

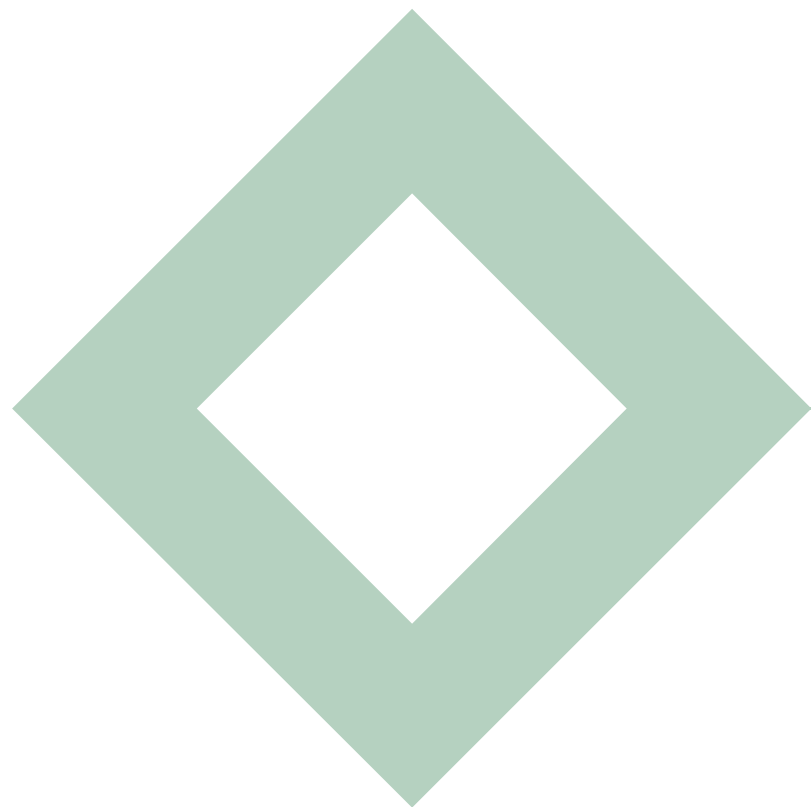
Dixon's Academy. Manchester. Morgan Sindall.

SUSTAINABILITY

ENERGY STRATEGY AND PART L COMPLIANCE

STAGE 4 REPORT

REVISION P04 – 06 SEPTEMBER 2023



STAGE 4

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
P01	24/03/2023	Stage 3 – draft for comment	J. Daoud	V. Wall	J. Nuttall
P02	28/03/2023	Updated Stage 3 issue	J. Daoud	V. Wall	J. Nuttall
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P04	06/09/2023	Updated Stage 4 issue	S. Hunt	K. Krasowska	J. Nuttall

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Executive Summary.

Hoare Lea has been appointed to produce an Energy Strategy report for the proposed development, Dixon's Academy, Manchester.

This Energy Strategy details how the Proposed Development will include a highly efficient, low-carbon new build sports hall and teaching block which is anticipated to significantly reduce potential CO₂ emissions compared to the notional building regulations target. The main school refurbishment comprises replacement of MEP services including an upgraded ventilation strategy along with targeted façade replacement and a new roof.

High efficiency servicing equipment and façades selected in line with the Department for Education's (DfE) Specification 21+ (Spec21+) requirements will minimise the energy usage of the building. Using the Energy Efficiency hierarchy referenced in the DfE's Technical Annex 2H, the strategy has been developed to ensure that the Proposed Development is efficient and achieves the highly ambitious Energy Use Intensity (EUI) targets of Annex 2H.

This strategy has been prepared to demonstrate that, at the concept design stage, the design team has given due consideration to the principles of energy and sustainability, and how these could be implemented for the Proposed Development.

Sustainable Estate Strategy

This Energy Strategy aligns with the high-level findings of the Sustainable Estate Strategy prepared by Waterman in October 2022, building on the recommendations within to develop a Climate Resilient Roadmap to net zero.

The Energy Strategy.

The strategy has been developed using the 'Be Lean, Clean, Green' energy hierarchy which utilises a fabric first approach to maximise reduction in energy through passive design measures.

Be lean	Regulated carbon emission reduction against Part L baseline. High performance, energy efficient building fabric and building services will be utilised to reduce carbon emissions and energy demand through good practice passive design measures. Daylight design and passive ventilation strategies will minimise energy consumption requirements.
Be clean	No further carbon emission reduction Incorporation of an onsite district heating and a CHP system has been deemed to be unsuitable due to the lack of existing infrastructure and net zero ambitions requiring a move away from fossil-fuels.
Be green	Introduction of low-energy, renewable technologies minimise energy consumption. Utilisation of high efficiency air source heat pumps and Photovoltaic (PV) panels for the building is anticipated to significantly reduce energy consumption and associated carbon emissions for the Proposed Development.

Assessing the proposed development against the Building Regulations Part L2 (2021) results in compliance of a **126.1%** betterment over the notional building when using the maximum required photovoltaic system installation.

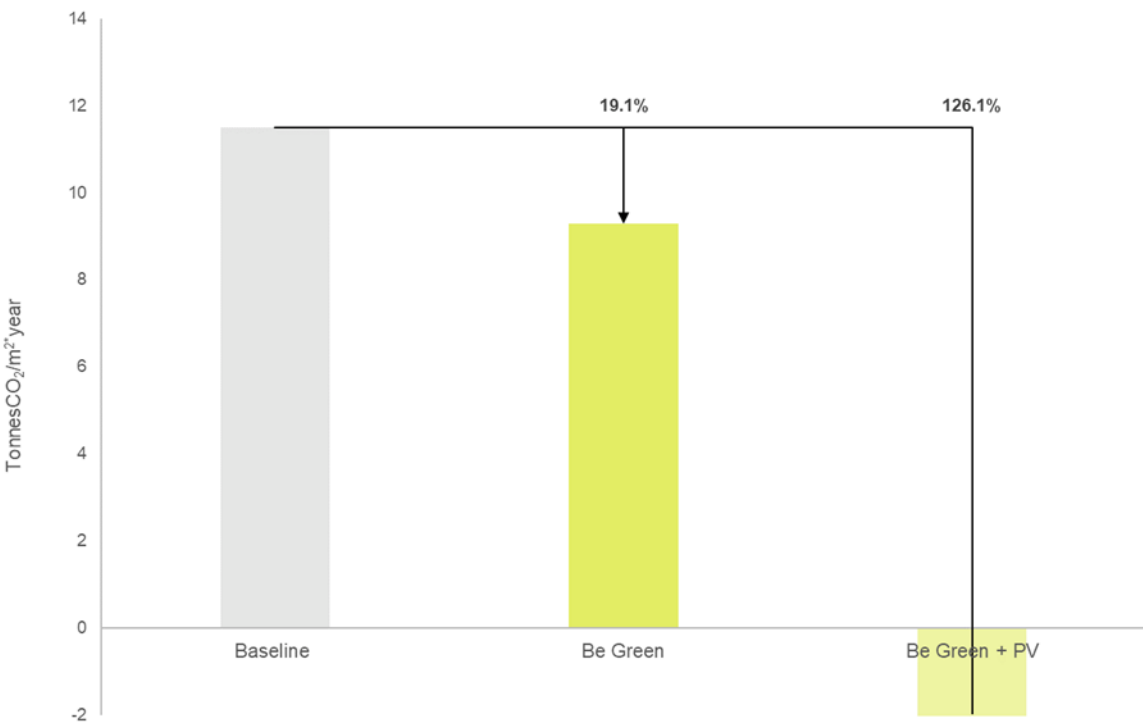


Figure 1 - Betterment over the Part L (2021) notional Baseline.

1. Introduction.

This Energy Strategy for the proposed Dixon's Academy development, located in Manchester, has been developed for Morgan Sindall at RIBA Stage 4. The report summarises the outputs of the energy modelling simulations typically used to demonstrate compliance with Approved Building Regulations Part L and Employer's Requirements for school projects Part A and Part B, hereafter known as Spec21+.

1.1 Proposed Development

The Proposed Development comprises of one main building comprised of 2 storeys and a small single storey building which is attached to the main structure. The construction works include an extension to the main building which amounts to ~1700m² of classroom and gymnasium spaces, highlighted in grey below. Alongside this, the entire building is set to have a new roof and façade replacement, aside from single storey section to the rear.

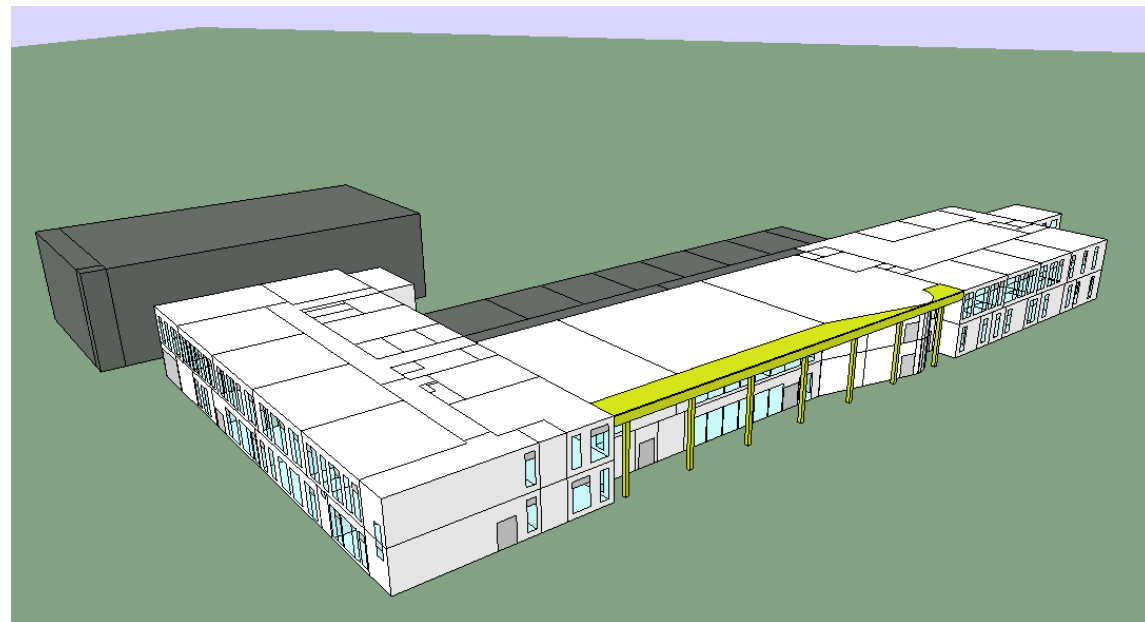


Figure 2 – DSM Model.

1.2 Approach to assessment.

The following assessment report considers the approach to reducing carbon dioxide (CO₂) emissions and optimising energy efficiency within the development and sets out how the Proposed Development will address and achieve the relevant targets.

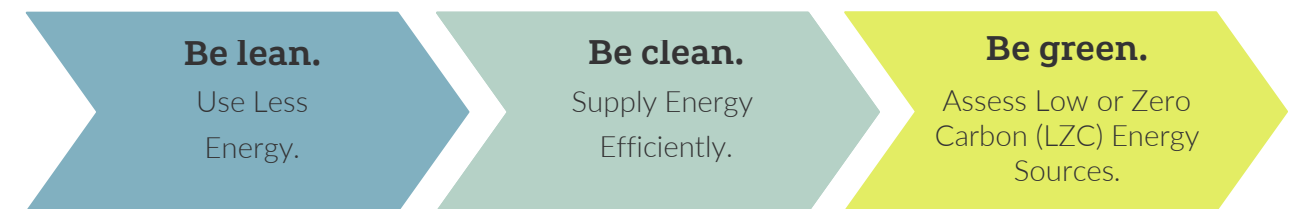
As such it demonstrates a proposed route to compliance with Approved Document Part L2 (2021), conservation of fuel and power, based upon the performance parameters stated within this report.

The Proposed Development is modelled in a Dynamic Simulations Modelling (DSM) software package (see Section 10) with the assigned parameters and then tested against Part L2 methodology.

The Existing Development has been assessed in Appendix A of this document.

1.2.1 Part L2 compliance discussion.

The assessment has used the energy hierarchy as part of the design strategy that prioritises passive design in a Be Lean, Be Clean and Be Green approach:



1.2.1.1 Definitions and limitations

Definitions:

The following definitions should be understood throughout this statement:

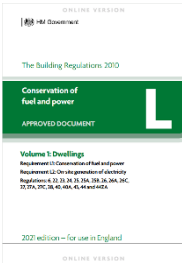
- **Energy demand:** the 'room-side' amount of energy which must be input to a space to achieve comfortable conditions. In the context of space heating, this is the amount of heat which is emitted by a radiator, or other heat delivery mechanism.
- **Energy requirement:** the 'system-side' requirement for energy (fuel). In the context of a space heating system using a gas boiler, this is the amount of energy combusted (e.g. gas) to generate useful heat (i.e. the energy demand).
- **Regulated CO₂ emissions:** the CO₂ 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).

Limitations:

The appraisals within this statement are based on Part L calculation methodology and should not be understood as a predictive assessment of likely future energy requirements or otherwise. Occupants may operate their systems differently, and / or the weather may be different from the assumptions made by Part L approved calculation methods, leading to differing energy requirements.

2. Assessment Drivers.

2.1 Building Regulations Part L2 2021.



The building is being assessed against the Building Regulations Part L2 2021.

Building Regulations Part L 2021 requires that the development as designed is not anticipated to exceed CO₂ emissions or Primary Energy than those set by the notional building (TER and TPER) calculated in accordance with 2021 methodology.

2.1.1 Limitations

The appraisals within the strategy are based on the Building Regulations Part L 2021 calculation methodology and should not be understood as a predictive assessment of likely future performance.

Occupants may operate their systems differently, and/or the weather may be different from the assumptions under Part L approved calculation methods, leading to differing energy requirements.

2.1.2 Unregulated energy and carbon.

The Part L compliance assessment only takes into account regulated energy uses (i.e. lighting, heating, cooling and ventilation) and does not consider unregulated energy uses. Unregulated sources include 'plug-in' consumption from items such as televisions, computers and fridge-freezers, etc.

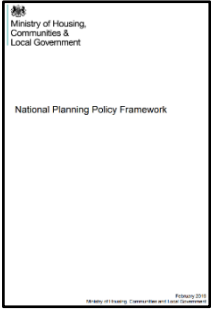
Due to these energy requirements being excluded from the Part L appraisal an assessment of the unregulated CO₂ emissions of the Proposed Development is not part of this Energy Strategy report.

A separate study of in-use energy demands has been prepared using the CIBSE TM54 methodology (ref: FS0998-HLEA-ZZ-ZZ-T-O-002).

2.1.3 Calculation tool.

The Part L2 2021 calculations were undertaken using IESve 2022.2.0 software, which is approved for use in assessing the performance of buildings in accordance with the Building Regulations Part L2 2021.

2.1.4 National Planning Policy Framework



The latest iteration of the National Planning Policy Framework (NPPF) was published in July 2021 and has superseded all Planning Policy Statements (PPS) and Planning Policy Guidance (PPG) documents, with the exception of PPS10 (Waste). The NPPF sets out the Government's strategy on the delivery of sustainable development.

The NPPF places responsibility for policy making with the Local Planning Authority, who shall communicate their policies through Local Plans and facilitate the creation of Neighbourhood Plans. The NPPF states that there is a presumption in favour of sustainable development.

The following is extracted from paragraph 11 of the NPPF:

"Plans and decisions should apply a presumption in favour of sustainable development."

For plan-making this means that:

- a) *all plans should promote a sustainable pattern of development that seeks to: meet the development needs of their area; align growth and infrastructure; improve the environment; mitigate climate change (including by making effective use of land in urban areas) and adapt to its effects.*
- b) *strategic policies should, as a minimum, provide for objectively assessed needs for housing and other uses, as well as any needs that cannot be met within neighbouring areas, unless:*
 - i. *the application of policies in this Framework that protect areas or assets of particular importance provides a strong reason for restricting the overall scale, type or distribution of development in the plan area; or*
 - ii. *any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole.*

For decision-taking this means:

- a) *approving development proposals that accord with an up-to-date development plan without delay; or*
- b) *where there are no relevant development plan policies, or the policies which are most important for determining the application are out-of-date, granting permission unless:*
 - i. *the application of policies in this Framework that protect areas or assets of particular importance provides a clear reason for refusing the development proposed; or*
 - ii. *any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole."*

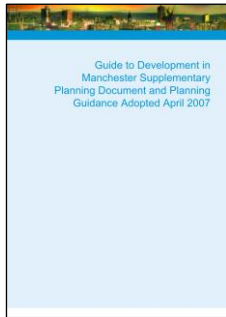
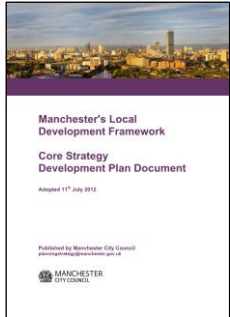
In respect of energy policy contained within the NPPF, paragraph 155 sets out that:

"To help increase the use and supply of renewable and low carbon energy and heat, plans should:

- a) *provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);*
- b) *consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and*
- c) *identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers."*

2.2 Manchester Core Strategy.

2.2.1 Local Planning Policy



Manchester City Council (MCC) documentation:

- Core Strategy (CS) (July 2012)
- Supplementary Planning Documentation and Planning Guidance (SPDPG) (April 2007)

This strategy summarises the response of the proposed development's design to the policy framework of the MCC Adopted Core Strategy, and SPDPG documentation that together form the city's policy landscape. The CS documentation supersedes the SPDPG and therefore the CS documentation will take precedence.

The Manchester Core Strategy Policy EN6 states that all other non-residential developments over 1,000m² will be expected as a minimum to meet the following targets (*unless this can be shown not to be viable*):

Target	% Minimum Requirement
Target 1; Network Development Area	CHP / District heating anchor or connection or where not feasible a 15% increase on Part L 2010
Target 2; Electricity Intense Buildings	+ 10% increase on Part L 2010
Target 3; Micro Generation Area	+ 15% increase on Part L 2010

Table 1 CO₂ Emission Reduction Targets, Manchester Core Strategy

Each of the above targets require above a 10% increase (increase is understood to be a reduction over the target) on Part L 2010 emission rates.

Building Regulations have been updated twice since 2010, firstly in 2013 and then again in 2021.

Between the Part L 2010 Building Regulations and the Part L 2013 Building Regulations the target emission rates were improved by 9% for non-domestic buildings. The 2021 update requires an average 27% improvement across the non-domestic building mix when compared to 2013.

As such, compliance with Part L 2021 exceeds the percentage improvement required by Manchester's Core Strategy.

2.3 Employer's Generic Design Brief: Part A and Part B (2022)

The Employer's requirements for school projects Part A and Part B, also known as Spec21+, sets out the Department for Education's general conditions and requirements for all new build or refurbished school developments.

The document and its associated annexes cover all aspects of the development design, with a particular focus on ensuing sustainable development is woven into each consideration. Those sections which specifically state the sustainability requirements relevant to this Energy Strategy Report are as follows:

Annex 2C: External Fabric

- Bio-solar photovoltaic green roofs shall be installed at Secondary Schools, comprising 100% green roofs with PVs to meet the kW peak per GIFA listed in Annexes 2G, 2H and 2J.
- Photovoltaic panels shall be installed at Secondary Schools to meet the kW peak per GIFA listed in Annex 2G.
- New Buildings shall be designed to the DfE Fabric Efficiency Standards as a minimum (*Section 4 of this report*) and exceed Part L requirements.

Annex 2H: Energy

This document gives guidance on the energy efficient design and regulation of energy benchmarking and monitoring. Key themes are summarised below.

- To meet Energy Use Intensity Targets, the energy efficiency hierarchy will be followed.
- Design to the Fabric First principle.
- Use a Dynamic Simulation Model (DSM) to inform an iterative process to evaluate feasibility of design concepts.
- Provide an Energy Strategy Report.
- Investigate the feasibility of a connection to a District Heat Network.
- To achieve Net Zero Carbon in operation at handover, the application of low energy fossil fuel free buildings will be prioritised.

Annex 2J: Sustainability

- Future proof the development against the risks of climate change.
- Prioritise the application of low energy, fossil fuel free buildings.
- Assess the risk of flooding to the building and the grounds.

2.3.1 Grid decarbonisation.

The national grid is continually decarbonising which makes the use of gas systems less beneficial when compared to electrically fuelled systems. Considering increasing ambition for zero-carbon developments – utilising an all-electric engineering strategy could help achieving this target.

As the national mix of electricity generation methods progresses towards greener solutions, the Building Regulations Part L 2021 value of the National Grid carbon factor has been shown to be closer to the UK National Grid value which fluctuates yearly.

2.3.2 Future projections

The Future Energy Scenarios (FES) document, produced by the National Grid, discusses how the UK's energy landscape is changing. The FES 2022 makes projections of how the mix of generation in the grid is likely to change between now and 2050 – the year by which the Climate Change Act 2008 set the target of reducing the UK's CO₂ emissions by 80% from 1990 levels. This target has now been revised to be Net Zero in light of the Committee on Climate Change's recent report and the declaration of a Climate Emergency.

The chart (Figure 3.1.1) illustrates the current and predicted carbon intensities of the national grid from 2005 up to 2050.

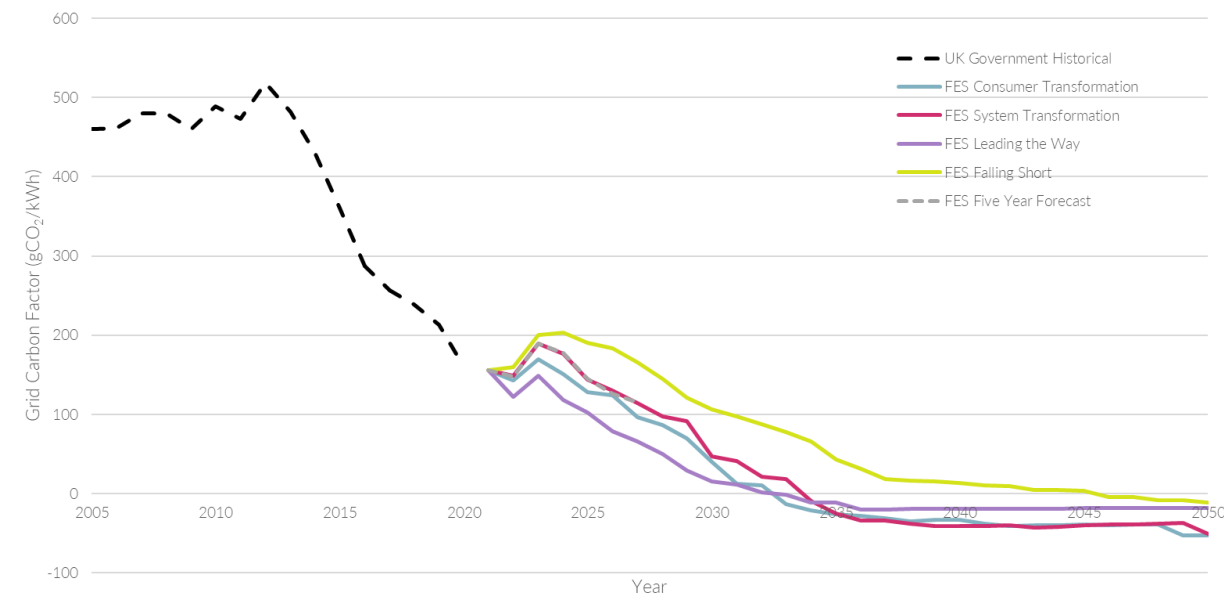


Figure 3.1.1 Future CO₂ intensity of electricity generation (gCO₂/kWh)

Offsetting the emissions of other industries will involve Carbon Capture and Storage (CCS) technologies on a significant scale in order for the UK as a nation to meet net zero carbon by 2050. It is important to note that CCS technology is not currently commercially demonstrated at a large scale, but the FES studies are useful as future forecasts.

3. Assessment Methodology.

The Proposed Development has been assessed using The National Calculation Methodology for demonstrating compliance with Approved Document Part L2 (2021). The following is a summary of the data used and inputs/assumption made.

3.1 Site context.

The images below show the Dynamic Simulation Model (DSM) and orientation.

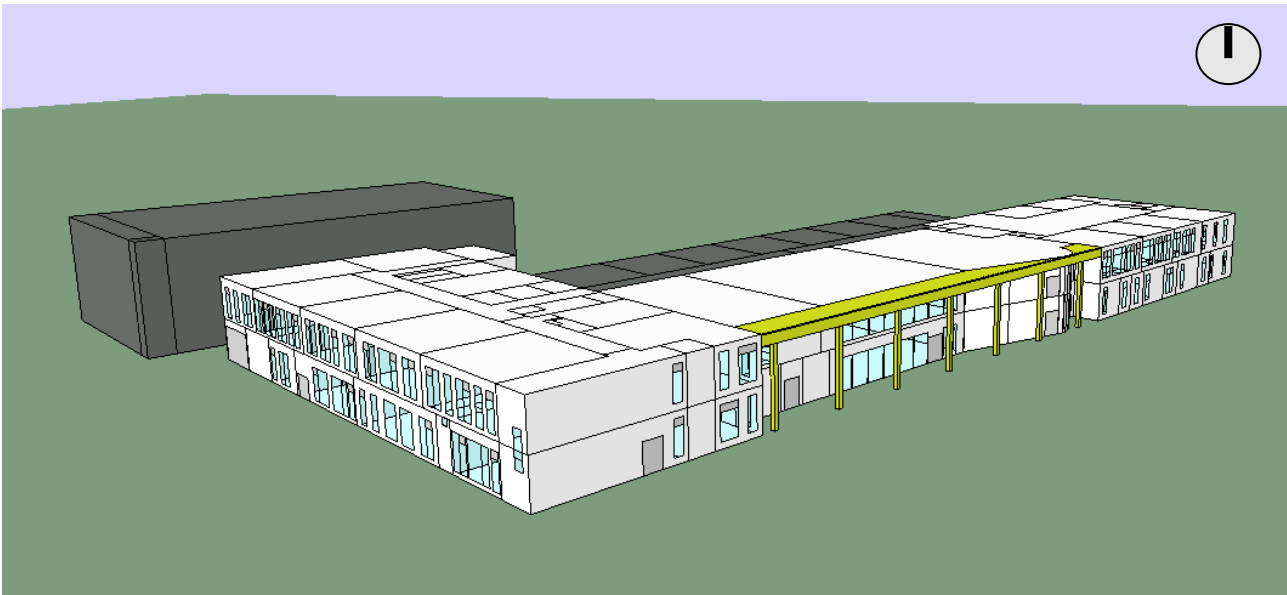


Figure 5 - DSM Model Image.



Figure 4 - Satellite Image of Location.

3.2 Architectural drawings.

The geometry used to assess Proposed Development was determined by the following information received.

Table 2 - Architectural Information.

Source	Data Type	Description	Date received
IBI Architects	Revit Model	FS0998-IBI-XX-XX-M3-A-000002	24/08/2023
	DWG	FS0998-IBI-XX-00-PL-A-200-001	
	DWG	FS0998-IBI-XX-01-PL-A-200-002	

3.3 Site location and weather data.

A building's thermal performance is its response to external environmental conditions. The more dependant a building is on passive features to achieve acceptable internal comfort, the more important the use of external weather information becomes.

Climate data is assigned to the virtual environment of the dynamic model to simulate external weather conditions that are likely to occur. Thermal comfort calculations require the simulation to be tested against CIBSE Design Summer Year (DSY) climate data.

The UK Meteorological Office (MO) collects weather data at stations across the UK. Climate variables measured at hourly intervals include air temperatures, wind speed and direction and air pressure etc.

CIBSE licenses the historic weather data from the MO for 14 locations in the United Kingdom: Belfast, Birmingham, Cardiff, Edinburgh, Glasgow, Leeds, London (3 sites), Manchester, Newcastle, Norwich, Nottingham, Plymouth, Southampton and Swindon.

The weather variables are synthesised into 2 types of CIBSE weather file type both the current and future climate:

– Design Summer Year (DSY): 2006 and 2016

The DSY is a single continuous year rather than a composite one made up from average months. The DSY is used for overheating analysis.

– Test Reference Year (TRY): 2006 and 2016

The TRY is composed of 12 separate months of data each chosen to be the most average month from the collected data. The TRY is used for energy analysis and for compliance with the UK Building Regulations (Part L).

The closest CIBSE weather file location for the proposed development is **Manchester TRY**.

3.4 Building Fabric Specification.

Optimising the developments fabric is seen to be the most robust and effective way to improve energy efficiency and in turn reduce carbon emissions whilst also impacting thermal comfort. The performance of the envelope i.e. material performance is unlikely to deteriorate significantly with time and therefore the benefits of these measures will continue at a similar performance for the duration of their installation.

The performance of the glazing has also been carefully considered to maximise natural daylight penetration to reduce the reliance of artificial lighting whilst also allowing a controlled amount of passive solar heating.

Useful solar heat gain reduces heating demand in winter but with careful consideration to the glazing specification, this will help limit solar gain in the summer which would therefore reduce the potential risk of glare and overheating. External shading, as well as window recess have been included to mitigate the risk of overheating within the occupied zones of the development.

The target building fabric performance is detailed below. The new build performance, as well as the existing envelope, is intended to match the Spec 21+ requirements. However, the existing single storey section will remain in accordance with Part L 2006 which was in force at the time of construction (2007).

Table 3 - Fabric and Construction Parameters.

Parameter	Part L (2021) Limiting Values	Annex 2C Minimum Requirements	Dixons Academy (W/m².K)		
			New build	Existing building (refurbished)	Existing building (retained)
External Wall	0.26	0.15	0.15	0.15	0.35
Louvred Panels	-	-	0.90	0.90	0.90
Passive Vent Panels	-	-	0.90	1.90	0.90
External Glazing – Typical (g-value)	1.60	1.10	1.10 (0.40)	1.10	2.2
Roof	0.18	0.12	0.12	0.12	-
Ground Floor	0.18	0.12	0.12	0.25	0.25
Fabric Air Permeability Average (m³/m².h at 50Pa)	8.00	3.00	3.00	3.00	9.00

3.5 System Parameters

Detailed heating, hot water, ventilation and lighting system parameters can be found in Appendix C of this report.

3.6 Photovoltaic Array parameters

In line with the requirements of Annex 2C, photovoltaic panels are included to offset the Energy Use Intensity requirements as per Annex 2H: Energy of 67 kWh/m².

The PV array with a yield of 361,775 kWh/year has been modelled. For further details refer to Section 9.1.

4. Energy Strategy

As per the requirements of Technical Annex 2H: Energy, the energy efficiency hierarchy has been followed in order to minimise the energy use intensity of the proposed development.

4.1 Be Lean.

Passive design and energy efficiency measures form the basis for the reduction in overall energy demand and carbon emissions for the proposed development. This energy strategy aims to reduce the energy demand initially by optimising the envelope and building services within the development.

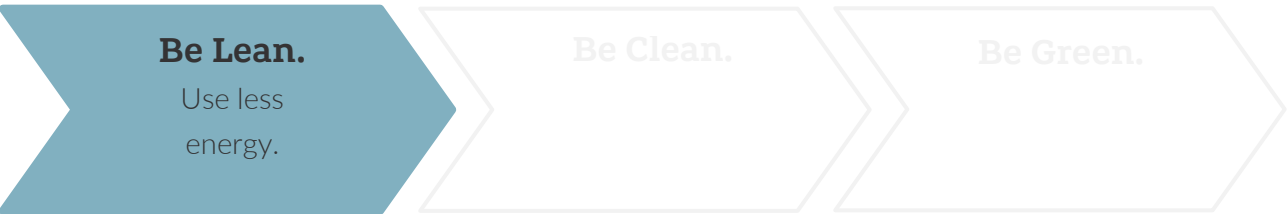


Figure 4.1: Be Lean.

4.2 Passive design and energy efficient features.

Passive Design measures are those which reduce the demand for energy within buildings, without consuming energy in the process.

These are the most robust and effective measures for reducing CO₂ emissions as the performance of the solutions, such as façade insulation, is unlikely to deteriorate significantly with time, or be subject to change by future property owners. In this sense, it is possible to have confidence that the benefits these measures will continue at a similar level for the duration of their installation.

	Fabric performance <u>New build:</u> A ‘fabric first’ approach has been taken in order to reduce the energy demand and CO₂ emissions from the Proposed Development. The overriding objective for the façade design will be to achieve the optimum balance between providing natural daylighting benefits to reduce the use of artificial lighting, the provision of passive solar heating to limit the need for space heating in winter and limiting summertime solar gains to reduce space cooling demands. <u>Refurbishment:</u> The existing buildings envelope will be upgraded to align with the U-values of the new build. The façade design has been redeveloped to achieve the optimum balance between providing natural daylight to reduce the use of artificial lighting, the provision of passive solar heating to limit the need for space heating in winter and limiting summertime solar gains to reduce space cooling demands. <u>Replacement:</u> The new roof will be designed to meet new build U-value targets outlined in Annex 2H. Any replacement windows will meet the same standard.
	Space heating Within some occupied spaces, heat will be supplied from the air source heat pump via radiators. Classrooms are anticipated to use an LTHW Heating Coil within the Natural Ventilation Heat Recovery (NVHR) unit to convert incoming air in to tempered air for the room. Halls (dining, halls and sports) will utilise LTHW Radiant Panels.

	Space cooling/ ventilation In order to align with Spec +21, Annex 2J, there will be no cooling across the entire development. However, the ventilation strategy which provides nighttime purge will aid in summertime cooling.
	Mechanical ventilation The ventilation strategy will be adopted across both the new build and existing building. Natural Ventilation is to be promoted where possible and will be able to be utilised for the majority of the occupied time, with additional ventilation used in extreme weather. NVHR units will mean that ventilation in winter is not uncontrolled and will reduce the instances of draughts resultant from cold air being required to ventilate.
	Domestic hot water (DHW) system The Proposed Development will feature water efficient fixtures and fittings including WCs with low flush volume and flow reducers in the taps of wash hand basins and on showers to limit overall water consumption. Hot water is expected to be generated by water source heat pumps linked to the air source heat pumps providing the space heating.
	Natural daylight and lighting strategy In the context of office and teaching usages, artificial lighting tends to provide a significant contribution to regulated CO₂ emissions. As such, the implementation of energy efficient lighting design is paramount to reducing overall emissions for these spaces. Therefore, it is anticipated that the proposed development will be supplied with high efficiency lighting installations representing best practice. Full lighting control systems including daylight linkage and presence detection will also be incorporated into non-domestic design. Natural daylight has also been maximised across the site with reduced external canopies, glazed external doors and the addition of a rooflight to each classroom space. As well as the reduced energy requirement that will be achieved by implementing these strategies, the contribution to internal heat gains and associated cooling requirements will be reduced. This will further reduce the total energy requirements and CO₂ emissions of the building.

5. Be Clean

This stage of the energy hierarchy includes consideration of connection to available district heat networks, or the use of on-site heat networks and decentralised energy production such as Combined Heat and Power (CHP) in order to provide energy and reducing consumption from the national grid and gas networks, through the generation of electricity, heating and cooling on-site.

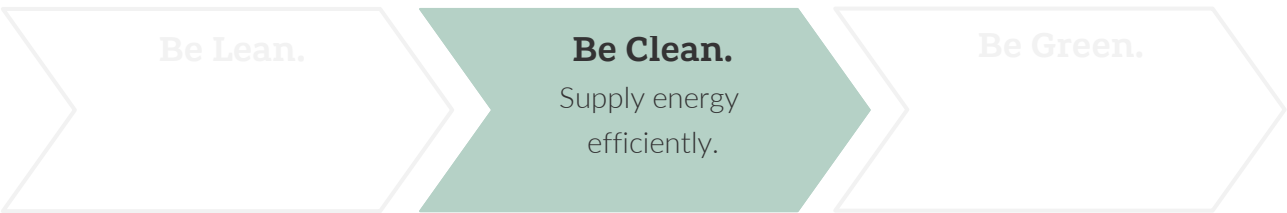


Figure 5.1: Be Clean.

5.1 District/decentralised heat network.

Currently, there is no proposed low-carbon heat network near the development site.

Due to the development being electrically led, the utilisation of technology such as CHP would offer very little benefit in terms of carbon emission reduction. Furthermore, the carbon emission benefit of gas fired CHP will diminish as the national grid continues to decarbonise.

Table 4 - Clean Energy Supply.

	Combined heat and power (CHP) Due the recent changes to the carbon emission factors in Part L, the use of Combined Heat and Power (CHP) is likely to offer a ‘negative benefit’ within the next five years and therefore has not been explored as part of the energy strategy.
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6. Be Green

This section explores the feasibility of Low and Zero Carbon (LZC) technologies to allow for the production of renewable energy onsite in order to deliver further reduction in carbon emissions.

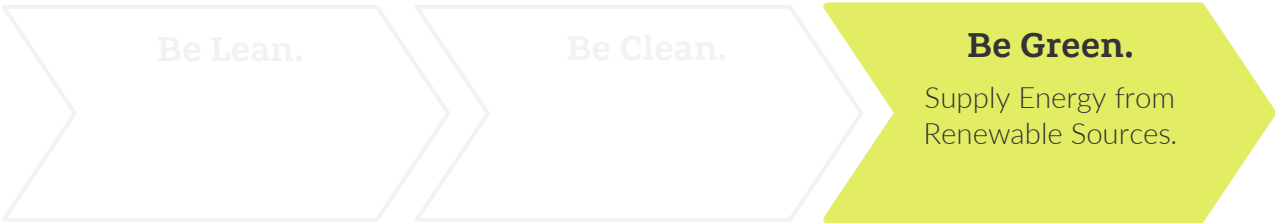
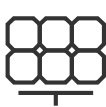


Figure 6.1: Be Green.

6.1 Low and zero carbon (LZC) technology assessment.

Renewable or zero carbon technologies harness energy from the environment and convert this to a useful form. Many renewable technologies are available, however, not all of these are commercially viable or suitable for urban locations. The following systems have been deemed most appropriate for the proposed site.

	Air source heat pumps Air Source Heat Pumps (ASHP) use thermodynamic principles to convert heat from the outside ambient air into useable heat within the building. Unlike some other sources of renewable energy, heat pumps do require energy (typically electricity or gas) to pump and compress refrigerant through the system. However, under the Renewable Energy Directive 2009/28/EC they are classified as renewable technologies provided that the final energy output significantly exceeds the primary energy input required to drive the heat pump. ASHP need to be located externally with access to the ambient air, typically at roof level. Suitability to Proposed development: Due to grid decarbonisation and the Part L 2021 carbon factors, it is expected that ASHP technology will offer significant carbon emission reductions over a gas boiler scenario. ASHP plant can be located at roof level and integrated into space heating and hot water systems (albeit potentially with some degree of ancillary top-up heating to raise water temperatures). Implementing heat-pump technology brings the additional benefit of a shift towards combustion-free development, with the associated benefit to local air quality.
	Photovoltaics Photovoltaic panels harness energy from sunlight and convert this into useful energy in the form of electricity. A PV system requires viable roof space in order for the system array to be installed and function effectively. Suitability to proposed development: Due to the requirements of Annex 2J, the inclusion of PV is stated to be necessary. The provision and location of PV panels has been reviewed in detail, with consideration of the following aspects: - Area required for access, biodiversity and for plant (ASHP) - Overshading

7. Part L2 Assessment.

The proposed development has been assessed against the most current version of Part L which is 2021 as per the requirements of the National Planning Policy Framework.

Two different options have been assessed for a route to compliance:

- Be Green: Proposed development with ASHP
- Be Green + PV Proposed development with ASHP + PV

7.1 Part L2 assessment results

Figure 6 show the results for the Building Emission Rate (BER) in comparison to the Target Emission Rate (TER).

The proposed development demonstrates a 19.1% betterment beyond the Part L 2021 baseline building without additional PV. With the PV contribution, apportioned to the extension based on the weighted area, a betterment of 126.1% is demonstrated.

Scenario Result

Table 5 - Compliance Results for Scenario Testing.

		Be Green	Be Green + PV
Emission Rate	TER (kg.CO ₂ /m ² /year)	5.66	
	BER (kg.CO ₂ /m ² /year)	4.58	-1.48
	Percentage betterment	-19.1	-126.1%
Primary Energy	TPER (kWh/m ² /year)	50.33	
	BPER (kWh/m ² /year)	-56.430	-101
	Percentage betterment	-212.1%	-300.7%

As demonstrated by Table 5, without the implementation of Photovoltaics on the proposed development, the development would still achieve a 19.1% betterment over the CO₂ requirements of Part L2 (Part L 2021). However, with the installation of the maximum mandatory PV cells (as required by Technical Annex 2J), a 126.1% betterment is observed.

Overall, it is anticipated that the Proposed Development will achieve up to a **126.1%** reduction in CO₂ emissions beyond the Building Regulations Part L 2021 'baseline' Target Emission Rate (TER) based on Part L2 (2021) carbon factors when using the parameters listed within this report.

The TER baseline is a benchmark determined by the Part L notional case and is the minimum requirement set by Part L in order to gain compliance with Building Regulations.

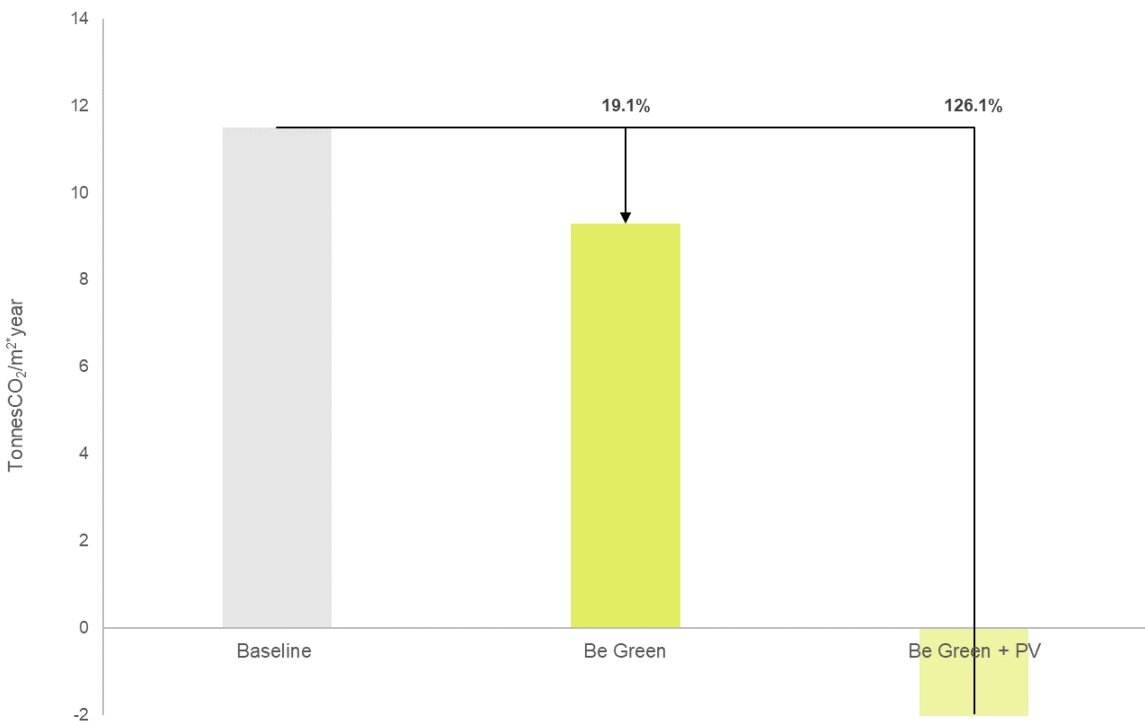


Figure 6 Building Emission Rate (BER) compared to Target Emission Rate (TER)

8. Conclusion

This Energy Strategy for Dixon’s Academy has shown that this Proposed Development will include a highly efficient, low-carbon scheme which significantly reduces potential CO₂ emissions.

High efficiency servicing equipment and façades selected in line with the Spec21+ requirements will minimise the energy usage of the building. Using the Energy Efficiency hierarchy stated in Annex 2H, the strategy has been developed to ensure that the Proposed Development is efficient. As stated earlier in this report, the results contained within this document should not be misunderstood to be an operational energy model required by Annex 2H that will be developed in line with developing design information availability.

This strategy has been prepared to demonstrate that, at the planning stage, the Applicant and design team have given due consideration to the principles of energy and sustainability, and how these could be implemented for the Proposed Development.

8.1 The Energy Strategy.

The strategy has been developed using the ‘Be Lean, Clean, Green’ energy hierarchy which utilises a fabric first approach to maximise reduction in energy through passive design measures.

Be lean	Regulated carbon emission reduction against Part L baseline. High performance, energy efficient building fabric and building services will be utilised to reduce carbon emissions and energy demand through good practice passive design measures. Daylight design and passive ventilation strategies will minimise energy consumption requirements.
Be clean	No further carbon emission reduction Incorporation of an onsite district heating and a CHP system has been deemed to be unsuitable due to the lack of existing infrastructure and net zero ambitions requiring a move away from fossil-fuels.
Be green	Introduction of low-energy, renewable technologies minimise energy consumption. Utilisation of high efficiency air source heat pumps and Photovoltaic (PV) panels for the building is anticipated to significantly reduce energy consumption and associated carbon emissions for the Proposed Development.

Assessing the proposed development against the Part L2 (2021) Building Regulations results in a **126.1%** betterment over the notional building.

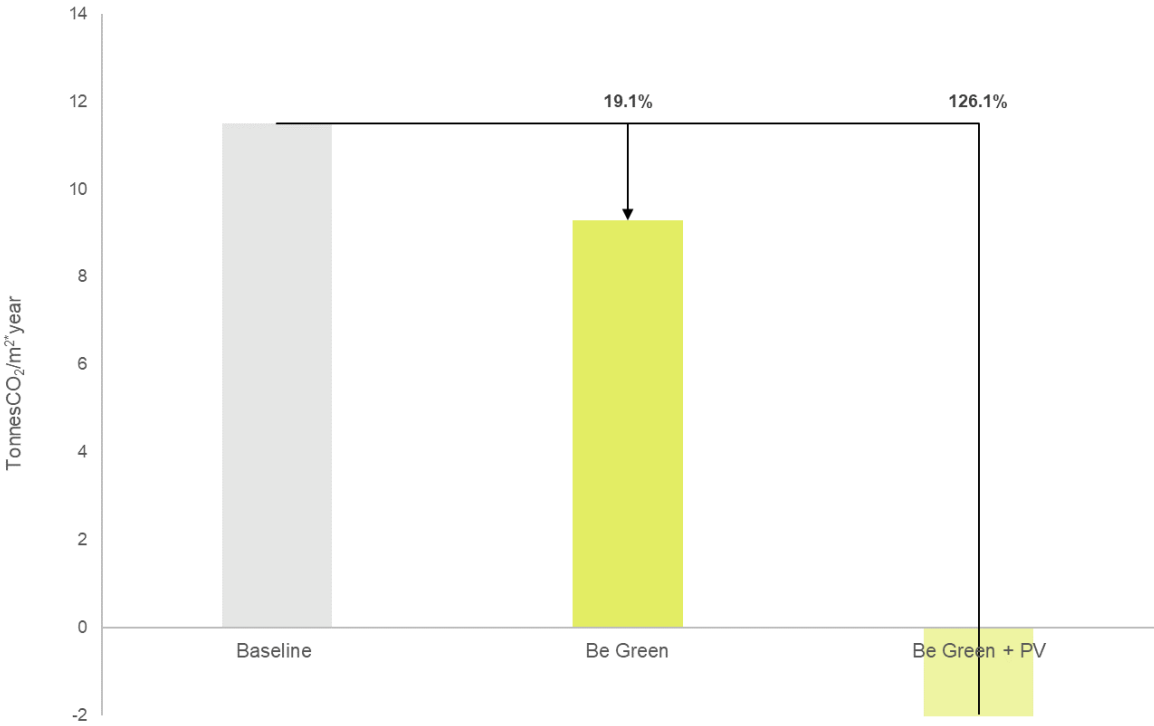


Figure 7 - Part L 2021 carbon factor reductions over the notional baseline for the proposed development.

Appendix A: Existing Building.

The proposed development has been assessed against the most current version of Part L which is 2021.

Part L2 Requirements.

Provision or renovation of thermal elements.

Where new thermal elements are to be provided or a renovation of the existing thermal element is required, reasonable provision should be for these new elements to meet the U-values detailed in Table 6. Additionally, continuity of insulation should be ensured, and thermal bridging minimised.

Table 6: U-values for new thermal elements.

Building element	Building Regulations Part L2B		Proposed Development Specification	
	Threshold U-value (W/m²K)	Improved U-value (W/m²K)	Existing building (Refurbished) U-Value (W/m²K)	Existing building (Retained) U-Value (W/m²K)
Walls – external or internal cavity insulation	0.70	0.55	-	-
Walls – external or internal insulation ¹	0.70	0.30	0.15	0.35
Floors ²	0.70	0.25	0.25	0.25
Flat roofs or roofs with integral insulation ³	0.35	0.18	0.12	-
All other windows, roof windows and rooflights ⁴	n/a	n/a	1.10	2.20
Pedestrian Doors ⁵	n/a	n/a	1.60	1.60
High-usage entrance personnel doors	n/a	n/a	2.20	2.20

Notes:

1. The U-value of the retained existing building has been applied to the single storey building attached to the northeast of the main structure. All other existing walls have the U-value of the refurbished existing building.

2. The U-value of the floor of an extension can be calculated using the exposed perimeter and floor area of the whole enlarged building.

3. Roof includes roof parts of dormer windows and wall includes wall parts (cheeks) or dormer windows.

4. The U-value of the retained existing building has only been applied to the single storey building attached to the northeast of the main structure. All other existing walls have the U-value of the refurbished existing building.

5. Where the door has more than 60%of its internal face area glazed

A less provision may be appropriate where meeting such a standard would create significant problems in relation to adjoining floor levels.

This applies for those elements included in extensions and replacements of existing thermal elements within the host building.

However, exception can be made where improvement to meet the target parameters is unfeasible. Examples are:

- Thickness of additional insulation would reduce usable floor area of any room by >5%.
- Thickness of additional insulation would create difficulties with adjoining floor levels.
- The weight of additional insulation would not be supported by existing structural frame.
- A simple payback time calculation higher than 15 years is demonstrated.

The client's aspirations to achieve a net-zero development require the delivery of Part L2 compliance. The relevant Part L sections include mitigation of heat gains and losses through improved fabric, fixed building services elements and consequential improvements. Adjustments will be made to the fabric to achieve U-values and g-values beyond the Improved U-values in

Renovation of Thermal Elements.

Under Part L2B renovation of thermal elements is defined as:

- a. Provision of a new layer means either of the following activities:
 - i. Cladding or rendering external surface of the thermal element or
 - ii. Dry lining internal surface of a thermal element.
- b. Replacement of an existing layer means:
 - i. Stripping element to expose basic structural components and rebuilding.
 - ii. Replacing the waterproof membrane on a flat roof.

Where a thermal element is subject to renovation such as the above, the whole element performance should be improved to achieve or better the value in column 'Improved U-value' of Table 6 provided the area to be renovated is greater than 50% of the surface of the individual thermal element or constitutes a major renovation where more than 25% of the surface area of the building envelope undergoes renovation.

Alternatively, if the values in column 'New Element U-value' of Table 6 are not feasible or would not achieve a simple payback period of 15 years or less, the element should be upgraded to a standard that would achieve a simple payback of less than 15 years.

Where renovation of thermal elements is to be undertaken, this should follow the requirements listed above and where feasible achieve the improved U-values listed in Table 6.

Retained Thermal Elements.

Retained thermal elements should be upgraded when the following circumstances apply:

- Where an existing thermal element is part of a building subject to a material change of use.
- Where an existing thermal element is to become part of the thermal envelope, where previously it was not.
- Where an existing thermal element is being upgraded as a consequential improvement.

Table 6, column a) outlines the U-values that should be achieved when upgrading thermal elements where it is economically (payback through energy savings made in 15 years), technically and functionally (e.g. not resulting in reduced headroom) feasible.

Where not feasible to achieve the improved U-values, a lesser standard may be appropriate but should be no worse than 0.7 W/m².K. Upgrades to thermal elements should also avoid gaps in insulation, minimise air leakage and limit thermal bridging.

Upgrades to retained thermal elements should follow the requirements listed above and where feasible achieve the improved U-values listed in Table 6.

Material Change of Use.

Material change of use is when:

- a. The building is used as a hotel or a boarding house, where previously it was not
- b. The building was an institution, where previously it was not
- c. The building is used as a public building, where previously it was not
- d. The building is not a building described in Classes I to VI in Schedule 2, where previously it was
- e. The building controls a room for residential purposes, where previously it did not
- f. The building, which contains at least one room for residential purposes, contains a greater or a smaller number of such rooms than it did previously
- g. The building is used as a shop where previously it was not

This section of Part L2 does not apply as the existing school building will continue to be used as a school.

Change of Energy Status.

This is defined as ‘any change which results in a building becoming a building to which the energy efficiency requirements of these Regulations apply, where previously it was not’.

The work that results in a change in energy status must be carried out to ensure that the building complies with the applicable requirements of Part L of Schedule 1.

Reasonable provision would be, when there is a material change of use or change of energy status:

- a. Where controlled services or fittings are being provided to meet the requirements of controlled fittings. If the area of openings in the newly created building is more than 25% of the total floor area, the area of openings should either be reduced to be not greater than 25%, or the larger area compensated in some other way.
- b. Where there is provision of a thermal element, these should meet the requirements of thermal elements in L2.
- c. Retained thermal elements to be upgraded in accordance with L2.
- d. Where an existing window (including roof window or rooflight) or door which separates a conditioned space from unconditioned space or the external environment has a U-value that is worse than 3.3 W/m².K to follow guidance in L2 on controlled fittings unless it is a display window or high usage entrance door.
- e. Such building work may be one of the triggers for consequential improvements.

To allow more design flexibility, approved calculation tool may be used to demonstrate that the CO₂ emissions from the building as it will become are no worse than if the building had been improved following a-e above.

Change of energy status is not considered applicable to the Proposed Development.

Controlled Fixtures and Fittings.

In Part L2, controlled fixtures and fittings refer to the replacement, enlargement of provision of new windows and doors, including the frame.

Replacing the glazing, but keeping the existing frames, is not providing a controlled fitting, and such work is not notifiable and does not need to meet Part L standards.

Table 6 provides an overview of the limiting parameters for controlled fittings. New or replacement windows or doors should be draught-proofed units achieving U-values equivalent to or better than column ‘a’.

Where low-e secondary glazing is installed, draught-proofing should be also included on the secondary glazing to minimise risk of condensation forming between the primary and secondary glazing.

Where an existing window or door is enlarged or a new one created the total area of windows and doors should not exceed 25% of the total floor area of the building.

If a replacement window cannot meet the requirements because of the need to maintain external appearance, replacement windows should achieve a centre pane U-value of 1.2 W/m².K.

U-values of windows, roof-windows, rooflights and doors shall be calculated using the methods and conventions in BR443.

In cases where buildings have high internal gains, a less demanding U-value for glazing may be an appropriate way of reducing overall CO₂ emissions.

Table 7: U-values of windows and doors (extensions included).

Controlled Fittings	a) Maximum U-values for new and replacement windows and doors	b) Alternative maximum U-values for replacement windows and doors
Windows in buildings of domestic character	1.60 or WER Band C	1.2 centre pane or low-e secondary glazing
All other windows, roof windows and rooflights	1.80	
Curtain Walling	1.80	U _{Limit} = 0.8 + [(1.2 + (FOL x 0.5)) x GFFOL is fraction of opening lights, GF is glazed fraction
Pedestrian Doors where door has more than 60% of its internal face area glazed	1.80	1.2 centre pane
High-usage entrance doors for people	3.50	N/A
Vehicle access and similar large doors	1.50	N/A
Other large doors	1.80	N/A

Any replacement or enlargement of controlled fittings should meet requirements of Table 12 and/or Appendix D.

Controlled Services.

Where there is the provision or extension of controlled services, reasonable provision would be demonstrated by following the guidance set out in the Non-Domestic Building Services Compliance Guide (NDBSCG).

In general terms:

- a. For new fixed building services
 - i. Efficiency of not less than those quoted in the NDBSCG.
 - ii. Efficiency not less than that of the controlled service being replaced.
- b. Provide new HVAC systems with appropriate controls to achieve energy efficiency:

Replacement of renewable energy should be no less efficient than the one it replaces. Consider connection to existing heat networks.

The new MEP design should meet the minimum requirement as reported in Appendix D.

Consequential Improvements.

Consequential improvements are triggered in existing buildings over 1000m² of floor area where the work consists of:

- An extension
- The initial provision of any fixed building service
- An increase to the installed capacity of any fixed building service

Consequential improvements should be applied in addition to the principal works, where the latter should comply with the energy efficiency requirements in the normal way.

If improvement works are proposed, other than the trigger activities listed above, developers can use these as contributing to the consequential improvements.

For example, if, as well as extending the building, the proposals include total window replacement, then the window replacement work would satisfy the requirement for consequential improvements, provided the cost was at least 10% of the cost of the extension.

Examples of practical or economically feasible measures (i.e. those with simple payback of less than 15 years) are as follows:

- a. Upgrading heating, cooling or ventilation systems more than 15 years old (new services should be compliant with the efficiencies as given within the Non-Domestic Building Services Compliance Guide).
- b. Upgrading general lighting systems that have an average lamp efficacy of less than 40 lamp lumens per circuit Watt and that serve areas of more than 100m².
- c. Installing metering in line with CIBSE TM39.
- d. Upgrading thermal elements and windows, roof lights and doors in line with the guidance.
- e. Increasing on-site low and Zero Carbon (LZC) provisions.
- f. Measures specified in the recommendation report produced in parallel with the energy performance certificate.

The design allows for a partial refurbishment of the development including the extension and should meet the requirements a-d listed under Section 'Consequential Improvements'.

Consequential improvements on extending a building.

If a building is extended or the habitable area increased, compliance with this requirement could be achieved by implementing those measures listed above to the extent that their value is not less than 10% of the value of the principle works.

The design allows for a partial refurbishment of the development with a proposed extension. Based on this, the clause is relevant.

Consequential improvements on building services.

Where work to an existing building involves the provision, extension, alteration and replacement of any fixed building service, the guidance below should be followed:

- a. Improve in the first instance, fabric of those parts of the building served by the service where this is economically feasible.
- b. Adopt measures such as listed above, such that their value is not less than 10% of the value of the principal works.

Where there is an increase in installed capacity of the heating system, upgrades to the building fabric is required in line with the Table 6: U-values for new thermal elements. Additionally, where the U-value of windows exceed 3.3 W/m².K, these should be upgraded.

Where there is an increase in installed capacity of the cooling system, thermal elements in heated areas which have U-values worse than Table 7 column a) should be upgraded.

If the area of windows and roof windows within the area served exceeds 40% of the façade area or the area of rooflights exceeds 20% of the area of the roof and the design solar load exceeds 25 W/m², then the solar control provisions should be upgraded such that:

- a. Solar gain per unit floor area averaged over period 0630 to 1630 is not greater than 25 W/m².
- b. Design solar load is reduced by at least 20%.
- c. Effective g-value no worse than 0.3.
- d. Zone or zones satisfy criterion 3 check of Part L2 based on software calculations.

Any general lighting system within the area served by the relevant fixed building service which has an average lamp efficacy of less than 45 lamp lumens per circuit Watt should be upgraded with new luminaires and/or controls.

Where there is to be an increase in the installed capacity of the fixed building service, improvements to the building fabric should be made in the first instance, prior to the adoption of the measures listed above.

9. Simulation Modelling.

A dynamic simulation model was created to assess the design.

Integrated Environmental Solutions Virtual Environment (IESve) is a Dynamic Simulations Modelling (DSM) software package that has the capabilities of enabling the user to create a virtual representation of a building.

The results presented in this report were calculated using the approved compliance software **IESve 2023 (v2023.1.0.0)** for Part L modelling.

The IESve model for the Proposed Development was drawn based on the information received as listed in Section 3.2 Architectural drawings.

Modelling disclaimer.

It should be noted that the data generated by this work is obtained using computer simulations. These simulations are the best means of predicting the performance of the building at this stage. Full certainty can only be achieved by measuring the performance of the building and associated systems after a period of use.

The actual performance and/or energy usage for the building once occupied may vary from the calculated values submitted to Building Control. These differences will occur due to a number of variable parameters between the modelled building and the actual building. Such differences will include the hours of operation, levels of occupancy, how the plant is used and the design criteria with regards to how the rooms are environmentally controlled.

Whilst the simulations have been undertaken in good faith using reasonable skill and care, Hoare Lea can take no responsibility for differences between the computer simulations and the actual performance of the completed building due to the inherent complexity and variability of the physics in a building and its environment.

Appendix B: Floor plans.

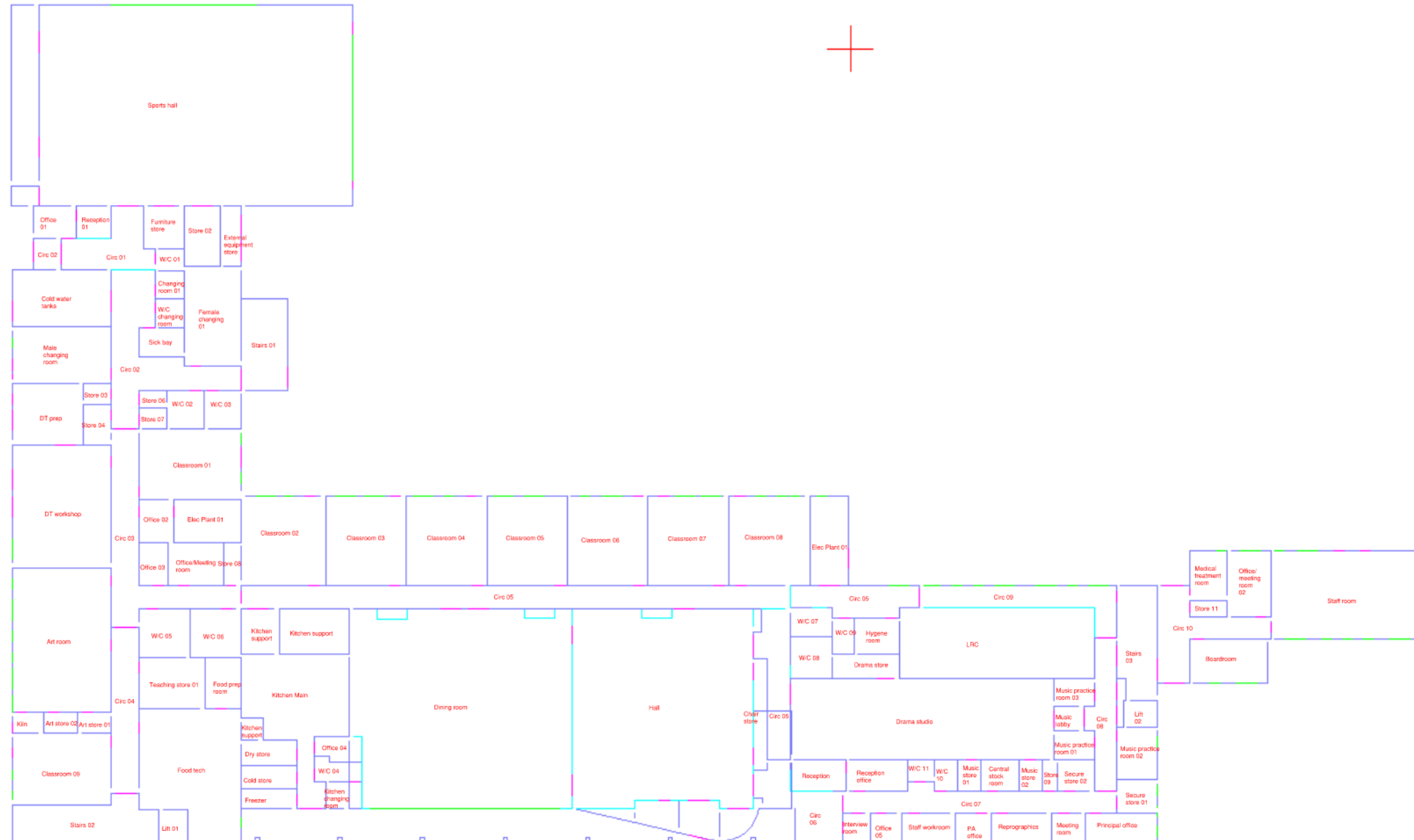


Figure 8 Ground floor plan from IES model confirming room names

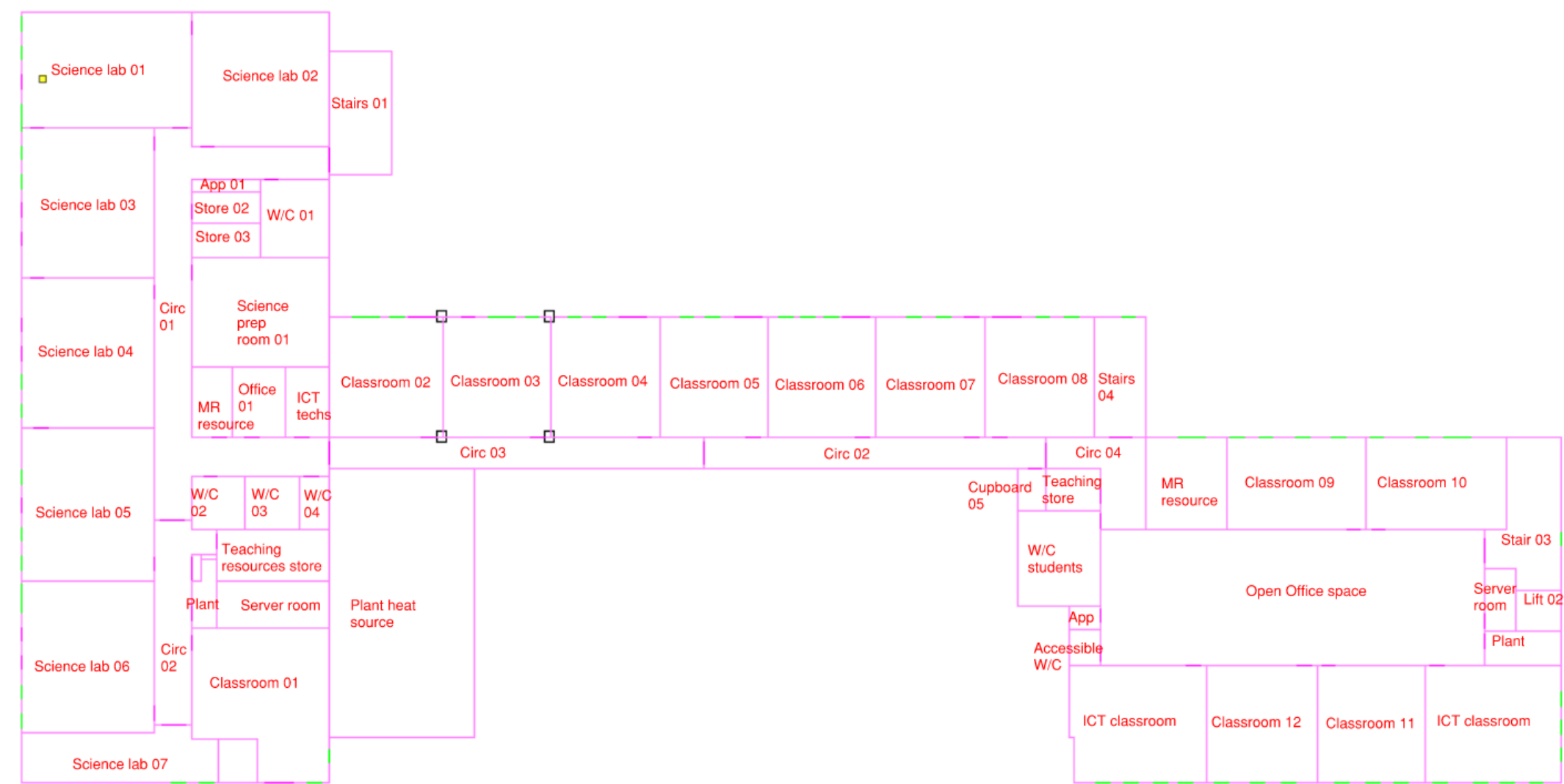


Figure 9 First floor plan from IES model confirming room names

Appendix C: Calculation Parameters.

Building Specification

The target building fabric performance is detailed below:

Table 8 - Fabric and Construction Parameters.

Parameter	Dixons Academy (W/m².K)		
	New build	Existing building (Refurbished)	Existing building (Retained)
External Wall	0.15	0.15	0.35
Louvred Panels	0.90	0.90	0.90
Passive Vent Panels	0.90	1.90	0.90
External Glazing – Typical (g-value)	1.10 (0.40)	1.10	2.2
Roof	0.12	0.12	-
Ground Floor	0.12	0.25	0.25
Fabric Air Permeability Average (m³/m².h at 50Pa)	3.00	3.00	9.00

Heating, Cooling and Ventilation Systems

The table below details the systems associated with each space type.

	Detail	Units	00 – DX Unit	01 – NVHR Heating	02a – Radiant Panels + MVHR	02b – Radiant Panels + NVHR	03 – AHU LTHW Heating Coil
	System Name/Description	-	Cooling	NVHR + LTHW Coil	MVHR + Radiant Panels	NVHR + Radiant Panels	Warm Air System
Heating	UK NCM System Type	-	Single Room Cooling System	Heating Using Water: Convectors	Central Heating Using Water: Radiant	Central Heating Using Water: Radiant	Central heating using air distribution
	Heat Source	-	ASHP (electric)	ASHP (electric)	ASHP (electric)	ASHP (electric)	ASHP (electric)
	Fuel Type	-	Electricity	Electricity	Electricity	Electricity	Electricity
	Was the System Installed After 1998	Y/N	Y	Y	Y	Y	Y
	Generator Seasonal Efficiency (COP)	%	4.00	3.95	3.95	3.95	3.95
	Does it Qualify for ECAs	-	-	-	-	-	-
	Pack Chiller Type	-	Heat Pump	-	-	-	-
	Pack Chiller Power	kW	-	-	-	-	-
Cooling	Chiller Fuel Type	-	Electricity	-	-	-	-
	Generator Seasonal EER (SEER)	%	3.50 (4.50)	-	-	-	-
	Does it Qualify for ECAs	Y/N	-	-	-	-	-
Adjustment & Metering	Ductwork Air Leakage CEN Classification	-	Class B	Class B	Class B	Class B	Class B
	AHU Air Leakage CEN Classification	-	Class L2	Class L2	Class L2	Class L2	Class L2
	System Specific Fan Power (SFP)	W/l/s	1.60	-	-	-	1.60
	Does the System have Provision for Metering	Y/N	Y	Y	Y	Y	Y
	Does the Metering Warn "Out of Range" Values?	Y/N	Y	Y	Y	Y	Y
Ventilation	Cooling / Ventilation Mechanism	-	Air Conditioning	Mechanical Ventilation	Mechanical Ventilation	Mechanical Ventilation	Mechanical Ventilation
	Air Supply Mechanism	-	Balanced A/C or Mechanical Vent	Local Ventilation Unit	Balanced A/C or Mechanical Vent	Local Ventilation Unit	Balanced A/C or Mechanical Vent
	Heat Recovery Type	-	Thermal Wheel	Plate Heat Exchanger	Plate Heat Exchanger	Plate Heat Exchanger	Thermal Wheel
	Heat Recovery Seasonal Efficiency	%	80%	75%	80%	50%	75%
			Server Room	Classrooms, Seminar Room, Science Labs, Art Room, DT Classroom and Prep Room, ICT Rooms, LRC	Dance Studio, Changing	Sports Hall, Main Hall	Kitchen

	Detail	Units	04a – Radiators + NV	04b – Radiators + AHU	04c – Radiators + MVHR	04d – Radiators + Supply	04d – Radiators + Extract
	System Name/Description	-	NV	AHU	MVHR	Supply Air	Extract Air
Heating	UK NCM System Type	-	Central Heating Using Water: Radiators	Central Heating Using Water: Radiators	Central Heating Using Water: Radiators	Central Heating Using Water: Radiators	Central Heating Using Water: Radiators
	Heat Source	-	ASHP (electric)	ASHP (electric)	ASHP (electric)	ASHP (electric)	ASHP (electric)
	Fuel Type	-	Electricity	Electricity	Electricity	Electricity	Electricity
	Was the System Installed After 1998	Y/N	Y	Y	Y	Y	Y
	Generator Seasonal Efficiency (COP)	%	3.95	3.95	3.95	3.95	3.95
	Does it Qualify for ECAs	-	-	-	-	-	-
Cooling	Pack Chiller Type	-	-	-	-	-	-
	Pack Chiller Power	kW	-	-	-	-	-
	Chiller Fuel Type	-	-	-	-	-	-
	Generator Seasonal EER (SEER)	%	-	-	-	-	-
	Does it Qualify for ECAs	Y/N	-	-	-	-	-
Adjustment & Metering	Ductwork Air Leakage CEN Classification	-	-	Class B	Class B	Class B	Class B
	AHU Air Leakage CEN Classification	-	-	Class L2	Class L2	Class L2	-
	System Specific Fan Power (SFP)	W/l/s	-	1.60	-	-	-
	Does the System have Provision for Metering	Y/N	Y	Y	Y	Y	Y
	Does the Metering Warn "Out of Range" Values?	Y/N	Y	Y	Y	Y	Y
Ventilation	Cooling / Ventilation Mechanism	-	Natural Ventilation	Mechanical Ventilation	Mechanical Ventilation	Mechanical Ventilation	Mechanical Ventilation
	Air Supply Mechanism	-	-	Balanced A/C or Mechanical Vent	Balanced A/C or Mechanical Vent	Zonal Supply System	Zonal Extract System
	Heat Recovery Type	-	-	Thermal Wheel	Plate Heat Exchanger	Thermal Wheel	-
	Heat Recovery Seasonal Efficiency	%	-	75%	80%	80%	-
			Corridors, Stairs	Dining Room	Offices, Boardroom, Staff Rooms, Music Practice, Lighting, Drama, Reception Office, Science Prep, Reprographics	Kitchen Office and Dry Store	WCs, Cleaners, Stores, Plant, Hygiene Room

Local Ventilation Specific Fan Powers (SFPs).

* Specific Fan Powers (SFPs) based on Manufacturers data

Unit Reference	System	Supply and / or Extract AHU Fan Power*	Local Extract Fan Power	Air Changes	Heat Recovery
MVHR	Supply and Extract	0.66	-	-	80%
NVHR	Supply and Extract	0.30	-	-	75%
AHU 1	AHU	1.60	-	-	75%
Extract	Extract	-	0.66	10 ACH	75%

Domestic Hot Water Systems.

Domestic Hot Water system: DHW – Storage	
Generator	Seasonal efficiency: 300% Electric Air Source Heat Pump
Storage	Storage volume: 802 litres Storage losses: 0.0029 kWh/l/day
Secondary Circulation	Circulation losses: 7.00 W/m Pump power: 0.15 kW Loop Length: 379 metres Time switch: Yes

Lighting Parameters.

Table 9 shows the target installed power densities and lighting controls for each space. The luminaire efficacy data was taken from the Relux interior lighting document.

The values are specified as an average for these space types.

Table 9 - Lighting Installed Power Densities and Controls per Space Type.

Template Name*	Lux Level	Luminaire Efficacy (lm/W)	Light Output Ratio (LOR)	Constant illuminance control	Lighting Controls **	Photoelectric (Daylight) Control	Total Parasitic Power (W/m²)	Display lamps (lm/W)
Classrooms	300	99.98-134.18	0.9	No	Auto On – Off	Yes	0.05	-
Cupboard	100	107.63-117.63	0.9	No	Man-On-Auto-Off	No	0.05	-
WCs	100	107.63-136.46	0.9	No	Auto On – Off	No	0.05	-
Office	300	121.77-127.5	0.9	No	Auto On – Off	Yes	0.05	-
Sports Hall	500	168.88	0.9	No	Auto On – Off	Yes	0.05	-
Reception	300	126.92-127.5	0.9	No	Auto On – Off	Yes	0.05	95
Staff	300	126.92	0.9	No	Auto On – Off	Yes	0.05	-
Stairs and Circulation	100	99.29-149.88	0.9	No	Auto On – Off	No	0.05	-

* Values assumed for the majority of rooms – a full breakdown of each individual room can be provided on request

Outer Perimeter Zones

Control algorithm: ramp(e1,0,1,300,0.10)

A formula suitable for applying as a dimming profile controlling lighting gain as a function of available daylight. It modulates the lighting gain as a function of the illuminance on the working plane, e1.

The value of the profile falls from 1 at zero illuminance to 0.10 at illuminance 300 lux, thereafter, remaining constant at this value.

The value 0.10 represents the fraction of the room's lighting gain which is not subject to daylight control.

The illuminance e1 has been computed using the link to Radiance

** Lighting Controls are defined as follows:

Auto On – Auto Off: Specifies presence detection sensors within the space which automatically switches lighting on when occupants are detected and switches lighting off when the space is detected to be unoccupied.

Manual On – Auto Off: Specifies absence detection sensors within the space. Lighting is required to be manually switched on. Automatically switches lighting off when the space is detected to be unoccupied.

9.1 Photovoltaic Cells

90,443.75 kWh generation apportioned to new build
361,775 kWh total generation of entire development
20% panel efficiency
175.6 kWp/m2 (active panel area)

9.2 Power factor

Electric Power Factor 0.9-0.95

Be Green + PV BRUKL Output

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Building Global Parameters			Building Use	
	Actual	Notional	% Area	Building Type
Floor area [m ²]	2029.8	2029.8		Retail/Financial and Professional Services
External area [m ²]	4837.8	4837.8		Restaurants and Cafes/Drinking Establishments/Takeaways
Weather	MAN	MAN		Offices and Workshop Businesses
Infiltration [m ³ /hm ² @ 50Pa]	3	4		General Industrial and Special Industrial Groups
Average conductance [W/K]	970.9	1404.7		Storage or Distribution
Average U-value [W/m ² K]	0.2	0.29		Hotels
Alpha value* [%]	25	10		Residential Institutions: Hospitals and Care Homes
				Residential Institutions: Residential Schools
				Residential Institutions: Universities and Colleges
				Secure Residential Institutions
				Residential Spaces
				Non-residential Institutions: Community/Day Centre
				Non-residential Institutions: Libraries, Museums, and Galleries
			100	Non-residential Institutions: Education
				Non-residential Institutions: Primary Health Care Building
				Non-residential Institutions: Crown and County Courts
				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

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

	Actual	Notional
Heating	6.61	18.58
Cooling	0	0
Auxiliary	3.26	3.34
Lighting	4.58	6.04
Hot water	4.57	5.41
Equipment*	35.4	35.4
TOTAL**	19.01	33.36

^{***} Total is net of any electrical energy displaced by CHP generators, if applicable.

	Actual	Notional
Photovoltaic systems	178.22	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
<i>Displaced electricity</i>	<i>178.22</i>	<i>0</i>

	Actual	Notional
Heating + cooling demand [MJ/m ²]	85.36	185.83
Primary energy [kWh _{pe} /m ²]	-234.65	50.33
Total emissions [kg/m ²]	-19.66	5.66



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