HOARE LEA

One Murphy Hub, Ollerton.

J. Murphy & Sons Ltd.

SUSTAINABILITY
STAGE 2 REPORT – APPROVED DOCUMENT PART L2 2021 ASSESSMENT

REVISION P01 – 01 DECEMBER 2023

STAGE 2

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
P01	01/12/2023	Part L2 compliance check	J. Daoud	K. Krasowska	T. Smith

Project number: 2325075
Document reference: SWF-HOA-SW-ZZ-RP-Y-00004.docx

Contents.

1. Executive summary.

This Part L assessment has been prepared on behalf of Murphy Property for the proposed office and workshop at the One Murphy Hub, Ollerton Development.

The study set out within this report was undertaken to test compliance of the non-residential buildings in accordance with Part L Volume 2, 2021.

This report consists of two separate Part L compliance assessments for each of the office and workshop buildings. The results of the Be Green assessment have been presented in scenarios, each which demonstrate a scenario with Low and Zero Carbon (LZC) technologies only -in this case Air Source Heat Pumps (ASHP)- and scenarios with varying amount of PV array. Each of the scenarios are described below:

Office

Scenario 1: ASHP only
Scenario 2: ASHP and PV array of 2080 sqm (east- and west-facing car park canopies)

Workshop

Scenario 1: ASHP only
Scenario 2: ASHP and roof PV array of 675 sqm (south-facing only)
Scenario 3: ASHP and roof PV array of 1350 sqm (north- and south-facing)

Be lean.

Target: betterment above baseline.	Office; 4.3% and Workshop; 6.1% reduction over baseline Appendix A details the target fabric and system performance parameters.

Be clean.

	Currently, the development will not be using a district heat network, therefore there are no results to display in this section.

Be green.

Target: betterment above baseline.	Office; 7.5% and Workshop; 7.1% reduction over baseline excluding PV contribution Solar PV can be installed on site on the canopy over the parking areas across from the office building, and on the roof of the workshop building, represented by 'Be Green' scenarios 2,3.

The office and workshop currently comply with Part L with a 7.5% and 7.1% betterment, respectively.
With indicative PV arrays specified, the final be Green reductions are estimated to achieve up to 265-576% reduction from notional building as specified by Building Regulations Part L2021.

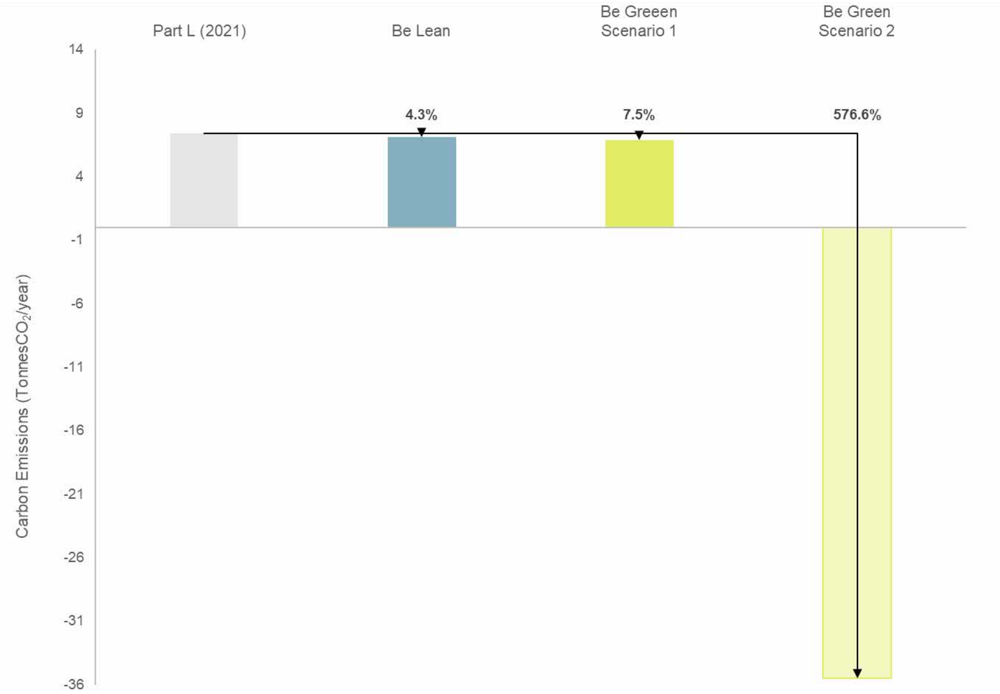


Figure 1 Carbon reduction summary of office building.

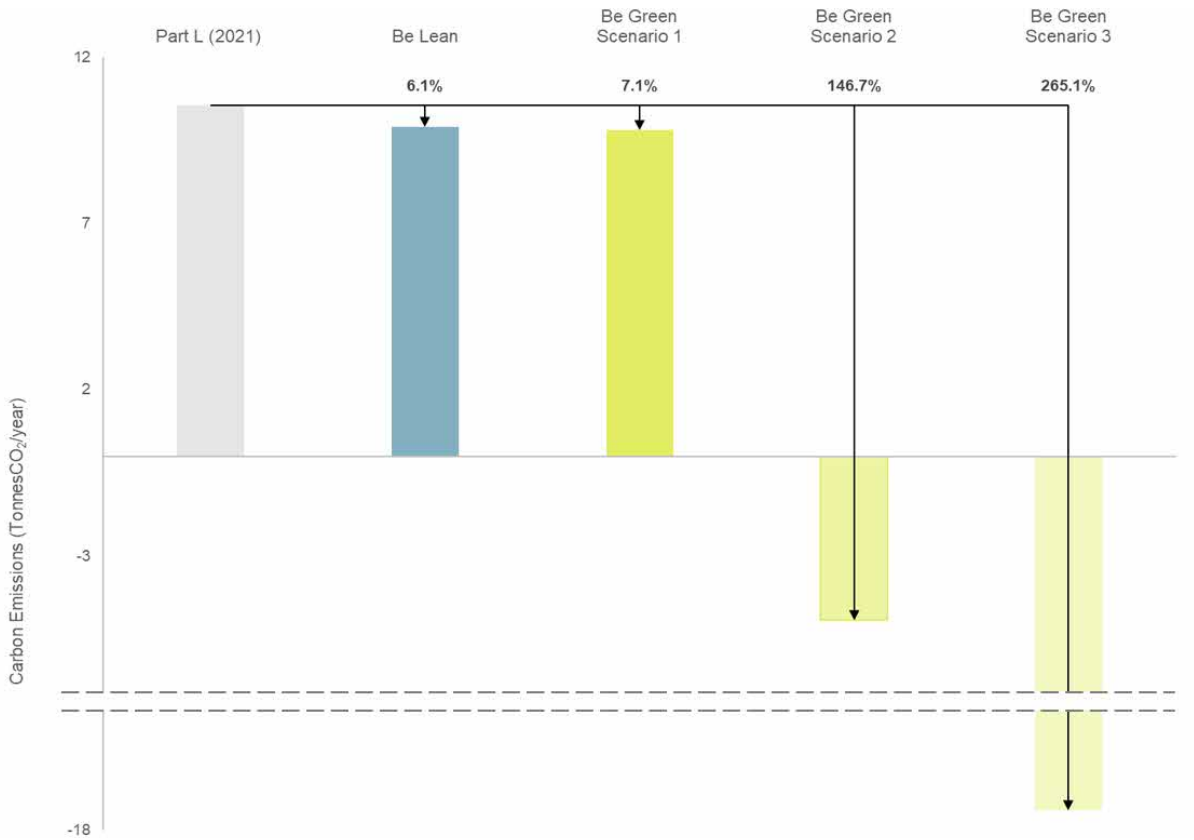


Figure 2 - Carbon reduction summary of the workshop (the graph above has been cut to fit page).

1.1 Approved Document Part L2 of the Building Regulations.

The results of the Part L assessment indicate that proposed development achieves compliance with criteria set out in:

The proposed development has been assessed to determine the actual development's Building Emission Rate (BER) and Building Primary Energy Rate (BPER) compared to the Target Emission Rate (TER) and Target Primary Energy Rate (TPER) determined by the notional building.

1.2 Development targets.

A policy review has been undertaken and is outlined in Section 3.

National drivers - Approved Document Part L of the Building Regulations.
Part L of the Building Regulations is the mechanism by which government is driving reductions in the regulated CO_2 emissions from new buildings. The assessment of the proposed development against policy targets has been carried out using Building Regulations Part L 2021 methodology.

Regional drivers – Nottingham Local Plan Part 1 & 2.
This Part L report follows the most recent publication of the Nottingham Local Plan Part 1 & 2. 'Be Lean, Be Clean, Be Green, Be Seen' has been adopted by the Nottingham Plan and calculations demonstrating the energy requirements and associated CO_2 emissions for the development have been carried out using Building Regulations approved software in order to comply with Policy 1: Reducing carbon dioxide emissions.

With this, SAP10.2 carbon factors have been utilised in line with GLA Energy Assessment Guidance issued in April 2020.

Local drivers – Nottingham Local Plan Part 1 & 2.
As well as the Nottingham Local Plan Part 1 which makes reference to the energy hierarchy, part 2 states policy CC1 and CC2. CC1 is sustainable design and construction, while CC2 is Decentralised Energy and Heat Networks.

1.3 Compliance procedure and software.

The Part L, Volume 2 assessment was carried out using the government approved Integrated Environmental Solutions Virtual Environment (IESve 2023.1.0.0) software to create a Dynamic Simulation Model (DSM) of the proposed development.

2. Introduction.

This report sets out to demonstrate a route to compliance with Approved Document Part L, conservation of fuel and power, for the One Murphy Hub, Ollerton development.

2.1 Assessment Approach.

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 strategy has been developed using a 'fabric first' approach and follows the energy hierarchy where applicable.

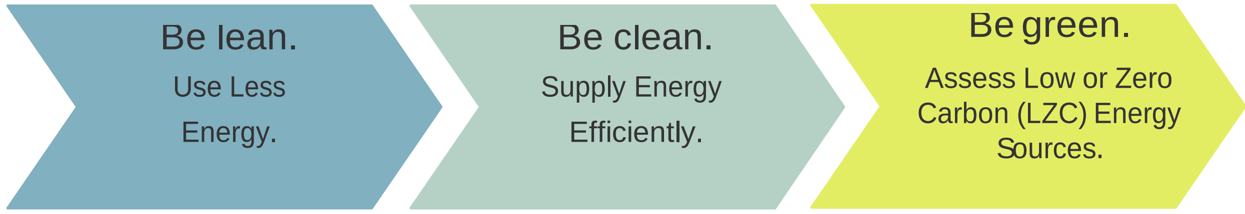


Figure 2: Energy hierarchy.

3. Key Drivers.

As a summary, the national planning policy appliable to the proposed development are outlined within this section.

3.1 Building Regulations Part L2 (2021).

The proposed development has been assessed in accordance with criteria set out in Part L, Volume 2 2021.

3.1.1 Schedule 1: Conservation of Fuel and Power.
Schedule 1 of the Building Regulations Part L states that reasonable provisions shall be made for the conservation of fuel and power in building by:

Limiting heat gains and losses:

- through thermal elements and other parts of the building fabric;
- from pipes, ducts and vessels used for space heating, space cooling and hot water services
- Providing fixed building services which:
  - are energy efficient;
  - have effective heat controls; and
  - are commissioned by testing and adjusting as necessary to ensure they use no more fuel and power than is reasonable in the circumstances.

3.1.2 Demonstrating compliance.
To demonstrate compliance with Part L, Volume 2, there are a number of regulations which must be met. Regulation 25 through to 26C detail the required energy performance of the new building.

Table 2: Part L2 Criteria.

Regulation 25	Minimum energy performance requirements for new buildings These requirements are in the form of a target primary energy rate and a target emission rate.
Regulation 25B	Nearly zero-energy requirements for new buildings Where a building is erected, it must be a nearly zero-energy building
Regulation 26	CO_2 Emission rates for new buildings Where a building is erected, it shall not exceed the target CO_2 emission rate (TER) for the building
Regulation 26C	Target Primary Energy rates for new buildings Where a building is erected, it must exceed the target primary energy rate (TPER) for the building

3.2 National Planning Policy Framework.

The latest iteration of the National Planning Policy Framework (NPPF) was published in September 2023 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."

3.3 Relevant Regional, Local and Site-Specific Policies.

As a summary of regional, local and site-specific planning policy documents applicable to the proposed development have been identified and include the below listed:

London Plan (March 2021)
LLDC Local Plan (2020 to 2036)
Your Sustainability Guide to Queen Elizabeth Park 2030 (2010)

3.3.1 Nottingham Local Plan Part 1.

The Nottingham Local Plan part 1 requires major non-domestic development and redevelopment proposals to submit a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.

Within this strategy, it is requested that, as a minimum, it should contain the following information where feasible:

1. All development proposals will be expected to mitigate against and adapt to climate change, to comply with national and contribute to local targets on reducing carbon emissions and energy use unless it can be demonstrated that compliance with the policy is not viable or feasible. Sustainable Design and Adaptation

2. Development, including refurbishment where it requires planning permission, will be expected to take account of the following:

a) how it makes effective use of sustainably sourced resources and materials, minimises waste, and water use. For residential development, planned water use should be no more than 105 litres per person per day;
b) how it is located, laid out, sited and designed to withstand the long and short term impacts of climate change, particularly the effect of rising temperatures, sustained periods of high temperatures and periods of intense rain and storms;
c) that the building form and its construction allows for adaptation to future changes in climate; and
d) that the building form and its construction permits further reduction in the building's carbon footprint, where feasible and viable. Reducing Carbon Dioxide Emissions

3. Development should demonstrate how carbon dioxide emissions have been minimised in accordance with the following energy hierarchy:

a) Using less energy through energy efficient building design and construction, including thermal insulation, passive ventilation and cooling;
b) Utilising energy efficient supplies – including connecting to available heat and power networks; and
c) Maximising use of renewable and low carbon energy generation system.

4. Further guidance on how development should contribute to reducing carbon dioxide emissions will be set out in part 2 Local Plans, where appropriate. 39 Decentralised Energy Generation

5. The extension of existing or development of new decentralised renewable and low-carbon energy schemes appropriate for the plan area will be promoted and encouraged, including biomass power generation, combined heat and power, and micro generation systems. In line with the energy hierarchy, adjacent new developments will be expected to utilise such energy wherever it is feasible and viable to do so. Flood Risk and Sustainable Drainage

6. Development will be supported that adopts the precautionary principle, that avoids areas of current and future flood risk, which, individually or cumulatively does not increase the risk of flooding elsewhere and, where possible, reduces flood risk.

7. Where no reasonable site within Flood Zone 1 is available, allocations in Flood Zone 2 and Flood Zone 3 will be considered on a sequential basis.

8. Where it is necessary to apply the Exception Test, the following factors will be taken into account when considering if development has wider sustainability benefits to the community that outweigh flood risk: a) there are exceptional and sustainable circumstances for locating the development within such areas, including the necessary re-use of brownfield sites; and b) the risk can be fully mitigated by engineering and design measures.
9. Where appropriate, further guidance on the application of the sequential and Exception Test will be set out in part 2 Local Plans.

10.All new development should incorporate measures to reduce surface water runoff whilst managing surface water drainage in a sustainable manner, and Sustainable Drainage Systems should be incorporated into all new development unless it can be demonstrated that such measures are not viable or technically feasible

3.3.2 Local drivers – Nottingham Local Plan Part 2.

PolicyCC1: Sustainable Design and Construction Energy Efficient Buildings

1. In line with the energy hierarchy set out in the Core Strategy, wherever technically feasible and viable, the Council will require non-domestic developments of 1,000 square metres of floorspace or above to achieve "Very Good" in BREEAM assessments and negotiate for "Excellent" where viable and feasible. In order to support the NPPF aim of moving to a low carbon future, zero carbon development (both domestic and non-domestic) will be encouraged from 2019. Sustainable Design

2. All development proposals (including changes of use) will be expected to maximise opportunities to incorporate sustainable design features where feasible (such as grey water recycling, green roofs, maximising use of recycled materials, orientating buildings to optimise solar gain).

3. New dwellings should meet the optional higher National Housing Standard for water consumption of 110 litres per person per day, subject to viability.

4. Innovative sustainable design solutions for energy efficiency and low carbon energy generation and use over and above the Building Regulations will be supported.

Policy CC2: Decentralised Energy and Heat Networks The Existing Network

1. In line with the Core Strategy, the City Council will encourage connection to the existing decentralised energy and heat network as shown on the Policies Map. Connection will normally be expected where feasible and viable in terms of the development's location and forecast annual heat consumption. Future Development

2. The potential to develop low carbon and renewable energy resources (including decentralised heat and power networks) should be considered as part of development proposals, taking into account the site's characteristics and the existing heat and power demands on adjacent sites.

3. Planning permission will be granted for proposals to develop low carbon and renewable energy sources (including decentralised heat and power networks) unless there would be:

a) significant harm to residential amenity due to noise, traffic, pollution or odour;
b) significant harm to wildlife species or habitat;
c) unacceptable visual impact on the landscape;
d) unacceptable impacts on the setting of heritage assets; and
e) unacceptable impact on air safety.

In addition to the above criteria, wind turbines should avoid unacceptable shadow flicker and electro-magnetic interference and be sited a distance away from domestic properties consistent with the size and type of the turbine.

4. In the case of energy generation through wind power, permission will only be granted for proposals where:

a) the proposed site is identified in a Neighbourhood Development Plan or other Development Plan Document as a suitable site for wind energy generation; and
b) following consultation, it can be demonstrated that the planning impacts identified by the affected local community can be fully addressed, and therefore the proposal has the backing of the local community.

Table 3: Summary of applicable key policies related to energy and carbon – Nottingham Local Plan Part 1 and 2.

Part 1 - Policy 1: Climate Change	Description
Sustainable Design and Adaptation	Development, including refurbishment where it requires planning permission, will be expected to take account of the following: a) that the building form and its construction permits further reduction in the building's carbon footprint, where feasible and viable.
Reducing Carbon Dioxide Emissions	Development should demonstrate how carbon dioxide emissions have been minimised in accordance with the following energy hierarchy: a) Using less energy through energy efficient building design and construction, including thermal insulation, passive ventilation and cooling; b) Utilising energy efficient supplies – including connecting to available heat and power networks; and c) Maximising use of renewable and low carbon energy generation system
Part 2 – Policy CC1: Sustainable Design and Construction	**Description**
Energy Efficient Buildings	1. The Council will require non-domestic developments of 1,000 square metres of floorspace or above to achieve "Very Good" in BREEAM assessments and negotiate for "Excellent" where viable and feasible.
Sustainable Design	2. All development proposals (including changes of use) will be expected to maximise opportunities to incorporate sustainable design features where feasible (such as grey water recycling, green roofs, maximising use of recycled materials, orientating buildings to optimise solar gain). 4. Innovative sustainable design solutions for energy efficiency and low carbon energy generation and use over and above the Building Regulations will be supported.

4. Compliance procedure and software.

The proposed development has been assessed using The National Calculation Methodology for demonstrating compliance with Building Regulations Part L and the Local Planning Policy requirements.

4.1 Part L, Volume 2 compliance.

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).

The IESve model for the proposed development was drawn to geometry received from GTH architects, detailed in table 4.

4.2 Modelling disclaimer.

The calculations produced by Hoare Lea have been carried out with the information provided by the relevant architect to determine whether the proposed development can achieve compliance with Approved Document Part L, Volume 2 of the Building Regulations and Local Planning Policy requirements.

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 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, 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.

5. Assessment methodology.

5.1 Site Context.

The site is located in Nottingham.

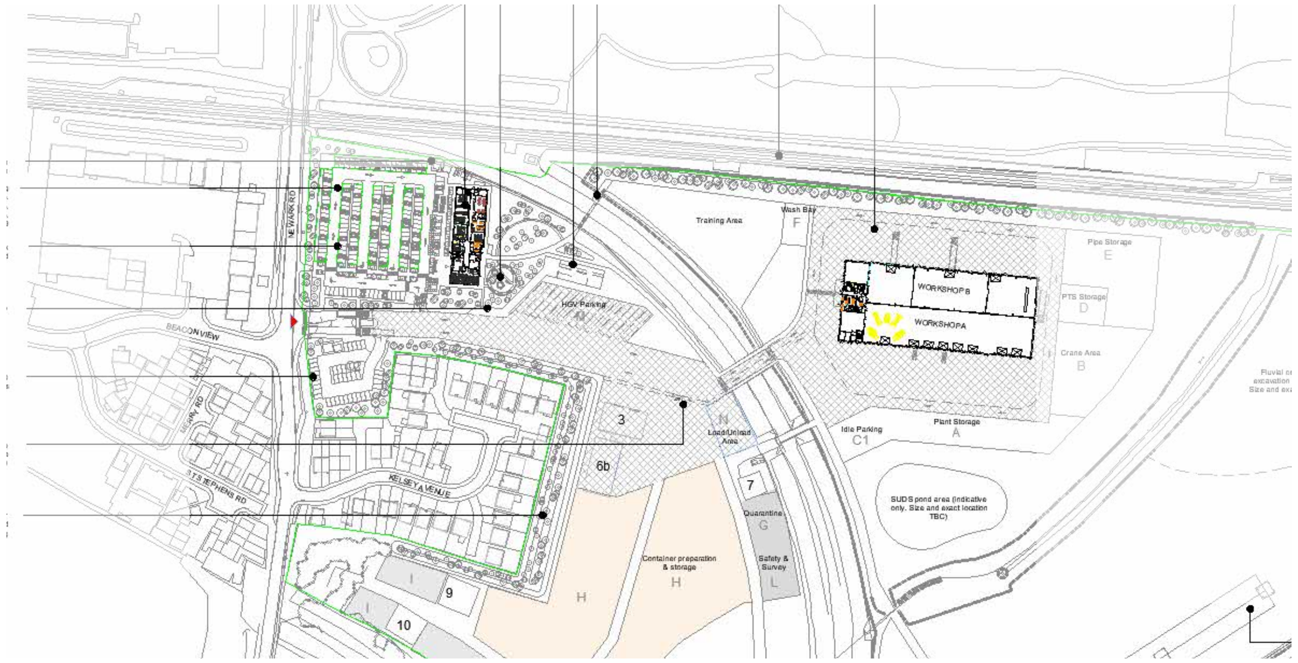


Figure 5: Proposed site plan of the One Murphy Hub development with respect to the surrounding area.

5.2 Architectural drawings.

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

Table 5: Architectural Information.

Source	Data Type	Description	Uploaded
GTH architects	Plans	DRAFT_117-GTH-0-ZZ-DR-A-1100-Site Plan - Proposed	09/11/2023
		DRAFT_117-GTH-02-00-DR-A-1000-GA Plan - Ground Floor	
		DRAFT_117-GTH-02-01-DR-A-1001-GA Plan - First Floor	
		DRAFT_117-GTH-02-02-DR-A-1002-GA Plan - Roof Plan	
		DRAFT_117-GTH-02-GF-DR-A-2000-Sections	
		DRAFT_117-GTH-02-GF-DR-A-2500-Elevations	
		DRAFT_117-GTH-03-DR-A-1000-GA Plan - Ground Floor	
		DRAFT_117-GTH-03-DR-A-1001-GA Plan - First Floor	
		DRAFT_117-GTH-03-DR-A-1003-GA Plan - Roof Plan	
		DRAFT_117-GTH-03-DR-A-2000-Sections	
		DRAFT_117-GTH-03-DR-A-2500-Elevations	

5.3 Site location and weather data.

A building's thermal performance is it's 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).

Following the standardised methodology behind the Part L requirements, the closest CIBSE weather file location for the proposed development is the Nottingham TRY (2016) and has been utilised for the purposes of these calculations.

5.4 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. Shading had been included on the façades to mitigate the risk of both overheating and increased cooling demand within the occupied zones of the development.

The target building fabric performance is detailed in Table 6 below:

Table 6: Fabric and Construction Parameters.

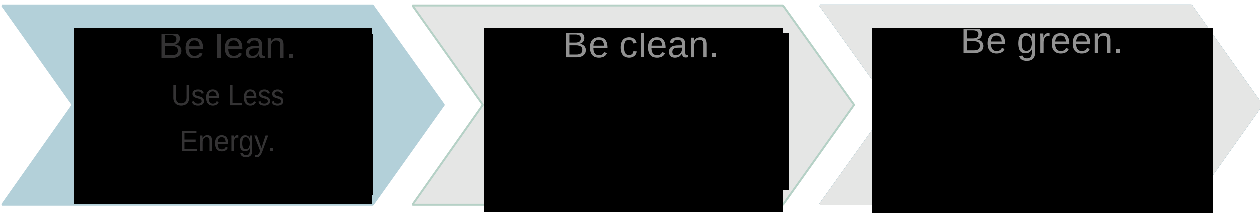
Parameter	Value
Fabric Air Permeability ($m^3/m^2 \cdot h$ @50Pa)	3.00
External Wall U-value ($W/m^2 \cdot K$)	0.15
Ground Floor U-value ($W/m^2 \cdot K$)	0.10
Roof U-value ($W/m^2 \cdot K$)	0.15
Glazing U-value ($W/m^2 \cdot K$)	1.20
Skylight U-value ($W/m^2 \cdot K$)	1.30
Glazing g-value	0.35
Glazing light transmittance	70%
Glazing Frame percentage	10%
Solid Door U-value ($W/m^2 \cdot K$) – Solid	1.60
Vehicular Access Doors U-value ($W/m^2 \cdot K$)	1.30

5.5 Calculation parameters.

The assessment for the proposed development has been undertaken with the consideration of the MEP Heating, Cooling and Ventilation (HVAC) systems, internal gains and profiles which are detailed in Appendix A: Calculation Input parameters.

6. 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 reduce the energy demand initially by optimising the envelope and building services within the development.



6.1 Passive design and energy efficiency 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 CO_2 emissions as the performance of the solutions, such as wall 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.

Table 7: Proposed fabric performance

Parameter	Value
Fabric Air Permeability (m^3/m^2·h @50Pa)	3.00
External Wall U-value (W/m^2·K)	0.15
Ground Floor U-value (W/m^2·K)	0.10
Roof U-value (W/m^2·K)	0.15
Glazing U-value (W/m^2·K)	1.20
Skylight U-value (W/m^2·K)	1.30
Glazing g-value	0.35
Glazing light transmittance	70%
Glazing Frame percentage	10%
Personal Door U-value (W/m^2·K) – Solid	1.60
Vehicular Access Doors U-value (W/m^2·K)	1.30

Table 8: Proposed system parameters

System parameters	
Ventilation	Mechanical ventilation with heat recovery Heat recovery efficiency: 75% System specific fan power: 1.4 W/(l/s)
Lighting	All low energy LED lighting Lighting densities have been based on similar project function and scale. This can be found in Appendix A. Lighting Controls: Auto on-off with daylight dimming in perimeter areas and control half-back sensors.

Full simulation inputs depicting the Proposed Development at the be lean stage are provided in Appendix A.

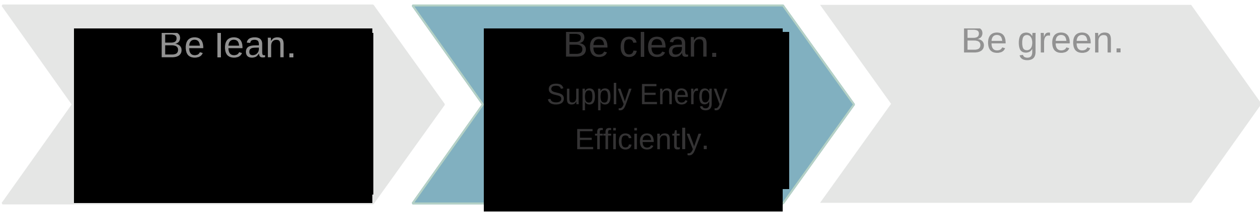
The Part L 2021 results are in line with the Nottingham Local Plan which requires following the energy hierarchy by prioritising the optimisation of all passive measures. This assessment demonstrates a carbon reduction beyond the Part L reduction of 4.3% and 6.1% for the office and workshop respectively.

Be lean summary.

Target: betterment above baseline.	Office; 4.3% and Workshop; 6.1% reduction over baseline Appendix A details the target fabric and system performance parameters.

7. 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.



Be clean summary.

	Currently, the development will not be using a district heat network, therefore there are no results to display in this section.

8. Be green.

The final step of the energy hierarchy 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.

Be lean. [redacted]

Be clean. [redacted]

Be green. Assess Low or Zero Carbon (LZC) Energy Sources.

8.1 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 city centre locations.

	Ground source heat pumps Ground Source systems would require extensive below ground works to bury and install the system on site. Given the existing building present at the site, which will be retained, Ground Source Heat Pumps are not considered a feasible option, and are not proposed
	Water source heat pumps Water source heat pumps use bodies of water, such as rivers, lakes or oceans to provide heating or cooling energy to a building.
	Air source heat pumps Air source heat pumps (ASHP) use thermodynamic principles to convert heat from the 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: ASHPs are considered suitable for the development and will be used.
	Solar thermal Solar Thermal Panels are similar to PV Panels in that they harness energy from solar energy. This technology however converts solar energy into thermal energy that can offset the demand on hot water generation systems. Suitability to Proposed Development: Solar thermal panels will not be suitable for this project as they would reduce available space for the photovoltaic array on the roof.

	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: Photovoltaic panels will be incorporated on canopies above parking spaces and on the roof of the workshop.
	Wind turbine For efficient operation and to yield high energy output, wind turbines require a consistent flow of air to generate electricity using wind energy. Suitability to Proposed Development: Although the Proposed Development is away from a dense urban environment, wind turbines have not been considered at this stage.
	Biomass Biomass boilers burn wood fuel or other bio-fuel sources to generate heat. These boilers can operate at high efficiencies, comparable to condensing gas boilers. However, they require a large fuel store to maintain continuous operation during the winter months. As such, area take for such plant is high. Furthermore, fuel deliveries in city-centre locations can prove difficult and security of fuel supply is an important consideration. Suitability to Proposed Development: The proposed development will use ASHPs therefore biomass heat generation is not considered for this project.

Full simulation inputs depicting the Proposed Development at the be clean and be green steps are provided in Appendix A.

Be green summary.

Target: betterment above baseline.	'Be Green' scenario 1: Office; 7.5% and Workshop; 7.1% reduction over baseline with ASHP only Following scenarios were tested to estimate carbon reductions upon implementation of PV technology, as follows: Office Scenario 2: ASHP and PV array of 2080 sqm (east- and west-facing car park canopies) – 576.6% reduction Workshop Scenario 2: ASHP and roof PV array of 675 sqm (south-facing only)- 146.7% reduction Scenario 3: ASHP and roof PV array of 1350 sqm (north- and south-facing)- 265.1% reduction

9. Summary.

9.1 The energy strategy.

The strategy has been developed using the 'be lean, clean and green' energy hierarchy which utilises a fabric first approach to maximise reduction in energy through passive design measures.

Be lean.

Target: betterment above baseline.	Office; 4.3% and Workshop; 6.1% reduction over baseline Appendix A details the target fabric and system performance parameters.

Be clean.

	Currently, the development will not be using a district heat network, therefore there are no results to display in this section.

Be green.

Target: betterment above baseline.	Office; 7.5% and Workshop; 7.1% reduction over baseline excluding PV contribution Solar PV can be installed on site on the canopy over the parking areas across from the office building, and on the roof of the workshop building, represented by 'Be Green' scenarios 2,3.

This strategy has shown that the Proposed Development achieves a sufficient reduction across the hierarchy and in all the Scenarios. The results of the Be Green assessment have been presented in scenarios, each which demonstrate a scenario with Low and Zero Carbon (LZC) technologies only -in this case Air Source Heat Pumps (ASHP)- and scenarios with varying amount of PV array. Each of the scenarios are described below:

Office
- Scenario 1: ASHP only
- Scenario 2: ASHP and PV array of 2080 sqm (east- and west-facing car park canopies)

Workshop
- Scenario 1: ASHP only
- Scenario 2: ASHP and roof PV array of 675 sqm (south-facing only)
- Scenario 3: ASHP and roof PV array of 1350 sqm (north- and south-facing)

All of the scenarios presented have demonstrated compliance and therefore all are considered a viable strategy. The demonstration of the scenarios is merely an optioneering exercise subject to client comment. Although the development has met compliance with the Part L requirements, the addition of PV technology can pose benefits such as offsetting carbon emissions, alleviating pressure off the national grid -as it decarbonises- and decreasing energy bills.

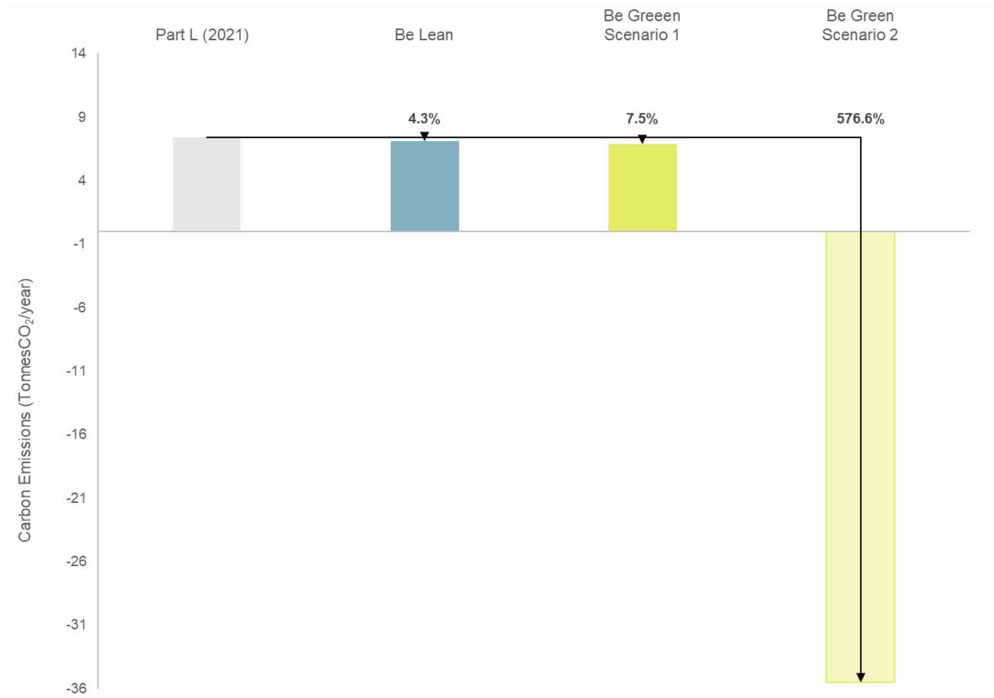


Figure 1: Carbon reduction summary of office building.

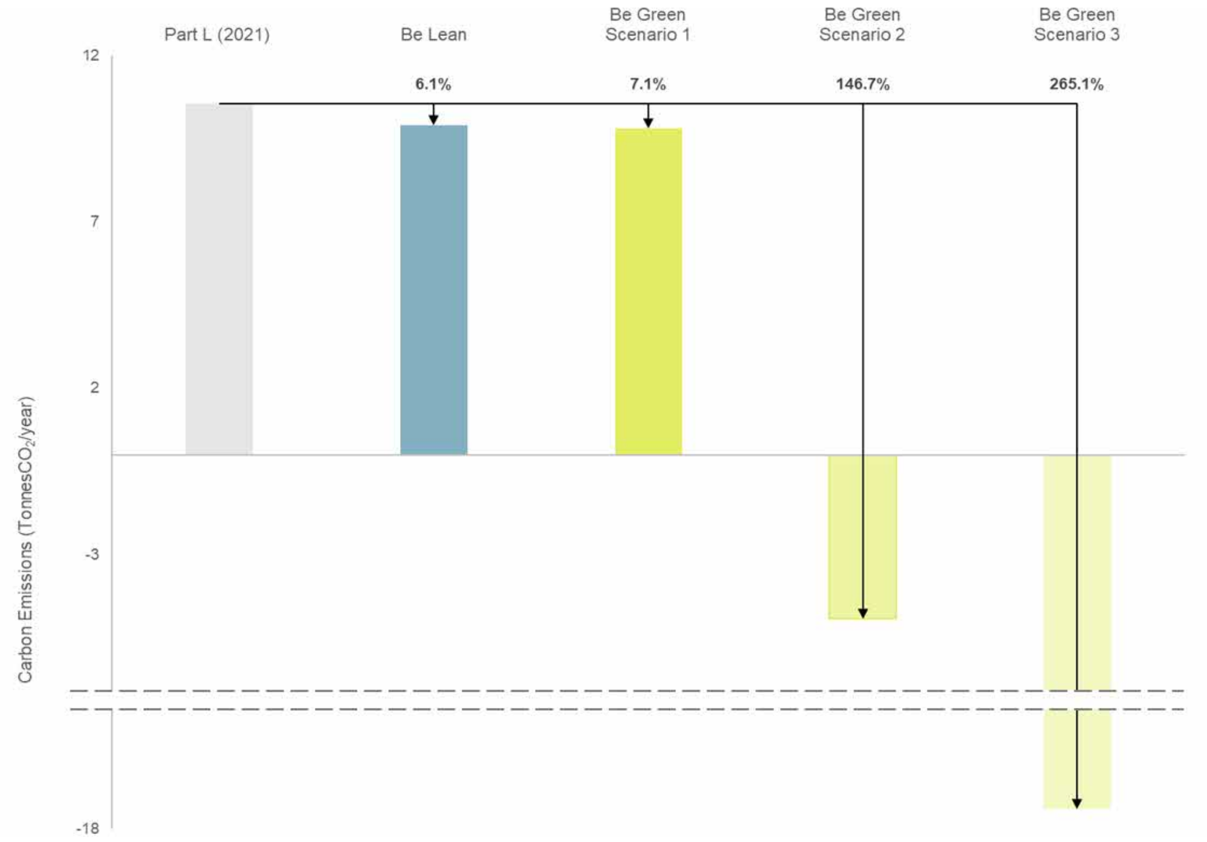


Figure 3 - Carbon reduction summary of the workshop (the graph above has been sectioned to fit page).

Conclusion.

This report summarises the assessment undertaken for the One Murphy Hub, Ollerton office and workshop development.

The Approved Document Part L, Volume 2 compliance assessment was undertaken using a series of calculation parameters which consisted of:

- Architectural geometry received from GTH Architects.
- Fabric parameters, agreed with GTH Architects and Murphy Property.
- Site location and weather data; and,
- System parameters which specify heating, ventilation, auxiliary power, lighting and domestic hot water details.

The results of the Part L compliance assessments indicate that the proposed development achieves the following results when the modelled with the parameters stated within this report:

Compliance with Approved Document L, Volume 2 (2021, England) with a betterment of 576.6% and 146.7% over the Target Emission for the office and workshop respectively.

Appendix A: Calculation Input Parameters.

Building Fabric Specification.

The target building fabric performance is detailed below:

Table 11: Fabric parameters.

Parameter	Value
Fabric Air Permeability ($m^3/m^2 \cdot h$ at 50Pa)	3.00
External Wall U-value ($W/m^2 \cdot K$)	0.15
Ground / Exposed Floor U-value ($W/m^2 \cdot K$)	0.10
Roof U-value ($W/m^2 \cdot K$)	0.15
Glazing U-value ($W/m^2 \cdot K$)	1.20
Skylight U-value ($W/m^2 \cdot K$)	1.30
Glazing g-value	0.35
Glazing light transmittance	70%
Glazing Frame percentage	10%
Solid Door U-value ($W/m^2 \cdot K$)	1.60
Vehicular Access Doors U-value ($W/m^2 \cdot K$)	1.30

Heating, cooling and ventilation systems.

The diagrams below detail which systems are associated with each space type:

Table 12: Non-Domestic Input Parameters.

	Detail	Units	System 01 – Radiator heating NV	System 02 – Radiator heating MV	System 03 – Radiator heating Extract	System 04– VRF with FCU	System 05 – DX cooling
	UK NCM System Type	-	Central heating using water: Radiators	Central heating using water: Radiators	Central heating using water: Radiators		Central heating using water: Radiators
Heating	Heat Source	-	Air Source Heat Pump	Air Source Heat Pump	Air Source Heat Pump	Air Source Heat Pump	Air Source Heat Pump
	Fuel Type	-	Electricity	Electricity	Electricity	Electricity	Electricity
	Generator Seasonal Efficiency	Ratio	3.10	3.10	3.10	3.10	3.10
Cooling	Pack Chiller Type	-	-	-	-	Heat Pump	Heat Pump
	Pack Chiller Power	kW	-	-	-	-	-
	Chiller Fuel Type	-	-	-	-	Electricity	Electricity
	Generator Seasonal EER (SEER)	%	-	-	-	3.50 (3.10)	4.00 (3.50)
	Does it Qualify for ECAs	Y/N	-	-	-	-	-
Adjustment & Metering	Ductwork Air Leakage CEN Classification	-	-	Class A	Class A	Class A	Class A
	AHU Air Leakage CEN Classification	-	-	Class L3	Class L3	Class L3	Class L3
	System Specific Fan Power (SFP)	W/ l/ s	-	1.40	-	1.40	1.40
	Pump Type		-	Constant	Constant	-	-
	Does the System have Provision for Metering	Y/N	-	Y	Y	Y	Y
	Does the Metering Warn "Out of Range" Values?	Y/N	-	Y	Y	Y	Y
Ventilation	Cooling / Ventilation Mechanism	-	-	Mechanical ventilation	Mechanical ventilation	Air conditioning	Air conditioning
	Air Supply Mechanism	-	-	Centralised balanced A/C or mech vent system	Local ventilation	Centralised balanced A/C or mech vent system	Centralised balanced A/C or mech vent system
	Heat Recovery Type	-	-	Plate Heat Exchanger	-	Plate Heat Exchanger	Plate Heat Exchanger
	Heat Recovery Seasonal Efficiency	%	-	80	-	80	80
	Demand Control Ventilation	-	-	N	N	Y – gas sensor, speed control	N
	Mechanical Exhaust Extract Flow Rate	Ac/ hr	-	-	6 ACH	-	-
	Exhaust/Terminal Unit Specific Fan Power	W(l/ s)	-	-	0.30 W/l/s	-	-
	Room type applied		Circulation, stairs, lobbies	Showers, changing	WC	Classroom, Training, Offices, First Aid, Prayer room, Lockers, Cafeteria	Comms

Lighting Parameters.

The table below shows the target installed power densities and lighting controls for each space.

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

Table 13: Lighting Installed Power Densities and Controls per Space Type.

Specific Lighting System/Area	Main Lighting Gains		Display Lighting		Main Lighting Controls									
	Design Illuminance (lux)	Installed Power Density (W/m²/100lux)	Lamp Efficacy (lm/W)	Time Switch?	Local Manual Switch?	Constant Illuminance Control?	Photoelectric Options					Occupancy Options		
							Photo-electric Options?	Control type	Sensor Type	Time-switch?	Parasitic Power (W/m²)	Sensing Type*	Parasitic Power (W/m²)	Time-Switch?
Cafeteria	500	1.30	-	N	N	Y	Y	Dimming	Standalone	Y	0.10	AUTO-ON-OFF	0.10	Y
Circulation Areas	100	1.80	-	N	N	N	N	-	-	-	-	AUTO-ON-OFF	0.10	Y
Classrooms	300	1.50	-	N	N	Y	Y	Dimming	Standalone	Y	0.10	AUTO-ON-OFF	0.10	Y
Comms	300	2.00	-	N	N	N	N	-	-	-	-	AUTO-ON-OFF	0.10	Y
First aid	300	2.00	-	N	N	Y	Y	Dimming	Standalone	Y	0.10	AUTO-ON-OFF	0.10	Y
Kitchen	500	2.00	-	N	Y	Y	Y	Dimming	Standalone	Y	0.10	MAN-ON-AUTO-OFF	0.10	Y
Office (incl. meeting rooms)	300	1.30	-	N	N	Y	Y	Dimming	Standalone	Y	0.10	AUTO-ON-OFF	0.10	Y
Plant	200	1.80	-	N	N	N	N	-	-	-	-	AUTO-ON-OFF	0.10	N
Prayer room	300	3.10	-	-	N	N	Y	Dimming	Standalone	Y	0.10	AUTO-ON-OFF	0.10	Y
Reception	300	1.30	95	Y	N	N	Y	Dimming	Standalone	Y	0.10	AUTO-ON-OFF	0.10	Y
Stair	100	1.80	-	N	N	N	N	-	-	-	-	AUTO-ON-OFF	0.10	Y
Shower	200	3.50	-	N	N	N	N	-	-	-	-	AUTO-ON-OFF	0.10	Y
Store	100	2.00	-	N	Y	N	N	-	-	-	-	MAN-ON-AUTO-OFF	0.10	Y
Workshop	300	1.30	-	N	N	Y	Y	Dimming	Standalone	Y	0.10	AUTO-ON-OFF	0.10	Y
W/C	200	2.00	-	N	N	N	N	-	-	-	-	AUTO-ON-OFF	0.10	Y

Domestic Hot Water Systems.

Table 14: DHW Details.

Hot Water system: DHW – POU 1	Kitchen/ Dining
Generator Type	Direct Electric
Fuel Type	Electricity
DHW Delivery Efficiency (%)	100
Storage Volume (l)	100
Storage Losses (kWh/ l*day)	0.015
Secondary Circulation Losses (W/ m)	9.00
Loop Length (m)	20.00
Pump Power (kW)	0.15
Time-switch	-

Hot Water system: DHW – POU 2	Showers	Toilets
Generator Type	Heat Pump	Heat Pump
Fuel Type	Electricity	Electricity
DHW Delivery Efficiency (%)	100	100
Storage Volume (l)	15	5
Storage Losses (kWh/ l*day)	0.015	0.015
Secondary Circulation Losses (W/ m)	-	-
Loop Length (m)	-	-
Pump Power (kW)	-	-
Time-switch	-	-

Appendix B: Office Be Lean BRUKL (2021).

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

Office Be Lean As designed

Date: Wed Nov 29 11:42:02 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.22

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.22

BRUKL compliance module version: v6.1.e.1

Foundation area [m²]: 715.95

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2annum$	4.92	
Building CO_2 emission rate (BER), $kgCO_2/m^2annum$	4.71	
Target primary energy rate (TPER), kWh_{PE}/m^2annum	52.73	
Building primary energy rate (BPER), kWh_{PE}/m^2annum	50.67	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

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

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.15	0.15	00000002:Surf[2]
Floors	0.18	0.1	0.1	00000002:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.15	0.15	01000001:Surf[1]
Windows** and roof windows	1.6	1.2	1.2	00000009:Surf[1]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	1.6	1.6	00000002:Surf[1]
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]

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

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

*** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

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

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

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Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	1514.4	1514.4
External area [m²]	2808.4	2808.4
Weather	NOT	NOT
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	703.99	861.2
Average U-value [W/m²K]	0.25	0.31
Alpha value* [%]	24.87	10

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

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
100	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	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
	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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	9.25	8.88
Cooling	3.28	1.19
Auxiliary	3.16	6.16
Lighting	6	8.37
Hot water	12.42	10.81
Equipment*	31.96	31.96
TOTAL**	**34.11**	**35.41**

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

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	113.13	108.73
Primary energy [kWh_{PE}/m^2]	50.67	52.73
Total emissions [kg/m²]	4.71	4.92

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Appendix C: Office Be Green BRUKL (2021).

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

2325075 - Robin Hood - Office Be Green -Rev 01 PV Canopy

As designed

Date: Wed Nov 29 17:31:36 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.22

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.22

BRUKL compliance module version: v6.1.e.1

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Foundation area [m²]: 715.95

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2annum$	4.92	
Building CO_2 emission rate (BER), $kgCO_2/m^2annum$	-23.45	
Target primary energy rate (TPER), kWh_{PE}/m^2annum	52.67	
Building primary energy rate (BPER), kWh_{PE}/m^2annum	-272.55	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

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

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.15	0.15	00000002:Surf[2]
Floors	0.18	0.1	0.1	00000002:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.15	0.15	01000001:Surf[1]
Windows** and roof windows	1.6	1.2	1.2	00000009:Surf[1]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	1.6	1.6	00000002:Surf[1]
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]
* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
** Display windows and similar glazing are excluded from the U-value check.
*** Values for rooflights refer to the horizontal position.
^ For fire doors, limiting U-value is 1.8 W/m²K
NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

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Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	1514.4	1514.4
External area [m²]	2808.4	2808.4
Weather	NOT	NOT
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	703.99	861.2
Average U-value [W/m²K]	0.25	0.31
Alpha value* [%]	24.87	10

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

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
100	**Offices and Workshop Businesses**
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	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
	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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	7.89	8.85
Cooling	3.21	1.2
Auxiliary	3.16	6.16
Lighting	5.46	8.36
Hot water	12.42	10.81
Equipment*	32.2	32.2
TOTAL**	**32.14**	**35.37**

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

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	217.91	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*217.91*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	112.71	108.42
Primary energy [kWh_{PE}/m^2]	-272.55	52.67
Total emissions [kg/m²]	-23.45	4.92

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Appendix C: Workshop Be Lean BRUKL (2021).

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

Workshop Be Lean - Lighting Density + Radiant Efficiency + HR + Rooflight

As designed

Date: Wed Nov 29 10:33:49 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.22

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.22

BRUKL compliance module version: v6.1.e.1

Foundation area [m²]: 495.92

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2annum$	2.12	
Building CO_2 emission rate (BER), $kgCO_2/m^2annum$	1.99	
Target primary energy rate (TPER), kWh_{PE}/m^2annum	22.52	
Building primary energy rate (BPER), kWh_{PE}/m^2annum	21.15	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

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

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.15	0.15	00000001:Surf[1]
Floors	0.18	0.1	0.1	00000001:Surf[2]
Pitched roofs	0.16	0.21	0.21	WR000002:Surf[25]
Flat roofs	0.18	0.15	0.15	WR000001:Surf[13]
Windows** and roof windows	1.6	1.21	1.21	00000015:Surf[0]
Rooflights***	2.2	1.3	1.3	WR000001:Surf[5]
Personnel doors^	1.6	1.34	1.6	00000001:Surf[0]
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
** Display windows and similar glazing are excluded from the U-value check.
*** Values for rooflights refer to the horizontal position.
^ For fire doors, limiting U-value is 1.8 W/m²K

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

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

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Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	4974.4	4974.4
External area [m²]	12414.6	12410.6
Weather	NOT	NOT
Infiltration [m³/hm²@ 50Pa]	3	5
Average conductance [W/K]	2794.86	4313.69
Average U-value [W/m²K]	0.23	0.35
Alpha value* [%]	25.47	10

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

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
100	**Offices and Workshop Businesses**
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	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
	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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	3.46	3.19
Cooling	0.3	0.1
Auxiliary	0.83	0.92
Lighting	3.43	5.02
Hot water	6.13	5.82
Equipment*	18.94	18.94
TOTAL**	**14.14**	**15.05**

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

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*0*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	34.07	33.56
Primary energy [kWh_{PE}/m^2]	21.15	22.52
Total emissions [kg/m²]	1.99	2.12

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Appendix C: Workshop Be Green BRUKL (2021).

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

Workshop Be Green - Rev01 - PV 1350 As designed

Date: Wed Nov 29 17:13:45 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.22

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.22

BRUKL compliance module version: v6.1.e.1

Foundation area [m²]: 500.78

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2annum$	2.12	
Building CO_2 emission rate (BER), $kgCO_2/m^2annum$	-3.5	
Target primary energy rate (TPER), kWh_{PE}/m^2annum	22.53	
Building primary energy rate (BPER), kWh_{PE}/m^2annum	-42.26	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

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

Fabric element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	First surface with maximum value
Walls*	0.26	0.15	0.15	00000001:Surf[1]
Floors	0.18	0.1	0.1	00000001:Surf[2]
Pitched roofs	0.16	0.21	0.21	WR000002:Surf[25]
Flat roofs	0.18	0.15	0.15	WR000001:Surf[13]
Windows** and roof windows	1.6	1.21	1.21	00000015:Surf[0]
Rooflights***	2.2	1.3	1.3	WR000001:Surf[5]
Personnel doors^	1.6	1.34	1.6	00000001:Surf[0]
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]
* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
** Display windows and similar glazing are excluded from the U-value check.
*** Values for rooflights refer to the horizontal position.
^ For fire doors, limiting U-value is 1.8 W/m²K
NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
m³/(h.m²) at 50 Pa	8	3

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Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	4974.4	4974.4
External area [m²]	12414.6	12410.6
Weather	NOT	NOT
Infiltration [m³/hm²@ 50Pa]	3	5
Average conductance [W/K]	2794.86	4313.69
Average U-value [W/m²K]	0.23	0.35
Alpha value* [%]	25.47	10

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

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
100	**Offices and Workshop Businesses**
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	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
	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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	2.91	3.15
Cooling	0.39	0.15
Auxiliary	0.83	0.92
Lighting	3.42	5.01
Hot water	6.13	5.82
Equipment*	19.39	19.39
TOTAL**	**13.68**	**15.06**

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

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	42.78	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*42.78*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	34.63	34.06
Primary energy [kWh_{PE}/m^2]	-42.26	22.53
Total emissions [kg/m²]	-3.5	2.12

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