



PROJECT | UNIVERSITY OF MANCHESTER
ZOCHONIS BUILDING LTM/ZCM

ENERGY STATEMENT

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1. INTRODUCTION

1.1. Purpose of the Report

This report has been produced to outline the potential and recommended energy strategy for the overall University of Manchester, Zochonis Building. The energy strategy will remain to some extent fluid and will require review and reassessment as the overall phasing of the scheme is further developed, however the principles set out within this document are to form the basis of the overall installation.

The report sets out the basis of the assessment, the options, the benefits and limitations of the options and identifies the reasoning behind the chosen solutions, so that this assessment can be reviewed, challenged and then agreed, so that the design process may proceed ahead to the next stages.

1.2. Project Description

The proposed works are for University of Manchester's LTM/ZCM scheme which is to target the Universities desire to achieve net zero carbon by 2038. In general the LTM (Long Term Maintenance) schemes are there to continuously assess the life of elements of the buildings spaces/fabric/mechanical and electrical systems. M&E undertaking the required maintenance and replacement of services as and when they become life expired.

The universities new carbon targets elevated a number of the buildings on the LTM programme to a ZCM (Zero Carbon Masterplan), this was implemented to undertake improvements to the buildings further than the requirements of the LTM, taking life expired systems/spaces and improving them over and above the minimum requirements in order to reduce the overall energy consumption of the buildings.

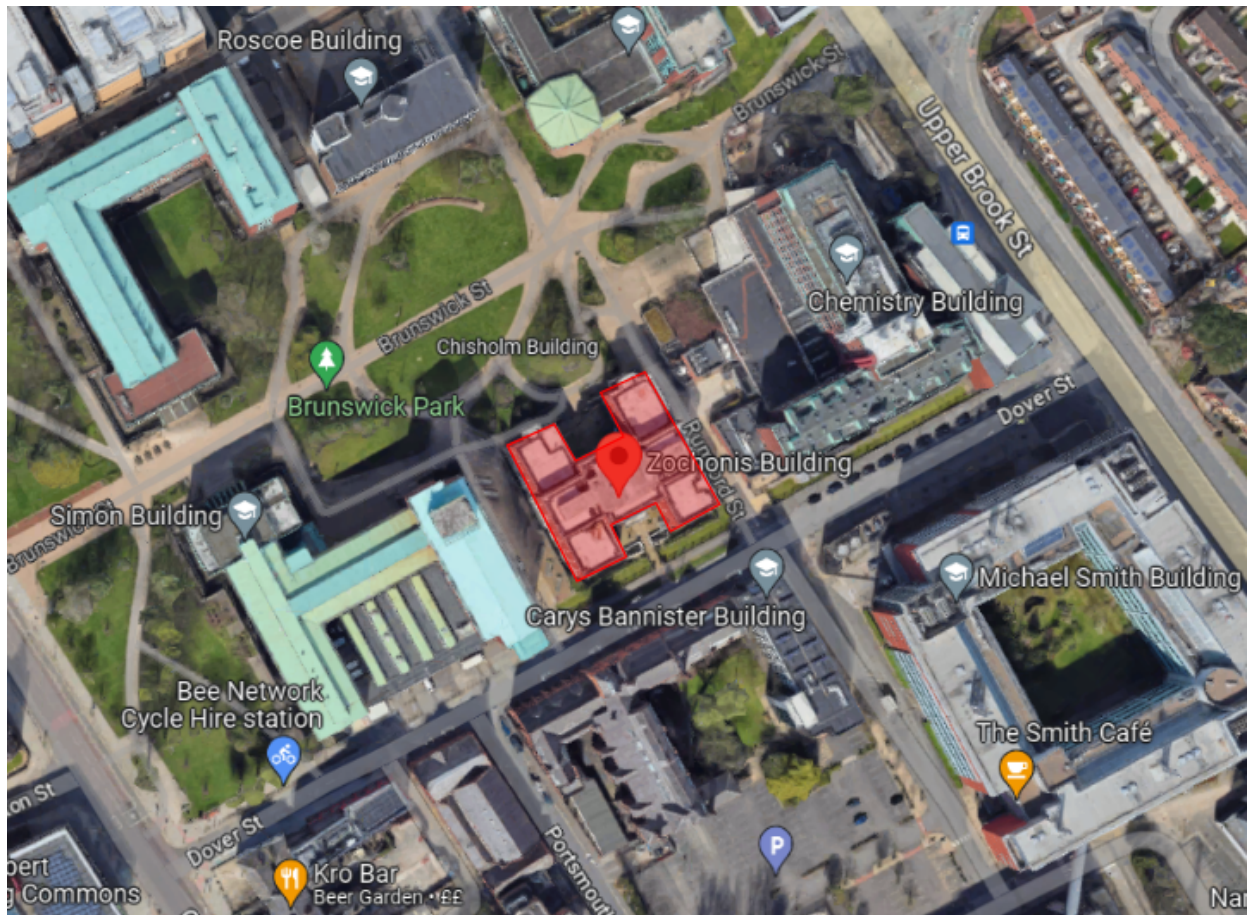
The proposed works as part of the ZCM scheme are to incorporate a new external escape stair, modify the existing rooftop plant areas to accommodate new mechanical plant, including air handling units, air source heat pumps and all the associated mechanical equipment.

The proposed works are being carried out on the University of Manchester, Zochonis Buildings located at:

Zochonis Building,
University of Manchester,
Brunswick Street,
Manchester,
M13 9NT.

The site is in a city environment and is predominantly surrounded by multi-story educational buildings.

The following plan shows the location of building in relation to the surrounding area.



2. GENERAL PRINCIPLES

The site energy strategy will be based on the options to provide both electrical energy and thermal energy.

The energy strategy will be based on a mantra of Lean, Mean and Green;

Lean – Reduce energy consumption via passive measures for example; improved thermal performance, orientation and utilising design techniques such as natural ventilation and thermal mass.

Mean – Where services are provided these will be energy efficient to reduce the base line energy consumption

Green – Application of green technologies to reduce the reliance on utility supplies.

The following sections will detail the existing facilities, the proposed strategy and technologies which could be applied to the development and will draw conclusions as to the recommended strategies to provide both the thermal and electrical requirements of the development.



2.1. National Planning Policy Framework

The NPPF was published in September 2023 and replaces all previous national guidance notes and statements. The document sets out the Government's planning policies for England and how they are expected to be applied. Its purpose is to perform a number of key roles to ensure:

A strong, responsive and competitive economy; Strong, vibrant and healthy communities; and Protection and enhancement of the natural, built and historic environment.

Central to achieving sustainable development is to secure reductions in greenhouse gas emissions, reduce vulnerability and provide resilience to the impacts of climate change.

To support and promote the move to a low carbon future, and reduce vulnerability to climate change, local planning authorities should:

- Plan for new development in locations and ways which reduce greenhouse gas emissions;
- Have a positive strategy to promote energy from renewable and low carbon sources;
- Design their policies to maximise renewable and low carbon energy development while ensuring that adverse impacts are addressed satisfactorily, including cumulative landscapes and visual impacts; and
- Direct development away from areas at highest risk of flooding or coastal change and ensure that flood risk is not increased elsewhere.

2.2. Local Planning Criteria

The Local Planning Authority has no requirement for a specific energy target relating to LZC technology.

The development is required to meet the requirements for Building Regulations Approved Document L2B and non-domestic building services compliance guide figures for mechanical and electrical efficiencies as a minimum.

2.3. Grants Available

A review of the available grants from the Government's Department of Energy and Climate Change website shows that at the time of conception of the scheme Salix funding was available and applied for. Please refer to the energy consultant's report for details of the proposal submission and requirements of the funding application.



3. EXISTING BUILDING

The below information details the baseline information for the building as it currently operates to understand the scope for improvement of the reduction of carbon emissions required to operate the building. This information is broken down into their respective sections aligning with the general principles of the Lean / Mean / Green ethos.

3.1. Available Site Energy Sources

The Zochonis building is an existing building which shares a central plant space with the adjacent building (Simon Building). The plantroom is located between the two buildings and accessed externally and has the following existing utility services provided to the plantroom;

Heating:

- Natural Gas –Supplying Boilers which connect to dedicated Zochonis Building Heating Header.
- CHP District Heating – Supply from Schuster Building Plantroom serving Zochonis Heating Header
- Steam District Heating – Steam Supply from Central steam system serving Zochonis Heating Header

The Zochonis Building also has a number of direct incoming supplies:

- Incoming water supply
- Incoming heating flow and return from the adjacent plantroom
- Incoming electrical supply to switch panel which also serves Dover Street

3.2. Existing construction

The external fabric elements of the Zochonis building has not been improved since its construction in 1953 and have been calculated to have the following approximate U-values (W/m²K):

- Roof – 2.2
- External Wall – 2.1
- Ground Contact Walls – 1.4
- External Floor – 1.4

The existing windows are anticipated to have the following U-values (W/m²K):

- Windows including Frame – 2.2

3.3. M&E Systems

The existing M&E systems for the majority of the building have been deemed life expired and are due for replacement as part of the LTM scheme.

3.3.1. Ventilation

The ventilation system consists of several independent systems which have been installed at different stages across the life span of the building:



- Existing supply only fans with LTHW heater battery for conditioning of supply air to the lecture theatres.
- Central extract fan for cleaner stores and toilets, where not located on an external wall.
- MVHR units to the basement seminar and office spaces which have no provision for natural ventilation
- Local Extract fans, installed ad-hoc to serve areas of the building where requirements have been identified through change of use to spaces.

3.3.2. Heating & Cooling

The majority of the secondary heating system is uninsulated, primary heating from the shared plantroom has been insulated and appear to be in slightly newer condition from that of the rest of the distribution throughout the building. The cooling systems have been installed as and when required with a number of external condenser units installed on the roof top plant areas and in the basement external lightwell. In summary the heating and cooling systems are as follows:

- Heating Variable temperature Circuit serving radiators throughout the building – Pipework uninsulated and controlled via radiator fitted TRV's
- Heating Constant Temperature Circuit serving heater battery on ventilation supply fan.
- Split DX Units installed ad-hoc to serve areas of the building where cooling requirements have been identified through change of use to spaces.

3.3.3. Lighting

Across the building several areas which have undertaken local refurbishment have had the lighting replaced with LED lighting systems. Although new fittings have been installed they have not been provided with enhanced lighting controls as a means to further reduce their energy consumption and were only replaced on a like for like basis.

3.4. Low Zero Carbon Technologies

The building is currently connected to two of the University of Manchester Central Energy networks, although not the primary source of energy to the Zochonis building, should any of the existing primary energy sources fail or need repair the sequencing of the central energy networks can be adapted to accommodate the requirements of the Zochonis Building. The capacity of these networks is not sufficient to provide full load to all the buildings on the network, as such a primary local source of energy for the building is still required. The energy networks consist of the following two systems:

- Steam
- CHP



4. BUILDING IMPROVEMENTS (LEAN)

The following section outlines various sustainable design options which have been considered for the scheme

4.1. Natural Ventilation & Night Cooling

4.1.1. System Description

The ability to adequately naturally ventilate a building is a major contributor to reducing on site carbon emissions by the avoidance of operating electrically driven ventilation fans. The feasibility of a room to be adequately naturally ventilated relies on a number of factors including ventilation opening, height of room, depth of room from window/vent opening, height of the stack above the room, level of internal heat gains and level of solar heat gains.

With the provision of natural ventilation to the building, the potential use of night cooling to pre-cool the building overnight can be implemented. This is best achieved by motorised ventilators providing a controlled ingress of cool night air into the building. The effectiveness of night cooling is dependent on the ability of the building fabric to store the coolth overnight so that it is slowly released during the following day, however, even with low thermal mass buildings, night cooling can be beneficial. Any night cooling scheme will need to consider security of the building accommodate this.

4.1.2. Suitability for the Site

The glazing has been replaced within the past 10 years and is therefore has a reasonable remaining life expectancy before replacement becomes a necessity. As such replacement of the windows are not part of the current scope of works and due to the limitations within budget and restrictions on the use of louvres in the external façade the existing ventilation strategy is to be retained. There is however scope to increase the high level opening of the windows in order provide a larger free area.

There is also potential to operate the proposed air handling units at night in order to purge the corridor and internal spaces during the summer if there are excessive high temperatures. This provides an energy saving in not having to condition the spaces utilising the heat pumps. Therefore although natural ventilation may not be a viable option for night cooling it can be integrated into the control system under the operation of the AHU's and MVHR's.

4.2. Thermal Mass & Structure

4.2.1. System Description

The thermal mass and overall construction of the building fabric (walls, floors, ceilings etc) can provide a considerable passive design benefit for alleviating peak cooling conditions, when used in conjunction with a night ventilation scheme.

Thermal mass systems operate on the general principle of an energy store, holding energy during periods of excess and then releasing the energy slowly at other times. In the case of high thermal mass building structures (e.g. stone buildings such as churches and castles), the internal summertime temperatures are always considerably lower than the external temperatures, due to the effect the fabric has on the internal environment. In these instances, the fabric cools down during the night when the ambient temperatures are lower, and then retains this stored coolth so that during the day, heat is absorbed from the room into the fabric. The cycle then repeats itself the following night.



This effect can be used to delay the times when the internal rooms reach peak temperatures, such that the room may be at its warmest a few hours after the actual peak solar gain time. In this instance, the overall cooling load will be reduced, making the potential for using passive cooling measures such as natural ventilation more feasible and avoiding the need for mechanical cooling.

4.2.2. Suitability for the Site

Use of natural ventilation cannot be accommodated overnight for security reasons, therefore to provide night cooling, mechanical plant would need to operate to draw in cool air at night to cool down the fabric. The energy associated with operating the ventilation plant outweighs the benefit of the inclusion of the thermal mass.

4.3. U-Value Improvements & Air Leakage

4.3.1. System Description

The Zochonis Buildings structure consists of a concrete frame with double skin brickwork split with an air cavity, because of this even with internal lining to the building there will still be some loss through the thermal bridging of the structure through the floor construction on each of the floors. The only way to resolve this would be to overclad the external walls, however due to the age of this building this is not a practical solution. As such in order to at least achieve minimum standards for u-values any thermal bridging needs to be considered and the base line u-value product applied to the building needs to be improved above the minimum standard. The cavity wall is not a traditional cavity, in some locations the cavity is local to the room and others continuous through all the buildings floors. The internal leaf is not always constructed of brick work and in some locations has been boarded, or transformed to be utilized as a riser. Due to the existing thermal performance being so poor any improvement to the u-value will have a large reduction on the carbon emissions of the building in the winter months.

The roof of the Zochonis building has past its current life expectancy and is due for repair, this has been taken as an opportunity to enhance the thermal construction of the roof in order to further improve the existing fabric of the building.

4.3.2. Suitability for the Site

The simplest method for improving the u-values in the Zochonis building is to internally line the external walls with insulated plasterboard this target improvement as a minimum would be to the minimum standards set out in approved document part L2B, however for this scheme the target is to get as close to as reasonably practicable to the new build construction standards. This is the most viable option for improving the lean energy measures of the building. This in turn will decrease the air leakage to the building as it will seal any residual openings from the original cavity construction.

5. EFFICIENT DESIGN MEASURES (MEAN)

The following section details the efficient design measures used within the design process, which will at a minimum target the baseline compliance figures from the non-domestic building services compliance guide. Where financially viable the design will go over and above the minimum baseline compliance figures in order to maximise the overall carbon reduction of the building:

LED lighting, including lighting / day lighting controls where appropriate.



Low loss electrical transformers

Metering of primary energy use items

Provision of fully integrated and intelligent building management system for effective and adaptive control of all services

High performance heat recovery systems on ventilation plant utilising plate heat exchangers and integrated ASHP

Low specific fan powers on air handling units

Limiting heat gains and losses from pipes, ducts and vessels by provision of thermal insulation to all services.

Ambient temperature heating distribution.

Local electric water heating due to low demand and size /quantity of toilet provision.

All services will be commissioned and adjusted as necessary to ensure they use no more fuel and power than is required.

6. SUSTAINABLE DESIGN OPTION REVIEW (GREEN)

6.1. General

The following information outlines the various sustainable design options that have been considered for the new development and discusses their suitability for inclusion in the ongoing design process.

6.2. Combined Heat and Power (CHP) Plant

6.2.1. System Description

There are two types of combined heat and power systems which could be used, namely, gas fired, and biomass fired systems. The only main effective difference between the systems is the fuel source used to fire the plant, one using natural gas and the other using biomass (wood chip or wood pellet).

The gas fired Combined Heat and Power systems are not renewable energy systems but are considered low carbon green energy systems as both heat and electricity is produced, one of which will take priority from a design aspect, with the other being deemed as a waste product, albeit still beneficial in that it can be utilised where possible.

This arrangement ultimately results in an overall lower carbon emission for the system when compared with the separate grid supplied electricity and gas fired boiler systems, which would be used to provide the same electricity and heating provision to the development.

The use of biomass to fuel the CHP unit does not carry the same carbon emission factor as the gas system and is therefore a considerably lower carbon emitting system. Whilst it still does emit carbon, it is in effect considered a green, carbon neutral system, so long as the fuel deliveries are sourced locally or delivered by biofuel powered transport.

A CHP system therefore derives its name (combined heat and power) from the fact that fuel is burnt to provide both power (electricity) and heat, with the generation of these two useful energy sources leading to this type of system to be called a cogeneration system.



When linked to an absorption chiller unit, the water heat from the CHP plant can also be used to provide cooling (absorption chiller units are heat driven systems) and these systems are called tri-generation systems as three useful energy sources are now available.



Photo showing a small scale gas CHP Unit

Photos of a biomass fuelled CHP packaged unit



6.2.2. *Suitability for the Site*

On its own there is not a sufficient base load for simultaneous heating and electrical supply to the building throughout the year. Therefore, CHP is not deemed a viable option suitable for this project.

6.3. Ground Source Heat Pump

6.3.1. *System Description*

Ground source heat pumps transfer the renewable heat stored in the ground into a building to provide space heating and possibly a preheat to domestic hot water demand. The ground temperature a few metres down remains at a constant 11°C - 12°C throughout the year. Utilising the constant temperature from the ground as a heat source and passing this through the refrigeration cycle, this 11-12°C heat



can be upgraded to a flow temperature of 30-40°C that can then be supplied to the building's heating system.

This type of system is well suited to underfloor heating systems that run at this lower flow temperature, although it can be used for radiator systems as well, the radiators just need to be larger than installed in a traditional system running at a 60°C flow temperature.

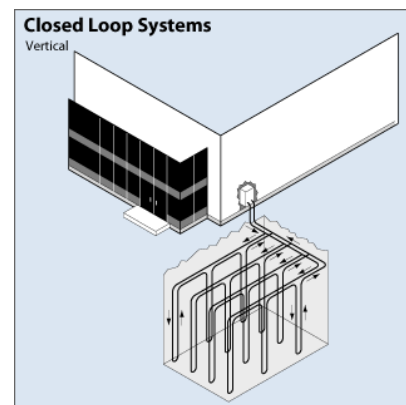
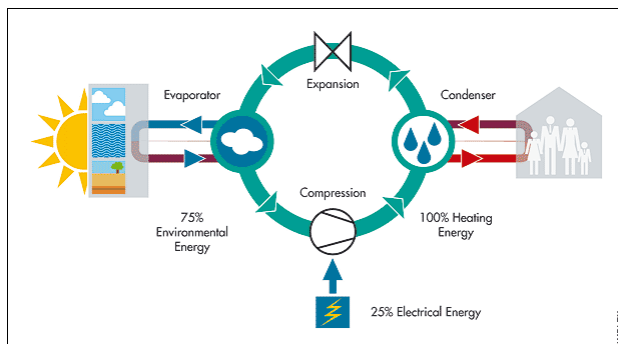
Typically, under the most favourable conditions, a ground source heat pump can achieve a 4:1 operational efficiency, so 4KW of heat will be produced for every 1KW of electricity used.

The main components of the ground source heat pump system are: -

- Ground loop - Pipes buried in the ground
- Heat pump
- Heat distribution system.

There are two main options for the ground loop (the external pipes) and these are to bury the pipes in trench at depth of around 2 metres, or alternatively, vertical bore holes can be drilled straight downwards.

Simple schematic diagram of heat pump energy cycle



6.3.2. Suitability for the Site

Ground source heat pumps is not a viable option for this scheme due to the lack of available land.

6.4. Air Source Heat Pumps

6.4.1. System Description

The air source heat pump system utilises the same technology as the ground source heat pump systems with the exception that the energy is drawn from the air and not from the ground.

It therefore has similar advantages and disadvantages, but with the following specific items when compared with ground source systems.

Typical picture of an air source heat pump condenser:



6.4.2. *Suitability for the Site*

Air source heat pumps are a viable option for this site, as multiple heat grades can be utilised with the technology, allowing for heat provision for both a low grade heat output system such as underfloor heating as well as a high grade heat system in radiant panels and domestic water supply. With the use of buffer stores the efficiencies of the heat pumps can also be optimised to operate them at their most efficient performance levels. For the Zochonis building due to limitations on plant space and the associated ancillary equipment needed to accommodate both low and high grade heat options, ASHP will only be considered as a low grade heat source.

6.5. Solar Water Heating

6.5.1. *System Description*

Solar Hot water systems are well established in many countries however the perception that the UK weather is not sunny enough has reduced their use in the UK. However solar thermal systems do not actually require direct sunlight and therefore do in fact work very successfully within the UK.

The system uses the thermal energy from the sun collected in solar thermal panels on the roof of the building to heat water that is passed through pipes fixed to the solar plates. These systems are generally operated with a back-up source of heat as for a traditional system, such as gas or electricity.

There are two types of solar collectors, flat plate collectors or evacuated tube collectors. Evacuated tube collectors are more efficient but also tend to be more expensive. If flat plate collectors are installed the ideal tilt of the collector would be 40°. If evacuated tube are used the angle is less critical.

During the summer months, in general, almost all the hot water demand can be met by a sufficiently sized solar hot water system, with a significant reduction in the amount in winter months when there is less solar energy available.

As with the photovoltaic system the optimum location for the panels are on a sloped roof with a southerly orientation, however east and west orientations are also acceptable.

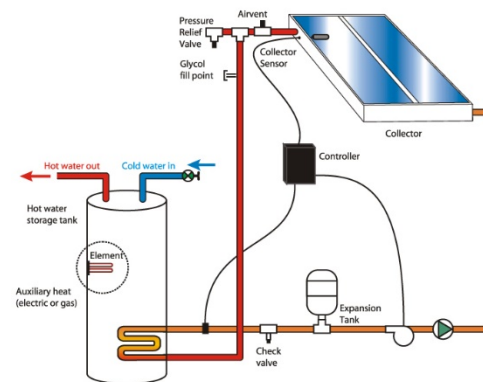


6.5.2. Suitability for the Site

This system may offer some local benefit to supplement the water heating demand however, with the demand for domestic hot water within the building decreasing during the summer months it is more beneficial to use the available roof space for other low carbon technologies.



Closed Loop, Freeze-Protection System



6.6. Photovoltaic Cells

6.6.1. System Description

Photovoltaic cells convert sunlight directly into electricity with no waste and no emissions. When the light from the sun hits the silicon in the PV cell direct current electricity (DC) is created. The DC is collected in a central location and converted to alternating current (AC) so that it can be used to supply household appliances.

During daylight hours electricity produced from PV panels would be supplemented by the local distribution network operator (DNO). If, however excess electricity is produced then electricity can be fed back into the electricity grid.

Where new PV systems are installed the DNO must be notified and an agreement set up to either buy back the excess electricity from each system or the occupants can register as an independent energy generator and sell Renewable Obligation Certificates (ROC's) to OFGEM. At present 1ROC = 1000kWh energy, this scheme will remain in place until 2027.

This type of system depends on the roof area available facing predominantly south with a horizontal angle of up to 40°. Roofing products that can replace conventional roof tiles or framed systems attached to the roof can be installed.

The electricity generated by the PV cell can be stored or used in one of the two following manners.

PV cells are primarily available in three forms:

Mono-crystalline Silicon Cells: These are considered to be the most efficient, typically range from 17% to 20%, but are normally the most expensive.

Polycrystalline Silicon Cells: These are not as efficient as mono-crystalline, typically range from 13% to 16%



Thin-Film Silicon: These are another polycrystalline technology, but the silicon is deposited onto a base material as opposed to being manufactured into wafer thin sheets. They again have an average efficiency of 15%.

In the recommended roof top location, the maximum peak electrical generation from a PV cell in the North West of England is approximately 70 W/m². When averaged out, considering shading effects, seasonal variations, angle of incident of sun to solar panel etc the figure for electrical generation that can be expected to be achieved is approximately 20 W/m².

The current solar cell technologies are well established and provide a reliable product, with sufficient efficiency and energy output for at least 25 years of lifetime.

Their method of connection can be direct online or via batteries.

For direct online, the electricity that is generated by the PV cells is channelled straight into the buildings supply network via a DC to AC convertor and the synchroniser unit, similar to the battery storage option, except with this option the electricity is fed direct into the building supply. The PV cell electricity is therefore only available during the periods when there is sufficient daylight. This option has the advantage that it does not require large plant areas for battery storage.

This is the normal method of integrating PV cells to the LV infrastructure.

For battery connected systems, the electricity generated by the PV cells is produced as direct current (DC) electricity. This can be taken from the cells and stored directly into batteries. The batteries can then be discharged as and when required through a DC to AC convertor unit and the AC electricity can then be used to power standard equipment.

The drawback of the battery storage option is the space required for the batteries and the additional maintenance requirement. The advantage is that stored electricity can be used during period of poor daylight or overnight.



6.6.2. Suitability for the Site

The building has a large electrical requirement for a large portion of the year and significant roof area for the PV Cells, then PV cells are a viable option for this site.



6.7. Wind Turbines

6.7.1. System Description

Wind energy has been identified and utilised for many years as a source of clean and renewable energy. The United Kingdom is Europe's windiest country and benefits from 15% of Europe's total wind energy resource. The technology exists to easily convert the wind energy directly into electricity using modern wind turbines where the power of the rotating shaft is converted into electricity via a generator unit.

The design of the wind turbine blades has been developed over the recent years into a highly sophisticated element that encompasses aeronautical design with blades harnessing the lift effect of the wind passing over them. The output from a modern wind turbine is dependent on the speed of the wind and power from the wind increased to the cube of the wind speed, meaning that only small increases in wind speed can provide dramatic increases in power output. As wind speed increases with height above the ground a wind turbine is best located on a high mast or tower. The optimum location for a wind turbine is on a flat topped hill with clear air paths around the turbine free from obstructions such as large trees or buildings.

In similar fashion to the photovoltaic cells the electricity generated from the wind turbine can be either stored in batteries or fed direct into the buildings electrical supply. Unlike photovoltaic cells the wind turbine will continue to generate after dark and therefore the electricity generated can be used to support the essential systems within the building.

Wind turbines primary can be ground mounted or building mounted.

Ground based wind turbines are mounted upon a mast that is fixed to the ground. The ground based system has the advantage that the full weight of the mast and the forces exerted by the operation of the turbine blades can be easily accommodated within the mast foundations.

Building mounted wind turbine unit are fixed to a mast that is in turn fixed to the building structure. This type of application has the benefit of raising the wind turbine to a greater height above the ground where the wind speeds are higher and therefore raising the wind turbine above the majority of the local obstructions such as trees or buildings.

However, the design of a building mounted wind turbine is very complex and must be fully coordinated into the structure of the building not only to provide sufficient structural support for the weight and turning moment forces of the turbine unit assembly but also to ensure that the vibration from the operational turbine is not transferred into the structure but is fully isolated at the source. As a result of this it is very difficult to successfully accommodate a wind turbine onto the structure of an existing building.

The location of a wind turbine up the top of a building also causes additional problems with regard to access for maintenance of the unit and the need for specialist access platforms.

The anticipated electrical output from a wind turbine is dependent on the size of the rotor blade and the wind speed at the location that the unit is installed.



6.7.2. Suitability for the Site

In general, the site is not considered as being suitable for wind turbine installation because of the potential noise issues, close proximity of the residential and commercial properties within the area and required safety exclusions zones.

Therefore, wind turbines will not be considered further for this site.



7. CONCLUSIONS OF SITE SUITABILITY ASSESSMENT

It can be seen that there are many LZC technologies which could be considered for the proposed development, a number of which are not considered suitable. The following table identifies those technologies which have been discussed within this report and are deemed either suitable for inclusion within the proposed development or worth further consideration.

System	Viability for site	Proposed for the site
Lean Proposals		
Natural ventilation	Yes	Yes
Fabric Improvements & Air Permeability	Yes	Yes
Thermal Mass & Structure	Yes	No
Night Cooling	No	Further Development Required
Mean Proposals		
LED Lighting	Yes	Yes
Lighting Controls	Yes	Yes
Heat recovery AHUs	Yes	Yes
Ambient Temperature Heating Systems	Yes	Yes
Water Source Domestic Water	No	No
Enhanced Heating Controls	Yes	Yes
Green Proposals		
Gas fired combined heat and power	Yes	Yes – Reuse Existing
Heat pump systems	Yes	Yes
Solar water heating	No	No
PV cells	Yes	Yes
Wind Turbines	No	No

The existing systems and building fabric at the Zochonis Building are currently inefficient, dated and in need of significant overhaul/upgrade in order to achieve the Universities ambition of a Zero Carbon estate by 2038. A key element to this is heat decarbonization which in turn triggers both complementary & supplementary energy/system efficiency improvements. Over the next two years the following works are crucial to this strategy (overall works to be completed by no later than the end of July 2025) and are crucial to transitioning away from imported gas towards renewable forms of imported electricity:

- Upgraded Roof & insulation – new Bauder roof system (achieves U value of 0.18)
- External Wall Upgrade - with insulated plasterboard (achieves U value of 0.25)
- LED lighting
- Ventilation upgrade(s)
- Air Source Heat Pumps (ASHP) & new secondary heating system
- BMS
- Solar PV panels – 11% contribution

The impact of such changes could be an 80% reduction in carbon emissions. equating to a saving of 238 tons of Carbon each year with annual energy bills reducing by 31% each year. The fabric upgrades reduce the primary energy associated with heating by 48%.



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