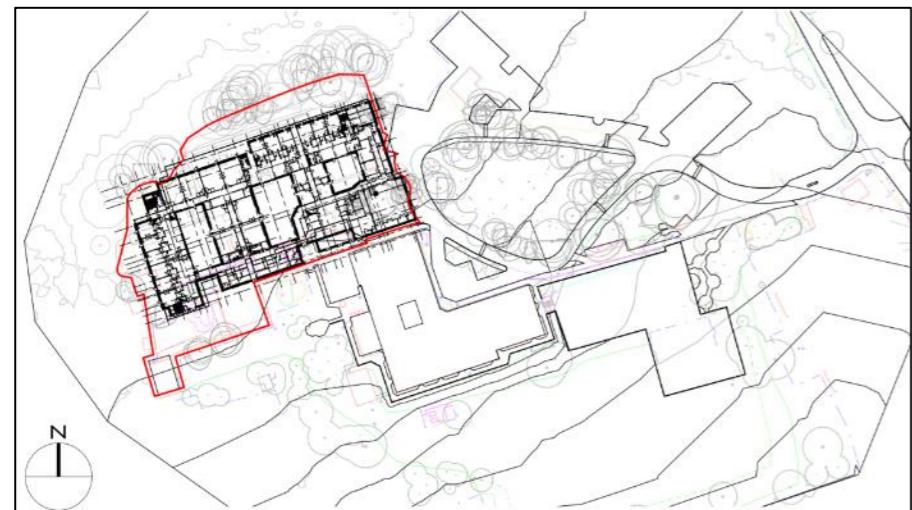


Figure 1 – Building Orientation

The teaching classrooms are positioned in the North to avoid the South orientated locations that could result in overheating issues due to the high internal gains and solar gains in the summer. In addition, shading elements have been provided to the East side to mitigate overheating and glare.

#### Glazing Ratio, Solar Energy and Light Transmittance

The Proposed Development will take a 'fabric first' approach to reducing energy demand and CO<sub>2</sub> emissions. In designing the elevations, the design team have been mindful to balance the solar energy transmittance and light transmittance values of the glass, to control solar gains and to maximise daylight respectively.



Figure 2 – Typical Pinn River School Window (Forest Bridge School)

The window design is carefully designed to maximise the opportunity for daylighting and natural ventilation while preventing excess solar gains in the summer.

Solar gains are beneficial in winter months as a means of avoiding the need for active heating to maintain comfortable internal temperatures. However, in summer months excessive solar gains can lead to the potential for high internal temperatures.

The use of curtain walling is limited to prevent excess heat loss.

#### Thermal Insulation

Demand for space heating can be significant in school. However, the demand can be significantly reduced through the provision of an efficient thermal envelope, by reducing the thermal transmittance of the building envelope where appropriate and reduce heating requirements.

Table 1 outlines the proposed U-values the Proposed Development. At this stage, the proposed building aims to improve upon the notional values, which will assist in reducing the requirement of LSC technologies for compliance.

Table 1: Fabric and construction targets.

PARAMETER	ANNEX 2C VALUE	OUR PROPOSALS
Roof	0.12W/m <sup>2</sup> K	0.12W/m <sup>2</sup> K
Wall	0.15W/m <sup>2</sup> K	0.15W/m <sup>2</sup> K
Ground Floor	0.12W/m <sup>2</sup> K	0.12W/m <sup>2</sup> K
Windows	1.1W/m <sup>2</sup> K	1.1W/m <sup>2</sup> K, G=0.37, LT=0.69 1.1W/m <sup>2</sup> K, G=0.32, LT=0.69 (specific skills and SALT rooms)
Roof Lights	Not Defined	2.0W/m <sup>2</sup> K. g=0.45, LT=0.69
Doors	Not Defined	1.6W/m <sup>2</sup> K.

#### Fabric Air Permeability

Fabric air permeability is a measure of the volume of air that can penetrate through the fabric of a building, leading to ventilation heat loss and gain.

High air permeability can lead to uncomfortable drafts and dramatically increase the demand for space heating in winter (and space cooling in summer where relevant) when the air-flow works in reverse i.e. cool air escaping from the building.

The worst acceptable air permeability is 8m<sup>3</sup>/m<sup>2</sup>.hr is required by Approved Document L (2021). However, Annex 2C requires a figure of 3m<sup>3</sup>/m<sup>2</sup>.hr. The Development has a baseline target of 3m<sup>3</sup>/m<sup>2</sup>.hr. Our proposals shall achieve the Annex 2C requirements

Table 2: Whole building air permeability

ELEMENT	AIR PERMEABILITY @50PA [M3/M2.HR]		
	Acceptable Limit	Annex 2C	Our Proposals
Whole Building	8	3	3

#### Energy Efficient Measures

Energy efficiency measures are those which seek to service the demand for energy (i.e. the remaining demand after implementation of passive design measures) in the most efficient way. The tables below present the services (heating, ventilation, and hot water) proposed for the building.

#### Space Heating

Primary space heating shall be provided by Air Source Heat Pumps. These shall be optimised to a mean flow temperature of 43°C to maximise the seasonal efficiency. Additionally, the heat pump system shall be dedicated to space heating, to prevent high flow temperatures required for domestic hot water production. Our Proposed ASHP system shall achieve a SCOP of 3.19 or greater.

#### Ventilation

Ventilation shall be provided by natural ventilation whenever possible to minimise energy consumption through mechanical ventilation. During the coldest days, natural ventilation alone would cause considerable energy wastage, draught and poor comfort. We will therefore provide heat recovery hybrid ventilation units to supplement the natural ventilation system. These units combine plate heat exchanger with an extremely low Specific Fan Power to maximise energy efficiency

- 42% Heat Recovery.
- 0.053W/l/s Specific Fan Power
- Provide cooling, when required

The low SFP ensures that the heat recovery hybrid ventilation units offer significantly lower in-use energy performance than the best MVHR systems



Where natural/ heat recovery hybrid ventilation is not possible, we shall use decentralised MVHR units.

Table 3: Ventilation design efficiencies

PARAMETER	PROPOSED DESIGN
MVHR	Heat Recovery: 77-83%, SFP: 0.90-1.39 W/(l/s)
NVHR	Heat Recovery: 42%, SFP: 0.14 (year weighted) W/(l/s)
Zonal Extract	SFP: 0.4 /l/s

#### Domestic Hot Water

Domestic Hot Water generation and distribution can be a significant source of energy consumption in school buildings, particularly where centralised systems are used.

As such, the DHW shall be provided with a dedicated domestic hot water storage system which shall be served from an integral air source heat pump. The system shall achieve a COP of 3.19 or greater.

#### Lighting

The development will be provided with energy-efficient LED lighting throughout. All lighting shall be high efficiency, achieving the following minimum lm/W outputs

AREA	MINIMUM LM/W
Teaching areas	>120Lm/W
Sports halls	>140Lm/W
Circulation	>100Lm/W

Total installed power densities shall be as per power density shown below:

SPACES	INSTALLED POWER DENSITY [W/M2]	LUX
Typical Teaching Space	5.00	300
Dining area	5.00	300
Offices	5.00	500
Server Room	5.00	300
Changing Areas	5.00	200
Toilets	5.00	200
Parasitic Lighting Controls	0.20	-
Parasitic emergency Losses	0.50	-

Lighting will be linked to daylight sensors and presence detectors to prevent unnecessary use where appropriate.

#### Pipework Insulation

Heating and hot water pipework will be insulated in accordance with the requirements of the Building Regulations. This will serve to minimise heat gains and losses to / from pipework from source to use and improve system efficiency. Careful attention will be paid to insulating joints and knuckles to minimise standing heat losses.

#### Metering and Controls

The school shall be provided with enhanced metering and monitoring system linked to the server data system.

#### Be Clean

The following sections discuss the infrastructure and clean energy supply measures that have been considered for the Proposed Development in order to further reduce regulated CO<sub>2</sub> emissions and outline the technologies that will be implemented.

#### Decentralised Energy Networks

The Proposed Development is not in or near an 'Opportunity Area' for the implementation of a heat network. Therefore, and due to this and space constraints, the Proposed Development is not designed to be provided with a means of connection to external networks.

Further, the Proposed Development is not considered a 'dense' development in terms of heating distribution. Therefore, a district heating installation could result in significant distribution losses, and such an installation is not expected to be an efficient solution for providing heating and hot water.

#### On-Site Combined Heat and Power (CHP)

Over recent years, the use of a Combined Heat and Power (CHP) engine has been the de facto solution to reduce regulated CO<sub>2</sub> emissions when designing a medium to large development with high heat load – savings of 25%-45% or more are typically achievable. CHP relies on the fact that it is possible to produce and distribute electricity at a lower carbon factor, due to the difference between the Building Regulations quoted carbon factors of the National Grid and the natural gas used to fuel the CHP. Considering this principle, it is logical that if the carbon factor of the National Grid is significantly reduced (which is the reality), the emissions savings offered by CHP will be heavily affected.

Under the Part L 2021 methodology, CHP is calculated to provide c.30% carbon emissions reduction (standard building fabric). In contrast, the analysis suggests that utilising actual 2016 grid carbon factors, implementing a CHP would have actually resulted in a 17% emissions increase compared to using individual gas boilers.

As long as the carbon factor continues to decrease as projected in all scenarios, any CHP deployed from 2016 onwards will in reality actually cause a net emissions increase.

## Be Green

The following sections discuss the renewable energy generation measures that have been considered, and those which will be implemented at the Proposed Development.

Renewable technologies harness energy from the environment and convert this to a useful form. Many renewable technologies are available. However, not all these are commercially viable, suitable for the location or appropriate for the Proposed Development.

Technologies considered for the Proposed Development include:

- Photovoltaics

### Photovoltaic Panels

We have sought to maximise the amount of PV on the building. We have undertaken a detailed assessment to determine the optimum PV Configuration. We have opted to configure panels in a shallow pitch, South orientation (10deg pitch). This allows panels to be installed which maximises the size of the PV array which increases the output when compared to a south facing array (due to reduced shading of panels). Furthermore, this configuration reduces the amount of ballast required, reducing structural loadings on the roof.

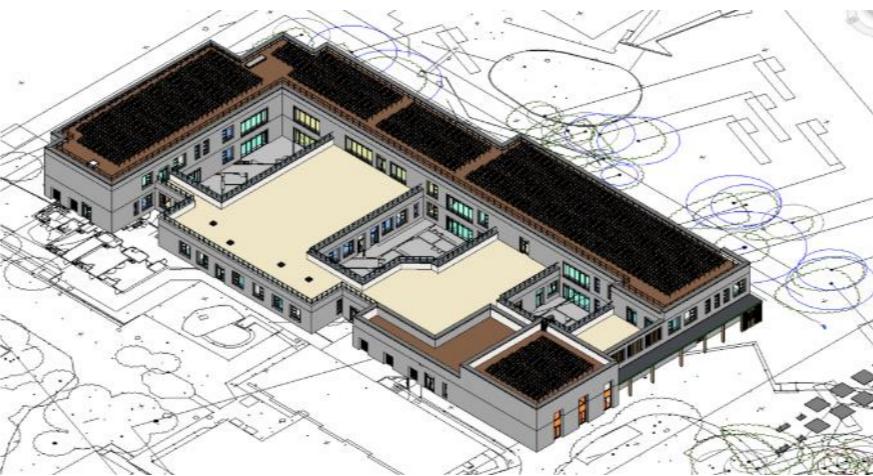
Our proposed PV array is provided as part of a Biosolar roof system, with 989m<sup>2</sup> of PV Panel

Dynamic simulation modelling has been taken with the London weather file been used to estimate the total generation of the Pinn River school PV Array. This provides a reliable and benchmarked estimate of the PV Performance.

### THE PINN RIVER SCHOOL

Building NIA	4893	m <sup>2</sup>
EUI	56.79	kWh/m <sup>2</sup> .annum
<b>Total Building Energy Usage</b>	<b>277,873</b>	<b>KWh/annum</b>

We estimate our 989 m<sup>2</sup> PV Array would generate **182,965kWhr/annum**. This would equate to a 175kW(p) KV array.



The assessment is based upon calculated data for our Pinn River school model and pro-rata to suit our proposed PV Layout.

The proposed PV array shall ensure the building meets the Net-Zero Carbon in operation requirement (Appendix H).

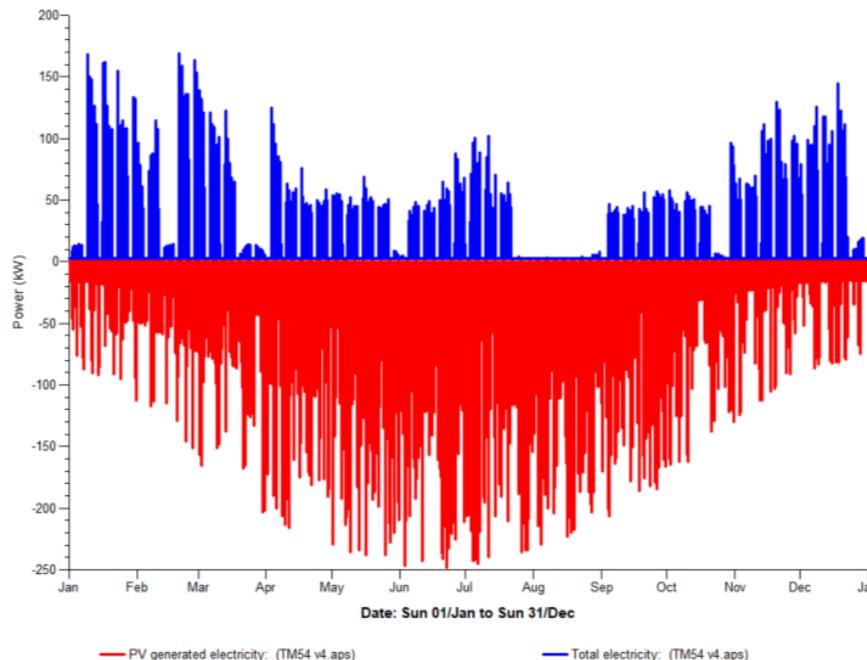


Figure 3 - Graph of PV Generated Electricity against Total Building Energy Demand;

## Carbon Offsetting

Our energy strategy demonstrates the following

### THE PINN RIVER SCHOOL

Consumption	277,873	kWh/m <sup>2</sup> .annum
Generation	182,965	kWh/m <sup>2</sup> .annum
<b>Deficit</b>	<b>94,908</b>	<b>KWh/annum</b>

To mitigate this, an offsetting payment shall be made. This is calculated on the basis of £95/tonne for 30 years in accordance with the requirements of the London Plan.

Average Carbon Factor	0.145kg/kWhr
Residual Emissions	13,761.66kg/annum
Carbon Offset	13.671 tonnes/annum
	13.67tonnes x £95 x 30years
	<b>£39,218.85</b>

## 4. ENERGY ASSESSMENT

The energy usage of the proposed school has been assessed using CIBSE TM54:22 'Evaluating Operational Energy Performance of Buildings at the Design Stage' methodology. The assessment has been used to demonstrate that our proposals meet or exceed the EUI targets contained in Annex 2H.

Detailed thermal modelling of the building shall be undertaken at the next stage. The energy assessment for the building has blended results and data from the Pinn River school benchmark model and project specific, Quasi steady-state calculations.

Modelling and calculations assume the school is occupied during the periods contained within Annex 2H Tables 3 and 4.

## Heating

Space Heating is calculated using Dynamic Simulation Modelling (DSM). Project specific calculations shall be undertaken at the next stage.

Pinn River school dynamic simulation modelling has indicated that the heating EUI is **7.18 kWh/m<sup>2</sup>**.

It should be noted that our Pinn River school TM54 energy modelling included energy associated with fans and pumps.

## Lighting

The predicted annual energy consumption for interior lighting has been calculated following the methodology referenced in the SLL Code for

Lighting and is commonly referred to as LENI (Lighting Energy Numeric Indicator).

The calculations are based upon the following lighting power densities:

SPACES	INSTALLED POWER DENSITY [W/M <sup>2</sup> ]	LUX
Typical Teaching Space	5.00	300
Dining area	5.00	300
Offices	5.00	500
Server Room	5.00	300
Changing Areas	5.00	200
Toilets	5.00	200
Parasitic Lighting Controls	0.20	
Parasitic emergency Losses	0.50	-

Based upon the dynamic simulation analysis, the total lighting EUI is **7.30 kWh/m<sup>2</sup>**.

The actual LENI calculations can be found at Appendix C.

There may be opportunity to improve on classroom lighting efficiency at the next stage.

## External Lighting Services

The design and selection of the external lighting will be confirmed at the next stage. We have included an EUI **6.00 kWh/m<sup>2</sup>**, however, this shall be calculated at the next stage as there are no specific details regarding the external lighting.

## Lifts

The lifts are designated for disabled use only and as such, the usage will be highly variable depending largely on the cohort at any one time. As such, we have assumed that the energy consumption for Lifts shall achieve the EUI figure of **1.00 kWh/m<sup>2</sup>**. Further calculations shall be done on the next stage when information is available.

## Small Power

The selection of equipment and how it is operated is largely outside of our control. The calculations, accordance with TM54, (shown in Appendix B) result in a small power EUI at **10 kWh/m<sup>2</sup>**.

The figure is relatively low due to the lack of ICT classrooms. We would however recommend that a more detailed understanding of small power usage is investigated at the next stage. This will require careful engagement with the school to ensure low energy equipment is procured and energy usage is well managed.

## Catering

An EUI of **7.00 kWh/m<sup>2</sup>** has been allowed for catering, however, a detailed catering energy modelling shall be undertaken at the next stage.

## Server

TM54 considers power consumption in the server room to include the servers, switches, and other ancillary equipment, as well as the cooling system. While cooling and small power could be considered under the separate TM54 headings, this would not affect the overall energy consumption. It is noted that Power over Ethernet (PoE) energy usage within the classroom is included within our server room energy calculation.

Our estimated energy consumption is based upon our Pinn River school equipment selections, with careful consideration to minimising energy usage during the un-occupied periods. We shall select ICT equipment which will set back during out of our periods. The calculations are shown in Appendix D.

Normal Operation: 10 hours per day, 5 days per week, 39 weeks per year  
1950 Hours

Out of hours 14 hours per day, 7 days per week, 365 days per year  
6810 Hours

We have included an EUI **7.73 kWh/m<sup>2</sup>**.

It is noted that the server room energy consumption is akin to the total heating load. As such, we would focus on making energy savings at the next stage.

## Domestic Hot Water

All scenarios assume a daily hot water consumption of 28.35 litres/person/occupied days specified using BREEAM UK NC Water consumption calculator 2018 for the Education: Primary School. The variable is conditioned by potential shifts in the occupancy density. The indicative calculation is provided in the Appendix E.

The EUI of the domestic hot water accounts for **4.90 kWh/m<sup>2</sup>**.

## Internal Heat Gains

The internal heat gains are calculated automatically for all processes and equipment in the building, except for lifts and escalators; this data should be obtained from the manufacturer and entered in manually by the user as per the relevant Appendices.

## Space Heating, Fans & Pumps

The space heating loads have been undertaken using the above bespoke internal gains and profiles in a DSM (Dynamic Simulation Model).

Pump energy has been determined using the methodology used within NCM and allocated based on the below assumptions:

- LTHW pumping: 0.3W/m<sup>2</sup>
- LTHW & CHW pumping: 0.9W/m<sup>2</sup>
- Circulation – 66 meters loop: 15 W/m
- Secondary circulation pump: 0.2 W/m<sup>2</sup>

## Humidification & Dehumidification

No humidification or dehumidification energy has been accounted for.

## Building Related Services

The selection and details of ancillary services will be confirmed at the next stage. We have included an EUI **2 kWh/m<sup>2</sup>** under the management factor, which meets the DfE target. This shall be calculated at the next stage.

## 5. COMPARISON WITH DFE BENCHMARKS

Comparing results to DfE Current Targets for primary school shows that if the building is operated as anticipated (Pinn River scenario):

- Total Energy: 11.20% below DfE Current Targets, 56.79 kWh/m<sup>2</sup>

However, if the hours of use of the building are higher than anticipated and the use of the lighting, small power and domestic hot water are higher (High End Scenario):

- Total Energy: 8.90% above DfE Current Targets, 69.72 kWh/m<sup>2</sup>

If the hours of use of the building are much higher than anticipated and the use of the lighting, small power, and domestic hot water (Worst Case Scenario):

- Total Energy: 24.30% above DfE Current Targets, 79.55 kWh/m<sup>2</sup>

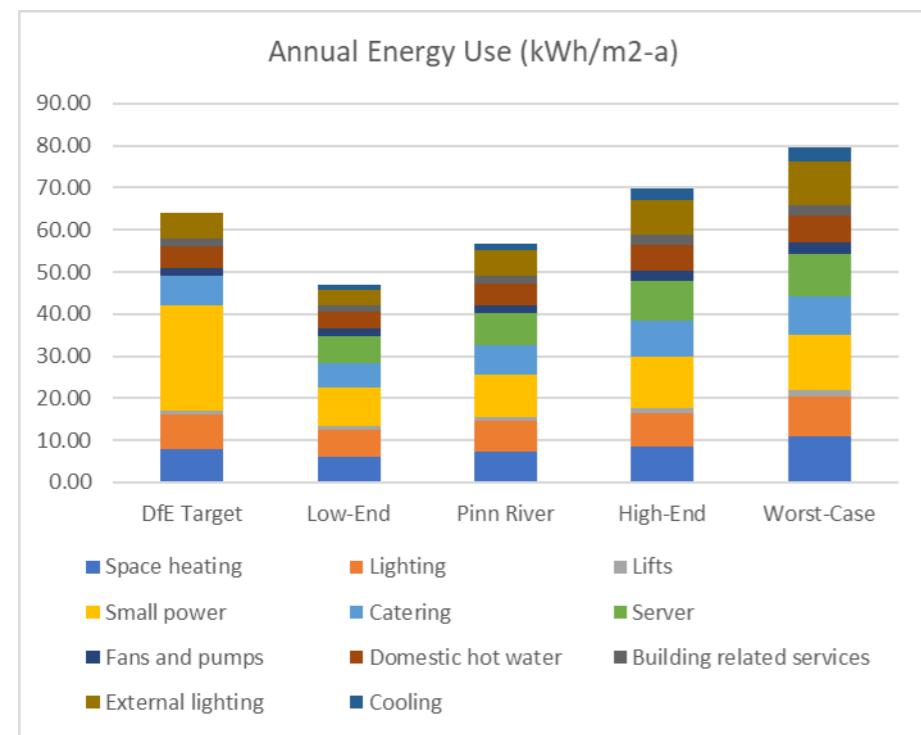


Figure 4. Annual Energy Use Comparison

Table 4. Energy Consumption per allowance & scenario

End Use (kWh/m2)	DfE Target	Low-End	Pinn River	High-End	Worst-Case
Space heating	8.00	6.05	7.18	8.45	10.85
Lighting	8	6.57	7.30	8.02	9.48
Lifts	1	0.78	1.00	1.30	1.60
Small power	25	9.10	10.00	12.20	13.10
Catering	7	5.80	7.00	8.54	9.17
Server	0	6.41	7.73	9.43	10.13
Fans and pumps	2	1.82	2.00	2.44	2.62
Domestic hot water	5	4.00	4.90	5.98	6.42
Building related services	2	1.60	2.00	2.44	2.62
External lighting	6	3.50	6.00	8.40	10.20
Cooling	-	1.34	1.68	2.52	3.36
Total Energy Consumption	<b>64</b>	<b>45.24</b>	<b>56.79</b>	<b>69.72</b>	<b>79.55</b>

## 6. BUILDING PERFORMANCE EVALUATIONS REVIEW AND MONITORING PLAN

As per the DfE's Output Specification requirements set out in Technical Annex 2H – Section 5 'In use Monitoring' and in order to record and benchmark the energy consumption and water usage, the design solution will be designed to allow 15 minute interval continuous monitoring and benchmarking data using iSERV methodology (or equivalent system) and allow data to be uploaded to the K2n national benchmarking database (or equivalent system) on at least a monthly basis, and preferably on a daily basis, to enable automated reporting against DfE targets.

The data will allow the School's facility managers to identify and remedy problems such as inadequate system control or incorrect default settings. These reports will help the school to manage their energy consumption and identify avoidable waste.

The iSERV (or equivalent) facilities and services spread sheet will be completed prior to financial close and this information will benchmark the new building against other similar schools. This may identify areas where energy is being wasted and identify where savings might be made.

The BMS shall be provided via an IP based system such as Trend IQ4 using an IQVision supervisor. This will allow the BMS to be interrogated via the internet from any device.

A supervisor PC shall be provided in the main office, which shall include;

- Graphics for each major plant item; menu driven for selection; monitoring and control of all major plant items; global and individual control and adjustment of operating times/temperatures for each operating zone; monitoring and reporting of fault/trip conditions and critical alarms
- Heating schematic; ventilation schematic; domestic hot water schematic; electrical schematic, sub-metering and energy graphic. All graphics to show live values and allow historical review of energy usage for the previous 2-week period as a minimum. Automatic uploading of sub-metering, zone temperature and CO<sub>2</sub> data monthly to the iSERV system to allow data analysis with feedback to School staff for monitoring and benchmarking purposes and to assist with the formal BPE reviews at 6 and 12 months following handover
- Web enabled to allow remote access to all data
- A BMS head end and a user interface display on the ground floor plant room control panel

## APPENDIX A

### Main Profiles:

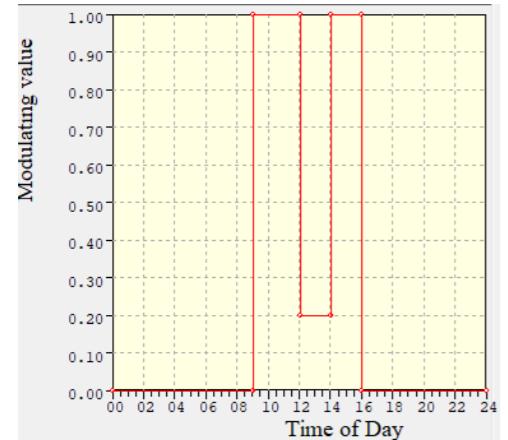


Figure a - Occupancy profile – Teaching areas

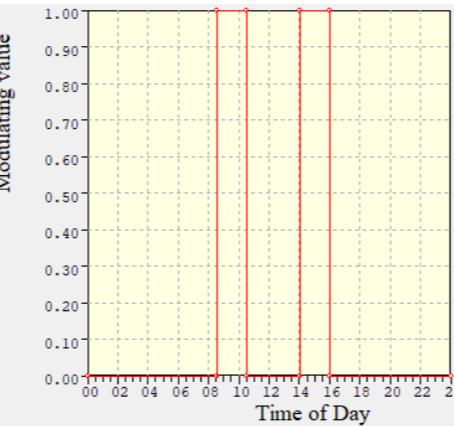


Figure d - Occupancy profile – Main Hall

WD:School_Plant_mod		
DAY_0051 Modulating		
	Time	Value
1	00:00	0.000
2	07:00	0.000
3	07:00	1.000
4	17:00	1.000
5	17:00	0.000
6	24:00	0.000

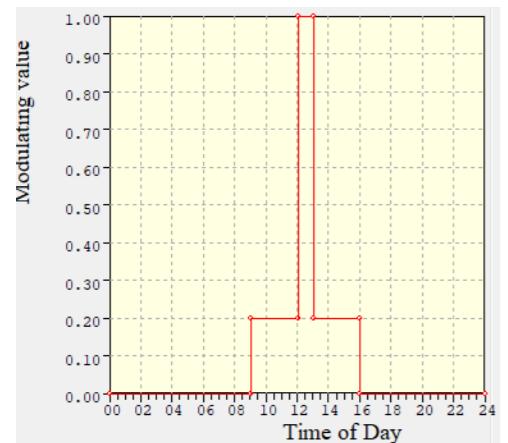


Figure b - Occupancy profile – Typical office/staff room

WD:School_Equip_mod		
DAY_0028 Modulating		
	Time	Value
1	00:00	0.050
2	07:00	0.050
3	07:00	0.200
4	09:00	1.000
5	12:00	1.000
6	12:00	0.500
7	14:00	0.500
8	14:00	1.000
9	15:30	1.000
10	15:30	1.000
11	17:00	0.200
12	17:00	0.050
13	24:00	0.050

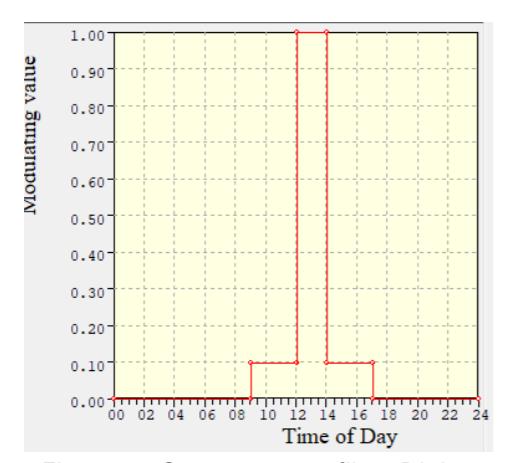


Figure c - Occupancy profile – Dining

WD:School_Light_mod		
WDSC0000 Modulating		
	Time	Value
1	00:00	0.000
2	07:00	0.000
3	07:00	1.000
4	17:00	1.000
5	17:00	0.000
6	24:00	0.000

APPENDIX B: INTERNAL GAIN FIGURES

Space Name	Lighting Max. Sensible Gain (W/m <sup>2</sup> )	Variation Profile	Occupancy (m <sup>2</sup> /person)	Variation Profile	Equipment Max. Sensible Gain (W/m <sup>2</sup> )	Variation Profile
1F_Activity Space EY/KS1 7	5	School_Light_mod A	5.6655	off continuously	0	School_Equip_mod A
1F_Activity Space EY/KS1 8	5	School_Light_mod A	5.63	off continuously	0	School_Equip_mod A
1F_Activity Space EY/KS1 9	5	School_Light_mod A	5.643333333	off continuously	0	School_Equip_mod A
1F_Activity Space KS2 10	5	School_Light_mod A	5.644666667	off continuously	0	School_Equip_mod A
1F_Activity Space KS2 11	5	School_Light_mod A	5.650833333	off continuously	0	School_Equip_mod A
1F_Activity Space KS2 12	5	School_Light_mod A	5.605333333	off continuously	0	School_Equip_mod A
1F_Activity Space KS3 27	5	School_Light_mod A	4.773142857	off continuously	0	School_Equip_mod A
1F_Activity Space KS3 28	5	School_Light_mod A	4.826857143	off continuously	5	School_Equip_mod A
1F_Activity Space KS3 29	5	School_Light_mod A	4.826571429	off continuously	5	School_Equip_mod A
1F_Activity Space KS4/P16 38	5	School_Light_mod A	4.837714286	off continuously	5	School_Equip_mod A
1F_Activity Space KS4/P16 39	5	School_Light_mod A	4.804428571	off continuously	5	School_Equip_mod A
1F_Activity Space KS4/P16 40	5	School_Light_mod A	4.816571429	off continuously	5	School_Equip_mod A
1F_AHT Office 130	5	School_Light_mod A	2.227	off continuously	5	School_Equip_mod A
1F_Bursar/PA 129	5	School_Light_mod A	3.4515	off continuously	5	School_Equip_mod A
1F_Cleaners Store 221	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Cleaners Store 225	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Conference Room 116	5	School_Light_mod A	2.0187	off continuously	5	School_Equip_mod A
1F_EY/KS1 Family Dining Area	5	School_Light_mod A	12.003	off continuously	5	School_Equip_mod A
1F_Food Store 181	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Furniture Store 189	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Furniture Store 190	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Furniture Store 191	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Furniture Store 192	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
1F_Hallway 1	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
1F_Hallway 2	5	School_Light_mod A	0	off continuously	50	School_Equip_mod A
1F_Hallway 3	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
1F_Hallway 4	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Hallway 5	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Hallway 6	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Hallway 7	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Head Teachers Office 122	5	School_Light_mod A	2.607333333	off continuously	5	School_Equip_mod A
1F_Individual Toilet Accessible	5	School_Light_mod A	2.4005	off continuously	5	School_Equip_mod A
1F_Individual Toilet Accessible	5	School_Light_mod A	2.365	off continuously	0	School_Equip_mod A
1F_Individual Toilet Accessible	5	School_Light_mod A	2.351	off continuously	0	School_Equip_mod A
1F_Individual Toilets Accessible	5	School_Light_mod A	2.3975	off continuously	0	School_Equip_mod A
1F_KS2 Family Dining Area 53	5	School_Light_mod A	12.7785	off continuously	0	School_Equip_mod A
1F_KS3 Family Dining Area 54	5	School_Light_mod A	12.119	off continuously	0	School_Equip_mod A
1F_KS4/P16 Family Dining Are	5	School_Light_mod A	9.86675	off continuously	0	School_Equip_mod A
1F_Large Hygiene Room 285	5	School_Light_mod A	2.588333333	off continuously	0	School_Equip_mod A
1F_Large Hygiene Room 286	5	School_Light_mod A	2.7188	off continuously	0	School_Equip_mod A
1F_Lift	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
1F_Lift 1	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
1F_Mobile Workstations 288	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
1F_MSI Classroom KS2/KS3 2	5	School_Light_mod A	8.137125	off continuously	0	School_Equip_mod A
1F_MSI Classroom KS3 33	5	School_Light_mod A	8.141	off continuously	0	School_Equip_mod A
1F_Open Plan Activity EY/KS1	5	School_Light_mod A	4.931	off continuously	0	School_Equip_mod A
1F_Open Plan activity KS2 15	5	School_Light_mod A	5.27825	off continuously	0	School_Equip_mod A
1F_Open Plan Activity KS3 32	5	School_Light_mod A	4.93325	off continuously	0	School_Equip_mod A
1F_Secondary Food Room 46	5	School_Light_mod A	14.12266667	off continuously	5	School_Equip_mod A
1F_Secondary Library 57	5	School_Light_mod A	3.27	off continuously	5	School_Equip_mod A
1F_Secondary life Skills 43	5	School_Light_mod A	14.465	off continuously	5	School_Equip_mod A
1F_Secure/Exam Archive Store	5	School_Light_mod A	0	off continuously	10	School_Equip_mod A
1F_Server Room 269	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A

1F_SLT Office 131	5	School_Light_mod A	1.846	off continuously	50	School_Equip_mod A
1F_SLT Office 132	5	School_Light_mod A	1.814875	off continuously	0	School_Equip_mod A
1F_SLT Office 133	5	School_Light_mod A	1.20975	off continuously	0	School_Equip_mod A
1F_SLT Office 134	5	School_Light_mod A	1.356875	off continuously	0	School_Equip_mod A
1F_Small Group Room 94	5	School_Light_mod A	1.96575	off continuously	0	School_Equip_mod A
1F_Small Group Room 95	5	School_Light_mod A	1.99625	off continuously	0	School_Equip_mod A
1F_Small Group Room 96	5	School_Light_mod A	1.97775	off continuously	0	School_Equip_mod A
1F_Small Group Room 97	5	School_Light_mod A	1.976	off continuously	0	School_Equip_mod A
1F_Small Group Room 98	5	School_Light_mod A	1.98475	off continuously	0	School_Equip_mod A
1F_Small Group Room 99	5	School_Light_mod A	1.9875	off continuously	0	School_Equip_mod A
1F_Small Group Room 100	5	School_Light_mod A	1.99675	off continuously	0	School_Equip_mod A
1F_Small Group Room 101	5	School_Light_mod A	1.9645	off continuously	0	School_Equip_mod A
1F_Specialist Store 180	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
1F_Staff Interview/Small Meetin	5	School_Light_mod A	1.1676	off continuously	0	School_Equip_mod A
1F_Staff Toilet Suite 253	5	School_Light_mod A	1.270666667	off continuously	5	School_Equip_mod A
1F_Staff Toilet Suite 257	5	School_Light_mod A	0.764	off continuously	5	School_Equip_mod A
1F_Staff Toilet Suite's 256	5	School_Light_mod A	1.983666667	off continuously	5	School_Equip_mod A
1F_Staff Work Room 115	5	School_Light_mod A	1.879291667	off continuously	5	School_Equip_mod A
1F_Staircase 275	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Staircase 276	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Stairwell 274	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teachig Store 157	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 144	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 145	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 146	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 147	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 148	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 149	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 150	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 151	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 152	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 153	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 154	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
1F_Teaching Store 155	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 156	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Teaching Store 178	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Wheelchair/Applications Bay	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
1F_Whole School Science & T	5	School_Light_mod A	14.273	off continuously	5	School_Equip_mod A
GF_Accessible/Staff Changing	5	School_Light_mod A	2.118	off continuously	5	School_Equip_mod A
GF_Accessible/Staff Changing	5	School_Light_mod A	2.145666667	off continuously	5	School_Equip_mod A
GF_Accessible/Staff Toilet 259	5	School_Light_mod A	3.021	off continuously	5	School_Equip_mod A
GF_Accessible/Staff Toilet 260	5	School_Light_mod A	2.3905	off continuously	5	School_Equip_mod A
GF_Activity Space EY/KS1 1	5	School_Light_mod A	5.653333333	off continuously	0	School_Equip_mod A
GF_Activity Space EY/KS1 2	5	School_Light_mod A	5.654666667	off continuously	0	School_Equip_mod A
GF_Activity Space EY/KS1 3	5	School_Light_mod A	5.624833333	off continuously	0	School_Equip_mod A
GF_Activity Space KS2 4	5	School_Light_mod A	5.633833333	off continuously	0	School_Equip_mod A
GF_Activity Space KS2 5	5	School_Light_mod A	5.652666667	off continuously	0	School_Equip_mod A
GF_Activity Space KS2 6	5	School_Light_mod A	5.599333333	off continuously	0	School_Equip_mod A
GF_Activity Space KS3 21	5	School_Light_mod A	4.768714286	off continuously	0	School_Equip_mod A
GF_Activity Space KS3 22	5	School_Light_mod A	4.830428571	off continuously	0	School_Equip_mod A
GF_Activity Space KS3 23	5	School_Light_mod A	4.828142857	off continuously	0	School_Equip_mod A
GF_Activity Space KS4 24	5	School_Light_mod A	4.829857143	off continuously	50	School_Equip_mod A
GF_Activity Space KS4 25	5	School_Light_mod A	4.810285714	off continuously	0	School_Equip_mod A

GF_Activity Space KS4 26	5	School_Light_mod A	4.816285714	off continuously	5	School_Equip_mod A
GF_Art Store Room 173	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
GF_Attention & Listening Devel	5	School_Light_mod A	3.783	off continuously	5	School_Equip_mod A
GF_Cafe 121	5	School_Light_mod A	1.485916667	off continuously	5	School_Equip_mod A
GF_Central Plant Room 261	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
GF_Chair Store 196	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Cleaner Store 223	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Cleaners Store 224	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Cleaners Stores 222	5	School_Light_mod A	0	off continuously	50	School_Equip_mod A
GF_Cupboards	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
GF_Drama Store 182	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
GF_EY/KS1 Family Dining Are	5	School_Light_mod A	21.8585	off continuously	0	School_Equip_mod A
GF_Food Store Room 176	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Furniture Store 185	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Furniture Store 186	5	School_Light_mod A	0	off continuously	5	School_Equip_mod A
GF_Furniture Store 187	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Furniture Store 188	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_General Office/IT Manager	5	School_Light_mod A	6.069714286	off continuously	0	School_Equip_mod A
GF_General Store 193	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_General Store 226	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 1	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 2	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 3	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 4	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 5	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 6	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 7	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 8	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 9	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 10	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 11	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 12	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 13	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hallway 14	5	School_Light_mod A	0	off continuously	0	School_Equip_mod A
GF_Hydrotherapy Pool 113	5	School_Light_mod A	5.3900625	off continuously	0	School_Equip_mod A
GF_i-Lab 45	5	School_Light_mod A	2.461818182	off continuously	0	School_Equip_mod A
GF_Individual Toilet 245	5	School_Light_mod A	2.3975	off continuously	0	School_Equip_mod A
GF_Individual Toilet 246	5	School_Light_mod A	2.347	off continuously	5	School_Equip_mod A
GF_Individual Toilet Accessible	5	School_Light_mod A	2.336	off continuously	0	School_Equip_mod A
GF_Individual Toilet Accessible	5	School_Light_mod A	2.3825	School_Occ_mod A	10	School_Equip_mod A
GF_Kitchen Dry Store 228	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Kitchen Prep/ Servery Suit	5	School_Light_mod A	7.9735	School_Occ_mod A	10	School_Equip_mod A
GF_Kitchen Toilet 229	5	School_Light_mod A	1.7005	School_Occ_mod A	10	School_Equip_mod A
GF_KS2 Family Dining Area 50	5	School_Light_mod A	11.942	School_Occ_mod A	10	School_Equip_mod A
GF_KS3 Family Dining Area 51	5	School_Light_mod A	11.673	School_Occ_mod A	10	School_Equip_mod A
GF_KS4/P16 Family Dining Are	5	School_Light_mod A	11.972	School_Occ_mod A	10	School_Equip_mod A
GF_Large Hygiene Room 237	5	School_Light_mod A	3.1772	School_Occ_mod A	10	School_Equip_mod A
GF_Large Hygiene Room 238	5	School_Light_mod A	3.1112	School_Occ_mod A	10	School_Equip_mod A
GF_Large Hygiene Room 239	5	School_Light_mod A	2.4845	School_Occ_mod A	10	School_Equip_mod A
GF_Large Hygiene Room 240	5	School_Light_mod A	2.587166667	School_Occ_mod A	10	School_Equip_mod A
GF_Large Hygiene Room 243	5	School_Light_mod A	2.282666667	School_Occ_mod A	10	School_Equip_mod A
GF_Laundry 118	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Life Skills Room Small 42	5	School_Light_mod A	3.944	School_Occ_mod A	10	School_Equip_mod A
GF_Lift 277	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A

GF_Lift 278	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Main Hall 48	5	School_Light_mod A	2.54203125	School_Occ_mod A	10	School_Equip_mod A
GF_Medical Store 195	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Mobility Equipment Store 2	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Mobility Equipment Store 2	5	School_Light_mod A	0	School_Occ_mod A	5	School_Equip_mod A
GF_Mobility Equipment Store 2	5	School_Light_mod A	0	School_Occ_mod A	5	School_Equip_mod A
GF_MSI Classroom EY/KS1 16	5	School_Light_mod A	8.070875	School_Occ_mod A	5	School_Equip_mod A
GF_MSI Classroom KS1 17	5	School_Light_mod A	8.0825	School_Occ_mod A	5	School_Equip_mod A
GF_MSI Classroom KS2 18	5	School_Light_mod A	8.07675	School_Occ_mod A	5	School_Equip_mod A
GF_MSI Classroom KS2 19	5	School_Light_mod A	8.0685	School_Occ_mod A	5	School_Equip_mod A
GF_MSI Classroom KS3 34	5	School_Light_mod A	8.069875	School_Occ_mod A	5	School_Equip_mod A
GF_MSI Classroom KS3/KS4 3	5	School_Light_mod A	8.058375	School_Occ_mod A	5	School_Equip_mod A
GF_MSI Classroom KS4/P16 3	5	School_Light_mod A	8.063375	School_Occ_mod A	15	School_Equip_mod A
GF_MSI Classroom P16 37	5	School_Light_mod A	8.038625	School_Occ_mod A	10	School_Equip_mod A
GF_Music Store Room 175	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Nurse's Base/MI Room 58	5	School_Light_mod A	2.175857143	School_Occ_mod A	10	School_Equip_mod A
GF_Open Plan Activity 13	5	School_Light_mod A	4.919	School_Occ_mod A	10	School_Equip_mod A
GF_Open Plan Activity 30	5	School_Light_mod A	4.83975	School_Occ_mod A	10	School_Equip_mod A
GF_Open plan Activity 31	5	School_Light_mod A	5.36025	School_Occ_mod A	10	School_Equip_mod A
GF_Open Plan Activity KS2 14	5	School_Light_mod A	5.068	School_Occ_mod A	10	School_Equip_mod A
GF_Oxygen Cylinder Store 197	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Parents Room 124	5	School_Light_mod A	1.970333333	School_Occ_mod A	10	School_Equip_mod A
GF_PE Store (Ext) 172	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_PE Store 183	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_PE Store 184	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Physical Therapy & Develo	5	School_Light_mod A	4.151	School_Occ_mod A	10	School_Equip_mod A
GF_Pool Plant 268	5	School_Light_mod A	0	School_Occ_mod A	5	School_Equip_mod A
GF_Pool Store 203	5	School_Light_mod A	0	School_Occ_mod A	25	School_Equip_mod A
GF_Premises Manager Office 1	5	School_Light_mod A	4.8055	School_Occ_mod A	10	School_Equip_mod A
GF_Primary Food Room 41	5	School_Light_mod A	6.859	School_Occ_mod A	10	School_Equip_mod A
GF_Pupil Changing and Showe	5	School_Light_mod A	1.733875	School_Occ_mod A	10	School_Equip_mod A
GF_Pupil Changing and showe	5	School_Light_mod A	4.24425	School_Occ_mod A	10	School_Equip_mod A
GF_Pupil Changing for Pool 23	5	School_Light_mod A	8.037666667	School_Occ_mod A	10	School_Equip_mod A
GF_Pupil Changing for Pool 23	5	School_Light_mod A	6.196	School_Occ_mod A	10	School_Equip_mod A
GF_Pupil Changing for Pool 23	5	School_Light_mod A	6.196	School_Occ_mod A	10	School_Equip_mod A
GF_Reception Area 125	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Reception Area 126	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_SALT 1:1 102	5	School_Light_mod A	2.425666667	School_Occ_mod A	10	School_Equip_mod A
GF_SALT 1:1 103	5	School_Light_mod A	2.613	School_Occ_mod A	10	School_Equip_mod A
GF_SALT Resource Room 104	5	School_Light_mod A	2.2845	School_Occ_mod A	10	School_Equip_mod A
GF_SALT Therapy Room 105	5	School_Light_mod A	2.035333333	School_Occ_mod A	10	School_Equip_mod A
GF_Sensory Integration Room	5	School_Light_mod A	6.68125	School_Occ_mod A	10	School_Equip_mod A
GF_Sensory Integration Room	5	School_Light_mod A	0	School_Occ_mod A	5	School_Equip_mod A
GF_Server Room 264	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Sick Bay128	5	School_Light_mod A	0	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room	5	School_Light_mod A	3.945	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room 59	5	School_Light_mod A	3.9825	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room 61	5	School_Light_mod A	4.077	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room 62	5	School_Light_mod A	4.0655	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room 87	5	School_Light_mod A	1.95375	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room 88	5	School_Light_mod A	1.981	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room 89	5	School_Light_mod A	1.9935	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room 90	5	School_Light_mod A	1.98	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room 91	5	School_Light_mod A	1.96725	School_Occ_mod A	10	School_Equip_mod A

GF_Small Group Room 92	5	School_Light_mod A	2.01675	School_Occ_mod A	10	School_Equip_mod A
GF_Small Group Room 93	5	School_Light_mod A	1.9725	School_Occ_mod A	5	School_Equip_mod A
GF_Specific Skills Developmen	5	School_Light_mod A	2.324666667	School_Occ_mod A	5	School_Equip_mod A
GF_Specific Skills Developmen	5	School_Light_mod A	2.328666667	School_Occ_mod A	5	School_Equip_mod A
GF_Specific Skills Developmen	5	School_Light_mod A	3.395333333	School_Occ_mod A	5	School_Equip_mod A
GF_Specific Skills Developmen	5	School_Light_mod A	3.322333333	School_Occ_mod A	10	School_Equip_mod A
GF_Specific Skills Developmen	5	School_Light_mod A	3.208333333	School_Occ_mod A	15	School_Equip_mod A
GF_Staff Wellness and Activity	5	School_Light_mod A	0.447708333	School_Occ_mod Dining A	10	School_Equip_mod A
GF_Staff Toilet Suite 254	5	School_Light_mod A	1.286333333	School_Occ_mod Dining A	10	School_Equip_mod A
GF_Staff Toilet Suite 255	5	School_Light_mod A	1.565	School_Occ_mod Dining A	10	School_Equip_mod A
GF_Staff Wellness and Activity	5	School_Light_mod A	0.530666667	School_Occ_mod Dining A	10	School_Equip_mod A
GF_Staircase 3	5	School_Light_mod A	0	School_Occ_mod Dining A	10	School_Equip_mod A
GF_Staircase 273	5	School_Light_mod A	0	School_Occ_mod Dining A	10	School_Equip_mod A
GF_Stairwell 272	5	School_Light_mod A	0	School_Occ_mod Dining A	10	School_Equip_mod A
GF_Supervisable Toilet 244	5	School_Light_mod A	3.874	School_Occ_mod Dining A	10	School_Equip_mod A
GF_Teaching Store 138	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 139	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 140	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 141	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 142	5	School_Light_mod A	0.788	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 143	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 158	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching store 159	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 160	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 161	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 162	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 163	5	School_Light_mod A	0	School_Occ_mod Staff A	5	School_Equip_mod A
GF_Teaching Store 164	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 165	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 166	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 167	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 168	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 169	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 170	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Teaching Store 171	5	School_Light_mod A	0	School_Occ_mod Staff A	5	School_Equip_mod A
GF_Teaching Store 177	5	School_Light_mod A	0	School_Occ_mod Staff A	5	School_Equip_mod A
GF_Teaching Store 179	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Themed Space 56	5	School_Light_mod A	4.56525	School_Occ_mod Staff A	0	School_Equip_mod A
GF_Therapy Management Offic	5	School_Light_mod A	2.151857143	School_Occ_mod Staff A	5	School_Equip_mod A
GF_Toilet	5	School_Light_mod A	1.512666667	School_Occ_mod Staff A	5	School_Equip_mod A
GF_Wheelchair/Appliances Ba	5	School_Light_mod A	0	School_Occ_mod Staff A	10	School_Equip_mod A
GF_Whole School Art & Music	5	School_Light_mod A	13.6255	l_Plant_mod Main Hall & Dining a	5	School_Equip_mod A

APPENDIX C: LENI CALCULATIONS

Space type	Classrooms	Offices	Main Hall	Kitchens	Changing Rooms	Circulation	Cupboards	Toilets	Dining areas	Nurse Base	Parents Room	Laundry	Server Room	Pool	Plant Rooms	Library
Treated floor area [m2]	2022.00	370.00	162.70	90.00	109.00	1250.80	256.00	189.80	208.00	18.00	11.80	4.50	24.00	87.00	68.00	19.60
No. of spaces																
Luminaire type	-	-														
No. luminaires	-	-														
Power per luminaire [W]	-	-														
Installed power density [W/m2]	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
<b>Total installed power [W]</b>	<b>10110</b>	<b>1850</b>	<b>814</b>	<b>450</b>	<b>545</b>	<b>6254</b>	<b>1280</b>	<b>949</b>	<b>1040</b>	<b>90</b>	<b>59</b>	<b>23</b>	<b>120</b>	<b>435</b>	<b>340</b>	<b>98</b>
Controls	b+d	b+d	b+d	b+d	d	d	d	d	d	b+d	b+d	b+d	d	b+d	d	b+d
Constant illuminance factor (Fc)	0.70	0.70	0.70	0.70	0.85	0.85	0.85	0.85	0.85	0.70	0.70	0.70	0.85	0.70	0.85	0.70
Occupancy dependency factor (Fo)	0.80	0.80	0.80	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.80	1.00	1.00	0.80	1.00	0.80
Daylight dependency factor (Fd)	0.80	0.80	0.80	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.80	1.00	1.00	0.80	1.00	0.80
Average lighting hrs per year	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950
Daylight usage hrs [hr/year] (Td)	1725	1725	1726	1726	1725	1725	1725	1725	1725	1725	1725	1725	1725	1725	1725	1725
Non-daylight usage hours (Tn)	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224	224
Energy use for illumination [ kWh/year]	9081	1662	731	491	903	10361	2121	1258	1378	123	53	31	199	391	563	88
Parasitic control annual energy consumption	1011.00	185.00	81.35	45.00	54.50	625.40	128.00	94.90	104.00	9.00	5.90	2.25	12.00	43.50	34.00	9.80
Parasitic emergency annual energy consumption	1011.00	185.00	81.35	45.00	54.50	625.40	128.00	94.90	104.00	9.00	5.90	2.25	12.00	43.50	34.00	9.80
Parasitic energy use (Ep)	2022	370	163	90	109	1251	256	190	208	18	12	5	24	87	68	20
Total Energy Consumption [kWh/year]	11103	2032	894	581	1012	11611	2377	1448	1586	141	65	35	223	478	631	108
<b>LENI [kWh/m2/year]</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>6</b>	<b>9</b>	<b>9</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>5</b>	<b>8</b>	<b>9</b>	<b>5</b>	<b>9</b>	<b>5</b>
<b>TOTAL BUILDING LENI</b>	<b>7.30</b>															
<b>Total Building Energy Consumption [kWh/year]</b>	<b>23221</b>															

**APPENDIX D: SERVER ENERGY CALCULATIONS**

<i>Hours of operation</i>	<i>Normal Hours</i>	1950	<i>hours</i>	(24/7/365)
	<i>Out of Hours</i>	6810		
	<i>Total</i>	8760		
<b><i>Normal Working Hours</i></b>				
<i>Number of Server Rooms</i>		2		
<i>Demand</i>		4	<i>kW</i>	
<i>Ratio of rated to operational demand</i>		0.67	<i>% (x100)</i>	
<i>Cooling Power Consumption</i>		70	<i>% of Server Power Consumption</i>	
		0		
<i>Annual Energy Consumption</i>		10,452	<i>kWhrs per annum</i>	
		2.136112814	<i>kWhr/m<sup>2</sup></i>	
<b><i>Out of Hours</i></b>				
<i>Number of Server Rooms</i>		2		
<i>Demand</i>		3	<i>kW</i>	
<i>Ratio of rated to operational demand</i>		0.67	<i>%</i>	
		0		
<i>Cooling Power Consumption</i>		70	<i>% of Server Power Consumption</i>	
		0		
<i>Annual Energy Consumption</i>		27,376	<i>kWhrs per annum</i>	
		5.59497241	<i>kWhr/m<sup>2</sup></i>	
<i>Total Energy Consumption</i>		7.731	<i>kWhr/m<sup>2</sup></i>	

**APPENDIX E: DHW CALCULATIONS**

<b><i>Central Domestic Hot Water</i></b>	
No of occupants	180
Daily water consumption [l/person]	28.350
No. of occupied days per year	195
Density of water [kg/l]	1.000
Volume of water consumed per year [kg]	995085.000
Supply temperature of DHW	60.000
Cold supply temperature	10.000
delta T [K]	50.000
Specific heat capacity	4.187
Annual energy consumption [ kWh/year]	<b>57866.957</b>
Annual energy consumption [ kWh/m2]	11.826
<b><i>System COP</i></b>	
DHW generation efficiency	3.190
Annual energy consumption [ kWh/year]	<b>5686.555</b>
Annual energy consumption [ kWh/m2]	1.162
<b><i>Associated Losses</i></b>	
Size of the vessel [l]	800.000
Storage losses [kWh/m2]	0.065
Loop length [m]	66
Losses per m2 [kW/m2]	55
Circulation [kWh/m2]	3.472
Secondary circulation pump	0.200
Total losses [kWh/m2]	3.737
Annual energy consumption (incl. losses)	<b>4.899</b>

## APPENDIX F: RENEWABLES ANALYSIS

Date	PV generated electricity (MWh)
Jan 01-31	-7.3671
Feb 01-28	-11.1243
Mar 01-31	-21.7304
Apr 01-30	-30.2367
May 01-31	-39.1723
Jun 01-30	-44.7604
Jul 01-31	-43.1235
Aug 01-31	-37.5221
Sep 01-30	-27.1412
Oct 01-31	-16.4919
Nov 01-30	-8.1618
Dec 01-31	-5.8839
Summed total	-292.7155

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