EXPEDITE

Cardiff Sixth Form College – Site 1

Bute Pl, Cardiff

Dukes Education

Expedite Building Services

MEP – Energy Strategy Review

P03 – June '22

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Revision	Purpose of Issue	Edited	Reviewed	Date
P01	Initial Draft	MH	DH	Dec’ 21
P02	Updated to suit MEP strategy and include energy modelling results	DH	MH	June’ 22
P03	Updated to suit DWD comments	DH	MH	July’ 22

1. Introduction

The energy strategy for the proposed developments at Merchants Place and Cory's Building has been prepared to support the planning application.

It details the intended fabric first approach and provides a summary of the proposed services and renewable technologies that are being incorporated within the scheme.

It illustrates the results from the Building Regulations Part L compliance modelling that has assessed the energy performance based on the fabric and services strategy outlined in this report.

The proposed development consists of the conversion of the two existing listed buildings together with a new purpose built building in the rear courtyard. The development will provide educational facilities, including classrooms, science labs, admin offices, canteen, student café and auditorium.

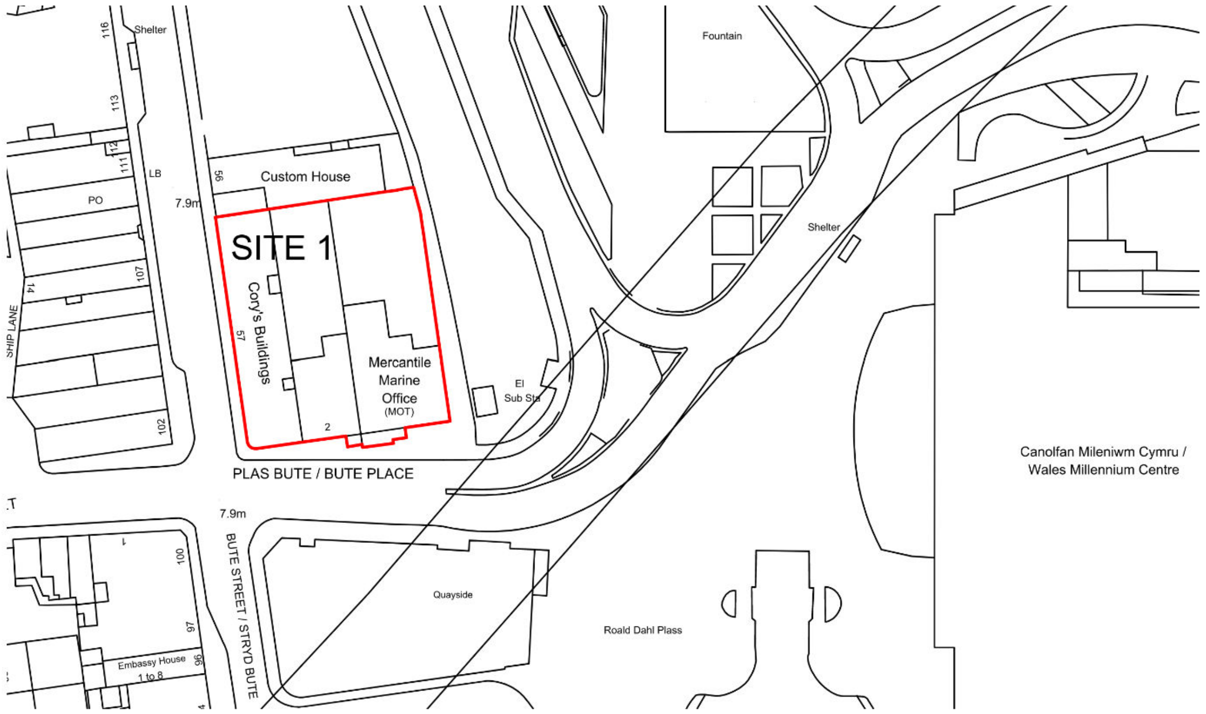


Figure 1 - Site location plan

2. Philosophy.

2.1 Potential aspirations

The Energy strategy for Site 1 development should reflect the client aspirations and respond to local policy requirements to deliver an effective development commensurate to the local community. With respect to energy, the following principles could be considered.

2.1.1 Energy Hierarchy

The project will follow the energy hierarchy of be lean, be clean and be green:

Be Lean - The energy strategy aims to firstly implement passive design and energy efficiency measures to reduce energy demand and CO_2 emissions.

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

These are the most effective and robust measures for reducing CO_2 emissions as the performance of the solutions, for example wall insulation, is unlikely to deteriorate significantly with time, or be subject to change by future property owners. In this sense, it is possible to have confidence that the benefits of the measures would continue at a similar level for the duration of their installation.

The Be Lean philosophy promotes that the design of the elevations should seek to passively minimise heating, cooling, and lighting requirements:

Be Clean - The strategy will be to consider the use of clean energy source using heat pump technologies for space heating, domestic water generation and cooling where required.

Be Green - Significant CO_2 savings are expected through the Be Lean and Be Clean measures. However, to maximise CO2 reduction, the potential for renewable energy sources will be assessed.

The strategic approach to the development of the site will be to reduce demand for energy consumption in the first instance (Be Lean) prior to the consideration of integrating low/zero carbon (LZC) energy sources (Be Clean and Be Green).

2.1.2 Conserve

Historic buildings are inherently energy inefficient, typically demonstrating low ratio of external wall to volume. Providing enhanced fabric performance would likely be unviable due to cost and buildability issues. Measures to minimise heat losses and gains through the fabric should be targeted where practical by increasing insulation or replacing windows where practical to do so.

Where works are carried out to listed buildings, the appropriate listed building consent will be required for all demolition, alteration and extensions works. As such, improvement works will need to be investigated and discussed with the local planning authority.

2.1.3 Fabric Efficiency

A 'fabric first' approach should be taken in order to reduce the energy demand and CO_2 emissions from the proposed development.

Where additional insulation is being specified within the refurbished buildings, careful consideration should be made to prevent the formation of thermally bridged cold spots, which could result in the development of condensation and mould growth.

In buildings with poor airtightness, additional heating energy is required in winter as a result of higher heat losses. The scheme should be designed and built to very high standards in order to reduce air infiltration rates through robust detailing and high-quality construction techniques.

At this stage we are targeting a maximum air permeability rate of $3m^3/h/m^2$ at 50 Pa for the new buildings. This compares to a maximum air permeability of $10m^3/h/m^2$ and 8 $m^3/h/m^2$ under the 2013 and 2021 editing of the Part L building regulation respectively. This will be tested during the energy modelling that shall be carried out throughout the detailed design stages.

2.1.4 Zero combustion

By serving all demands for heat and hot water via electrical systems, the need for on-site combustion is removed. This has co-benefits for both local air quality and CO_2 emissions, future-proofing the development for a transition to zero carbon as the grid decarbonises further.

2.1.5 Generate

Unobstructed southerly roofscapes lend themselves to the integration of solar PVs and thus potential exists to generate a proportion of the electrical energy requirements from the incident solar radiation.

2.2 National Policy

The Energy Strategy of the proposed development has been developed using the current Building Regulations Part L methodology at the time of the stage 2 design (2013 edition with 2016 amendments).

It should be noted that the new version of the Building Regulations Part L has just come into effect from June 2022. The full extent of the changes and associated impacts will be reviewed during the next stage of the design.

2.2.1 Future Wales: the national plan 2040

- Policy 12 (Regional Connectivity) states where car parking is provided for new non-residential development, planning authorities should seek a minimum of 10% of car parking spaces to have electric vehicle charging points.
- Policy 16 (Heat Networks) states that as a minimum, proposals for large-scale, mixed-use developments of 100 or more dwellings or 10,000sqm or more of commercial floorspace should consider the potential for a heat network. However, there is also potential for heat networks below this threshold and developers and planning authorities should explore these opportunities wherever possible.
- Policy 17 (Renewable and Low Carbon Energy and Associated Infrastructure) states that in determining planning applications for renewable and low carbon energy development, decision makers must give significant weight to the need to meet Wales' international commitments and our target to generate 70% of consumed electricity by renewable means by 2030 in order to combat the climate emergency.

2.2.2 Planning Policy Wales 2021

Planning Policy Wales states that Development proposals should:

- Mitigate the causes of climate change, by minimising carbon and other greenhouse gas emissions associated with the development's location, design, construction, use and eventual demolition; and
- Include features that provide effective adaptation to, and resilience against, the current and predicted future effects of climate change.

The Welsh Government planning policy recognises an energy hierarchy. The Welsh Government expects all new development to mitigate the causes of climate change in accordance with the energy hierarchy for planning as set out below:

- Reduce energy demand
- Use energy efficiently
- Renewable energy generation
- Minimising carbon impact of energy generation
- Minimise extraction of carbon intensive energy materials

All aspects of the energy hierarchy have their part to play, simultaneously, in helping meet decarbonisation and renewable energy targets.

The Welsh Government has set targets for the generation of renewable energy. The most relevant for our proposals is 'for Wales to generate 70% of its electricity consumption from renewable energy by 2030'. The planning system has an active role to help ensure the delivery of these targets, in terms of new renewable energy generating capacity and the promotion of energy efficiency measures in buildings.

2.2.3 Technical Advice Note 12 (Design)

TAN 12 states that Developments should achieve environmental sustainability by incorporating:

- Sustainability measures to reduce the environmental impact associated with buildings and minimising the demand for energy (low and zero carbon sources), water, and materials and creation of waste;
- Approaches to development which create new opportunities to enhance biodiversity; and
- Adaptable and flexible development that can respond to social, technological, economic and environmental conditions/changes (e.g. the current and future effects of climate change) over time to minimise the need to demolish and rebuild.

2.3 Local Policy

As well as national Building Regulations and national policy, the proposed development is required to comply with local policy in place at the time of the planning submission, including the Cardiff City Council (CCC) policy documents.

2.3.1 Cardiff Local Plan 2006 - 2026

Policy T1 (Walking and Cycling) encourages sustainable modes of transport.

Policy KP5 (Good Quality and Sustainable Design) states that all new developments will be required to be of a high standard, sustainable design and make a positive contribution to the creation of distinctive communities, places and spaces. With regards to sustainability the policy states that development should do this by:

- Providing a healthy and convenient environment for all users that supports the principles of community safety, encourages walking and cycling, enables employment, essential services and community facilities to be accessible by sustainable transport and maximises the contribution of networks of multi-functional and connected open spaces to encourage healthier lifestyles;
- Maximising renewable energy solutions;
- Achieve a resource efficient and climate responsive design that provides sustainable water and waste management solutions and minimise emissions from transport, homes and industry.

Policy KP15 (Climate Change) states that to mitigate against the effects of climate change and adapt to its impacts, development proposals should take into account the following factors:

- Reducing carbon emissions;
- Protecting and increasing carbon sinks;
- Adapting to the implications of climate change at both a strategic and detailed design level;
- Promoting energy efficiency and increasing the supply renewable energy;
- Avoiding areas susceptible to flood risk in the first instance in accordance with the sequential approach set out in national guidance; and
- Preventing development that increases flood risk.

Policy EN12 (Renewable Energy) states that development proposals are required to maximise the potential for renewable energy. The Council will encourage developers of major and strategic sites to incorporate schemes which generate energy from renewable and low carbon technologies. This includes opportunities to minimise carbon emissions associated with the heating, cooling and power systems for new development. An independent energy assessment investigating the financial viability and technical feasibility of incorporating such schemes will be required to support applications.

The 2017 Planning Obligations supplementary planning document (SPD) also mentions a Renewable Energy being prepared to provide additional guidance but from our research this has not yet been delivered by the Council.

The Cardiff Green Infrastructure SPG provides planning advise on a number of areas relating to development and the environment. It aims to make best use of land to deliver a wide range of economic, health and community benefits.

2.4 Decarbonisation of the electricity grid

The carbon factor of the National Grid, which is the amount of carbon dioxide released per kWh of electricity produced and distributed is recognised in building regulations guidance. The cardon factor for electricity in the 2013 edition of the regulations was 0.519 $kgCO_2/kWh$. This has been significantly reduced in subsequent publications including SAP10.0, which reduced the carbon factor to 0.233 $kgCO_2/kWh$ when released in 2018. This was subsequently revised to 0.136 $kgCO_2/kWh$ in the revised SAP10.1 guidance released in 2019.

This reduction is a reflection of the changing mix of electricity generation methods towards greener solutions. Figure 2 shows how the mix of generation techniques serving the National Grid, as well as the associated carbon factor, has varied over the past ten years. It shows how the carbon intensity of the grid has reduced to less than half its value in 2012.

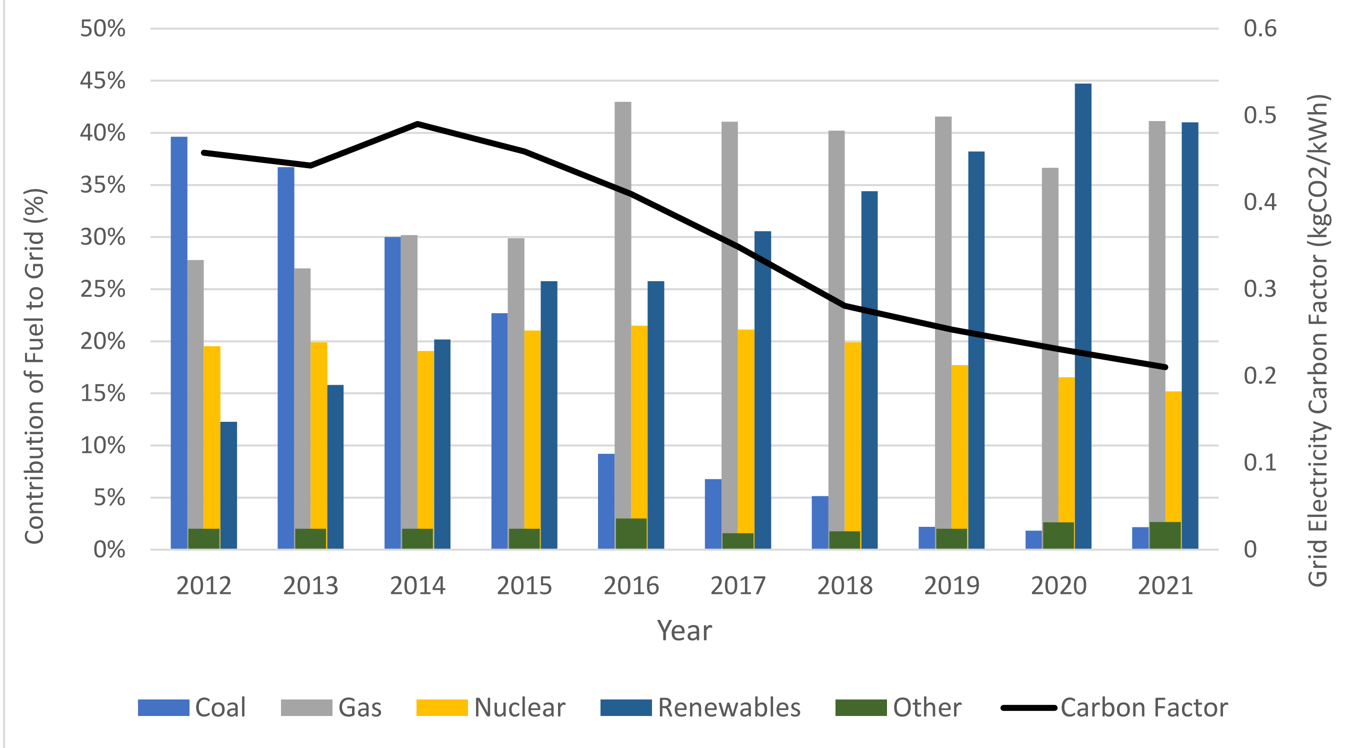


Figure 2 - Historic mix of generation methods and associated carbon factor for the National Grid

2.5 Impact of grid decarbonisation

The carbon emissions associated with the combustion of natural gas are unlikely to change significantly in the coming years, whereas the carbon factor of grid electricity, and consequently the emissions from operating electrical plant, is projected to decrease in the long-term.

2.6 Part L2 2021 Carbon Factors

The modelling carried out to date has been based on the current version of the Welsh Building Regulations (2014 edition). The revised regulations are due to be released later in the year although we expect the building to be assessed under the current regulation based on the project programme.

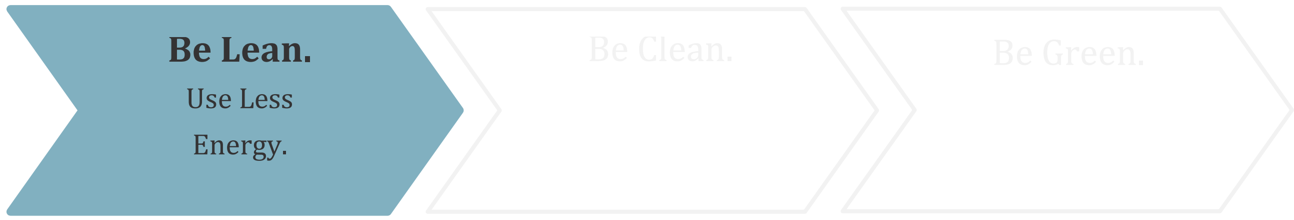
However, we can take some guidance from the recently revised English version of the Part L guidance which came into force in June 2022. One of the main changes from this guidance is that the carbon factor for grid electricity is no longer represented as a single figure but instead varies seasonally to reflect the changing mix of electricity generation methods accordingly. This is illustrated in Table 1 which is taken from the 2021 edition of the National Calculation Methodology (NCM) modelling guide.

Table 1 – CO_2 emission and primary energy factors for grid supplied electricity and grid displaced electricity except that generated by PV system

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$kgCO_2/kWh$	0.163	0.160	0.153	0.143	0.132	0.120	0.111	0.112	0.122	0.136	0.151	0.163
kWh_{PE}/kWh	1.602	1.593	1.568	1.530	1.487	1.441	1.410	1.413	1.449	1.504	1.558	1.604

3. Strategy

3.1 Be Lean.



The following sections detail the passive design and energy efficiency measures that are considered viable for the proposed development.

3.1.1 Building Envelope

A 'fabric first' approach should be taken in order to reduce the energy demand and CO_2 emissions from the proposed development. The overriding objective for the façade design of each building should be to achieve the optimum balance between providing natural daylighting benefits to reduce the use of artificial lighting, the provision of passive solar heating to limit the need for space heating in winter, and limiting summertime solar gains to reduce space ventilation demands.

3.1.2 Thermal Insulation

The buildings of the proposed development should be designed to incorporate an efficient thermal envelope.

Improvements upon the U-value performance standards required by Building Regulations Part L 2013 will be implemented where determined to be beneficial and viable.

3.1.3 Fabric Performance and Air Permeability

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

High air permeability can lead to uncomfortable draughts and dramatically increase the demand for space heating in winter, and space cooling in summer, when the air-flow works in reverse i.e. cool air escaping from the building. The proposed development should be designed to achieve a high standard in order to reduce air infiltration rates through the incorporation of robust building detailing and high quality construction techniques.

Table 2 illustrates target fabric parameters that are proposed for the new build construction. These performance characteristics shall be fully reviewed throughout the design process through detailed thermal modelling.

Table 2 - Summary of target building envelope parameters for the new build elements

Element	Target Value
External Walls	0.15W/m²/K
Roofs	0.12W/m²/K
Ground Floor	0.12W/m²/K
Windows	1.2W/m²/K
Air Permeability Values	3m³/hr/m²
G-value	0.4-0.6 orientation dependant and as required for overheating mitigation

It should be noted that the values illustrated in Table 2 are for new build element only. Whilst there is limited scope to upgrade elements to the existing heritage buildings, every effort has been made to consider opportunities to improve the building performance with the following measures being incorporated:

- Replace existing windows with new "slim-line" double glazing unit, retaining the existing design and configuration.
- Provision of roof insulation to Merchants Place

3.1.4 Glazing Ratio

It is important to consider the amount of glazing, and how this relates to the total external wall area (i.e. the glazing ratio).

With the glass technology currently available on the market, glazing ratio is an important metric to drive efficiency, whilst carefully balancing design and daylight / sunlight requirements. The glazing ratio should recognise the sun path and be designed to maximise its benefits. On southerly elevations, the glazing ratio achieves the benefit that solar gains can bring in winter months whilst considering the overheating risk. However, for northerly orientations, heat loss becomes a more critical consideration as there is less benefit from solar gains in winter.

3.1.5 Glazing Energy & Light Transmittance

As noted, the design of the elevations of the buildings could consider a moderate approach to fenestration, which would help to ensure a balance between the benefits of passive solar heating in winter months whilst limiting the likelihood of high internal temperatures in summer.

Percentages of glazing in combination with the use of shading and solar control glazing with appropriate g-values will be considered. Where the risk of overheating is low higher g-values would be evaluated as this would assist in minimising space heating demands in winter.

3.2 Energy Efficiency Measures

Energy efficiency measures are those which seek to service the demand for energy (i.e. the remaining demand after implementation of passive design measures) in the most efficient way.

3.2.1 Heating

Heating system losses should be minimised by insulation of the pipework and ductwork used to distribute the heating medium.

3.2.2 Hot Water

To limit the demand for hot water, the development will include water-efficient fixtures and fittings including WCs with low flush volume, flow reducers in the taps of wash hand basins and aerated shower heads, to limit overall water consumption in line with Building Regulations Part G.

3.2.3 Ventilation

Ventilation rates are to be in accordance with Part F, whether this is through Mechanical Ventilation with Heat Recovery (MVHR), mechanical extract only or natural ventilation.

MVHR units can be a valuable addition to the building services. They maintain good indoor air quality by providing fresh air to occupied rooms whilst extracting air from the same room or vitiated air from toilets, bathrooms, kitchen etc. Providing fresh air minimises the risk of stale and stagnant air, and limits the risk of condensation and mould growth. Coupled to a heat exchanger, the warmth in extracted air can be recovered and delivered to the supply air. In this mode, MVHR units reduce space heating demand. The heat recovery mechanism will be provided with a bypass to avoid returning hot air to the rooms in summer months.

3.2.4 Cooling

The need for active cooling has been designed out wherever possible; where not, the cooling demand will be minimised. It is not currently considered that active cooling will be necessary in many areas. At this stage, we have assessed the active loads associated with the IT equipment and propose air conditioning to the ground floor incoming comms room which houses the main IT distribution cabinets.

3.2.5 Lighting

Workplace and classroom areas will be provided with low-energy, efficient light fittings throughout, to achieve an efficacy of at least 45 lamp lumens per circuit Watt (lml/Wc) and total output of greater than 400 lamp lumens. External lighting for communal areas will also be low-energy efficient fittings, and linked to daylight sensors and / or presence detectors to prevent unnecessary use.

If implemented inefficiently, lighting can provide a significant contribution to the regulated CO_2 emissions of a development. As such, the implementation of energy efficiency lighting design is paramount to reducing overall emissions for the proposed development as a whole.

The lighting specification for the proposed development will be considered in conjunction with the potential for lighting control systems incorporating daylight linkage and presence detection.

As well as reduced energy requirement that would be achieved by implementing these strategies, the contribution to the internal heat gains would be reduced. This would further reduce the propensity for overheating and CO_2 emissions of each building.

3.2.6 Variable Speed Pumps

Variable speed pumps and controls allow the system to modulate during periods of low demand. Using variable speed pumps therefore uses less energy than traditional pumps, which run at a constant speed. The use of variable speed pumps shall be provided to all heating circuits through the development.

3.2.7 Controls

The control of the heating, cooling, ventilation and lighting systems will be fundamental to the energy efficiency of each typology. The use of the following measures will be explored:

- Zoned thermostatic control;
- Time control;
- Variable flow control;
- BMS (Building Management System) automated control;
- Lighting PIR (Passive Infra-Red Sensor) control;
- Daylight linked lighting control;
- CO_2 detection (for requirement controlled ventilation); and
- Energy management control.

3.2.8 Energy Metering

Metering and sub-metering will be considered to enable the efficient use of resources. Energy metering allows the monitoring of the following energy uses:

- Space heating;
- Domestic hot water;
- Major fans;
- Lighting;
- Small power;
- Contribution from LZC technologies; and
- Any other major energy uses.

3.2.9 Unregulated Energy

Unregulated energy includes small power electricity use (computers, plug in devices) and catering energy consumption.

It is anticipated that the proportion of unregulated energy will gain in significance when compared to regulated energy as each revision of Building Regulations Part L comes into force and regulated energy is reduced.

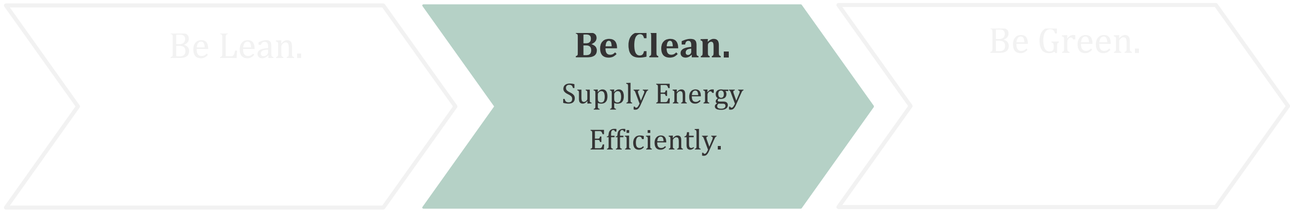
It is therefore foreseeable that energy efficiency and the rising cost of energy would play an increasing role when future building users are deciding which appliances to purchase and the frequency of their use. However, it is not possible at present to quantify the extent of this potential reduction.

Given the uncertainty, measures to educate the future building users on how they can reduce their equipment energy use could be encouraged. This could be provided in the form of building user guides and tenant fit-out guides.

The guidance measures detailed within these types of documents could consider:

- Use of A / A+ rated white goods;
- Energy star rated computers and flat screen monitors;
- Energy efficient lifts; and
- Voltage optimization and power factor correction.

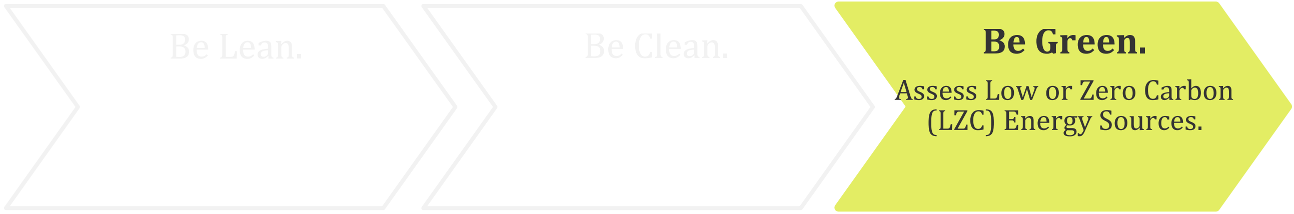
3.3 Be Clean.



This stage of the energy hierarchy refers to the use of technologies to provide energy whilst reducing consumption from the national grid and gas networks.

Section 4 summarises the services strategy options that shall be pursued as part of the detailed design stages. These include air source heat pumps (ASHP) for heating and hot water generation, efficient heating zoning and control, energy monitoring, high efficient LED lighting with automatic sensing and control.

3.4 Be Green.



The following sections discuss various low carbon and renewable energy generation measures. Table 3 identifies the technologies that have been considered but discounted whilst the following sections describe those that are considered suitable for the proposed development.

Table 3 - Summary of Renewable Options

Renewable Option	Brief Description	Appraisal
Solar thermal	Solar thermal panels operate by capturing solar energy and transferring to a thermal store to generate hot water.	Technically viable but needs to utilise the same roof area as any PV installation and PV is considered to most suitable. This is because both PV and solar thermal essentially achieve the same end result (the production of heat albeit indirectly for the PV system which would power the ASHP installation). Distance between the roof panels and ground floor thermal storage vessels increases energy losses and costs for the solar thermal option.
Ground source heat pumps (GSHP)	Ground source heat pumps can be used to extract heat from the ground by circulating a fluid through a system of pipes to a heat exchanger which transfers the energy to a distribution network.	Area of land available for a closed-loop GSHP installation severely limits the contribution this system can offers which makes it cost prohibitive.
Vertical axis wind turbine	Wind turbines use the force of the wind to drive a rotor and generator to produce electricity.	Significant visual impact to the site and not 'in keeping' with the historical nature of the existing buildings. Flicker from turbines impacting on adjacent buildings. Limited output for a single turbine.
Combined heat and power (CHP)	A CHP engine is a device that when burning fuel will produce useful electricity, as well as heat	Whist CHP units can be an efficient solution in certain applications, the thermal base load for our building is inadequate to achieve sufficient operation. A gas fired installation would not be considered a sustainable technology due to the carbon factor of gas and hydrogen CHP, as a new technology, is still in its infancy.

3.4.1 Air Source Heat Pumps

Heat pumps generate heating and hot water using a refrigeration cycle, the result of which is significantly higher efficiencies than using the electricity directly, as with radiant panel or storage heaters. Efficiencies of 400% or more for space heating and upwards of 300% for hot water can be achieved.

The emissions reductions offered by heat pumps will continue to increase as the grid decarbonises, meaning they are a futureproof technology.

Further to this, heat pumps require no on-site combustion and do not, therefore, contribute to any degradation of local air quality.

3.4.2 Cardiff District Heating Network

It's planned that the Cardiff Heat Network Project will distribute waste heat generated by the Viridor incinerator through a network of underground pipes to transport waste heat from the Viridor Energy Recovery Facility to buildings in and around the Cardiff Bay area.

We understand that the first phase of the heat network will initially provide heating to a number of large buildings in the city, including County Hall (or a replacement council headquarters), the new Indoor Arena, the Millennium Centre, Tŷ Hywel, Cardiff & Vale College main building and Tresllian House.

The network could be operational within two years of installation works beginning. To achieve connection into the district heating network in the future requires the use of a heat exchanger assembly known as a thermal substation. This comprises of a plate heat exchanger and associated ancillary pipework and control valves. To ensure the potential for future connection to our building, we have a dedicated area within our plantroom for the thermal substation to be sited. The size of this zone meets the spatial requirements of the thermal substation based on the actual building load.

As seen within the Figure 3, Site 1 is adjacent to the proposed route identified in Phase 1. We will therefore discuss this option with Cardiff Council Energy Officer as there appears to be the potential for Cardiff 6th Form development to be connected to the District Heating Network.

District heating has many economic, environmental and social benefits, such as carbon reduction, reduced maintenance costs, increased comfort and reduced fuel poverty for private residence and local authority tenants.

There are also health and safety benefits, as the absence of boilers and fuel storage reduces risks of fire, explosion and carbon monoxide build-up. As district heating networks are mostly fuelled by renewable and local energy, this also leads to improved air quality. It is also much quieter than traditional heating systems.

District heating also has wider societal and environmental benefits for consumers, such as the creation of green jobs. Its environmental benefits include reduced carbon emissions, therefore contributing to EU and national carbon reduction targets, and reduced dependency on fossil fuels and international markets.

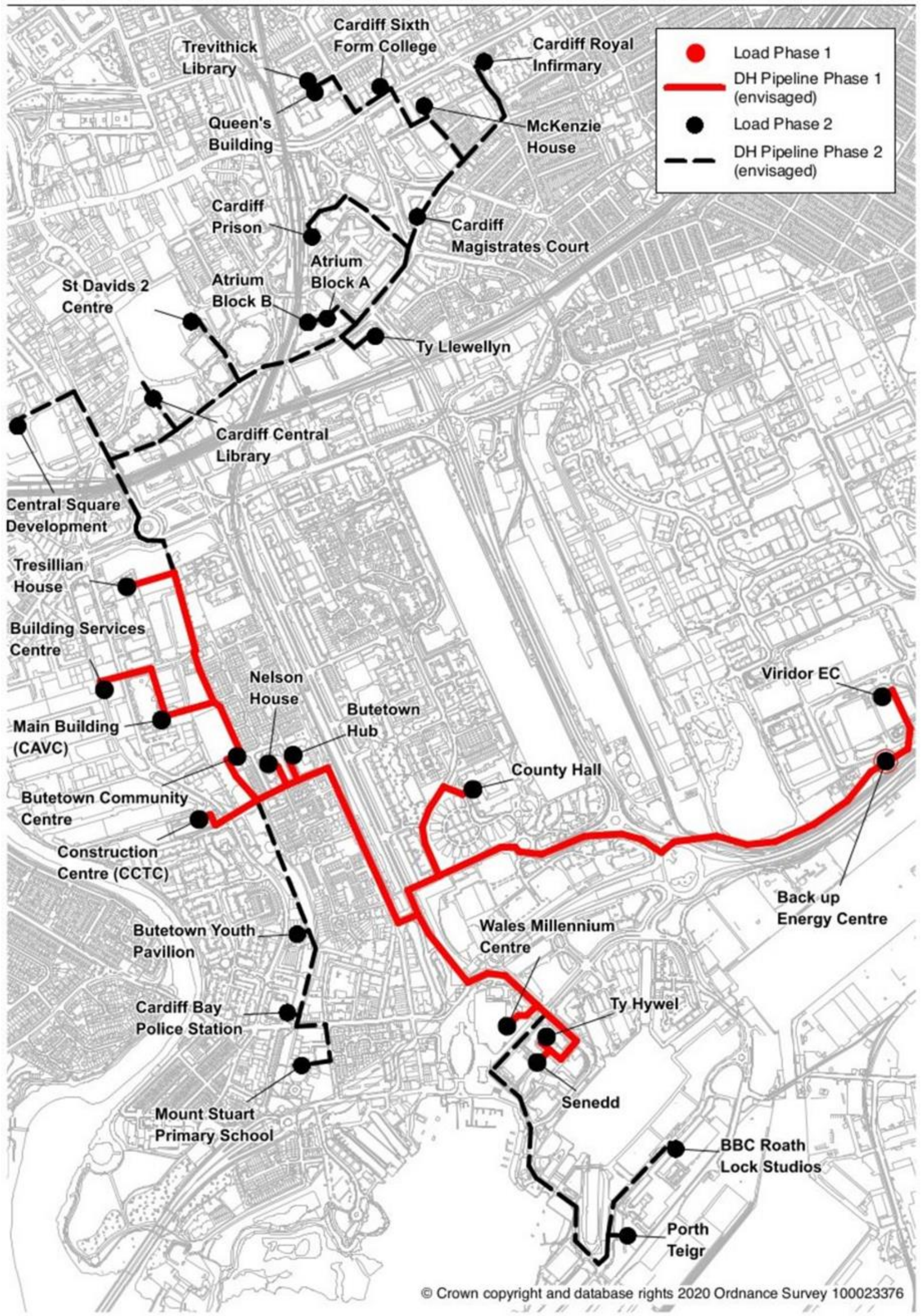


Figure 3 - The proposed pipe network for the heating project, updated in 2020

3.4.3 Energy Storage

Renewable generating technologies are advantageous as they are able to offset higher carbon forms of energy. However, most of these technologies rely on unpredictable or intermittent natural energy to operate (i.e. solar radiation or wind) which do not necessarily occur at times of energy demand. Energy storage offers the opportunity to capture the generated energy for use at a time of later demand.

For electricity, this is advantageous for multiple reasons. Firstly, the price to import (consume) a unit of electricity from the grid is significantly greater than the price at which the network operator will buy any generated electricity. As such, if locally generated electricity can be used on site to offset grid-supplied electricity, substantial financial savings can be made.

In the transition to electric vehicles and heating, grid resilience is an increasing worry. By storing electricity either generated locally, or at off peak times, the battery can then supply the electricity demands at times of peak grid demand. This reduces the development's overall peak demand and consequent impact on the local grid infrastructure.

Conversations with the local distribution network/systems operator (DNO/DSO) could result in a reduction in the necessary financial contribution should it be shown that the chosen storage and management strategy provide a tangible reduction in peak electricity demand.

3.4.4 Photovoltaic Cells (PV)

Photovoltaic panels harness energy from daylight and convert this into useful energy in the form of electricity. A PV system requires viable roof space in order for the system array to be installed and function effectively.

To compliment the energy strategy and achieve the sustainability aspiration of the development we shall incorporate PV panels of the roof of the development.

Two roof areas have been identified as suitable for a PV installation; the south end roof section of Cory's building or the roof of the new build extension. At this stage it is assumed that the roof of Cory's building shall be utilised and the scheme currently includes 100m^2 of PV generation.

3.4.5 Summary of Technologies

Following the LZC appraisal, the following strategy and technologies shall be taken forward to the final design:

- Air source heat pump generation for heating and hot water
- Space allocated at ground floor for the future installation of a thermal substation to support connection onto the district heating network at a later date as required.
- Provision of a minimum of 100m^2 of PV panels to the roof.

The above strategies are described in greater depth in section 4.

4. Services Overview

Ensuring high thermal performance will reduce overall energy demand and high efficiency systems will reduce the energy required to meet this demand, the result of which should be lower energy bills and high levels of thermal comfort.

4.1 Building fabric and energy efficiency

By specifying a high thermal performance of the building fabric, including a low U-value and air permeability, heat losses in winter can be minimised and unwanted heat gains in summer can be avoided, assisting to mitigate the risk of overheating.

4.2 Servicing strategy

4.2.1 Primary Heating

An all-electric heating and cooling strategy is to be implemented in line with the sustainability aspirations of the development.

Primary heating to the development shall be delivered via air source heat pump (ASHP) units as a dedicated, centralised energy solution serving all air handling plant and space heating emitters. The primary air source heat pumps will also support the generation of domestic hot water.

The primary heating system will comprise of two principal circuits;

- Higher temperature circuit (at approx. 70/50ºC) for the generation of domestic hot water and space heating within the existing buildings.
- Lower temperature circuit (at approx. 45/40ºC) for space heating within the new build areas and tempering of air at the air handling plant.

Maximising the use of a lower temperature circuit will help the air source heat pumps operate at a higher efficiency. As such, all ASHP plant shall be configured to operate at the lower heating temperature with water-to-water heat pumps utilised to achieve a higher temperature circuit.

The higher temperature circuit is proposed for the space heating of the existing building to help overcome the greater heat losses commensurate with an older building. Conversely, a lower temperature circuit will be appropriate for the new build element, where heat losses are expected to be lower.

Space heating shall generally be achieved via radiators whereby the following energy saving and efficiency measure shall be incorporated;

- Each radiator will be provided with a thermostatic radiator valve (TRV) for local control
- Heating energy usage on each floor will be logged remotely via an energy meter linked to an automatic meter reading (AMR) system
- All heating plant will be sequenced and controlled via the building management system (BMS).
- A weather compensation system will be used to assess the loads in the building against the external conditions, altering the flow temperature accordingly, to provide the most energy-efficient heating generation possible at that time.
- Control of the zones on the floors will be through the BMS which will allow individual temperature control of each zone.

4.2.2 Cooling

A further ASHP will also be installed within the roof plant area which will be dedicated to operating in cooling mode to serve the air handling plant. The colling provided to the air handling plant shall only provide tempered air, it does not achieve air conditioning to the spaces.

This ASHP will operate in conjunction with the other ASHPs. Heat recovered by this system, from the air handling plant, will be transferred back into the heating system to maximise efficiencies.

Where server rooms or similar process areas require any cooling, this will be met from the cooling system utilising local cooling units such as fan coil units (FCUs).

4.2.3 Domestic Water Generation

The proposed strategy for hot water generation shall be via heat pump installations. The air source heat pump installation as described in section 4.2.1 is to be utilised as the primary source/supply to secondary water-to-water heat pumps that can achieve elevated temperatures as required for domestic hot water generation.

The delivery of domestic hot water will be via LTHW plate heat exchangers which shall serve smaller calorifier/buffer vessels.

The plate and buffer vessels are to be sized to achieve enough storage to accommodate intermittent peak flows and provide some resilience but not to have excessive storage that is energy demanding. This achieves the optimum balance between resilience and energy efficiency.

4.2.4 On-Site Renewable Energy

To compliment the primary heating and domestic water strategy, we shall utilise on-site electrical generation through use of photovoltaic (PV) panels mounted on the roof of the new or existing development. This will achieve direct contribution to the electrical requirements of the building. The modelling carried out to date has included 100m^2 of PV panels. The Part L compliance modelling demonstrates the building performance and contribution from the PV system.

4.2.5 Lighting

According to the Carbon Trust, lighting accounts for around 20% of the electricity used in the UK and 75% of installations are out of date and unable to meet current design standards.

LEDs are one technology that represents an immediate and potentially significant opportunity for organisations, when it comes to reducing energy bills and improving carbon credentials.

Building regulations are increasingly calling for the adoption of intelligent lighting and environment control systems that will help improve efficiency and reduce energy consumption.

LED lighting combined with smart controls can reduce energy use while providing a high quality light experience. At a basic level, such systems can be used to turn off or dim unnecessary lighting, by sensing when someone is in the area. But going far beyond that, advanced systems can now provide additional benefits for businesses, such as improved monitoring and maintenance, and an enhanced experience for occupants.

Providing the optimal working environment for staff is a key area of development, with daylight harvesting being one energy management technique that can prove beneficial.

It works by monitoring the level of ambient/natural light in a work space and dimming or switching off lighting when sufficient natural light is present (as well as when the space is unoccupied). This not only helps reduce energy use and expenditure, but improves the working environment.

Workplace lighting strategy:

- Use LEDs to reduce lighting energy costs by around 30-50%
- Use occupancy sensors that dim or switch off lighting when there is nobody in the area to reduce electricity use by up to 30%
- Use sensors to adjust artificial lighting based on the amount of natural light available to reduce electricity use by up to 40%

5. Part L Compliance Modelling

Part L compliance modelling has been carried out by RedSix who have undertaken L2A and L2B energy modelling as appropriate for the new build and refurbishment areas of the development.

At the time of carrying out the stage 2 design and energy modelling for the project, the current version of the Building Regulations Part L for Wales is the 2014 edition. The English version of the Part L guidance has been released in June this year (2022) and the Welsh version is due to follow later in the year. Based on the current project programme, it is anticipated that the building will be assessed under the current version of the building regulations although the proposed fabric first, energy efficient, all-electric solution is expected to be robust against the regulations changes.

Refer to Appendix A for RedSix energy modelling report.

5.1 Energy Modelling Summary

A summary of the energy modelling results is outlined below:

Table 4 - Part L2 Results

	Notional ($kgCO_2/m^2$.annum)	Building ($kgCO_2/m^2$.annum)	Part L2 Improvement
Merchants & Cory's	170.2	26.3	84.55%
SkyView	29.6	18.8	36.49%

Table 5 - EPC Results

	EPC Score	EPC Rating
Merchants & Cory's	40	B
SkyView	18	A
Whole Development	26	B

The results demonstrate that the development complies with the energy requirement as assessed through the building regulations Part L. In addition, the proposed development meets both the national and local policy requirements, by seeking to maximise the potential for renewable energy using renewable and low carbon technologies. The energy strategy ensures that the development minimises carbon emissions associated with the heating, cooling and power systems. This is achieved through implementation of the following measures:

- Highly efficient fabric for the new build elements
- Upgrades to the existing building elements where practical including replacement glazing and new roof insulation
- All electric heating and hot water generation via ASHP units
- Provision of thermal substation to allow for future connection onto the district heating network
- Provision of PV panels for on-site generation and to compliment the electric heating/hot water strategy. Incorporation of PV panels is shown to increase the Part L improvement margin by over 3%.

6. Appendices

6.1 Appendix A – Part L2 Modelling Results

Part L2 and EPC RIBA Stage 2 Report

New Academic Hub, Bute Street,
Cardiff.

06.07.2022

Quality Management

Issue/ Revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	First Issue	Second issue	Third Issue	
Date	09/06/2022	22/06/2022	06/07/2022	
Prepared by	G Forwood	G Davies	G Forwood	
Signed				
Checked by	G Davies	G Forwood	G Davies	
Signed				
Date	09/06/2022	22/06/2022	06/07/2022	
Project Number	850	850	850	

CONTENTS

EXECUTIVE SUMMARY

This report has been prepared on behalf of Expedite to demonstrate compliance with Building Regulations Part L2A and L2B covering RIBA stages 1-2 for the new Academic Hub at Bute Street, Cardiff. It details the methodology undertaken as well as parameters used.

The project is made up of existing buildings with an addition of a new infill building to the rear. The two existing historic buildings are made up of the Cory's Building and the Merchant Building, with the new infill building currently known as Skyview.

This document has detailed the calculations undertaken to demonstrate compliance with the part L2A (2014) and L2B (2014) (Wales) of the building regulations.

A baseline model has been created which has been based on existing survey and design information available. Three separate simulations have been conducted, one for the new infill building (Part L2a) and two for the existing buildings (L2b notional and proposed).

The potential EPC asset rating has been determined for both the existing block and new block of the development and also for the development as a whole. Additionally, the improvement over part L regulations has also been shown, demonstrating that both the new and existing blocks achieve building regulation compliance requirements.

This report has also considered the potential connection of the proposed district heat network. It has been demonstrated that marginal improvements could be made through the use of the district heat network.

Note: This analysis and report have been based on the architectural drawings received to date (01/06/2022). Where detailed design data is not currently available assumptions have been made to complete the calculation process.

THE PROPOSED DEVELOPMENT

The proposed development is made up of existing buildings with an addition of a new infill building to the rear. The two existing historic buildings are made up of two buildings: Cory's Building and the Merchant Building. The new infill building is currently known as Skyview.

The following drawings provided by Expedite were used to establish the geometry of the model.

- 21.22-EDS-XX-00-DR-A-(01)21-02-Proposed Ground Floor Plan
- 21.22-EDS-XX-01-DR-A-(01)22-02-Proposed First Floor Plan
- 21.22-EDS-XX-02-DR-A-(01)23-02-Proposed Second Floor Plan
- 21.22-EDS-XX-03-DR-A-(01)24-02-Proposed Third Floor Plan
- 21.22-EDS-XX-04-DR-A-(01)25-02-Proposed Fourth Floor Plan
- 21.22-EDS-XX-05-DR-A-(01)26-02-Proposed Fifth Floor Plan
- 21.22-EDS-XX-06-DR-A-(01)27-02-Proposed Sixth Floor Plan
- 21.22-EDS-XX-07-DR-A-(01)28-02-Proposed Seventh Floor Plan
- AS21.22.02.20-00-North Elevation Proposed
- AS21.22.02.21-00-East Elevation Proposed
- AS21.22.02.22-00-South Elevation Proposed
- AS21.22.02.23-00-West Elevation Proposed
- AS21.22.03.20-00-NS Section 01 Proposed
- AS21.22.03.25-00-EW Section 01 Proposed

The drawings above will be subject to further development throughout the design process. These further developments will be reflected within the RIBA Stage 3-4 analysis, where compliance with regulations will be re-assessed. Any likely amendments will affect the carbon emissions of the building and are likely to also affect the potential risk of overheating.

The aim of the project is to refurbish the existing buildings and add additional space through the rear infil building to provide an updated and larger sixth form teaching block.

In order to comply with approved document L2B and the consequential improvements set out within, it is proposed that the external windows will be upgraded and additional roof insulation to the merchant building will be installed.

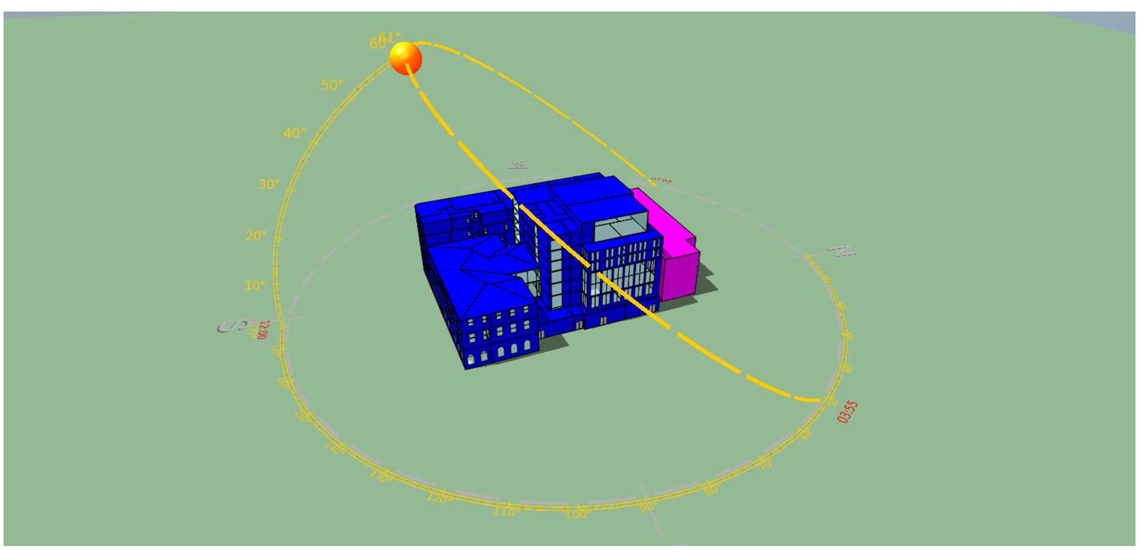


Figure 1: Model Image 1

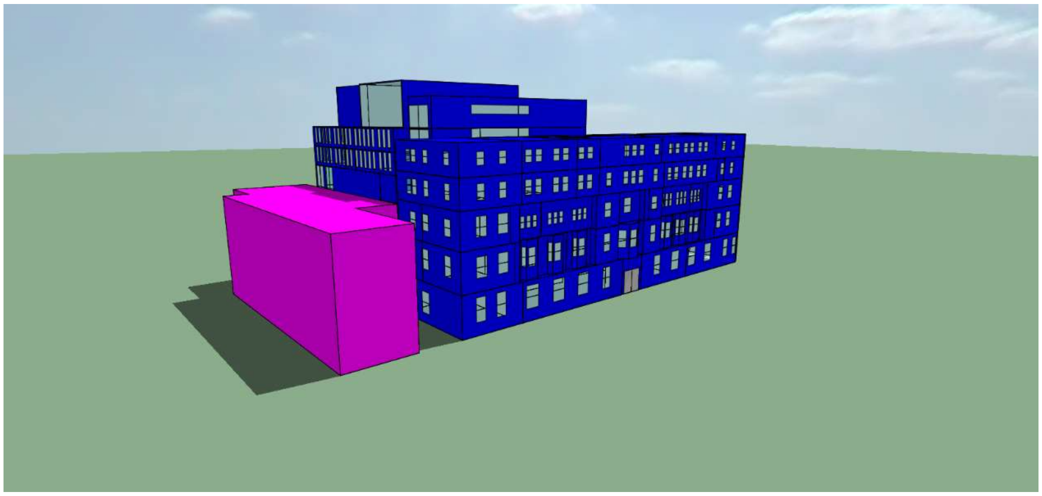


Figure 2: Model Image 2

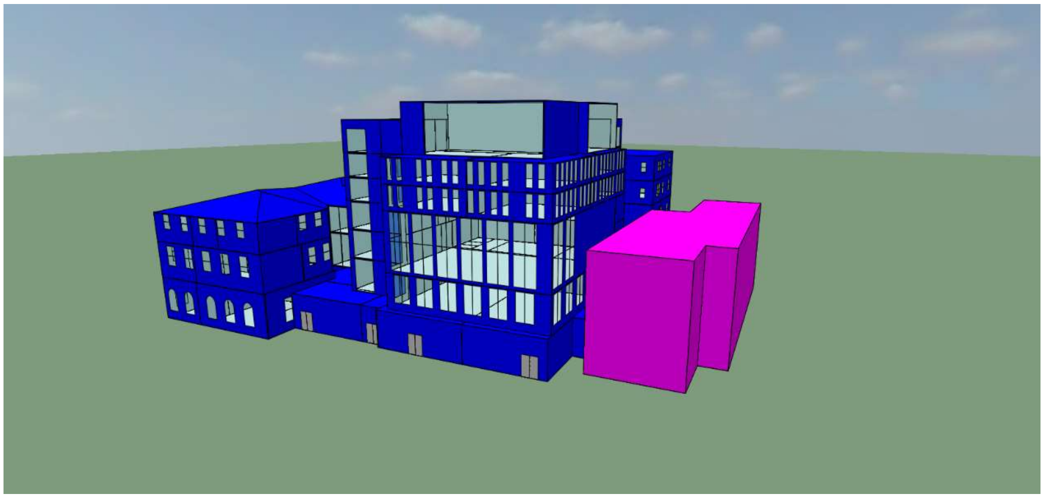


Figure 3: Model Image 3

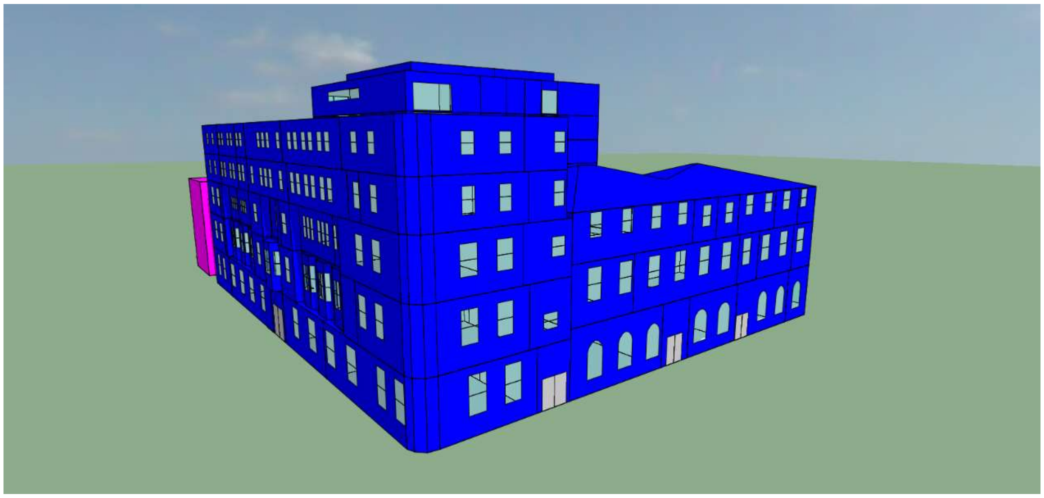


Figure 4: Model Image 4

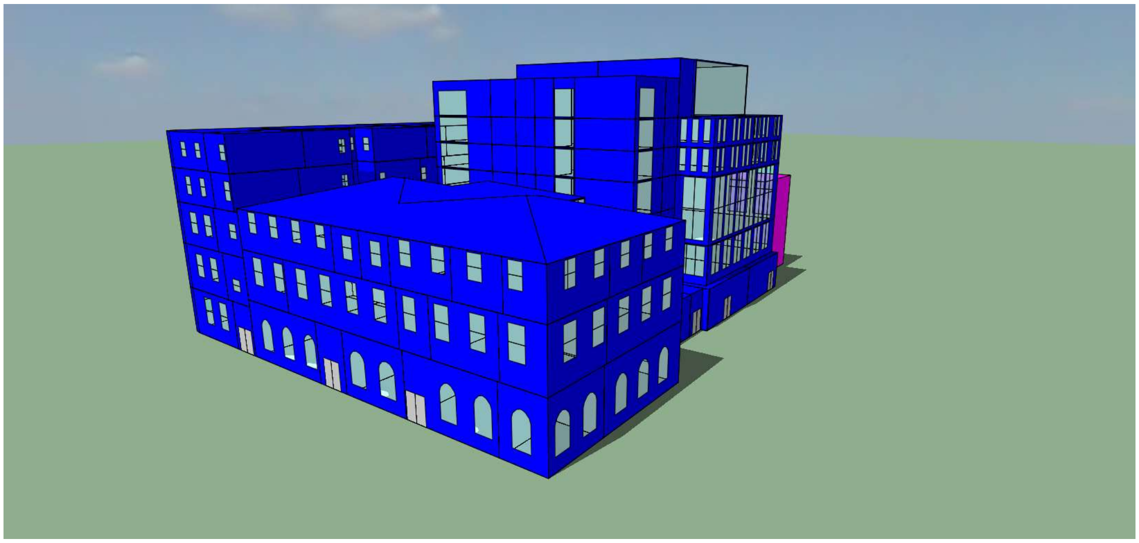


Figure 5: Model Image 5

METHODOLOGY

Part L Building Regulations

The building regulations for Wales were published in 2014 and the current emphasis is to increase the minimum levels of energy efficiency for building fabric and services. Therefore, CO2 targets will not be achieved through the use of renewables alone and the principle of reducing the overall energy demand is reinforced.

The required CO2 targets for a building can be made through the improvement in insulation levels, optimising air permeability, increasing plant efficiency, reducing fan power, increasing natural daylight hence reducing electrical lighting use and through the introduction of renewable technologies.

In Approved Document L2B (Conservation of fuel and power in existing buildings other than dwellings), analysis of large extensions should be carried out in accordance with the guidance in Approved Document L2A (Conservation of fuel and power in new buildings other than dwellings) if the proposed extension is both: greater than 100m2 and greater than 25% of the total useful floor area of the existing building. As a result, a consequential improvement shall apply to the existing building (Approved Document L2B Section 4).

Following the Building Regulation requirements, the new extension of the building, which is greater than 25% of the total floor area will have to comply with the Approved Document L2A. In turn, the existing building shall comply with Approved Document L2B.

For that reason, two separate analyses were carried out and will be presented in this report, as follows:

- Merchant & Corys Buildings – Analysis under Part L2b
- Skyview Building – Analysis under Part L2a.

Software

IESVE V2021.3.1.0 has been used to carry out a dynamic simulation which is fully accredited for use in Building Regulation calculations and is in accordance with CIBSE AM11: Building Energy and Environmental Modelling.

Weather Data

The weather file (TRY) selected for the project is Cardiff, in accordance with the SBEM weather locations applications. This also represents the nearest available location to the proposed project.

Building Type

The simulation uses an NCM activity database and covers the whole year for activities associated with planning use Type C2 University or College.

Demonstrating compliance with Part L2A/L2B 2014 (Wales)

The evidence required by building control which demonstrates compliance with Part L2A and L2B 2014 requires the construction of a model and an assessment of the actual buildings carbon emissions (kgCO2/m2).

When the model is run within the simulation, two models are created and tested. The first being the 'actual' building, this model is based on the input data for the building itself. The other model is called the 'notional' building, which is tested and construction u-values, systems and glazing areas in accordance with 2010 Building Regulations. Both models have the same geometry, and the same activity templates.

When demonstrating compliance with Part L2B 2014, two separate IES models were created, one being the 'Actual' and the other being the 'Notional' Building. The 'Actual' IES building model includes the proposed system and material upgrades to the development and the 'Notional' IES model reflects the building as it is today with no improvements, or where proposed improvements meet the regulatory minimums. The BER from each model is taken and the reduction in CO2 emission rate equates to the percentage improvement over regulations.

SIMULATION PARAMETERS

This section summarises the key input parameters used in the current simulation analysis for both the existing and new buildings.

Merchant & Cory's Buildings

This analysis reflects and incorporates the following proposed improvements to the existing block, utilising the parameters and fabric performance specifications detailed in the tables below, which represents the existing block as it is proposed, as close as practically possible.

Existing Buildings – EPC Parameters	
Air Permeability	10 m3/hr.m2 @50Pa
Lighting	LED 110 lm/w
ASHP to LTHW radiators (COP 2.5)	Whole Building
DHW	ASHP (COP 4.99)
Mechanical ventilation supply (SFP 1.9) – Heat Recovery (65% - 68%)	Whole Building
Mechanical Extract (SFP 0.3)	WC's and café only
Solar Photovoltaics	100m2 (Whole development)

Construction Type	U-Value (W/m2.K)	Description
Ground Floor	0.70	Existing, uninsulated
External Wall – Cory's Building	0.96-1.84	Solid Stone Walls (Various thicknesses)
External Wall – Merchant's Building	0.98	Brick walls
Cory's Building Roof	1.96	Concrete planks 300mm thick, no insulation
Merchant's Building Proposed Roof	0.24	Pitched, timber trusses with slate coverings. 250mm Rockwool insulation.
Glazing	1.6	New glazing
Glazing g-Value	0.4	
External Door	2.20	

SKYVIEW

The simulation analysis for the Skyview building is based on the below M&E parameters, fabric performance specifications which represents the proposed new block:

Proposed/ Baseline EPC Parameters	
Air Permeability	3 m3/hr.m2 @50Pa
Lighting	LED 110 lm/w
ASHP to LTHW radiators (COP 2.5)	Whole Building
DHW	ASHP (COP 4.99)
Mechanical ventilation supply (SFP 1.9) – Heat Recovery (65% - 68%)	Whole Building
Mechanical Extract (SFP 0.3)	WC's and canteen only
Solar Photovoltaics	100m2 (Whole development)

Construction Type	U-Value (W/m^2.K)
Ground Floor	0.12
External Wall	0.15
Roof	0.12
Glazing	1.2
Glazing g-Value	0.4
External Door	2.20

PART L COMPLIANCE & EPC RESULTS

Based upon the above parameters, the following Part L2 and EPC results are achieved.

Part L2 Results

	Notional (kgCO2/m2.annum)	BER (kgCO2/m2.annum)	Part L2 Improvement
Merchant & Cory's	170.2	26.3	84.55%
SkyView	29.6	18.8	36.49%

EPC Results

	EPC Score	EPC Rating
Merchant & Cory's	40	B
SkyView	18	A
Whole Development	26	B

HEAT NETWORK REVIEW

This section explores the connection of the district heating network within the development, which would supply the space heating and hot water demand.

The carbon factor of 0.031 kg CO_2e/kWh has been used which relates to the 'total carbon content of heat from CHN', taken from the 'Low Carbon Heat Supplies from the Cardiff Heat Network' (March 2022).

The table below sets out the results of the analysis with the inclusion of a connection to the district heat network.

	EPC Score	EPC Rating
Existing Block	23	A
New Block	13	A
Whole Development	16	A

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