



ECOUNICO

Energy Statement

School of Art, University of Reading



On Behalf of **University of Reading**

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Executive Summary

This Energy Statement supports the planning application for the proposed School of Art development in the Reading Borough Council.

According to the local planning policies, the development is only required to meet Part L of the building regulations. However, the University of Reading (UoR) has an aspiration to become Net Zero by 2030. Therefore, the UoR aims to achieve the highest possible energy efficiency targets and carbon reduction targets for this project by following the LETI guidance for schools where possible with an aspiration to meet the operational Net Zero target.

The Energy Strategy follows the Energy Hierarchy: Be Lean, Be Clean and Be Green. The overarching objective in the formulation of the strategy is to maximise the reductions in total CO₂ emissions through the application of the hierarchy with a technically appropriate and cost-effective approach.

After reduction of the energy demand by using LETI guidance where possible, the energy strategy proposes to connect the development to an existing district heating network with CHP as well as providing a large PV system for the building to generate renewable electricity.

The energy and carbon assessments are carried out based on the current Part L 2013 building regulations and the associated carbon factors. In order to provide a more realistic carbon assessment for the future, in addition to the Part L 2013 carbon assessment outputs, adjusted Part L 2013 carbon assessment outputs are provided which are based on the upcoming Part L 2021 carbon factors. The Part L 2021 carbon emission factors listed below:

- Natural gas: 0.210 kgCO₂/kWh
- Grid electricity: 0.136 kgCO₂/kWh

The summary of the overall reduction in Part L 2013 CO₂ emissions after each stage of the energy hierarchy is presented in the table below.

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline	33.3	24.6	57.9
After energy demand reduction	26.2	24.6	50.8
After energy efficient supply from DH network	21.7	24.6	46.3
After use of renewable energy	-9.0	24.6	15.6

The regulated and total CO₂ savings for the entire development expressed in terms of actual and percentage reduction after each stage of the energy hierarchy are presented in the table below.

	Regulated Energy CO ₂ savings		Unregulated Energy CO ₂ savings
	Tonnes per annum	%	%
Savings from energy demand reduction	7.4	22%	13%
Savings from heat network	4.2	13%	7%
Savings from renewable energy	30.5	92%	53%
Total cumulative savings	42.2	127%	73%
Carbon shortfall/surplus	-9.0	-	16

The energy assessment shows that the proposed energy supply strategy may result in circa 42.2 tCO₂ reduction of regulated CO₂ emissions per annum which equates to circa 127% reduction over the regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy can be reduced by circa 73% over the baseline.

The assessment results show that the proposed energy strategy can achieve the regulated operational Net Zero target.

The summary of the overall reduction in adjusted Part L 2013 CO₂ emissions using the new Part L 2021 carbon emission factors after each stage of the energy hierarchy is presented in the table below.

Table 8.4 Summary of adjusted Part L 2013 CO₂ emissions after each stage of the Energy Hierarchy

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline adjusted to Part L2A 2021	18.9	6.4	25.3
After energy demand reduction	15.1	6.4	21.5
After energy efficient supply from DH network	18.5	6.4	25.0
After use of renewable energy	10.5	6.4	17.0

The regulated and total CO₂ savings for the entire development expressed in terms of actual and percentage reduction after each stage of the energy hierarchy are presented in the table below.

	Regulated Energy CO ₂ savings		Unregulated Energy CO ₂ savings
	Tonnes per annum	%	%
Savings from energy demand reduction	3.8	20%	15%
Savings from heat network	-3.4	-18%	-14%
Savings from renewable energy	8.0	42%	32%
Total cumulative savings	8.4	44%	33%
Carbon shortfall/surplus	10.5	-	17

The energy assessment shows that with the new Part L 2021 carbon factors the proposed energy strategy may result in circa 10.5 tCO₂ reduction of regulated CO₂ emissions per annum which equates to circa 44% reduction over the adjusted regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy can be reduced by circa 33% over the baseline.

The increase in the CO₂ savings from the heat network is associated with the use of CHP technology and use of significantly reduced electricity carbon factor which represent decarbonisation of electricity grid. This issue will be resolved by converting the existing CHP and boiler heating plant to a ground coupled, water source heat pump system which could deliver circa 35-55%.

It is anticipated that with the use of the water source heat pump system the development will likely be able to achieve the regulated operational Net Zero target and potentially even the regulated and unregulated operational Net Zero target.

In summary, the proposed energy strategy for the development:

- 1 Informs the built form and orientation of the buildings to respond to daylight and indoor comfort levels;
- 2 Includes best practice LETI building fabric standards and energy efficient design of building services;
- 3 Complies with Part L 2013 Building Regulations;
- 4 Connects to the existing heating network with CHP which is planned to be replaced with a ground coupled, water source heat pump system within the next 10 years;
- 5 Exceeds the regulated operational Net Zero Target against the Part L 2013 baseline with the current carbon factors.
- 6 Has a potential to meet and exceed the regulated operational Net Zero Target against the Part L 2013 baseline adjusted to the part L 2021 carbon factors when the existing heating network CHP is replaced with the ground coupled, water source heat pump system.

1 Introduction

1.1 Background

Ecounico has been instructed by University of Reading (UoR) to prepare an Energy Statement for the proposed School of Art development in the Reading Borough Council.

The document accompanies the full planning application, to redevelop the site of the existing Central Kitchen building to accommodate Reading School of Art, which is being relocated from its existing location within the eastern part of the Whiteknights Campus to the Pepper Lane entrance.

To support the planning application this document identifies and describes the energy and water efficiency design and low carbon/renewable technology options that have been explored and the preferred options for achieving the required reduction in carbon emissions.

This document has been produced to demonstrate how the proposed development can fulfil the relevant requirements of the National Planning Policy Framework and Reading Council's Local Plan policies.

1.2 Description of Development

Reading School of Art is part of the School of Arts and Communication Design. The existing School of Art is located within building TOB1 which lies within Wokingham Borough. As part of future proposals at the campus, the existing School of Art building is to be demolished.

To ensure the School of Art remains at the Whiteknights Campus, the proposal subject to this application is to re-locate the School of Art to the current unoccupied Central Kitchen building, which lies within Reading Borough.

The proposal would see the Central Kitchen building refurbished and extended to house the School of Art, with the extension located on the existing hardstanding forecourt area to the east of the existing building. The refurbishment and extension will provide workshops, studio and gallery space as well as a staff and student welfare area, shop and visitor space.

The proposed School of Art building will accommodate the following:

- Circa 1,900 sq.m. of gross internal floor space and circa 1400 sq.m of net internal floor space. This includes 970 sq.m. of existing gross internal floor space and 920 sq.m new gross internal floor space from an extension.
- The existing Car Park 11 will be utilised in connection with these proposals. There is no increase in student numbers proposed.

The aim is to remain at an intake of 80 undergraduate students.

The ground floor plan of the proposed development is presented in Figure 1.1.

2 Planning Policies

This section summarises the relevant energy policy context for the development. The national and local policies and regulations related to energy and sustainability are summarised below.

2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) document sets out the Government's planning policies for England and was updated July 2021.

The NPPF is designed to consolidate all policy statements, circulars and guidance documents into a single, simpler National Planning Policy Framework, making the planning system more user-friendly and transparent. The framework's primary objective is a sustainable development, therefore focussing on the 3 pillars of sustainability. The framework is split into three sections; planning for prosperity (Economic), planning for people (Social) and planning for places (Environmental), each of which outlines guidance to tackle issues such as housing, transport infrastructure, climate change, business and economic development, etc.

In regard to climate change, the NPPF supports a reduction in greenhouse gas emissions and the delivery of renewable and low carbon energy. Climate change is covered in Section 14 '*Meeting the challenge of climate change, flooding and coastal change*'. In summary the framework advises:

To support the move to a low carbon future, local planning authorities should:

- plan for new developments in locations and ways which reduce greenhouse gas emissions;
- actively support energy efficiency improvements to existing buildings; and
- adopting nationally described standards when setting any local requirement for a building's sustainability.

In determining planning applications, local planning authorities should expect a new development to:

- comply with adopted Local Plan policies on local requirements for decentralised energy supply, unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
- take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

2.2 Reading Borough Council Planning Policies

A new Reading Borough Local Plan was adopted on 4th November 2019. This document sets out our planning policies for development in Reading up to 2036. It is the main policy document in deciding planning applications which contains the following energy policies.

Policy CC1: Presumption in Favour of Sustainable Development

A positive approach to considering development proposals will be taken that reflects the presumption in favour of sustainable development contained in the National Planning Policy Framework (NPPF). Where appropriate, the Council will work proactively with applicants jointly to find solutions which mean that proposals can be approved wherever possible.

Planning law requires that applications for planning permission must be determined in accordance with the development plan unless material considerations indicate otherwise. Planning applications that accord with the policies in the development plan (including, where relevant, with policies in neighbourhood plans) will be approved without delay, unless material considerations indicate otherwise. Proposed development that conflicts with the development plan will be refused, unless other material considerations indicate otherwise.

Where there are no policies relevant to the application or the policies which are most important to determining the application are out of date at the time of making the decision then permission will be granted unless material considerations indicate otherwise – taking into account whether:

- *The application of policies in the NPPF that protect areas or assets of particular importance provides a clear reason for refusing the development proposed; or*
- *Any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in the NPPF taken as a whole.*

Policy CC2: Sustainable Design and Construction

Proposals for new development, including the construction of new buildings and the redevelopment and refurbishment of existing building stock, will be acceptable where the design of buildings and site layouts use energy, water, minerals, materials and other natural resources appropriately, efficiently and with care and take account of the effects of climate change.

To meet these requirements:

- *All major non-residential developments or conversions to residential are required to meet the most up-to-date BREEAM 'Excellent' standards, where possible;*
- *All minor non-residential developments or conversions to residential are required to meet the most up-to-date BREEAM 'Very Good' standard as a minimum;*
- *All non-residential development or conversions to residential should incorporate water conservation measures so that predicted per capita consumption does not exceed the appropriate levels set out in the applicable BREEAM standard. Both residential and non-residential development should include recycling greywater and rainwater harvesting where systems are energy and cost effective.*

For some types of development, such as industrial uses, warehouses and schools might find it more difficult to meet these standards. In these cases, developments must demonstrate that the standard to be achieved is the highest possible for the development, and at a minimum meets the BREEAM 'Very Good' standard.

Policy CC3: Adaptation to Climate Change

All developments will demonstrate how they have been designed to incorporate measures to adapt to climate change. The following measures shall be incorporated into development:

- *Wherever possible, new buildings shall be orientated to maximise the opportunities for both natural heating and ventilation and reducing exposure to wind and other elements;*
- *Proposals involving both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measures such as solar shading, thermal mass, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, green walls, etc;*

- *Use of trees and other planting, where appropriate as part of a landscape scheme, to provide shading of amenity areas, buildings and streets and to help to connect habitat, designed with native plants that are carefully selected, managed and adaptable to meet the predicted changed climatic conditions; and*
- *All development shall minimise the impact of surface water runoff from the development in the design of the drainage system, and where possible incorporate mitigation and resilience measures for any increases in river flooding levels as a result of climate change.*

Policy CC4: Decentralised Energy

In meeting the sustainability requirements of this plan, developments of the sizes set out below shall demonstrate how consideration has been given to securing energy for the development from a decentralised energy source.

Any development of more than 20 dwellings and/ or non-residential development of over 1,000 sq m shall consider the inclusion of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision.

Where there is existing decentralised energy provision present within the vicinity of an application site, further developments of 10 dwellings or more or non-residential development of 1,000 sq m or more will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible.

2.3 Part L Building Regulations

Approved Document Part L2A 2013 incorporates a number of changes and additions compared to Part L2A 2010. Part L2A 2013 requires new non-domestic buildings to reduce their carbon emissions by a further 9% across the build mix, compared to Part L2A 2010.

Part L2A 2010 was based on comparing the actual building against a notional building. This approach remains the same for Part L2A 2013, however the notional building has been modified to have more energy efficient building fabric and reduced air permeability. Similar to Part L 2010, the notional building standards will change depending on the type of non-domestic building use.

There are also various changes on minimum standards for HVAC systems outlined in the second-tier document, *Non-domestic Services Compliance Guide 2013 Edition* compared with the 2010 Edition.

Part L2A 2021 will be released in June 2022 and will incorporate several changes in comparison to the current Part L2A 2013 regulations. All new non-domestic buildings will be required to have a carbon emission reduction of 27% compared to what is currently acceptable. Updated carbon factors will be specified for use in carbon emission calculations, meaning there will be greater emphasis required on electrical heating systems such as ground source heat pumps over gas-fuelled systems. Additionally, improved fabric and energy efficiency targets will be implemented to further reduce the reliance on renewable energy sources as compensation for poor thermal performance.

3 Energy Strategy Approach

3.1 Energy and Carbon Targets and Aspirations

The UoR has an aspiration to become Net Zero by 2030. As the School of Art project is a mix of refurbishment and new build, there is limited scope to make energy efficiency improvements of the existing building.

However, the UoR aims to achieve the highest possible energy efficiency targets and carbon reduction targets for this project by following the LETI guidance for schools where possible with an aspiration to meet the operational Net Zero target.

To achieve the aspirations and targets, the proposed energy strategy for the development will follow the Energy Hierarchy approach of Be Lean, Be Clean and Be Green to enable the maximum viable reductions in regulated and total CO₂ emissions over the baseline.

- be lean: use less energy and manage demand during operation through fabric and servicing improvements and the incorporation of flexibility measures
- be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly by connecting to district heating networks
- be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site

The proposed energy supply solutions aim to:

- Comply with the relevant regulatory requirements;
- Improve viability of the scheme by developing a technically robust and viable energy strategy;
- Use the LETI guidance to reduce operational energy usage and cost;
- Use low carbon and renewable energy technologies to achieve the operational Net Zero target if practical and cost effective.
- Improve feasibility, operation and management of the energy systems by promoting holistic design methods and solutions.

3.2 Energy and Carbon Assessment Methodology

An initial assessment of CO₂ performance of the School of Art is carried out using IES VE software. IES VE is an approved tool for calculating compliance with Part L2A which uses the standard National Calculation Methodology (NCM).

An assessment of the energy performance of the development considers regulated energy usage for different building services such as cooling, heating, lighting and ventilation. An estimate is also provided of unregulated electricity use (equipment) associated with computers, small power, and security systems, etc.

Although the produced data by the IES VE software provides estimations of possible energy and carbon performance of the non-residential development for assessment purposes, again it is not intended to be used as a detailed design tool.

The energy and carbon assessments are carried out based on the current Part L 2013 building regulations and the associated carbon factors. In order to provide a more realistic carbon assessment for the future, in

In addition to the Part L 2013 carbon assessment outputs, adjusted Part L 2013 carbon assessment outputs are provided which are based on the upcoming Part L 2021 carbon factors. The Part L 2021 carbon emission factors listed below:

- Natural gas: 0.210 kgCO₂/kWh
- Grid electricity: 0.136 kgCO₂/kWh

4 Baseline CO₂ Emissions

In order to assess CO₂ performance of the proposed energy strategy, a CO₂ emissions baseline needs to be established. This section sets out the approach taken to calculating the baseline CO₂ emissions for the the development.

The total baseline CO₂ emissions for the proposed development is defined as regulated CO₂ emissions covered by Building Regulations Part L as well as the unregulated CO₂ emissions not covered by Part L. The unregulated CO₂ emissions should be excluded when compliance with the planning policy is calculated.

The baseline CO₂ emissions of School of Art are calculated using IES VE software are based on the calculation of the energy consumption of a 'notional' building under the standard National Calculation Methodology (NCM). The IES VE modelling results in the form of BRUKL report have been provided in Appendix B.

The regulated, unregulated and total baseline CO₂ emissions for the proposed building is summarised in Table 4.1.

Table 4.1 School of Art Part L2A 2013 baseline CO₂ emissions

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline	33.3	24.6	57.9

The TER results from the BRUKL report have been converted using the upcoming Part L 2021 carbon emission factors through carbon emissions reporting spreadsheet to predict a more realistic CO₂ emissions baseline. The regulated, unregulated and total Part L 2013 baseline adjusted to the Part L 2021 carbon emission factors are summarised in Table 4.2.

Table 4.2 School of Art Part L2A 2013 baseline CO₂ emissions adjusted to Part L2A 2021 caron factors

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline adjusted to Part L2A 2021	18.9	6.4	25.3

5 Demand Reduction and Energy Efficiency

In accordance with the Energy Hierarchy, a key focus for the proposed energy strategy is to reduce the energy demands of the development as far as practically possible and viable by implementing various energy demand reduction measures. The aim of the demand reduction strategy is to achieve Part L 2013 Building Regulations compliance without contribution from low carbon or renewable energy sources.

The proposed design of the development follows sustainable design principals and standards, aiming to use natural resources efficiently, reduce energy consumption as well as contribution to the urban heat island effect.

A range of measures to reduce CO₂ emissions and increase resilience to climate change are proposed to be incorporated into the building design including good building fabric standards as well as energy efficient M&E systems and lighting.

5.1 Passive Design

The proposed design incorporates optimal thermal characteristics of buildings to achieve and maintain good environmental conditions with minimum resources of material and fuel. The passive design aims to maximise use of natural heating, cooling and ventilation to create comfortable considering inside the buildings.

It is proposed to incorporate passive solar design measures across the development. The proposed glazed areas have been designed to maximise daylight and optimise solar gains. The glazing specification is proposed to provide a balance of solar control and access to passive solar gain.

The proposed design uses natural ventilation where possible. Where use of natural ventilation is not possible, energy efficient mechanical ventilation systems will be used to supply fresh air and expel unwanted pollutants is proposed.

5.2 Building Fabric

As this development is a mix of refurbishment and new build, there is limited scope to make energy efficiency improvements of the existing building. In order to achieve the highest possible energy efficiency targets and carbon reduction targets for this project is proposed to use building fabric standards proposed in the LETI guidance for schools for the new build part of the development. The building fabric improvements are made and LETI building fabric standards are applied to the refurbishment part of the development where possible.

The proposed specification for individual building elements for the new build and refurbished parts of the development are presented in Table 5.1.

Table 5.1 Proposed fabric performance for individual building elements

Element	U-values (W/m ² K)	
	Proposed specification for the new part of the development	Proposed specification for the refurbished part of the development
External walls	0.13	0.35
Roof	0.12	0.25
Ground floor	0.12	0.25
Windows [1]	1.00	1.00
Doors	1.20	1.20
Airtightness	1 (m ³ /(hm ²) at 50 Pa)	10 (m ³ /(hm ²) at 50 Pa)

[1] Solar control glass with a g-value of 0.4 is proposed. Glazing performance will need to be reviewed alongside acoustic performance as the design is developed.

Implementing these (or similar) building fabric standards will help to deliver substantial reductions in CO₂ emissions compared with the current building performance and regulations.

5.3 Energy Efficiency Systems

The energy demand of the building can be further reduced by using energy efficient M&E systems. The below energy efficiency measures have been used to carry out the energy and carbon modelling for this report. The overarching principle for the selection of the energy efficient systems is to achieve maximum CO₂ reductions through energy demand reduction measures alone.

5.3.1 Ventilation

The average air tightness standard will conform to and exceed Approved Document Part L requirements.

It is proposed to use natural ventilation where possible. Most of the rooms in the building will use natural ventilation via high level motorised opening roof lights and low-level manual opening windows.

Where use of natural ventilation is not possible, it is proposed to provide Mechanical Ventilation with Heat Recovery (MVHR) to meet the fresh air supply requirements.

The MVHRs are selected with low Specific Fan Powers (SFP). This is achieved by using systems with high efficiency fan motors and radius bends and turning vanes in ductwork. MVHR systems will have a high heat recovery efficiency and an automatic control which may take the form of sensors to modulate their performance.

A more detailed ventilation strategy will be developed during detailed design with the aim to specify the most appropriate ventilation systems and achieve a pleasant indoor environment.

5.3.2 Cooling

Cooling will need to be provided to some rooms of the building to achieve a pleasant indoor environment. The cooling requirements have been minimised by the proposed solar gain control measures.

Cooling for this building can be effectively provided by direct expansion heat pumps (DXHPs) via ceiling mounted ducted fan coil units (FCUs). These systems will also provide space heating. DXHPs with Seasonal Energy Efficiency Ratio (SEER) of 6.76 have been used for Cooling will need to be provided to some rooms of the building to achieve a pleasant indoor environment. The cooling requirements have been minimised by the proposed solar gain control measures.

Cooling will only be provided to the following areas:

- AV Studio
- Screen Printing
- Metal Workshop
- Low Risk Wood Workshop
- High Risk Wood Workshop
- Ceramics Workshop

5.4 Heating and Hot Water

The space heating requirement of the proposed development will be significantly reduced by the proposed fabric, air tightness and ventilation measures.

It is proposed to provide most of the space heating and hot water demand from an existing District Heating (DH) system. Specifically, it is proposed to design the heating system to achieve the following:

- Variable flow rate heating system with high delta T and low return temperatures
- High efficiency motors and variable speed pumps for heating
- Appropriate controls for heating
- Temperature and zoning
- Appropriate insulation of heating pipes
- Low flow and return temperatures

Further information about the DH system is provided in Section 6.

DXHPs which will provide cooling will also supply space heating. These systems will also provide space heating in the rooms. DXHPs with Seasonal Coefficient of Performance SCOP of 4.35 have been used for modelling purposes.

For the purpose of energy modelling at the Be Lean stage, a gas boiler system with seasonal efficiency of 91% was used for the building.

5.4.1 Lighting

The fenestration levels aim to balance the need for maximising daylight and minimise the risk of excessive solar gains and limiting the need for artificial lighting during daylight hours. The electricity consumption

associated with lighting will be further reduced by using Light Emitting Diodes (LEDs) designed to achieve the LETI guidance lighting standards.

An appropriate lighting control system will be provided for the building. The system shall utilise intelligent luminaires providing daylight sensing, maintained illuminance, presence detection and scene setting if required.

The lighting control system will be based on individual controls for each area. The Galleries and Studios shall be provided with scene setting, mains dimming or other protocols. This would allow staff to turn off the lighting when not needed for public viewing and so reduce running costs and light damage to exhibits.

5.4.2 Metering

New check metering shall be provided to monitor electrical usage for lighting, power circuits including mechanical plant at all distribution boards, in accordance with the Building Regulations Part L.

5.5 CO₂ Savings after Energy Demand Reduction

Based on the proposed energy demand reduction measures, the total anticipated regulated CO₂ emissions have been calculated using the Building Emission Rate (BER) of the building. The IES VE modelling results including the BER in the form of BRUKL report are provided in Appendix B.

The energy assessment shows that the proposed energy strategy which is based on LETI standards may result in circa 7.4 tCO₂ reduction of regulated CO₂ emissions per annum which equates to circa 22% reduction over the regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy can be reduced by circa 13% over the baseline. The regulated, unregulated and total emissions are summarised in Table 5.1.

Table 5.1 Anticipated Part L 2013 CO₂ emissions after demand reduction

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline	33.3	24.6	57.9
After energy demand reduction	26.2	24.6	50.8

The Part L 2013 carbon assessment results have been adjusted using the new Part L 2021 carbon emission factors to predict the CO₂ emissions over the baseline. The adjusted regulated, unregulated and total emissions are summarised in Table 5.2.

Table 5.1 Anticipated Part L 2013 adjusted to Part L2A 2021 CO₂ emissions after demand reduction

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline adjusted to Part L2A 2021	18.9	6.4	25.3
After energy demand reduction	15.1	6.4	21.5

The energy assessment shows that with the new Part L 2021 carbon factors the proposed energy strategy may result in circa 3.8 tCO₂ reduction of regulated CO₂ emissions per annum which equates to circa 20% reduction over the adjusted regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy can be reduced by circa 15% over the baseline.

6 Efficient Energy Supply (Be Lean)

6.1 Energy Demand

An energy demand assessment has been carried out using the NCM methodology. The regulated and unregulated energy demands of the building are provided in Table 6.1.

Table 6.1 Regulated and unregulated energy demands

Building Use	Energy demand following energy efficiency measures (MWh/year)						
	Space Heating	Hot Water	Lighting	Auxiliary	Cooling	Unregulated Electricity	Unregulated Gas
School of Art	46,103	3,474	21,718	5,257	184	24,585	N/A

The estimated hot water demand will not be significant and the space heating load will not present a consistent demand and is seasonal in nature. It is also minimised through the application of the proposed energy efficiency measures.

6.2 Heat Supply from Existing District Heating Network

The UoR is served by an existing site wide district heating network powered from central gas fuel CHP plant. Waste heat is distributed around the site via a network of underground heating flow and return pipework to all the designated buildings.

Both the existing Energy Centre (EC) and the associated underground heating distribution pipework are in close proximity to the School of Art building. This presents an ideal opportunity to connect the new building to the DH network, powered by gas-fired Combined Heat and Power (CHP) engine and gas boilers, and provide Low Temperature Hot Water (LTHW) space heating via radiators and Underfloor Heating (UFH).

By utilising the DH network to heat the building, the project will utilise the availability of waste heat of the existing CHP system which would potentially help to increase the operating efficiency of the existing central heating plant.

Based on the available information, the DH network is powered by circa 1.2 MW CHP engine (E1165 500NOx L33 Natural Gas CHP Unit) and four high efficiency gas boilers with a total heat output of circa 9.9 MW. It is estimated that the CHP engine supplies at least 33% of heat output of the system.

There are plans in place by the UoR to seek grant funding from the Government to decarbonise and convert the existing central heating plant to a ground coupled, water source heat pump system which is likely to take place within the next 10 years.

Cooling will need to be provided to some rooms of the building to achieve a pleasant indoor environment. It is proposed to provide cooling to these rooms by DXHPs via ceiling mounted FCUs. The DXHPs can also supply space heating to these rooms which is considered to be the most practical way in lieu of supplying heating from the existing DH network.

All energy consumption associated with the development will be metered accordingly both centrally at the point of building entry and locally at each relevant system/circuit which will report back to the Building Energy Management System (BEMS).

6.3 CO₂ Savings after Energy Efficient Supply

The total anticipated regulated CO₂ emissions have been calculated after the energy efficiency supply from DH network using the Building Emission Rate (BER) of the building. The IES VE modelling results including the BER in the form of BRUKL report are provided in Appendix B.

The energy assessment shows that the proposed energy supply strategy which is based on use of the existing DH network with gas-fired CHP and gas boilers may result in circa 4.2 tCO₂ reduction of regulated CO₂ emissions per annum which equates to circa 13% reduction over the regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy can be reduced by circa 7% over the baseline. The regulated, unregulated and total emissions are summarised in Table 5.1.

Table 5.1 Anticipated Part L 2013 CO₂ emissions after use of DH network

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline	33.3	24.6	57.9
After energy demand reduction	26.2	24.6	50.8
After energy efficient supply from DH network	21.7	24.6	46.3

The Part L 2013 carbon assessment results have been adjusted using the new Part L 2021 carbon emission factors to predict the CO₂ emissions over the baseline. The adjusted regulated, unregulated and total emissions are summarised in Table 5.2.

Table 5.1 Anticipated Part L 2013 adjusted to Part L2A 2021 CO₂ emissions after use of DH network

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline adjusted to Part L2A 2021	18.9	6.4	25.3
After energy demand reduction	15.1	6.4	21.5
After energy efficient supply from DH network	18.5	6.4	25.0

The energy assessment shows that with the new Part L 2021 carbon factors the proposed energy strategy may result in circa 3.4 tCO₂ Increase in regulated CO₂ emissions per annum which equates to circa 18%

increase over the adjusted regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy could be increase by circa 14% over the baseline.

This increase is because the use of the new 2021 carbon factors makes the use of CHP technology as a low carbon heating system unviable. Although CHP technology for such a development could generally achieve CO₂ savings with Part L 2013 carbon factors applied, these are outdated and no longer reflect the current or future anticipated carbon intensity of the electricity or gas grids. As the electricity grid continues to decarbonise, the ongoing savings in carbon from gas CHP will reduce over time and therefore it makes better sense to utilise plant fuelled by electricity to deliver ongoing and significant carbon reduction.

This issue will be resolved by converting the existing CHP and boiler heating plant to a ground coupled, water source heat pump system which is likely to take place within the next 10 years. This system is anticipated to deliver significant CO₂ savings using the new 2021 carbon factors. The anticipated CO₂ savings from a ground coupled, water source heat pump system could be circa 45-65%.

7 Renewable Energy (Be Green)

The final part of the Energy Hierarchy is Be Green which seeks renewable energy technologies to be specified to provide a reduction in anticipated carbon dioxide emissions, where feasible.

The use of DH Network with the CHP engine and gas boilers restricts use of renewable energy technologies which will be feasible and appropriate for the development. Any renewable energy technologies that are to be included must be complementary and not conflict with the CHP engine. The following low and zero carbon technologies have been considered and compared for this particular development:

- Photovoltaic Panels (PV)
- Air Source Heat Pump (ASHP)
- Ground Source Heat Pump (GSHP)
- Wind Turbines
- Biomass Boiler
- Solar Thermal

The assessment of these technologies shows that PV systems are considered to be the most suitable renewable energy technology options for the development. All other renewable energy technology options are considered to be less suitable. A summary of the assessment can be found in Appendix A.

7.1 Photovoltaics (PV)

The renewable energy assessment shows that PV systems can be provided to generate renewable power. This technology can work well with all the other proposed technologies (e.g. CHP and gas boilers) and can supply additional CO₂ reductions for the development.

PV panels use solar radiation and convert it into usable electricity through the application of semiconductor technology. Solar panel outputs vary depending upon orientation, inclination, solar radiation levels, cloud cover and temperature.

PV panels can be ground mounted, roof mounted or building Integrated (incorporated into the facade of a building). Due to the roof space availability and costs, ground mounted and building integrated systems are not being considered for the site, whereas roof mounted systems are considered viable.

PV systems should ideally face south with an incline of 30°, although orientations within 45° of south and other angles can still generate outputs if panels are not over shaded. Optimum design of the PV installation is required to ensure maximum electrical output per kWp installed. There are a number of design considerations to be made to ensure the best use of the system. The key design considerations for designing and installing PV systems are:

- Design of PV installation to optimise inclination and orientation;
- Ensure that PV panels are not overshadowed;
- Ensure correct installation of PV arrays for good ventilation;
- Ensure that the electrical wiring from PV arrays to inverters is kept to a minimum to reduce electrical losses;

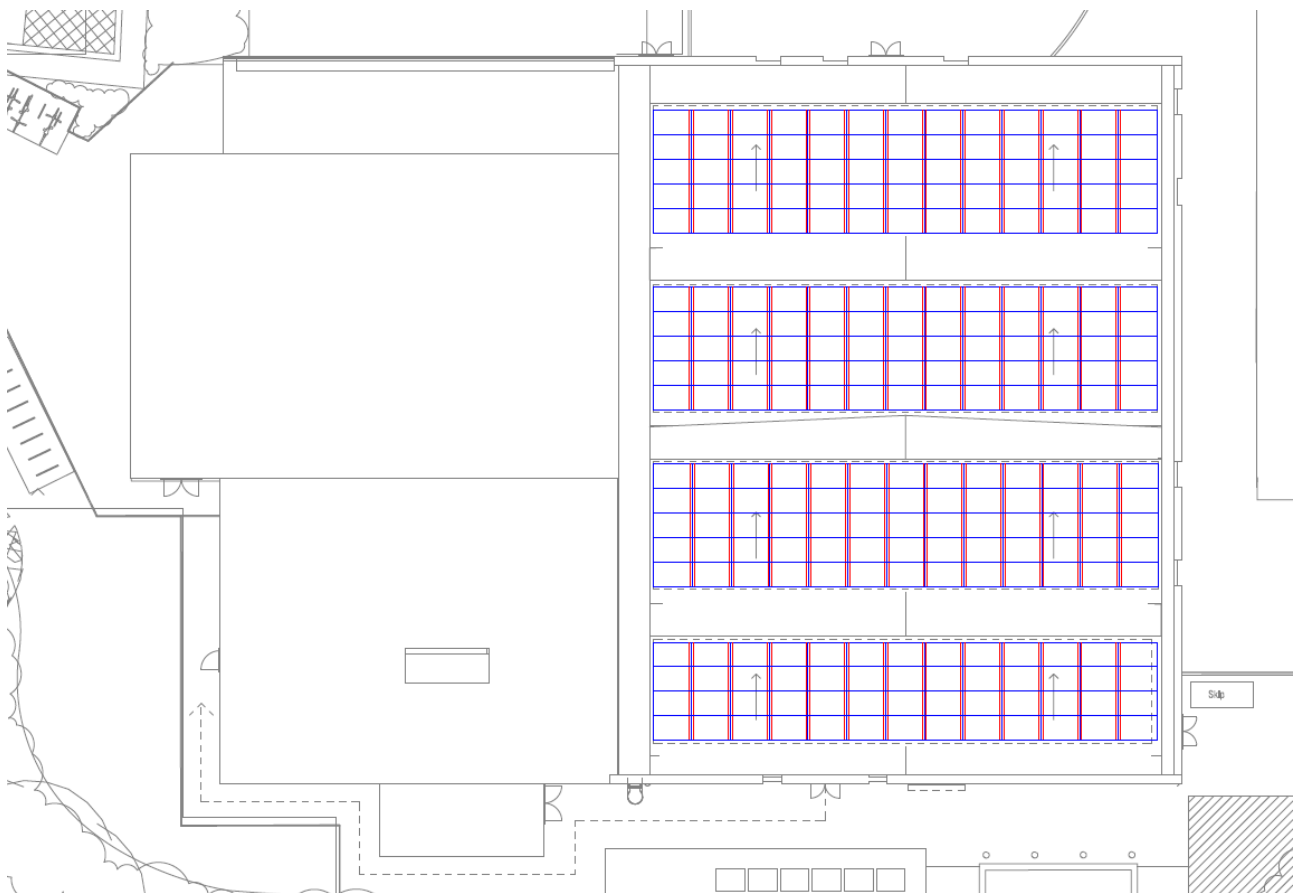
- Provide sufficient space around PV installations for safe access and maintenance of the modules and other equipment installed on the roof.

The electricity generating potential of PV panels is not dependent on development demand but on suitable available roof space for installation.

The LETI guidance suggests maximising renewables so that 70% of the roof is covered with PV.

It is proposed to locate the PV panels on the unshaded roofs of the new part of the building. The proposed roof areas for PV are illustrated in Figure 7.1.

Figure 7.1 Roof plan for the development indicating proposed areas for solar panels



It is proposed to provide circa 74.1 kWp of PV panels on the unshaded suitable roofs. Based on the BRUKL outputs, 1 kWp of PV panels will generate circa 794 kWh per annum which will equate to circa 58,825 kWh/year of renewable electricity generation.

The generated PV electricity will be used on site as much as possible helping to reduce the reliance on grid electricity. Any excess electricity will be exported to the grid. The required PV capacity will be confirmed during the detailed design stage.

7.2 CO₂ Savings after Renewable Energy

The total anticipated regulated CO₂ emissions have been calculated from renewable energy using the Building Emission Rate (BER) of the building. The IES VE modelling results including the BER in the form of BRUKL report are provided in Appendix B.

The energy assessment shows that the proposed energy supply strategy which is based on use of PV may result in circa 30.5 tCO₂ reduction of regulated CO₂ emissions per annum which equates to circa 92% reduction over the regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy can be reduced by circa 53% over the baseline. The regulated, unregulated and total emissions are summarised in Table 7.1.

Table 7.1 Anticipated Part L 2013 CO₂ emissions after use of PV

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline	33.3	24.6	57.9
After energy demand reduction	26.2	24.6	50.8
After energy efficient supply from DH network	21.7	24.6	46.3
After use of renewable energy	-9.0	24.6	15.6

The Part L 2013 carbon assessment results have been adjusted using the new Part L 2021 carbon emission factors to predict the CO₂ emissions over the baseline. The adjusted regulated, unregulated and total emissions are summarised in Table 7.2.

Table 7.2 Anticipated Part L 2013 adjusted to Part L2A 2021 CO₂ emissions after use of PV

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline adjusted to Part L2A 2021	18.9	6.4	25.3
After energy demand reduction	15.1	6.4	21.5
After energy efficient supply from DH network	18.5	6.4	25.0
After use of renewable energy	10.5	6.4	17.0

The energy assessment shows that with the new Part L 2021 carbon factors the proposed energy strategy may result in circa 8 tCO₂ reduction of regulated CO₂ emissions per annum which equates to circa 42% reduction over the adjusted regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy can be reduced by circa 33% over the baseline.

8 Summary and Conclusions

The Energy Strategy for the development has been formulated following the Energy Hierarchy: Be Lean, Be Clean and Be Green. The overarching objective of the proposed strategy is to use the LETI standards and achieve maximum realistic energy reduction and CO₂ savings using combination of energy demand reduction measures, energy efficiency and efficient energy supply technologies. The energy strategy measures are summarised and presented in Table 8.1.

Table 8.1 The Energy Strategy: Be Lean, Be Clean and Be Green principles

Energy Hierarchy	Energy Strategy Measures
Be Lean	Passive design • Optimised design to enable controlled solar gain and improve direct and indirect natural lighting • Natural ventilation in most of the building areas Building Fabric • Use of highly efficient building fabric standards based on LETI specification • Design with low air permeability rates based on LETI specification Energy Efficiency • Energy efficient lighting and appropriate controls • Efficient mechanical ventilation • High efficiency heating plant and auxiliary equipment • Appropriate controls for heating system • Appropriate temperature and time zoning • Appropriate insulation of heating distribution system • Appropriate energy metering and monitoring
Be Clean	Energy efficient energy supply • Heating and hot water system connected to the existing DH network powered by CHP and gas boiler. • There are plans in place to decarbonise and convert the existing central heating plant to a ground coupled, water source heat pump within the next 10 years. • Provision of space cooling and heating to some of the rooms by DXHPs via ceiling mounted FCUs
Be Green	Renewable energy • PV covering circa 70% of the roof to supply renewable electricity.

The summary of the overall reduction in Part L 2013 CO₂ emissions after each stage of the energy hierarchy is presented in Table 8.2.

Table 8.2 Summary of Part L 2013 CO₂ emissions after each stage of the Energy Hierarchy

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline	33.3	24.6	57.9
After energy demand reduction	26.2	24.6	50.8
After energy efficient supply from DH network	21.7	24.6	46.3
After use of renewable energy	-9.0	24.6	15.6

The regulated and total CO₂ savings for the entire development expressed in terms of actual and percentage reduction after each stage of the energy hierarchy are presented in Table 8.3.

Table 8.3 Summary of Part L 2013 CO₂ savings from each stage of the Energy Hierarchy

	Regulated Energy CO ₂ savings		Unregulated Energy CO ₂ savings
	Tonnes per annum	%	%
Savings from energy demand reduction	7.4	22%	13%
Savings from heat network	4.2	13%	7%
Savings from renewable energy	30.5	92%	53%
Total cumulative savings	42.2	127%	73%
Carbon shortfall/surplus	-9.0	-	16

The energy assessment shows that the proposed energy supply strategy may result in circa 42.2 tCO₂ reduction of regulated CO₂ emissions per annum which equates to circa 127% reduction over the regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy can be reduced by circa 73% over the baseline.

The assessment results show that the proposed energy strategy can achieve the regulated operational Net Zero target.

The summary of the overall reduction in adjusted Part L 2013 CO₂ emissions using the new Part L 2021 carbon emission factors after each stage of the energy hierarchy is presented in Table 8.4.

Table 8.4 Summary of adjusted Part L 2013 CO₂ emissions after each stage of the Energy Hierarchy

	CO ₂ emissions (tonnes/year)		
	Regulated	Unregulated	Total
School of Art CO ₂ Part L2A 2013 Baseline adjusted to Part L2A 2021	18.9	6.4	25.3
After energy demand reduction	15.1	6.4	21.5
After energy efficient supply from DH network	18.5	6.4	25.0
After use of renewable energy	10.5	6.4	17.0

The regulated and total CO₂ savings for the entire development expressed in terms of actual and percentage reduction after each stage of the energy hierarchy are presented in Table 8.5.

Table 8.5 Summary of adjusted Part L 2013 CO₂ savings from each stage of the Energy Hierarchy

	Regulated Energy CO ₂ savings		Unregulated Energy CO ₂ savings
	Tonnes per annum	%	%
Savings from energy demand reduction	3.8	20%	15%
Savings from heat network	-3.4	-18%	-14%
Savings from renewable energy	8.0	42%	32%
Total cumulative savings	8.4	44%	33%
Carbon shortfall/surplus	10.5	-	17

The energy assessment shows that with the new Part L 2021 carbon factors the proposed energy strategy may result in circa 10.5 tCO₂ reduction of regulated CO₂ emissions per annum which equates to circa 44% reduction over the adjusted regulated Part L 2013 carbon baseline. The overall CO₂ emissions from both regulated and unregulated energy can be reduced by circa 33% over the baseline.

The increase in the CO₂ savings from the heat network is associated with the use of CHP technology and use of significantly reduced electricity carbon factor which represent decarbonisation of electricity grid. This issue will be resolved by converting the existing CHP and boiler heating plant to a ground coupled, water source heat pump system which could deliver circa 35-55%.

It is anticipated that with the use of the water source heat pump system the development will likely be able to achieve the regulated operational Net Zero target and potentially even the regulated and unregulated operational Net Zero target.

In summary, the proposed energy strategy for the development:

- 1 Informs the built form and orientation of the buildings to respond to daylight and indoor comfort levels;
- 2 Includes best practice LETI building fabric standards and energy efficient design of building services;
- 3 Complies with Part L 2013 Building Regulations;
- 4 Connects to the existing heating network with CHP which is planned to be replaced with a ground coupled, water source heat pump system within the next 10 years;
- 5 Exceeds the regulated operational Net Zero Target against the Part L 2013 baseline with the current carbon factors.
- 6 Has a potential to meet and exceed the regulated operational Net Zero Target against the Part L 2013 baseline adjusted to the part L 2021 carbon factors when the existing heating network CHP is replaced with the ground coupled, water source heat pump system

Appendix A - Alternative Renewable Technologies

This appendix presents an assessment of the renewable technology options relative to the site which are considered to be less suitable or unsuitable for this development.

Heat Pumps

The ground can be used as both a source of heating and a source of cooling. Ground source heating involves heat pumps drawing heat from underground, whereas ground source cooling can either use heat pumps or make use of low temperature groundwater directly. Ground Source Heat Pumps (GSHP) are a relatively mature technology and utilise the energy in the ground through a refrigeration cycle. Where GSHP are used for both heating and cooling, depending on the season, this can be a very efficient solution. GSHP can be open loop or closed loop.

An open Loop GSHP system uses groundwater which is taken from an aquifer to supply heating or cooling. The water is then returned to the ground (sometimes via a borehole or sometimes via storm water drainage). Open loop systems require abstraction and discharge licences from the Environment Agency (EA). The ground conditions are currently unknown and it may not be suitable to use an open-loop system.

Closed loop GSHP system comprises a sealed system of buried pipes, normally containing brine or water/antifreeze solution. The solution is circulated continuously around a closed system. This system requires extensive ground works to bury the coils that extract the low-grade heat from the earth. They therefore require a large area for horizontal burial (40-100m long trench) or a vertical pile (50-100m) which is considerably more expensive but can be used where space is limited.

In a closed loop system there is a network of pipes containing a working fluid of water and glycol, which is pumped around the pipes, transferring heat from the low grade heat source to the working fluid. The heat pumps transfer the low grade heat to a higher temperature, and often to a second working fluid which is then pumped around the building.

The network of pipes can be located in the energy piles, trenches, lakes and rivers.

Alternatively, Air Source Heat pumps (ASHP) can be used as both a source of heating and a source for cooling. ASHP employs the same principle of operation as GSHPs, however in this instance the air is used as the heat source. If designed and installed correctly, they can provide moderate CO₂ savings.

The downside is that the air temperature, and therefore efficiency of the heat pump, is reduced in cold weather when the heat is most needed. This means that one either needs to oversize ASHPs to take into account degradation in performance or, alternatively, provide an auxiliary electric heater. Provision of an auxiliary heater reduces capital cost but adds to running costs and reduces carbon savings.

Outdoor air systems are widely implemented in the form of split systems, with indoor and outdoor units linked by refrigerant pipes running through the wall. Packaged air systems where outdoor air is ducted to an indoor package are also available.

There are plans in place by the UoR to seek grant funding from the Government to decarbonise and convert the existing central heating plant to a ground coupled, water source heat pump system which is likely to take place within the next 10 years.

There are energy studies carried out by Hysopt and Carbon Zero Consulting which consider optimising the existing district heating network. It is considered that a ground coupled, water source heat pump system air source heat pump system can be used to decarbonise the existing district heating network.

GSHPs and ASHPs can be used to supply heating (and cooling) for the building via the existing district heating network. Therefore, use of GSHPs and/or ASHPs technologies to supply heat to the building are considered to be variable for the development.

Biomass Boilers

Biomass boilers are now regarded as a conventional form of technology with a wide range of sizes and types to meet renewable targets. Biomass boilers use biomass as a fuel source, which is an alternative solid fuel to the conventional fossil fuels and has carbon emissions close to zero. Various types of biomass fuel are in use, the most common being wood chips and pellets.

Although pellets are more expensive than chips, they have greater energy content per unit of weight and require a lower storage volume. Pellet boilers also require less maintenance and produce considerably less ash residue.

There are some local/regional as well as national biomass suppliers who can supply biomass for the site. Biomass would need to be delivered to site in large trucks and the arrangements for supply and storage of the biomass fuel would need careful consideration. It would also require a suitable biomass storage space, which given the space constraints on this site is likely to be restrictive.

The potential reduction in carbon emissions from the installation of biomass boilers can be considerable. However, although biomass systems have a number of advantages, in the context of this development, the following issues prevent the installation of biomass boilers:

- Significant negative impact on local air quality;
- No space availability for fuel delivery and storage;
- Significantly higher capital costs in comparison with gas boiler system;
- Requirements of additional resources for management of the operation;
- The location of the development may not be suitable for large-scale fuel delivery;
- Security of biomass supply; and
- Not compatible with the connection to the existing district heating network system with CHP.

Taking into account the reasons above, a biomass boiler would not be suitable for the development and has therefore been discounted.

Solar Thermal

Solar Thermal heating systems can contribute to the hot water demand of a dwelling or building. Water or glycol (heat transfer fluid) is circulated to roof level where it is heated using solar energy before being returned to a thermal store in the plant room where heat is exchanged with water from the conventional system.

The system will produce relatively small CO₂ savings but will have significant negative impact of the cost of the heating system and its practicability. The system is also not compatible with the connection to the existing

district heating network system with CHP. Therefore, solar thermal systems are not recommended for this development.

Wind Power

Wind energy installations can range from small domestic turbines (1kW) to large commercial turbines (140m tall, 2MW). There are also different designs and styles (horizontal or vertical axis; 1 blade to multiple blades) to suit the location. They generate renewable electricity that can be provided for use on-site, or sold directly to the local electricity network.

Installation of large/medium scale wind turbine(s) could meet the renewable energy and carbon reduction targets however there is no appropriate space for the installation of large/medium scale wind turbines within the site.

Vertical axis turbines have a lower performance than horizontal axis turbines but work better in urban environments. However, effective energy generation through small scale roof mounted wind turbines is not feasible due to the following:

- The average wind speed at the site is estimated to be circa 4.8 m/s at 10 m and 5.6 m/s at 25 m above ground which is based on NOABL Wind Map (the wind speed was taken from the Rensmart Wind Map). The wind speed is marginal for effective operation of a wind turbine;
- Issues such as distance to the Heathrow airport, noise, telecoms interference and visual impact are likely to restrict installation of wind turbines;
- Installation of wind turbines on the roofs will have a significant visual impact;
- There will be risks associated with operation and maintenance of the turbines.

Taking into account the above, wind power is not recommended for this development.

Appendix B – Be Lean, Be Clean and Be Green BRUKL Reports

Project name

Art Building

As designed

Date: Thu Feb 10 20:12:08 2022

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO ₂ emission rate from the notional building, kgCO ₂ /m ² .annum	21.7
Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	21.7
Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	17.1
Are emissions from the building less than or equal to the target?	BER ≤ TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	U _a -Limit	U _a -Calc	U _i -Calc	Surface where the maximum value occurs*
Wall**	0.35	0.25	0.72	L0000003:Surf[17]
Floor	0.25	0.16	0.25	L0000017:Surf[0]
Roof	0.25	0.14	0.25	L0000002:Surf[4]
Windows***, roof windows, and rooflights	2.2	1.01	1.01	L0000002:Surf[8]
Personnel doors	2.2	1.11	1.2	L000001E:Surf[18]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building
U _a -Limit = Limiting area-weighted average U-values [W/(m ² K)] U _a -Calc = Calculated area-weighted average U-values [W/(m ² K)] U _i -Calc = Calculated maximum individual element U-values [W/(m ² K)] * There might be more than one surface where the maximum U-value occurs. ** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows. *** Display windows and similar glazing are excluded from the U-value check. N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.				

Air Permeability	Worst acceptable standard	This building
m ³ /(h.m ²) at 50 Pa	10	4.6

Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	<0.9

1- RADS and MVHR

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.85
Standard value	0.91*	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

2- RADS and NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

3- DX HP and MVHR (Lossnay Unit - LGH200RVXT-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.96	0.83
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

4- DX HP and MVHR (Lossnay Unit - LGH100RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	-	1.51	0.8
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

5- UFH and NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

6- DX HP and MVHR (Lossnay Unit - LGH35RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.96	0.82
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

7- RADS and S+E

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.85
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

8- UFH and MVHR

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.85
Standard value	0.91*	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

9- DX HP and MVHR (Lossnay Unit - LGH080RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.9	0.82
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

10- DX HP and MVHR (Lossnay Unit - LGH65RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.97	0.81
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

1- DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	-
Standard value	0.8	N/A

1- CHECK2-CHP

	CHPQA quality index	CHP electrical efficiency
This building	105	0.4
Standard value	105	0.2

Local mechanical ventilation, exhaust, and terminal units

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

Zone name	SFP [W/(l/s)]										HR efficiency	
	ID of system type	A	B	C	D	E	F	G	H	I		
	Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
L00 - Acc. WC		-	-	-	1.4	-	-	-	-	-	-	N/A
L00 - Acc. WC/Shower		-	-	-	1.4	-	-	-	-	-	-	N/A
L00 - AV Studio		-	-	-	-	-	-	-	0.2	-	-	N/A
L00 - Ceramic and Screen Printing		-	-	-	-	-	-	-	0.2	-	-	N/A
L00 - Metal Workshop		-	-	-	-	-	-	-	0.2	-	-	N/A
L00 - Spray Booth		0.3	-	-	-	-	-	-	-	-	-	N/A
L00 - Tech Office		-	-	-	1.4	-	-	-	-	-	-	N/A
L00 - WC		-	-	-	1.4	-	-	-	-	-	-	N/A
L00 - Workshop High Risk		-	-	-	-	-	-	-	0.3	-	-	N/A
L00 - Workshop Low Risk		-	-	-	-	-	-	-	0.2	-	-	N/A

General lighting and display lighting		Luminous efficacy [lm/W]			General lighting [W]
Zone name		Luminaire	Lamp	Display lamp	
	Standard value	60	60	22	
L00 - Acc. WC		-	100	-	22
L00 - Acc. WC/Shower		-	94	-	52
L00 - AV Store		134	-	-	36
L00 - AV Studio		148	-	-	743
L00 - Ceramic and Screen Printing		156	-	-	640
L00 - Circulation		-	100	-	157
L00 - Circulation		-	100	-	121
L00 - Flexible space / Gallery		160	-	-	357
L00 - Group Studio		160	-	-	794
L00 - Large Studio		160	-	-	1980
L00 - Long Gallery		160	-	-	517
L00 - Metal Workshop		156	-	-	270
L00 - PDRA		-	100	-	66
L00 - Shop		134	-	-	54
L00 - Spray Booth		155	-	-	188
L00 - Studio		160	-	-	1357

General lighting and display lighting		Luminous efficacy [lm/W]			
Zone name		Luminaire	Lamp	Display lamp	General lighting [W]
	Standard value	60	60	22	
L00 - Tech Office		134	-	-	66
L00 - WC		-	100	-	229
L00 - Welfare		-	148	-	107
L00 - Workshop High Risk		149	-	-	399
L00 - Workshop Low Risk		149	-	-	373

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

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L00 - AV Studio	N/A	N/A
L00 - Ceramic and Screen Printing	NO (-94.9%)	NO
L00 - Flexible space / Gallery	NO (-83.4%)	NO
L00 - Group Studio	NO (-88.6%)	NO
L00 - Large Studio	NO (-74%)	NO
L00 - Long Gallery	NO (-88%)	NO
L00 - Metal Workshop	N/A	N/A
L00 - Spray Booth	N/A	N/A
L00 - Studio	NO (-83.5%)	NO
L00 - Tech Office	N/A	N/A
L00 - Workshop High Risk	NO (-78.8%)	NO
L00 - Workshop Low Risk	NO (-83.7%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m ²]	1532.7	1532.7
External area [m ²]	4534.9	3987.2
Weather	SWI	SWI
Infiltration [m ³ /hm ² @ 50Pa]	5	3
Average conductance [W/K]	1006.2	1263.67
Average U-value [W/m ² K]	0.22	0.32
Alpha value* [%]	9.13	10

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

Building Use

% Area Building Type

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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	32.91	40.82
Cooling	0.12	0.22
Auxiliary	3.43	4.45
Lighting	14.17	19.15
Hot water	2.48	2.37
Equipment*	16.04	16.04
TOTAL **	53.11	67.01

* Energy used by equipment does not count towards the total for consumption or calculating emissions.

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

Energy Production by Technology [kWh/m²]

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

Energy & CO₂ Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m ²]	113.04	136.48
Primary energy* [kWh/m ²]	99.13	125.95
Total emissions [kg/m ²]	17.1	21.7

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

HVAC Systems Performance										
System Type	Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEFF	Cool SSEER	Heat gen SEFF	Cool gen SEER	
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
Actual	31.5	36.2	2.3	1.8	8.3	3.75	5.55	4.35	6.76	
Notional	38.7	33.8	4.2	2.5	9.9	2.56	3.79	----	----	
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
Actual	235.2	0	76.1	0	1.4	0.86	0	0.91	0	
Notional	228.1	0	73.5	0	1.4	0.86	0	----	----	
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
Actual	77.2	0	25	0	1	0.86	0	0.91	0	
Notional	133	0	42.9	0	1	0.86	0	----	----	
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
Actual	52.2	0	16.9	0	9.6	0.86	0	0.91	0	
Notional	107.1	0	34.5	0	6.6	0.86	0	----	----	
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
Actual	22.8	0	7.4	0	2.5	0.86	0	0.91	0	
Notional	19.7	0	6.4	0	3.3	0.86	0	----	----	
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
Actual	133.9	0	43.3	0	9	0.86	0	0.91	0	
Notional	179.2	0	57.7	0	7.5	0.86	0	----	----	
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
Actual	71.4	0	5.1	0	8.4	3.89	5.34	4.35	6.76	
Notional	35.7	2.1	3.9	0.2	11.7	2.56	3.79	----	----	
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
Actual	6.1	0.5	0.5	0	6.7	3.75	5.55	4.35	6.76	
Notional	12.1	1	1.3	0.1	9.7	2.56	3.79	----	----	
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
Actual	19.7	1.7	1.5	0.1	7.8	3.76	5.54	4.35	6.76	
Notional	41.3	13.7	4.5	1	16.6	2.56	3.79	----	----	
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
Actual	62.9	2.7	4.7	0.1	8.3	3.74	5.57	4.35	6.76	
Notional	63.3	4.4	6.9	0.3	14.3	2.56	3.79	----	----	
[ST] No Heating or Cooling										
Actual	0	0	0	0	0	0	0	0	0	
Notional	0	0	0	0	0	0	0	----	----	

Key to terms

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

Key Features

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

Building fabric

Element	U _{i-Typ}	U _{i-Min}	Surface where the minimum value occurs*
Wall	0.23	-	L0000000:Surf[19]
Floor	0.2	0.03	L0000008:Surf[28]
Roof	0.15	0.1	L0000005:Surf[1]
Windows, roof windows, and rooflights	1.5	1.01	L0000002:Surf[8]
Personnel doors	1.5	0.67	L0000002:Surf[17]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building
U _{i-Typ} = Typical individual element U-values [W/(m²K)]		U _{i-Min} = Minimum individual element U-values [W/(m²K)]	
* There might be more than one surface where the minimum U-value occurs.			

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	4.6

Project name

Art Building

As designed

Date: Thu Feb 10 20:07:24 2022

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO ₂ emission rate from the notional building, kgCO ₂ /m ² .annum	21.7
Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	21.7
Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	14.2
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	U _a -Limit	U _a -Calc	U _i -Calc	Surface where the maximum value occurs*
Wall**	0.35	0.25	0.72	L0000003:Surf[17]
Floor	0.25	0.16	0.25	L0000017:Surf[0]
Roof	0.25	0.14	0.25	L0000002:Surf[4]
Windows***, roof windows, and rooflights	2.2	1.01	1.01	L0000002:Surf[8]
Personnel doors	2.2	1.11	1.2	L000001E:Surf[18]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building
U _a -Limit = Limiting area-weighted average U-values [W/(m ² K)] U _a -Calc = Calculated area-weighted average U-values [W/(m ² K)] U _i -Calc = Calculated maximum individual element U-values [W/(m ² K)] * There might be more than one surface where the maximum U-value occurs. ** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows. *** Display windows and similar glazing are excluded from the U-value check. N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.				

Air Permeability	Worst acceptable standard	This building
m ³ /(h.m ²) at 50 Pa	10	4.6

Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	<0.9

1- RADS and MVHR

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.85
Standard value	0.91*	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

2- RADS and NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

3- DX HP and MVHR (Lossnay Unit - LGH200RVXT-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.96	0.83
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

4- DX HP and MVHR (Lossnay Unit - LGH100RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	-	1.51	0.8
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

5- UFH and NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

6- DX HP and MVHR (Lossnay Unit - LGH35RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.96	0.82
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

7- RADS and S+E

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.85
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

8- UFH and MVHR

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.85
Standard value	0.91*	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

9- DX HP and MVHR (Lossnay Unit - LGH080RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.9	0.82
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

10- DX HP and MVHR (Lossnay Unit - LGH65RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.97	0.81
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

1- DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	-
Standard value	0.8	N/A

1- CHECK2-CHP

	CHPQA quality index	CHP electrical efficiency
This building	105	0.4
Standard value	105	0.2

Local mechanical ventilation, exhaust, and terminal units

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

Zone name	SFP [W/(l/s)]										HR efficiency	
	ID of system type	A	B	C	D	E	F	G	H	I		
	Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
L00 - Acc. WC		-	-	-	1.4	-	-	-	-	-	-	N/A
L00 - Acc. WC/Shower		-	-	-	1.4	-	-	-	-	-	-	N/A
L00 - AV Studio		-	-	-	-	-	-	-	0.2	-	-	N/A
L00 - Ceramic and Screen Printing		-	-	-	-	-	-	-	0.2	-	-	N/A
L00 - Metal Workshop		-	-	-	-	-	-	-	0.2	-	-	N/A
L00 - Spray Booth		0.3	-	-	-	-	-	-	-	-	-	N/A
L00 - Tech Office		-	-	-	1.4	-	-	-	-	-	-	N/A
L00 - WC		-	-	-	1.4	-	-	-	-	-	-	N/A
L00 - Workshop High Risk		-	-	-	-	-	-	-	0.3	-	-	N/A
L00 - Workshop Low Risk		-	-	-	-	-	-	-	0.2	-	-	N/A

General lighting and display lighting		Luminous efficacy [lm/W]			General lighting [W]
Zone name		Luminaire	Lamp	Display lamp	
	Standard value	60	60	22	
L00 - Acc. WC		-	100	-	22
L00 - Acc. WC/Shower		-	94	-	52
L00 - AV Store		134	-	-	36
L00 - AV Studio		148	-	-	743
L00 - Ceramic and Screen Printing		156	-	-	640
L00 - Circulation		-	100	-	157
L00 - Circulation		-	100	-	121
L00 - Flexible space / Gallery		160	-	-	357
L00 - Group Studio		160	-	-	794
L00 - Large Studio		160	-	-	1980
L00 - Long Gallery		160	-	-	517
L00 - Metal Workshop		156	-	-	270
L00 - PDRA		-	100	-	66
L00 - Shop		134	-	-	54
L00 - Spray Booth		155	-	-	188
L00 - Studio		160	-	-	1357

General lighting and display lighting		Luminous efficacy [lm/W]			
Zone name		Luminaire	Lamp	Display lamp	General lighting [W]
	Standard value	60	60	22	
L00 - Tech Office		134	-	-	66
L00 - WC		-	100	-	229
L00 - Welfare		-	148	-	107
L00 - Workshop High Risk		149	-	-	399
L00 - Workshop Low Risk		149	-	-	373

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

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L00 - AV Studio	N/A	N/A
L00 - Ceramic and Screen Printing	NO (-94.9%)	NO
L00 - Flexible space / Gallery	NO (-83.4%)	NO
L00 - Group Studio	NO (-88.6%)	NO
L00 - Large Studio	NO (-74%)	NO
L00 - Long Gallery	NO (-88%)	NO
L00 - Metal Workshop	N/A	N/A
L00 - Spray Booth	N/A	N/A
L00 - Studio	NO (-83.5%)	NO
L00 - Tech Office	N/A	N/A
L00 - Workshop High Risk	NO (-78.8%)	NO
L00 - Workshop Low Risk	NO (-83.7%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m ²]	1532.7	1532.7
External area [m ²]	4534.9	3987.2
Weather	SWI	SWI
Infiltration [m ³ /hm ² @ 50Pa]	5	3
Average conductance [W/K]	1006.2	1263.67
Average U-value [W/m ² K]	0.22	0.32
Alpha value* [%]	9.13	10

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

Building Use

% Area Building Type

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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	51.99	40.82
Cooling	0.12	0.22
Auxiliary	3.43	4.45
Lighting	14.17	19.15
Hot water	2.7	2.37
Equipment*	16.04	16.04
TOTAL **	59.04	67.01

* 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	13.37	0
Solar thermal systems	0	0

Energy & CO₂ Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m ²]	113.04	136.48
Primary energy* [kWh/m ²]	80.59	125.95
Total emissions [kg/m ²]	14.2	21.7

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

HVAC Systems Performance										
System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEFF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	31.5	36.2	0.7	1.8	8.3	3.75	5.55	4.35	6.76
	Notional	38.7	33.8	4.2	2.5	9.9	2.56	3.79	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	235.2	0	53.4	0	1.4	0.86	0	0.91	0
	Notional	228.1	0	73.5	0	1.4	0.86	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	77.2	0	9.7	0	1	0.86	0	0.91	0
	Notional	133	0	42.9	0	1	0.86	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	52.2	0	9.7	0	9.6	0.86	0	0.91	0
	Notional	107.1	0	34.5	0	6.6	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	22.8	0	1.4	0	2.5	0.86	0	0.91	0
	Notional	19.7	0	6.4	0	3.3	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	133.9	0	27.9	0	9	0.86	0	0.91	0
	Notional	179.2	0	57.7	0	7.5	0.86	0	----	----
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	71.4	0	1.9	0	8.4	3.89	5.34	4.35	6.76
	Notional	35.7	2.1	3.9	0.2	11.7	2.56	3.79	----	----
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	6.1	0.5	0.1	0	6.7	3.75	5.55	4.35	6.76
	Notional	12.1	1	1.3	0.1	9.7	2.56	3.79	----	----
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	19.7	1.7	0.3	0.1	7.8	3.76	5.54	4.35	6.76
	Notional	41.3	13.7	4.5	1	16.6	2.56	3.79	----	----
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	62.9	2.7	1.3	0.1	8.3	3.74	5.57	4.35	6.76
	Notional	63.3	4.4	6.9	0.3	14.3	2.56	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

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

Key Features

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

Building fabric

Element	U _{i-Typ}	U _{i-Min}	Surface where the minimum value occurs*
Wall	0.23	-	L0000000:Surf[19]
Floor	0.2	0.03	L0000008:Surf[28]
Roof	0.15	0.1	L0000005:Surf[1]
Windows, roof windows, and rooflights	1.5	1.01	L0000002:Surf[8]
Personnel doors	1.5	0.67	L0000002:Surf[17]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building
U _{i-Typ} = Typical individual element U-values [W/(m²K)]		U _{i-Min} = Minimum individual element U-values [W/(m²K)]	
* There might be more than one surface where the minimum U-value occurs.			

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	4.6

Project name

Art Building**As designed****Date:** Thu Feb 10 20:03:44 2022**Administrative information****Building Details****Address:** Address 1, City, Postcode**Certification tool****Calculation engine:** Apache**Calculation engine version:** 7.0.13**Interface to calculation engine:** IES Virtual Environment**Interface to calculation engine version:** 7.0.13**BRUKL compliance check version:** v5.6.b.0**Certifier details****Name:** Name**Telephone number:** Phone**Address:** Street Address, City, Postcode**Criterion 1: The calculated CO₂ emission rate for the building must not exceed the target**

CO ₂ emission rate from the notional building, kgCO ₂ /m ² .annum	21.7
Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	21.7
Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	-5.8
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	U _a -Limit	U _a -Calc	U _i -Calc	Surface where the maximum value occurs*
Wall**	0.35	0.25	0.72	L0000003:Surf[17]
Floor	0.25	0.16	0.25	L0000017:Surf[0]
Roof	0.25	0.14	0.25	L0000002:Surf[4]
Windows***, roof windows, and rooflights	2.2	1.01	1.01	L0000002:Surf[8]
Personnel doors	2.2	1.11	1.2	L000001E:Surf[18]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building
U _a -Limit = Limiting area-weighted average U-values [W/(m ² K)] U _a -Calc = Calculated area-weighted average U-values [W/(m ² K)] U _i -Calc = Calculated maximum individual element U-values [W/(m ² K)] * There might be more than one surface where the maximum U-value occurs. ** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows. *** Display windows and similar glazing are excluded from the U-value check. N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.				

Air Permeability	Worst acceptable standard	This building
m ³ /(h.m ²) at 50 Pa	10	4.6

Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	<0.9

1- RADS and MVHR

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.85
Standard value	0.91*	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

2- RADS and NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

3- DX HP and MVHR (Lossnay Unit - LGH200RVXT-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.96	0.83
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

4- DX HP and MVHR (Lossnay Unit - LGH100RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	-	1.51	0.8
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

5- UFH and NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

6- DX HP and MVHR (Lossnay Unit - LGH35RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.96	0.82
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

7- RADS and S+E

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.85
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

8- UFH and MVHR

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	-	0.2	0	0.85
Standard value	0.91*	N/A	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

9- DX HP and MVHR (Lossnay Unit - LGH080RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.9	0.82
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

10- DX HP and MVHR (Lossnay Unit - LGH65RVX-E)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.35	6.76	0	0.97	0.81
Standard value	2.5*	3.2	N/A	1.1^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					
^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.					

1- DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	-
Standard value	0.8	N/A

1- CHECK2-CHP

	CHPQA quality index	CHP electrical efficiency
This building	105	0.4
Standard value	105	0.2

Local mechanical ventilation, exhaust, and terminal units

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

Zone name	SFP [W/(l/s)]										HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I			
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1		Zone	Standard
L00 - Acc. WC	-	-	-	1.4	-	-	-	-	-	-	-	N/A
L00 - Acc. WC/Shower	-	-	-	1.4	-	-	-	-	-	-	-	N/A
L00 - AV Studio	-	-	-	-	-	-	-	0.2	-	-	-	N/A
L00 - Ceramic and Screen Printing	-	-	-	-	-	-	-	0.2	-	-	-	N/A
L00 - Metal Workshop	-	-	-	-	-	-	-	0.2	-	-	-	N/A
L00 - Spray Booth	0.3	-	-	-	-	-	-	-	-	-	-	N/A
L00 - Tech Office	-	-	-	1.4	-	-	-	-	-	-	-	N/A
L00 - WC	-	-	-	1.4	-	-	-	-	-	-	-	N/A
L00 - Workshop High Risk	-	-	-	-	-	-	-	0.3	-	-	-	N/A
L00 - Workshop Low Risk	-	-	-	-	-	-	-	0.2	-	-	-	N/A

General lighting and display lighting		Luminous efficacy [lm/W]			General lighting [W]
Zone name		Luminaire	Lamp	Display lamp	
Standard value		60	60	22	
L00 - Acc. WC		-	100	-	22
L00 - Acc. WC/Shower		-	94	-	52
L00 - AV Store		134	-	-	36
L00 - AV Studio		148	-	-	743
L00 - Ceramic and Screen Printing		156	-	-	640
L00 - Circulation		-	100	-	157
L00 - Circulation		-	100	-	121
L00 - Flexible space / Gallery		160	-	-	357
L00 - Group Studio		160	-	-	794
L00 - Large Studio		160	-	-	1980
L00 - Long Gallery		160	-	-	517
L00 - Metal Workshop		156	-	-	270
L00 - PDRA		-	100	-	66
L00 - Shop		134	-	-	54
L00 - Spray Booth		155	-	-	188
L00 - Studio		160	-	-	1357

General lighting and display lighting		Luminous efficacy [lm/W]			
Zone name		Luminaire	Lamp	Display lamp	General lighting [W]
	Standard value	60	60	22	
L00 - Tech Office		134	-	-	66
L00 - WC		-	100	-	229
L00 - Welfare		-	148	-	107
L00 - Workshop High Risk		149	-	-	399
L00 - Workshop Low Risk		149	-	-	373

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

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
L00 - AV Studio	N/A	N/A
L00 - Ceramic and Screen Printing	NO (-94.9%)	NO
L00 - Flexible space / Gallery	NO (-83.4%)	NO
L00 - Group Studio	NO (-88.6%)	NO
L00 - Large Studio	NO (-74%)	NO
L00 - Long Gallery	NO (-88%)	NO
L00 - Metal Workshop	N/A	N/A
L00 - Spray Booth	N/A	N/A
L00 - Studio	NO (-83.5%)	NO
L00 - Tech Office	N/A	N/A
L00 - Workshop High Risk	NO (-78.8%)	NO
L00 - Workshop Low Risk	NO (-83.7%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m ²]	1532.7	1532.7
External area [m ²]	4534.9	3987.2
Weather	SWI	SWI
Infiltration [m ³ /hm ² @ 50Pa]	5	3
Average conductance [W/K]	1006.2	1263.67
Average U-value [W/m ² K]	0.22	0.32
Alpha value* [%]	9.13	10

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

Building Use

% Area Building Type

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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	51.99	40.82
Cooling	0.12	0.22
Auxiliary	3.43	4.45
Lighting	14.17	19.15
Hot water	2.7	2.37
Equipment*	16.04	16.04
TOTAL **	59.04	67.01

* 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	38.38	0
Wind turbines	0	0
CHP generators	13.37	0
Solar thermal systems	0	0

Energy & CO₂ Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m ²]	113.04	136.48
Primary energy* [kWh/m ²]	80.59	125.95
Total emissions [kg/m ²]	-5.8	21.7

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

HVAC Systems Performance										
System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEFF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	31.5	36.2	0.7	1.8	8.3	3.75	5.55	4.35	6.76
	Notional	38.7	33.8	4.2	2.5	9.9	2.56	3.79	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	235.2	0	53.4	0	1.4	0.86	0	0.91	0
	Notional	228.1	0	73.5	0	1.4	0.86	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	77.2	0	9.7	0	1	0.86	0	0.91	0
	Notional	133	0	42.9	0	1	0.86	0	----	----
[ST] Central heating using water: floor heating, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	52.2	0	9.7	0	9.6	0.86	0	0.91	0
	Notional	107.1	0	34.5	0	6.6	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	22.8	0	1.4	0	2.5	0.86	0	0.91	0
	Notional	19.7	0	6.4	0	3.3	0.86	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	133.9	0	27.9	0	9	0.86	0	0.91	0
	Notional	179.2	0	57.7	0	7.5	0.86	0	----	----
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	71.4	0	1.9	0	8.4	3.89	5.34	4.35	6.76
	Notional	35.7	2.1	3.9	0.2	11.7	2.56	3.79	----	----
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	6.1	0.5	0.1	0	6.7	3.75	5.55	4.35	6.76
	Notional	12.1	1	1.3	0.1	9.7	2.56	3.79	----	----
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	19.7	1.7	0.3	0.1	7.8	3.76	5.54	4.35	6.76
	Notional	41.3	13.7	4.5	1	16.6	2.56	3.79	----	----
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	62.9	2.7	1.3	0.1	8.3	3.74	5.57	4.35	6.76
	Notional	63.3	4.4	6.9	0.3	14.3	2.56	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

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

Key Features

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

Building fabric

Element	U _{i-Typ}	U _{i-Min}	Surface where the minimum value occurs*
Wall	0.23	-	L0000000:Surf[19]
Floor	0.2	0.03	L0000008:Surf[28]
Roof	0.15	0.1	L0000005:Surf[1]
Windows, roof windows, and rooflights	1.5	1.01	L0000002:Surf[8]
Personnel doors	1.5	0.67	L0000002:Surf[17]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building
U _{i-Typ} = Typical individual element U-values [W/(m²K)]		U _{i-Min} = Minimum individual element U-values [W/(m²K)]	
* There might be more than one surface where the minimum U-value occurs.			

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	4.6