MAX FORDHAM

Swords Cultural Quarter

Energy & Sustainability Strategy for Planning

Rev 4

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1	04/04/22	First Issue
2	12/04/22	Issued for Planning
3	09/06/22	Issued for Planning
4	07/07/22	PLANNING

CONTENTS

EXECUTIVE SUMMARY

This statement comprises of an energy strategy proposal and demand assessment for the Swords Cultural Centre building within the wider Swords Cultural Quarter site.

The report demonstrates how the proposed energy efficiency and renewable energy strategies have been incorporated in the design.

In summary:

1. Passive design features have been included as part of the building's massing, internal planning and orientation, as well as in the performance targets for the thermal insulation and airtightness of the building envelope and by the use of controlled daylight and passive environmental control where appropriate.
2. Further improvements in energy efficiency are proposed with the implementation of measures that range from the selection of energy efficient plant to the introduction of automatic control features.
3. A combination of energy benchmarks have been used in our analysis including CIBSE Guide F, CIBSE TM46 and Max Fordham data from post-occupancy reviews of previous projects.
4. A detailed building performance compliance assessment, using the Non-domestic Energy Assessment Procedure (NEAP), was carried out in SBEMie.
5. The Proposed building is predicted to comply with all legislation (Building Regulations Part L and EU Directive 2010/31/EU), using a combination of energy efficiency measures and the installation of roof mounted photovoltaic panels.
6. Renewable/low carbon energy systems will offset 20% of the buildings regulated carbon emissions. This will be achieved by the installation of roof mounted photovoltaic panels and 2no. air source heat pumps.

1.0 INTRODUCTION

This statement has been prepared by Max Fordham on behalf of Fingal County Council to accompany the planning application for Swords Cultural Quarter.

The report is structured as follows:

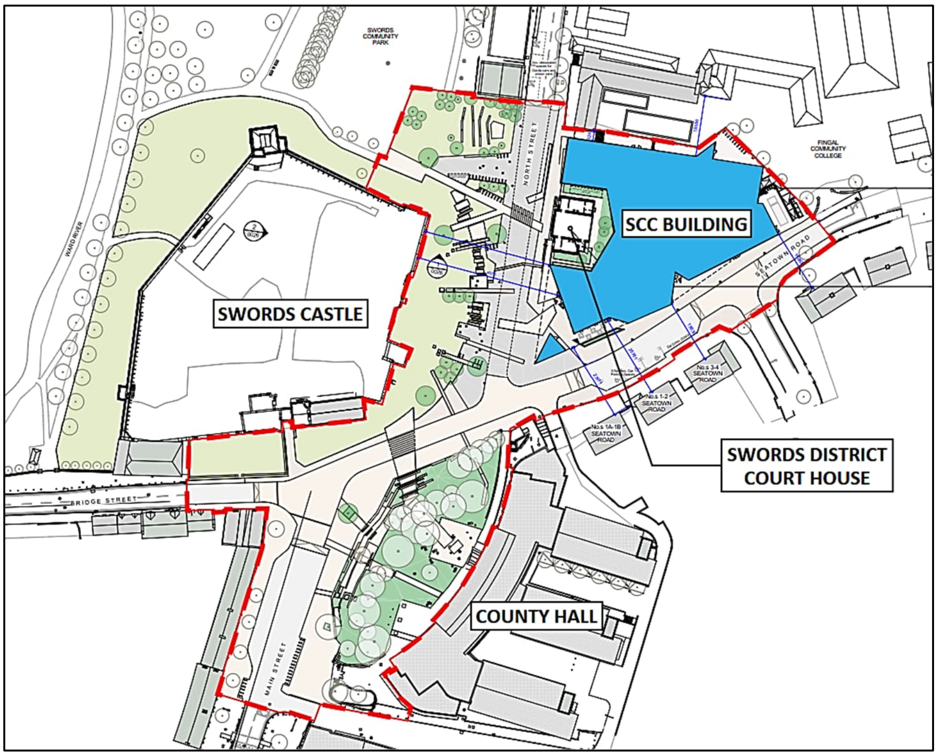
1. A contextual review of national and local planning policies.
2. A summary of the carbon and energy saving strategies proposed for the new development including an assessment of renewable/low carbon technologies.
3. Presentation of the proposed energy performance of the Swords Cultural Centre building.

1.1 Project Background

The Swords Cultural Quarter (SCQ) project being undertaken by Fingal County Council (FCC) will involve the design and delivery of the construction of the Swords Cultural Centre (SCC) and implementation of a Public Realm project. The overall site boundary, illustrated below, covers an area of 15,751m^2.

The Swords Cultural Centre (SCC) Building
The SCC building is to be located on the site of the current FCC executive carpark and St Michaels House centre. The site for the Swords Cultural Quarter also contains the Swords District Court House and is bordered by Main Street, Sea Point Road and the Fingal Community College. The proposed building will have a GIA of 5,686m^2 and a building footprint of 2,348m^2.

The Public Realm (Civic Space)
The public space to be redeveloped includes the Main Street, North Street, Bridge Street and Seatown Road junction, along with Main Street outside County Hall, North Street and Seapoint Road outside the SCC. The Public Realm covers an area of circa 13,200m^2.



Outline plan of the Swords Cultural Quarter

2.0 POLICY CONTEXT

The proposals outlined in this report have been developed within the context of the following national and local policies, that seek to address the challenges of climate change by improving the sustainability and lowering energy/carbon use of new developments.

2.1 National Policy

ROI Building Regulations
Buildings Regulations are minimum standards for design, construction, and alterations of buildings. They are a Statutory Instrument and approval by Building Control, or an approved inspector is required prior to construction and occupation.

Technical Guidance Documents published by the government set out ways to demonstrate compliance with Building Regulations. The following are applicable to the building fabric, mechanical, electrical, and public health systems at Swords Cultural Quarter;

- Fire Safety: Technical Guidance Document B
- Ventilation: Technical Guidance Document F
- Hygiene: Technical Guidance Document G
- Water and Waste: Technical Guidance Document H
- Heat Appliances: Technical Guidance Document J
- Conservation of Fuel and Energy: Technical Guidance Document Part L

Technical Guidance Document Part L: Conservation of Fuel and Energy
A key section of the Building Regulations that applies to the design of the MEP and energy systems is Technical Guidance Document Part L, which refers to the Conservation of Fuel and Energy in non-domestic buildings.

The energy performance objectives proposed in this document are aimed at meeting the requirements of the latest 2017 edition.

EU Directive 2010/31/EU Targets
The Near Zero Energy Building (NZEB) Directives now released for buildings owned and operated within Public Sector will be implemented for the Swords Cultural Quarter project and in particular the Swords Cultural Centre building.

In line with the Client's brief, the buildings will be designed to be in compliance with the 2017 Part L Building Regulations applicable to Near Zero Energy Building (NZEB) directives as follows:

- Minimum Reduction in Primary Energy of 60% below Technical Guidance Document (TGD) part L 2008: Conservation of Fuel and Energy – Buildings Other than Dwellings.
- A significant proportion of Primary Energy is to be delivered via Renewable Technologies with a target of 20% Renewables Energy Ratio (RER).

2.2 Local Policy

Fingal Development Plan 2017-2023
Our proposals for the Swords Cultural Quarter are generally in line with the key objectives set in the Fingal Development Plan 2017-2023 document that are relevant to the MEP systems. The Fingal Development Plan 2017-2023 sets out the policies and objectives for the development of the County over the Plan period and seeks to develop and improve the social, economic, environmental, and cultural assets of the County in a sustainable manner.

Key Strategic Policies (Section 1.6) of the Development Plan as they relate to this project include:

- Work with Irish Water to secure the timely provision of water supply and drainage infrastructure necessary to end polluting discharges to waterbodies, comply with existing licences and Irish and EU law, and facilitate the sustainable development of the County and the Region.
- Secure the timely provision of infrastructure essential to the sustainable development of the County, in particular in areas of resource and waste management, energy supply, renewable energy generation and Information and Communications Technology (ICT).
- Promote, drive and facilitate the transition in the future to an entirely renewable energy supply.

Additionally, specific objectives have been identified in the Fingal Development Plan relating to the delivery of the Swords Cultural Quarter. These objectives, together with our approach to addressing them, have been listed in Table 1, overleaf.

FCC Climate Change Action Plan 2019-2024
The proposals are also in line with the objectives set out in Fingal County Council's Climate Change Action Plan document. The Climate Change Action Plan 2019-2024 (CCAP) was developed by Fingal County Council in collaboration with the Dublin Local Authorities in partnership with the City of Dublin Energy Management Agency (Codema) and Dublin's Climate Action Regional Office (CARO); and launched in September 2019 following an extensive public consultation process.

The implementation of climate actions has been ongoing across all Council Departments, some of which have been completed. Specific objectives have been identified in the CCAP, relating to the delivery of the Swords Cultural Quarter. These objectives, together with our approach to addressing them, have been listed in Table 1.

Table 1 Policy objectives and our approach to addressing them

	PERFORMANCE TARGET	DESIGN APPROACH TO ADDRESS OBJECTIVE
EU Directive 2010/31/EU	Lighting luminaire efficacy to be at least 65 lumens/circuit Watt	LED lighting is being utilised throughout and most good quality modern LED fittings have an efficacy of above 65 lumens per circuit Watt. It will be ensured that high quality, modern, high efficacy products are chosen for the project.
	Include occupancy control and daylight dimming for lighting controls	Daylight dimming is included in all areas with external glazing. In addition, occupancy sensors are included in all open plan and public areas with no sense of ownership by the occupants.
	Specific fan power for mechanical ventilation maximum 1.8 W/(l/s)	All supply fans, extract fans and AHUs have been selected to ensure that the specific fan power does not exceed this value.
	Variable speed control of fans and pumps controlled via multiple sensors	Variable speed control has been included as the control method for all fans and pumps, unless explicitly required for the efficient function of specific plant/systems.
	20% of total primary energy for the building to be provided by renewable energy sources onsite or nearby	This requirement is being met by installing a combination of new air source heat pumps and photovoltaic panels.
Fingal Development Plan 2017-2023	DMS18 Utility Facilities Locate, where possible, new utility structures such as electricity substations and telecommunication equipment cabinets, not adjacent to or forward of the front building line of buildings or on areas of open space.	A new substation, to ESB Networks' specification, is proposed. It will be installed within the footprint of the Swords Cultural Centre (SCC) building. The location allows direct access as required by ESBN but has minimal visual impact to the site.
	DMS138 Renewable Energy Permit renewable energy developments where the development and any ancillary facilities or buildings, considered both individually and with regard to their incremental effect, would not create a hazard or nuisance.	A low and zero carbon technologies feasibility study was carried out in order to identify the most suitable technology for the application to this project. An appraisal of the site was carried out during the study, to ensure that the chosen proposals would not have a negative impact on the surrounding environment.
	DMS139 Overhead Cables Seek the placing underground of all electricity, telephone and TV cables in urban areas.	A utilities survey has been carried out, and several overhead cables have been identified on the existing site. We are liaising with the relevant utility providers and propose to divert existing overhead cables below ground. All applications for new utility connections have specified the use of underground installations only. All proposed site infrastructure across the Public Realm will be routed below ground.
	DMS140 Overhead Cables Require that, in all new developments, multiple services be accommodated in shared strips and that access covers be shared whenever possible	This site services design will be detailed at the next stage to take into consideration the minimisation of access covers. We will work in conjunction with utility providers and the relevant members of the design team to ensure site services routes and access covers are consolidated where possible and provide minimal impact to the site.
	PM28 Energy Efficiency and Climate Change Improve the efficiency of existing buildings and require energy efficiency and conservation in the design and development of all new buildings within the County.	As detailed in our Energy and Environmental Strategy, passive design is the foundation of the Max Fordham approach. We aim to maximise the energy efficiency by means of a demand-led strategy, using passive means to minimise energy demand before introducing energy efficient MEP services and finally by introducing renewable technologies.
	PM29 Energy Efficiency and Climate Change Promote energy efficiency and conservation above Building Regulations standards in the design and development of all new buildings and residential schemes in particular and require designers to demonstrate that they have taken maximising energy efficiency and the use of renewable energy into account in their planning application.	By incorporating passive design principles and ensuring that highly efficient plant is selected throughout, operational energy consumption and CO_2 emissions are kept to a minimum. The proposed MEP and sustainability strategy has been tested using energy performance modelling, which indicates that the proposed building will exceed Building Regulations targets for operational energy and carbon emissions.
	PM30 Energy Efficiency and Climate Change Encourage the production of energy from renewable sources, subject to normal planning considerations and in line with any necessary environmental assessments.	A low and zero carbon technologies feasibility study has concluded that the most appropriate low carbon technologies for this project are air source heat pumps and photovoltaic panels. We are proposing to install both.

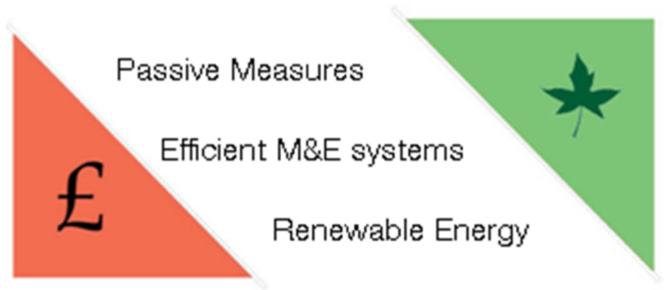
	EN01 Energy Efficient Design Support International, National and County initiatives for limiting emissions of greenhouse gases through energy efficiency and the development of renewable energy sources using the natural resources of the County in an environmentally sustainable manner where such development does not have a negative impact on the surrounding environment, landscape or local amenities	As above DMS138, PM29 and PM30
	EN04 Energy Efficient Design Encourage development proposals that are low carbon, well adapted to the impacts of Climate change and which include energy saving measures and which maximise energy efficiency through siting, layout and design.	As above DMS138, PM29 and PM30 We have ensured that our calculations take into consideration the impact of climate change. Examples include; applying a factor to the rainwater intensity calculations when designing the rainwater drainage system; using future climate weather files when carrying out building physics simulations.
	EN06 Renewable Energy Encourage and facilitate the development of renewable energy sources, optimising opportunities for the incorporation of renewable energy in large scale commercial and residential development.	As above PM30
	EN12 Solar Support Ireland's renewable energy commitments outlined in national policy by facilitating the exploitation of solar power where such development does not have a negative impact on the surrounding environment, landscape, historic buildings or local amenities.	Although our energy performance modelling concludes that the Building Regulations renewable energy targets can be met solely by the air source heat pump system, we are proposing to maximise the use of renewable energy by making use of the available roof space for the installation of photovoltaic panels.
	LP01 Light Pollution *(also covered in DMS150)* Require that the design of lighting schemes minimises the incidence of light spillage or pollution into the surrounding environment. New schemes shall ensure that there is no unacceptable adverse impact on neighbouring residential or nearby properties; visual amenity and biodiversity in the surrounding areas.	High performance light fittings are proposed, with the appropriate output and optics to avoid over-lighting and upward light spill. Downlights have been selected generally to avoid unnecessary sky glow and the use of up-lighting avoided. Any up-lights or Wall-mounted fittings will have high performance, directional optics with upward light spill.
CCAP 2019-2024	E5 Energy Efficiency & Renewables Complete the roll out of LED public lighting by 2021	This target has been achieved by the Council. However, this objective will be extended to the Swords Cultural Quarter, where we propose that all new light fittings installed on site will be LED.
	E14 Energy Efficiency & Renewables All new Council buildings built to nZEB standard	Our Energy and Environmental Strategy has been developed to ensure the development meets Building Regulations targets. We have carried out the building performance compliance modelling in SBEMie, which concludes that the proposed building is in compliance with the 2017 Part L Building Regulations applicable to Near Zero Energy Building (nZEB) directives.
	E34 Energy Efficiency & Renewables Install high visibility PV panels on suitable Council roofs such as libraries and community buildings	Although our energy performance modelling concludes that the Building Regulations renewable energy targets can be met solely by the air source heat pump system, we are proposing to maximise the use of renewable energy by making use of the available roof space for the installation of photovoltaic panels.

OUR APPROACH

The challenge for the environmental design of a building is to provide good comfort, visual, thermal and acoustic, but with the minimal energy used to achieve that provision of comfort.

We wish to maintain a comfortable and appropriate internal environment whilst using the minimum amount of energy possible. Our approach to this is driven by the following design hierarchy:

1. Passive Measures - minimise building energy use by considering the building form (“passive environmental control”) in order to avoid or minimise the need for mechanical cooling and heating, and artificial lighting.
2. Efficient M&E Systems - minimise plant energy use by selecting the most appropriate engineering systems and optimising system performance (“active environmental control”).
3. Renewable Energy - the use of appropriate on-site renewable energy technologies.



Given this approach, our design is driven by preferential investment in reducing the inherent baseline energy demand rather than in the application of renewable energy technologies at the outset. We also appreciate that investment in good building design and fabric specification often has a better life advantage when compared with high technology mechanical and electrical systems.

Following the design hierarchy, our approach will be based first on exploring passive means through which to reduce energy consumption; before going on to look at how the building’s remaining energy needs can be delivered most efficiently; and finally looking at the renewable technologies most appropriate to the site and building use.

BE LEAN (PASSIVE DESIGN)

Building form plays a very important part in defining the internal environment and reducing the need for energy-intensive intervention to maintaining appropriate internal conditions. We must use appropriate building design and 'passive engineering' first, before we consider any dynamic (active) systems to further control the internal environment.

The passive measures that are being integrated in the design are described in this section. Appendix B shows the sketches created during Stage 2A(i) in aiding the development of the environmental strategy.

Building Form and Orientation

The orientation and form of the building have been assessed to identify and maximise opportunities for daylighting and views out, while minimising the potential for solar gains during summer. Most occupied spaces have direct access to an external facade, which offers potential to naturally ventilate and daylight these spaces. The external facades have been orientated to the north and south-east.

Throughout this design stage, we have worked with the Architects and Facade Designers to optimise glazing area, glazed and opaque openings for ventilation, internal/external shading and fabric thermal performance to ensure full advantage can be taken of the proposed building orientation.

Fabric Performance

The EU Directive and ROI Building Regulations Part L 2017 stipulate targets for the U-Values for the thermal performance of the building elements and the air permeability of the building envelope. Table 2 summarises the maximum permissible building envelope performance requirements and the target values for the SCQ project;

Table 2: Proposed fabric performance

Building Element	Max Avg ROI Part L 2017	Reference Values for NZEB [1]	Proposed Values
Roof U-value (W/m^{2}K)	0.16	0.15	0.14
Wall U-value (W/m^{2}K)	0.21	0.18	0.15
Ground Floor U-value (W/m^{2}K)	0.21	0.15	0.14
Window U-value (W/m^{2}K)	1.6	1.4	1.3
Curtain Wall: U-value (W/m^{2}K)	1.8	-	1.4 [2]
Window: Light Transmission (%)	-	71	70 [3]
Windows: G-Value (%)	-	40	35-40 [3]
Curtain Wall: G-Value (%)	-	-	30
Air Permeability m^3/hr.m^2	-	3	3

[1] Figures taken from Appendix C of the Technical Guidance Document (TGD) Part L 2017. These parameters represent a building achieving NZEB performance

[2] Curtain wall specification to be developed with Architect and facade specialist. Based on current feedback, 1.4W/m^{2}K should be readily achievable with a double-glazed curtain wall with fixed glazing. As there is likely to be a significant quantity of operable windows and doors, the fabric performance of the curtain wall may be closer to 1.6W/m^{2}K.

[3] The glazing performance has been assessed on a façade-by-façade basis and the light transmission and specific g-values are proposed for each glazed element

The proposed fabric thermal performance figures indicated in Table 1 are significantly better than the Part L limiting factors and slightly better than the reference NZEB figures. This is to ensure the energy and carbon reduction targets are achieved, as well as the BREEAM energy credits maximised.

The energy modelling carried out using the proposed fabric performance has yielded positive results and indicates that the design exceeds the minimum Building Regulations and BREEAM targets. The results of the modelling also indicate that there is scope to relax the fabric performance targets if there comes the need to strike a balance between energy savings and, say, cost, wall thicknesses and the diminishing returns available from further increasing the thermal performance of a building envelope.

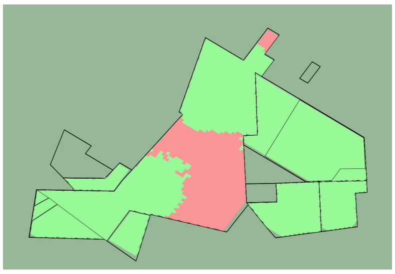
Daylighting

Adequate access to daylight is essential for the health and wellbeing of building users in giving them a connection with the outside and helping to maintain their circadian rhythms. Also, where daylight levels are high enough, users are less likely to turn the lights on, making the building more energy efficient.

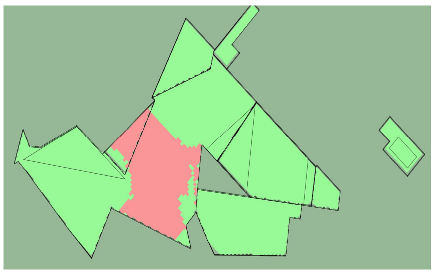
The facade designs, including glazing ratios, have been developed with O'Donnell & Tuomey Architects to achieve adequate daylight levels across the building, while ensuring the criteria for limiting solar gain is also met. A daylighting assessment has been undertaken to determine the potential for daylighting across each space and to understand the likelihood of achieving the related BREEAM HEA 01 Daylighting credit. The results of the modelling conclude that;

- 75% of the occupied area achieves an adequate average daylight factor
- 86% of the occupied area is illuminated to at least 300 lux by daylight for more than 2,000hr/year

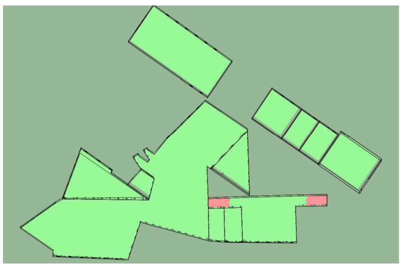
A visual representation of the results is illustrated below. This shows that it is mainly the deep open plan spaces that have areas that do not meet the criteria.



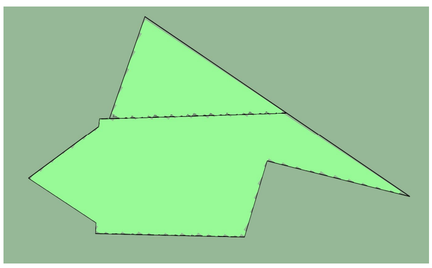
- *Ground Floor*



First Floor



- *Second Floor*



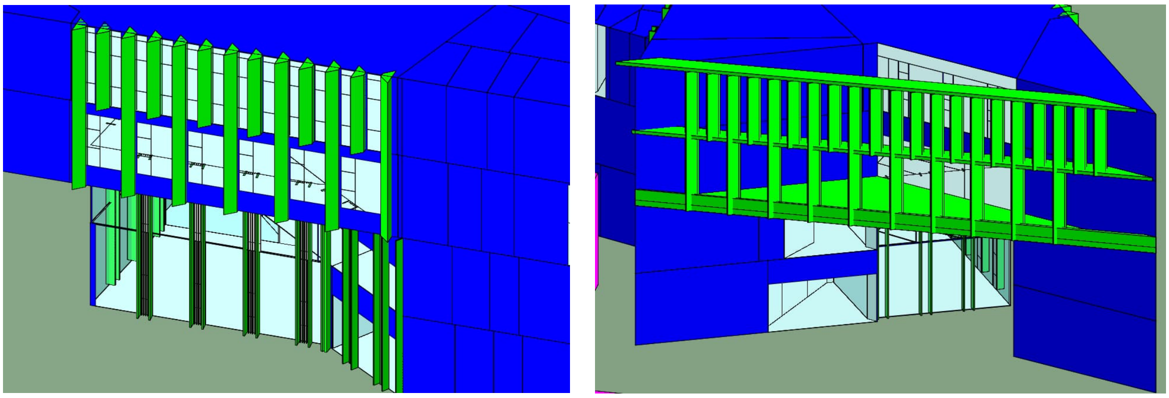
Third Floor

- *BREEAM compliance levels for 300 lux >2000 hours.*

Solar Shading
Aside from the size and orientation of glazing, the provision of shading devices where appropriate is key to an effective daylighting strategy. For example, north-facing glazing can be extremely useful for providing daylight, as there is no direct sunlight incident on this orientation, and thus shading is only required when necessary to reduce internal light levels. However, west-facing glazing needs to be carefully selected to ensure the thermal performance is adequate, and consideration given to the shading provisions as this is critical to limiting solar gains in the afternoon – the time of highest air temperatures – as well as providing glare control.

We have worked closely with the Design Team to develop the elevations, modelling several iterations of the design. The facade design has been optimised to maximise the passive benefits of daylight and winter-time solar gain, while minimising the risks of excessive solar gain and ensuring compliance with Criterion 3 of the Building Regulations Part L2.

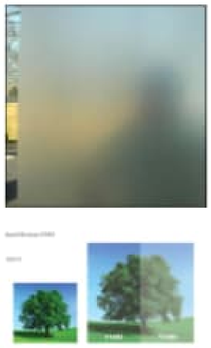
Throughout the design development, changes were made such as reducing glazing and adding external brise soleil to mitigate some solar gain. Further suggestions to the glazing specification have been made where majority of the glazing is set at a G-value of 0.35, to provide adequate protection.



3D views of solar shading devices modelled in IES VE

Internal shading will also be provided to control glare, particularly in the office, meeting and library areas. An options appraisal of glare control devices is shown in Table 3. This will form the basis of the design development during the next Stage.

Table 3 Glare control options appraisal

Integrated blind between panes	Motorised internal blind	Diffuse glass
		
This glazing technology is beneficial in terms of thermal performance (keeps more solar gains out than internal blinds) and less architecturally intrusive. Their operation can be automated to deploy when the sun is out and glare might be an issue. Capital costs and maintenance aspects need to be carefully considered.	This is the simplest solution that will work at all sunny hours whilst maximising daylight when it is not sunny. They can operate automatically based on sky conditions or be pulled down by users and then automatically raised once the sun has passed. Maintenance and wiring aspects are to be considered.	The use of a fritt on the glass is not the best way to reduce glare issues, as a coarse pattern would still let direct light in and a fully fritted window would not diffuse the sun beam enough and might even accentuate the issue as more hours could be "glary". A PVB interlayer or acid-etched glass would be more suitable as they would also let more diffuse light in, which will be useful for most hours in Swords
Capillary / interstitial technology	**Vertical fins / timber battens**	**Clear glass**
		
Capillary glass lets direct light through at certain angles only, maintaining views out whilst diffusing critical sun angles. They are fixed shading so don't require maintenance.	They can be designed to reduce the number of "glary" hours to times at which the sun is only perpendicular to the window – i.e. lunch time. Spacing and materiality will affect the daylighting of the space.	In areas with lower occupancy, an option would be to keep the windows clear and live with a few rare sun beams in winter. Solar gain control will also need to be considered, so shading may be required regardless of glare mitigation

Natural Ventilation

To meet energy targets and overall design objectives, the design team have sought to naturally ventilate as many spaces as possible during the summer months. Natural ventilation allows for the provision of fresh air and good thermal comfort in summer without the use of fan power.

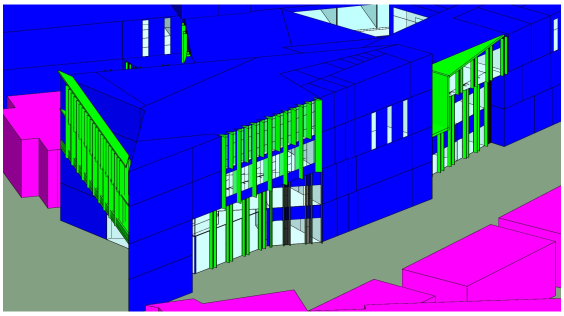
The Cultural Centre building is designed such that it can be naturally ventilated relatively easily. The vast majority of the above ground spaces will have access to naturally ventilated openings. Those that cannot be naturally ventilated are:

- Land-locked areas without access to external glazing/openings
- Areas with high occupancy and specific thermal/humidity control requirements such as; Gallery, Theatre and Rehearsal Room
- IT Comms Rooms, where controlled conditions are required to keep the equipment in good condition.
- Toilets, kitchen areas and waste stores for odour control.
- Any areas with strict acoustic requirements. At this stage, none of the proposed naturally ventilated spaces have been identified by the Acoustic Consultants as being problematic.

The facade has been designed to ensure enough natural ventilation opening is incorporated where needed. The required opening areas have been determined by means of dynamic thermal simulations, in line with the requirements of BREEAM HEA 04 Thermal Comfort credits.

The simulations also took into account the shading devices proposed by the Architect. These additions included an overhang and vertical shading as well as brise soleil along the curtain walling (shown in 3D below). The rooms have been assessed with reference to the adaptive criteria proposed by the CIBSE Technical Memorandum TM52 "The limits of the overheating in European buildings". The simulation has been carried out using the software IES VE and was based on ODT's Revit model.

The results of the modelling pass the TM52 criteria following the implementation of additional open area through openable louvered openings and windows. The result indicate that the spaces are not likely to overheat significantly when naturally ventilated.



3D view of TM52 IES VE model

Night-time ventilation & Thermal mass

The facade has also been designed to incorporate secure and weather-tight openings in the naturally ventilated spaces, where possible. These will be opened overnight in summer and will take advantage of cooler night-time temperatures to passively cool the building overnight. The effect of night-time ventilation was included in the dynamic thermal modelling.

Night-time ventilation is often coupled with exposed thermal mass, which absorbs heat during the day, and releases it overnight when the building is not occupied. Concrete has a high heat capacity and conductivity, meaning it has a big capacity to absorb heat during the day. In this way, a combination of night ventilation and thermal mass keeps the building cool through the hot part of the day, before venting away that heat overnight. The proposed structure is largely light-weight timber, which does not carry as much thermal inertia as solid concrete. However, thermal mass will be considered where possible as part of the night-purging strategy, such as the ground floor living room, which is exposed screed. This, in combination with secure night-time openings, will help cool the spaces down overnight in preparation for the next day.

3.0 BE CLEAN (ENERGY EFFICIENT SERVICES)

Following the integration of passive measures described above, focus will shift to examine the most efficient way of servicing the building's remaining needs. Some energy efficient measures are to be developed including:

- specifying high efficiency HVAC plant
- designing systems to allow plant to operate at its maximum efficiency
- specifying variable speed pumps and fans
- energy sub-metering for heat, power and lighting
- kill switches in appropriate areas to switch-off non-essential peripheral equipment outside occupied hours
- providing simple, efficient, and user-friendly controls

Water Efficiency
Measures will be implemented to minimise water use and wastage. These will include central monitoring and sub metering of water usage; leak detection and automatic shut off valves; and the specification of low-flow appliances. These measures will be specified and designed to maximise credits achieved in the BREEAM WAT 01, WAT 02 and WAT 03 categories.

Domestic hot water
Domestic hot water will be generated by local under-counter electric unvented storage heaters, due to the low demand throughout the building. These heaters are the more energy and space efficient solution. They don't have any standing and circulation heat losses and do not require a network of hot water pipework to circulate the building. Local point-of-use heaters are also easier to replace than central plant and are more resilient to scale build-up. Hot water demand will be minimised by specifying appropriate low flow fittings.

Heat Emitters
The type of heat emitters will be selected to maximise the efficiency of the chosen heat source, while being compatible with the Architectural language of each space. Variable speed pumping with differential pressure sensors will be used to match the flow rate to the demand, and thus reduce pumping energy associated with the heating system.

Mechanical Ventilation
Where mechanical ventilation is required – such as WCs – fans will be local to the areas served to minimise specific fan power; and where appropriate the systems will be designed with heat recovery – so that heat is transferred from the warm extract air to the cold supply air during the heating season.

Artificial Lighting
The electric lighting installation will consist of low energy LED light sources and fittings with a high light output ratio. Lighting controls will be grouped to avoid the unnecessary use of electric light, and automatic controls comprising occupancy detection and daylight dimming used where appropriate. Light levels will be appropriate to the space and chosen to minimise over-illumination and unnecessary energy use. Task lighting will be used for all study desks.

Metering and Monitoring
A comprehensive network of sub-meters will be provided for all services to enable attribution of energy use to specific end-uses. These meters will be linked to the central building management system (BMS) to provide central monitoring and logging of energy use – enabling the building users to see and target major energy consumers for reduction.

Controls
A central BMS will be provided to monitor system alarms, log energy use data, and control the HVAC systems. This coordinated and coherent control approach will ensure systems operate most efficiently and their operation is coordinated with each other to avoid opposing systems 'fighting' each other. Appropriate control setpoints and time schedules will be specified to allow the spaces to achieve the target conditions for human comfort and the preservation of the collections without unnecessary energy use. Efficient and user-friendly controls will be specified.

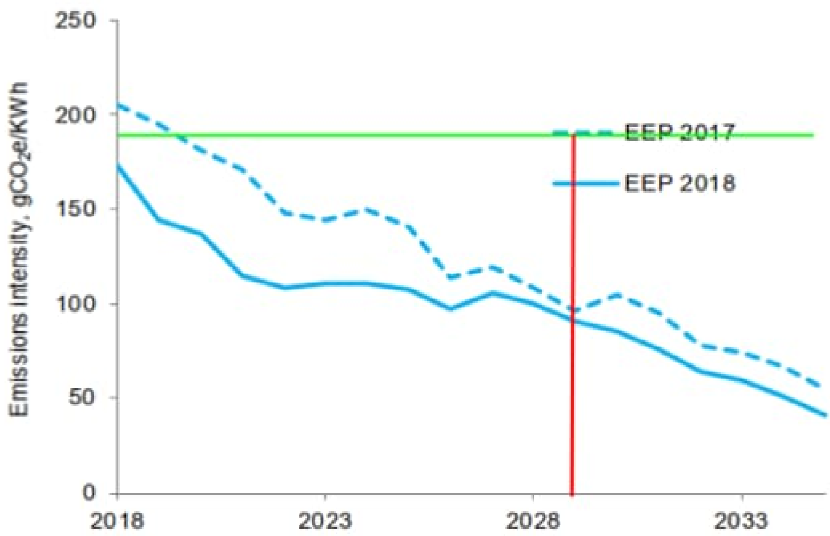
BE GREEN (USING RENEWABLE / LOW CARBON ENERGY)

Our approach maximises passive energy saving by proposing a well-insulated and air-tight building, and efficient M&E systems. While this may be sufficient to meet Irish Building Regulations Part L2 targets, there is an additional requirement for 20% of the operational energy use to be met by renewable sources, therefore LZC technologies are required.

Grid Decarbonisation
Historically, the carbon emissions intensity of grid electricity supply was at least double that of natural gas. This has now changed; grid electricity is rapidly decarbonising, as generators on the grid are switching from gas and coal to renewable technologies, such as offshore wind and solar farms.

In Ireland, the carbon intensity of electricity fell to 324 gCO_2/kWh in 2019. This is the lowest level since the 1940's, and 33% lower than in 2016. The dramatic reduction since 2016 was the result of an 86% reduction in coal and a 54% increase in renewables used for electricity generation.

The carbon emission factor of natural gas will remain constant. However, the carbon intensity of the electricity grid is projected to fall significantly below natural gas by over the next decade. Taking the UK as an example, by 2030 the UK Government Department 'BEIS' estimates that the carbon emission factor of grid electricity will be 100 grams of Carbon Dioxide per kWh.



Emissions intensity of the UKs electricity supply (From BEIS 2019)
Green=gas, blue=grid electricity.

Renewables Strategy
In line with current policy and the Client's low-carbon aspirations, our proposals are aimed at taking the site towards an electric based system and away from natural gas. There are several new technologies that can be implemented to achieve our sustainability aspirations and supply the site's energy needs without relying on natural gas as a fuel source. Based on our feasibility analysis summarised in Table 4, our recommendation is to install the following two technologies;

- Air Source Heat Pump (ASHP) to meet the space heating requirements
- Photovoltaic panels (PV) on the flat areas of the roof

A high-level feasibility analysis for a range of renewables has been carried out for the site which is summarised in the table below.

Table 4 Feasibility analysis of different types of LZC technologies

Category	Low or Zero Carbon Technology	Electricity Generation potential	Heat Generation	Feasibility	Commentary
Solar	Solar Thermal	No	Yes	Yes	There is sufficient roof area to make Solar Thermal feasible. The surrounding area is relatively low-rise, so solar shading isn't a major risk.
	Solar Photovoltaic	Yes	No	Yes	There is sufficient roof area to make Solar PV feasible. The surrounding area is relatively low-rise, so solar shading isn't a major risk.
Wind	Wind Turbines	Yes	No	No	There is a lack of space on site for a separate Wind Turbine. A wind turbine mounted to the building fabric has been ruled out, due to potential structural issues due to vibration and additional wind loading.
Hydro	Hydroelectric Plant	Yes	No	No	The nearby Ward River has insufficient flow to sustain the size of Hydroelectric plant that would be required to provide a meaningful amount of power.
Heat Pumps	Air Source Heat Pump	No	Yes	Yes	There is sufficient space for an air source heat pump at roof level.
	Ground Source Heat Pump (Vertical Loop)	No	Yes	Yes	There is sufficient space for boreholes to be drilled which could contain vertical heat loops.
	Ground Source Heat Pump (Horizontal Loop)	No	Yes	No	There is insufficient space for horizontal heat loops. This system requires a large amount of land area to work
	Water Source Heat Pump	No	Yes	No	The Ward River has insufficient water volume or flow be used as a heat source that could be used reliably year-round.
Alternative combustion Fuels	Anaerobic Digestion	No	Yes	No	There is insufficient organic waste produced on site to make this economically viable.
	Hydrogen Boiler	No	Yes	No	Hydrogen is currently very inefficient to produce, and supply infrastructure is lacking, therefore currently it is not a feasible technology with regards to reducing carbon emissions, or costs.
	Biomass Boilers	No	Yes	No	BREEAM does not recognise biomass systems fuelled by first generation biofuels. Therefor second-generation fuels would have to be used, which can be more unreliable to source. These systems also contribute to local air pollution and require expensive fuel deliveries and storage.

3.1 Air Source Heat Pump (ASHP)

Unlike traditional gas-fired boilers, which burn fuel to generate heat, heat pumps extract heat from a source and use refrigerant gases in an electrically powered compressor unit to boost the temperature for use in heating systems

Heat pumps have a significant advantage over combustion boilers because they don't produce any local pollution and run entirely on electricity. Their efficiencies (COP) are 2-5 times higher than those of gas boilers, which is what makes them a cost and carbon-effective solution, despite the present cost of electricity being higher than gas. With the Irish grid continuing to decarbonise, this CO_2 saving is predicted to grow and become even more significant. The other benefit is that gas is not required, so the maintenance of a gas network and boiler installation is not necessary.

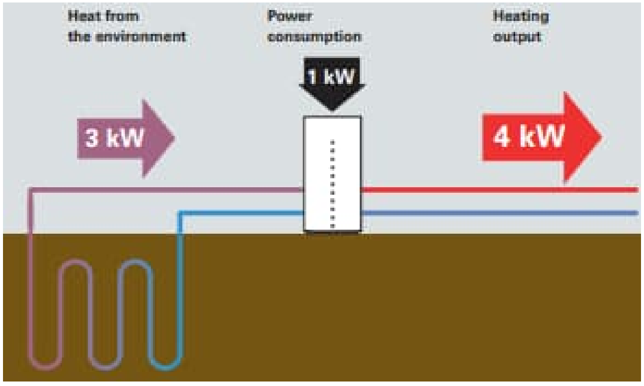


Illustration of heat pump COP of 4 i.e., 1 unit of electrical energy required to produce 4 units of heat

There are various types of heat pump technologies, whose efficiencies vary depending on the temperature of their heat source. Ground source heat pumps (GSHP) are generally more efficient than air source heat pumps (ASHP), as external ground temperatures are more consistent across the year than external air temperatures. However, GSHPs are more expensive to install, and require a large area of land for boreholes or ground loops.

Following the lifecycle cost, carbon, and energy assessment, it was concluded that ASHPs offer a more balanced solution for this project. Over a typical 25-year lifetime an ASHP would save 1,059,321 kgCO2e compared to a typical gas boiler. This is equivalent to the emissions produced by the entirety of Ireland in 15 minutes. ASHPs are able to provide the building's space heating load, which removes the need for a gas boiler. Based on the energy modelling carried out, the heat pumps alone are capable of the providing 20% RER required to meet Building Regulations NZEB.

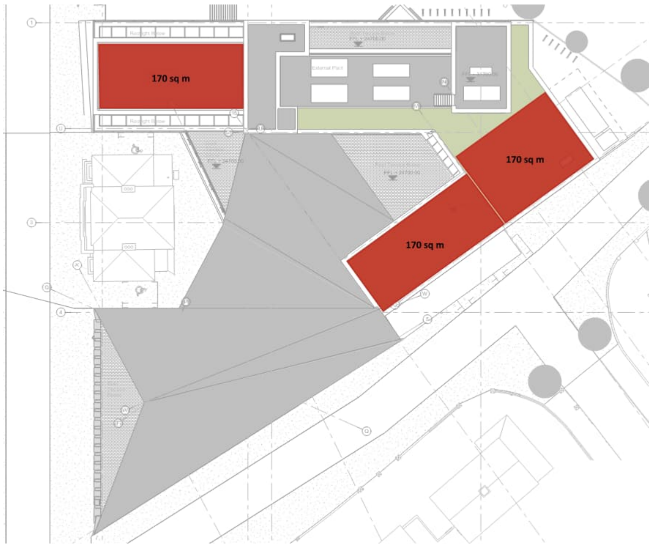
ASHPs comprise an outdoor condenser unit, which extracts heat from the outside air and transfers it to an indoor evaporator unit to raise the temperature to the indoor heating requirements. The upfront cost of ASHPs is higher than boilers, but they are cheaper and quicker to install than GSHPs as they do not require the ground loop infrastructure. They do, however, require a suitable outdoor space to locate the outdoor condenser.

Following consultations with the Acoustic Consultant and Architect, it is proposed that 2no. ASHPs will be located on the roof above the Rehearsal Room. This area has been identified as having the least visual and acoustic impact, whilst being fully accessible for maintenance.

3.2 Photovoltaic Panels

Photovoltaic (PV) panels are a low impact technology which provides CO_2 savings for a relatively low capital cost. PV is a relatively simple technology to install, with little ongoing maintenance involved.

We recommend installing PV panels on the flat roof area, angled to face the optimum orientation to maximise the solar irradiance received. As the panels will be on the flat roof, they will not be visible from ground level. The roof areas highlighted below have been identified as viable locations to site PV panels.



Available roof areas for PV panel installation, highlighted in red

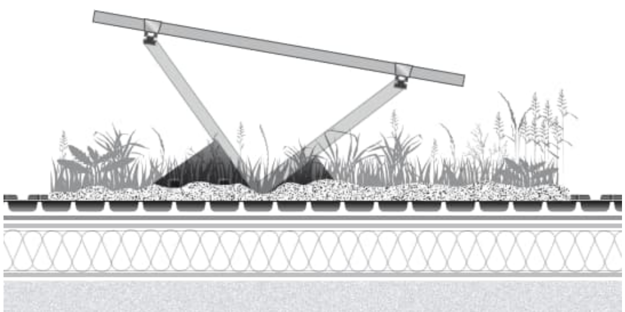
The maximum flat roof area available for mounting PV panels is roughly 500m^2, as shown in above. The photovoltaic panels will have south and south-east orientation mounted at an angle of 10^o, with a minimum walkway/access distance of 640mm between the panel arrays. The mounting angle and distance between the rows of panels were chosen so that self-shading between panels and overshading from parapets are avoided.

Taking into consideration the clearance spaces required for access walkways and to avoid overshading, as well as maximum travel distances dictated by the fire strategy, the overall effective PV panel area was calculated to be 197.1m^2, amounting to 38.7% of the total available flat roof area. This total effective area corresponds to the generation of 38.4kW peak load, assuming PV panels with a maximum output of 300W are used.

PV panels and green roofs
A significant part of the available flat roof area is proposed as green roof. The inclusion of both a green roof and a photovoltaic system can bring challenges to the designer on how to locate both within the roof area. However, layering the green roof and PV array so that they can co habit is a feasible solution.

The PV panels should be raised above the substrate and vegetation by using appropriate fixtures allowing the plants to also grow beneath the panels with sufficient light and moisture levels. Hence the use of PV panels will not compromise any of the green roof area.

An example of a compatible fixing system is the Bauder BioSOLAR, which is an integrated solution for mounting PV panels on a green roof or a blue roof, where the substrate and vegetation provide the ballasted installation mechanism to secure the array. This system allows for the entire roof area to qualify as a green roof, so does not put any relevant BREEAM credits at risk.



Bauder BioSOLAR PV mounting system

4.0 OPERATIONAL ENERGY USE AND CO_2 EMISSIONS TARGETS

When carrying out an operational energy use estimate at the early design stages, it is important that the results of the calculation are compared against existing industry benchmarks to determine whether they are within an acceptable range and whether the proposed design will deliver a building that performs better than the average existing stock.

In this case, the predicted data from CIBSE TM46, CIBSE Guide F and Max Fordham previous projects in the library sector have been used to set a benchmark for the Swords Cultural Centre. A detailed assessment using the Non-domestic Energy Assessment Procedure (NEAP) was also carried out using dynamic simulation modelling.

4.1 Energy Benchmarking

Benchmarks available for libraries are in relatively short supply and mostly date back to the 80's-90's. These benchmarks are obtained from CIBSE TM46 (2008), CIBSE Guide F (2012) and recent Max Fordham projects.

The benchmarks in this section of the report consider the whole buildings energy use, which will include energy used for the following:

- hot water
- heating and cooling
- internal lighting
- ventilation
- computers and other plug-in appliances
- servers
- external lighting
- lifts
- catering (if any)

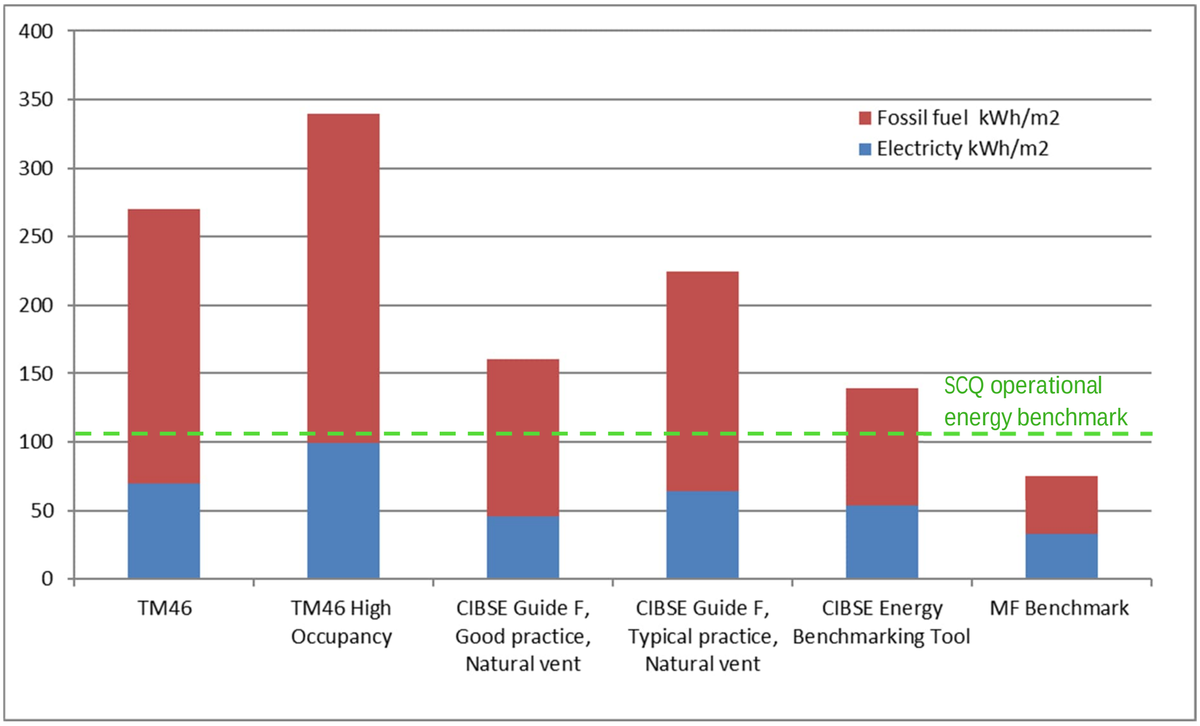
CIBSE Guide F
CIBSE Guide F benchmarks are generally used as guidance in the early design stages. However, it is worth noting that these benchmarks date back to the first edition of the guide in 1998 and have not been updated since. This means that often the benchmarks for the heating energy use will be higher than current practice, due to ongoing improvements in the Building Regulations regarding a building's fabric performance, and will be lower for electrical use, due to increased technology and ICT in modern buildings. The Guide F benchmarks are helpfully split into naturally ventilated buildings and air conditioned. For this assessment, only naturally ventilated benchmarks have been considered.

CIBSE TM46
Another potential source of reference data is *CIBSE TM46: 2008 Energy benchmarks*, which establishes benchmark categories and benchmark values that are used for the generation of Display Energy Certificates (DECs). Electricity and fossil fuel usage are provided as kWh/m^2 per year. Unfortunately, CIBSE TM46 does not distinguish between naturally ventilated and air-conditioned buildings, therefore making these benchmarks less significant for this operational energy study. The TM46 benchmarks are broadly based on the benchmarks from CIBSE Guide F.

CIBSE Benchmarking Tool
In 2019, CIBSE launched an online energy benchmarking tool, which aims to give relevant and reliable yardsticks of energy use trends in buildings. The online platform has been developed jointly with University College London (UCL) and uses real building energy data as it becomes available, to provide relevant and reliable benchmarks that represent the current trends of energy use in buildings. The platform is currently in Beta version but is intended to gradually update and replace the energy benchmarks in CIBSE Guide F.

Max Fordham Benchmarks
The MF benchmarks are based on any recently finished library projects where we have gained the in-use energy data, as well as current, relevant projects, such as the Grangegoreman Academic Hub.

Benchmark Data and Results
The chart below illustrates a comparison of the most applicable benchmarks for energy use in similar buildings, extracted from *CIBSE Guide F*, *CIBSE TM46* and past Max Fordham projects.



Column chart showing benchmark data for the energy use of libraries

As seen in the chart above, benchmark data varies considerably across various sources. The data also depends on several factors, including opening times, occupancy density etc. However, taking the benchmark data we do have available, a reasonable benchmark would be to take an average of the CIBSE Energy Benchmarking Tool data and our Max Fordham benchmark. This gives the following operational energy use benchmarks;

Table 5 Operational energy use benchmarks for Swords Cultural Quarter

	Electricity	Fossil Fuel	Total
Energy (kWh/m^2/yr.)	44	64	107

4.2 Energy Performance Compliance Modelling

Our Energy and Environmental Strategy has been developed to ensure the building meets the targets set out in the 2017 Part L Building Regulations applicable to Near Zero Energy Building (NZEB) directives. We have carried out the building performance compliance modelling in SBEMie, which concludes that the proposed building is in compliance with the 2017 Part L Building Regulations applicable to Near Zero Energy Building (nZEB) directives.

The building's energy performance is aimed at reaching the carbon reduction targets for new buildings, while ensuring the minimum contribution of renewable energy is also met. An energy assessment was carried out in order to demonstrate compliance with all the relevant targets. IESVE 2021 dynamic thermal simulation software was used to calculate the regulated loads of the building to test the proposed environmental strategy.

The geometry is based on the current general arrangement plans, produced by O'Donnell & Tuomey. The software was then used to test the building against the requirements of the Building Regulations Part L by comparing the model's performance to that of a notional building – one of exactly the same form, location and orientation, serviced by systems of a predefined efficiency.

In this assessment, most variables are defined by the Non-Domestic Energy Assessment Procedure – such as occupancy patterns, internal gains and heating set points – to enable a fair comparison across buildings that may in reality be subject to differing usage patterns. The notional building's emission rate is known as the 'Target emission rate' (TER), and the modelled building's emission rate is known as the 'Building emission rate' (BER). The TER was used as the 'baseline' emissions rate for the Building Regulations compliant development, with which the building was compared – the aim being to achieve a BER of less than the TER.

The output report from the Building Regulations calculations, known as BRIRL reports, is shown below

Table 6 Output results of BRIRL report

Primary Energy Consumption, CO2 Emissions, and Renewable Energy Ratio	
The compliance criteria in the TGD-L have been met.	
Calculated CO2 emission rate from Reference building	23.6 kgCO2/m2.annum
Calculated CO2 emission rate from Actual building	18.7 kgCO2/m2.annum
Carbon Performance Coefficient (CPC)	0.79
Maximum Permitted Carbon Performance Coefficient (MPCPC)	**1.15**
Calculated primary energy consumption rate from Reference building	123.8 kWh/m2.annum
Calculated primary energy consumption rate from Actual building	95.1 kWh/m2.annum
Energy Performance Coefficient (EPC)	0.77
Maximum Permitted Energy Performance Coefficient (MPEPC)	**1**
Renewable Energy Ratio (RER)	0.24
Minimum Renewable Energy Ratio	**0.1**

Energy and Carbon Emissions

As seen in Table 6, the target requirements set by the Building Regulations Part L were met. The proposed building achieves a Carbon Performance Coefficient (CPC) value of 0.79 and an Energy Performance Coefficient (EPC) value of 0.77, against the maximum permitted values of 1.15 and 1, respectively. Furthermore, as indicated in the BRIRL report, the total actual primary energy consumption for the building is 95.1 kWh/m^2/year, which is also lower than the operational energy use benchmark of 107 kWh/m^2/year.

Solar Gains and Overheating

Aside from energy performance and CO_2 emissions, the BRIRL report also outputs the solar gain limits and overheating risk of the proposed building. It was noted that the Irish SBEMie simulations do not take into account the effect of solar shading devices and self-shading of the building. This resulted in;

- the BRIRL reporting high risk of overheating
- the BRIRL reporting exceedance of solar gain limits
- a lower heating demand than expected, owing to higher solar gains
- a higher cooling demand than expected, owing to higher solar gains

We felt that this does not accurately represent the proposed building's performance. The following measures were therefore deemed appropriate;

1. For the overheating and internal gains assessment, the UK SBEM Part L compliance calculation method was used, which takes into account the effect of solar shading devices and shading from adjacent buildings. This was deemed more accurate than the Irish SBEMie.

2. In order to make sure that the Irish energy assessment isn't overestimating the amount of solar gain for the building, the g-values of the glazing were adjusted by taking the UK SBEM compliance model as a reference. In this way the effect of shading is accounted for in the energy assessment.

Renewable Energy Ratio
The proposed building achieves a Renewable energy Ratio (RER) value of 0.24, which exceeds the minimum required value of 0.1.

It is important to note that the Building Regulations Part L requirements, including the minimum Renewable Energy Ratio, were met without the use of PV panels. However, the addition of the PV panels has an impact on the energy performance of the building. More specifically, the performance coefficient CPC and EPC were improved by 3% and more specifically according to the energy assessment carried out, a total of 1 kg CO_2/m^2 are displaced using the photovoltaic panels. In addition, the RER also saw an increase of 12% with photovoltaic systems contributing to the generation of primary energy of 20,837 kWh/annum accounting for ~3% of the total building energy use.

After a preliminary analysis of the results and calculation of the Energy Performance Ratio for new constructions (EPR_{NC}), it was also predicted that the addition of the solar panels on the flat roof have the potential to achieve an additional BREEAM credit under ENE01.

Summary
Based on this analysis it is proposed that, by incorporating the strategies outlined in this Energy Statement, the 'as-designed' carbon emissions performance for the Swords Cultural Centre building achieves compliance with the 2017 Part L Building Regulations applicable to Near Zero Energy Building (NZEB) directives.