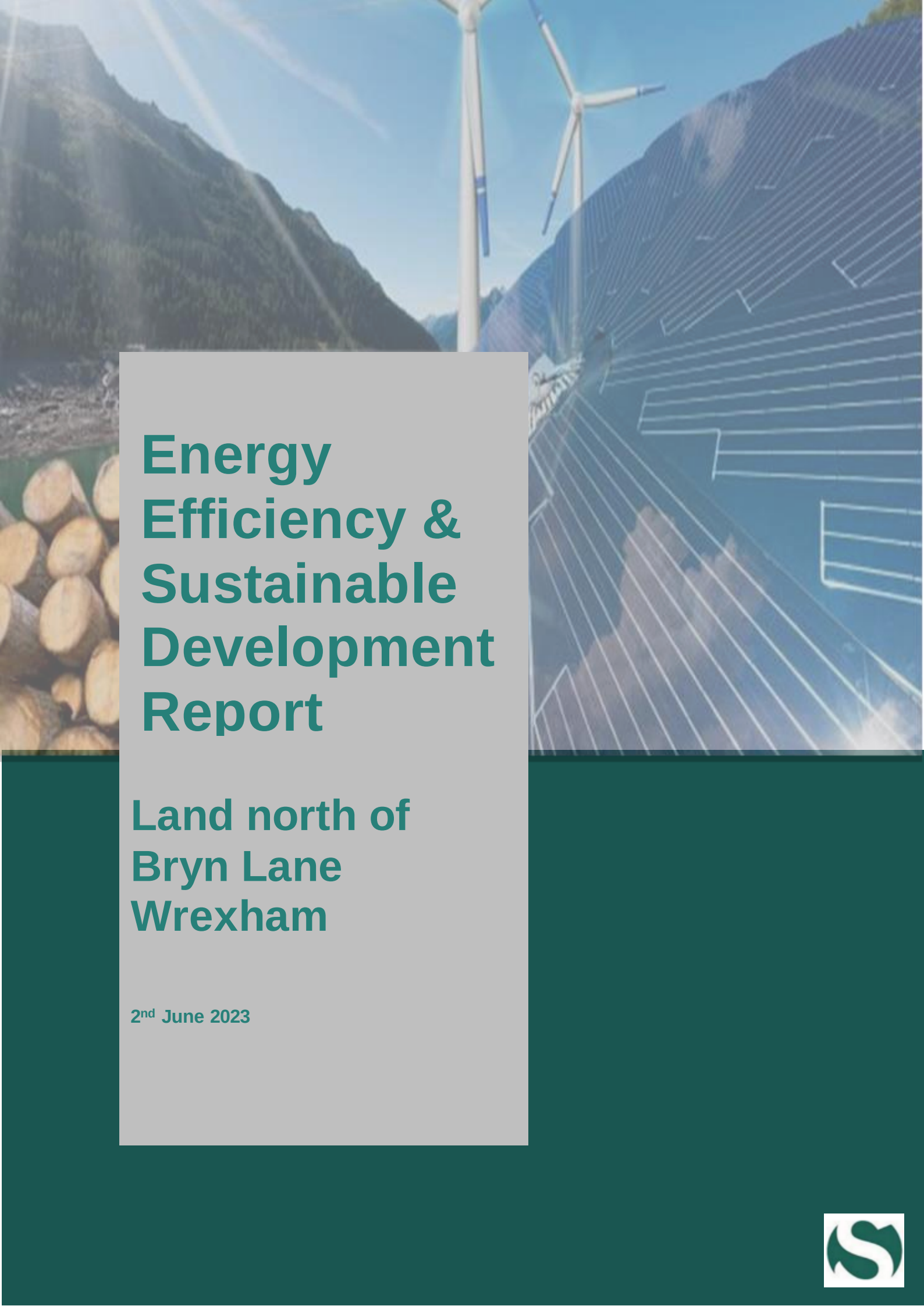




Energy Efficiency & Sustainable Development Report

Land north of
Bryn Lane
Wrexham

2nd June 2023



Document Issue Status

Issue No	Issue Date	Description	Written By	Approved By
1	28-03-23	First Draft Issued for Design Team Comment	D.J. Sorbie	S.M. Hunt
2	22-05-23	Design Team comments incorporated Planning Issue	D.J. Sorbie	S.M. Hunt
3	02-06-23	Further Design Team comments incorporated Planning Issue	D.J. Sorbie	S.M. Hunt

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LOW CARBON CONSULTANTS



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Executive Summary

This report has been instructed by Net World Sports (the applicant) in support of the hybrid planning application for an employment development comprising Use Class B1c, B2 and B8 uses with ancillary retail/hotel uses (Use Class A1/A3/C1/Sui Generis) and associated access, parking, servicing and landscaping on land to the north of Bryn Lane. In adopting the approach set out in this document the applicant aims to demonstrate their continued commitment to Sustainable Development into each and every construction project they undertake.

This document details commitment to both CO₂ and environmental impact reduction and demonstrates that the proposed scheme will improve the sustainability and environmental performance of the built environment beyond mandatory requirements by increasing energy efficiency, reducing CO₂ emissions, and implementing building integrated Low or Zero Carbon (LZC) technology when compared to a traditional equivalent scheme.

The report demonstrates how the proposed scheme meets the energy and sustainability policies of the Wrexham Unitary Development Plan (UDP) (adopted 2005), and also the emerging Local Development Plan 2013-2028.

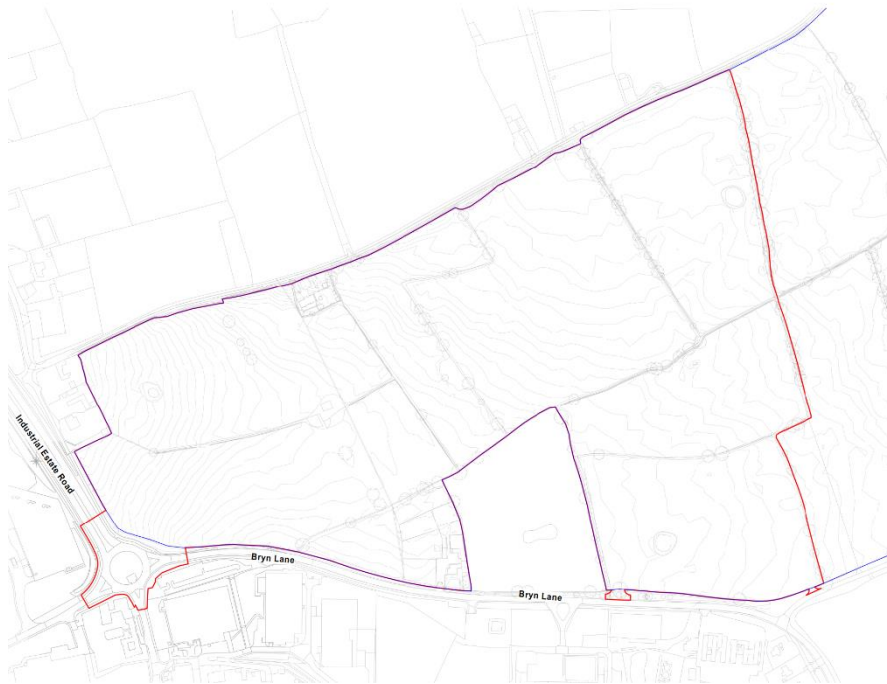
Energy Efficiency & Renewables

The proposed buildings will target a Design Stage EPC Rating of 'A' and will achieve betterment of the site specific BRUKL Target Emission Rate (TER) in excess of previous Building Regulation requirements by inclusion of the following;

- The treated areas of the building will have a 40% improvement in 'Air Permeability'
- Live Electric Vehicle Charging Points
- Passive (future) Electric Vehicle Charging Points
- LED Luminaires with an efficiency at least 40% better than 2013 Building Regulations
- Presence Control and daylight compensation Lighting Controls
- High Efficiency Air Source Heat pumps for heating and comfort cooling
- External lighting optimised for maximum efficiency
- High efficiency motors & controllers
- Water low flow control devices and leak detection to reduce wastage
- Circa 15% roof-lights to provide natural light and reduce artificial lighting & energy use
- Mechanical Ventilation Heat Recovery (MVHR) to offices & staff areas to reduce the heating requirement and improve air quality

Area of Proposed Development

The area of the development is shown in the image below, and the architect's proposal for the site



Existing Site Plan



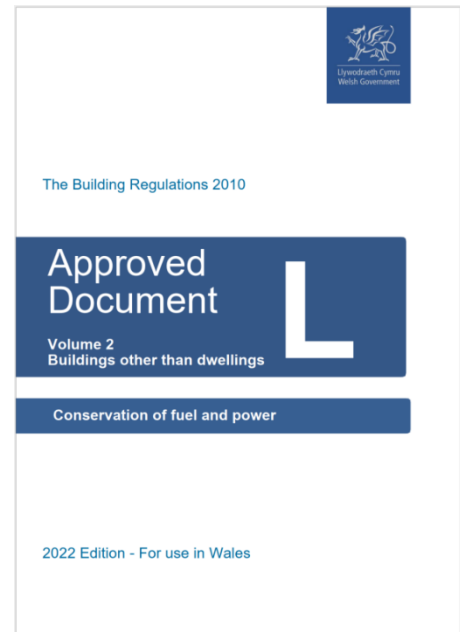
Proposed Site Plan

Refer to Architects plans for latest layouts

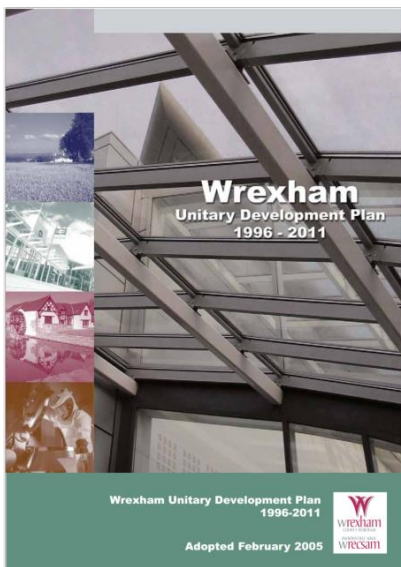
Relevant Legislation & Policy

Building Regulations

As required by current legislation the Development as a minimum will be carried out in accordance with current Building Regulations including Part L 'Conservation of Fuel & Power' This development will comply with the new more stringent energy efficiency and carbon reduction regulations which came into force March 2023



Relevant Planning Policy Includes



Key Energy & Sustainable Policies

RENEWABLE ENERGY

Policy PS12 Proposals for the generation of energy from renewable sources will be supported provided that the wider environmental benefits are not outweighed by any detrimental impacts of the proposed development (including any electricity transmission facilities needed) on the landscape, public safety, and the local environment

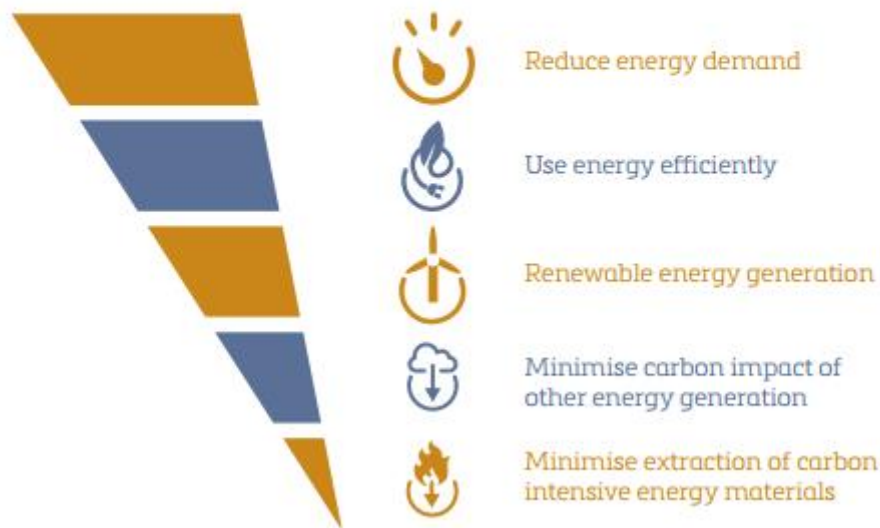
Energy Hierarchy for Planning

5.7.13 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 in the following energy policies. Reducing energy demand and increasing

Planning Policy Wales | Edition 11

Figure 10: The Energy Hierarchy for Planning



energy efficiency, through the location and design of new development, will assist in meeting energy demand with renewable and low carbon sources. This is particularly important in supporting the electrification of energy use, such as the growing use of electric vehicles and heat pumps. All aspects of the energy hierarchy have their part to play, simultaneously, in helping meet decarbonisation and renewable energy targets

5.4.7 The level of carbon reduction expected will be determined by the minimum required by Building Regulations (Part L). The contribution and mix that each of these low and zero carbon design solutions provides will be dependent on the design approach taken¹

Energy Assessment Outline Methodology

Energy Strategy

The fundamental approach for the energy strategy is as follows:

- Establish the baseline energy demand in line with statutory requirements in terms of Wales current Building Regulations Part L compliance using accredited thermal modelling software (TAS)
- Adopt passive and low energy design techniques in order to reduce the energy demand for the development beyond the baseline energy demand requirements.
- Assess the potential decentralized heating, cooling and power measures available to suit this development and establish potential energy/carbon dioxide reduction for viable solutions (clean scheme).
- Assess the potential low and zero carbon (renewable) technologies to suit the development and establish potential energy/carbon dioxide reduction for viable solutions.
- Establish the anticipated energy and carbon dioxide emission reductions for the development using current Building Regulations calculation methodologies.

This approach is in line with the principles detailed within the relevant planning policy statements and regulatory guidelines.

Energy Demand Assessment

The energy demand assessment will be carried out post planning consent at the commencement of the detailed design stage using EDSL TAS dynamic simulation software Version 9.5.4 that incorporates the SBEM calculation methodology in line with current Building Regulations Part L requirements in order to generate a predicted annual CO₂ emission rate.

The following fuel carbon dioxide emission intensity factors are to be used

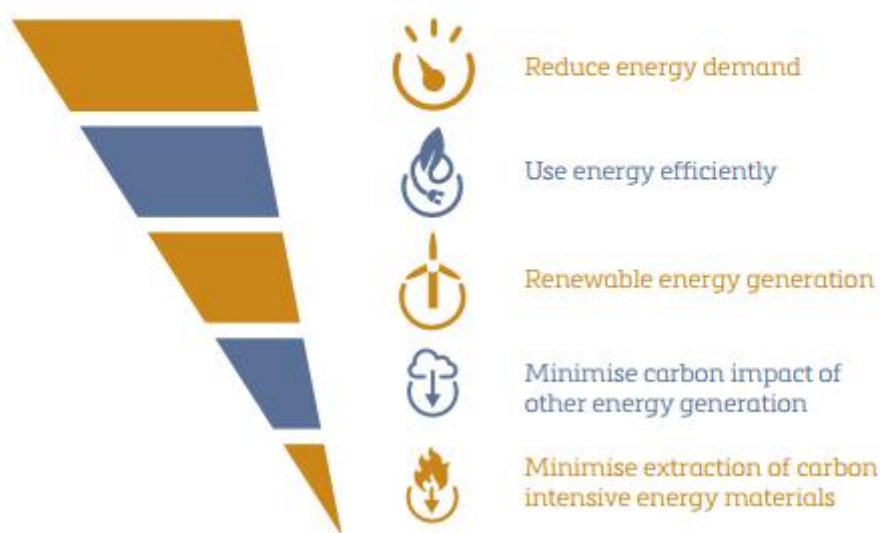
Current UK Government GHG Conversion Factors 2022	
Fuel	kg CO ₂ e / kWhr
Natural gas	0.200
Grid supplied electricity	0.193
Grid displaced electricity	0.193

Energy Hierarchy

The buildings will be designed in line with the Energy Hierarchy in accordance with the Welsh Government Technical Advice Note 12

Planning Policy Wales | Edition 11

Figure 10: The Energy Hierarchy for Planning



The Energy Hierarchy provides a logical process map for energy/carbon reduction for construction developments.

- **Be Lean: Reduce energy demand**
- **Be Clean: Supply energy efficiently**
- **Be Green: Use renewable energy**

These steps dictate construction specifications, in some instances the development layouts and of course, the build cost.

Be Lean

The Be Lean step of The Energy Hierarchy encourages developers to design in a way that reduces the energy demand of a development. All Energy Strategies need to demonstrate how energy efficiency measures reduce the energy demand.

Be Clean

Once a development has met the minimum carbon standard under 'Be Lean', developers must then consider how to provide heat and energy to a development. This means connecting into an existing district heating network where possible or where feasible providing an on-site communal heat network.

Wales Government are in a transition stage with Part L Building Regulations encouraging no/or limited on site combustion of fossil fuels. It is likely that the future UK Gov plan will be to remove all on site combustion. Currently developments are to demonstrate that they will not have a negative impact on local air quality and Combined Heat & Power engines will require NOx mitigation to be acceptable.

Be Green

Use on site renewable or low carbon energy generation to provide a proportion of the sites energy consumption .

Low carbon technologies can include heat pumps and renewable technologies include wind, solar thermal photovoltaics etc..

Treated & Un-Treated Areas

The Occupied ‘*Treated’ areas of these types of building typically only make up around only 3-5% of the complete building. The proposed heating and cooling to the ‘Treated’ area will be provided by low carbon technology air source heat pumps.

So although the proposed buildings are large energy use is low.

The plan shows the strategy for the buildings applied for in detail at this stage, the same approach will be taken from buildings developed in Zones A1, A2 and B, at Reserved Matters stage.

The plans below show the *Treated - highlighted green - to Untreated Grey Area Proportions.



*Treated defined as areas heated or cooled as assessed by the UK Gov NCM (National Calculation Methodology)

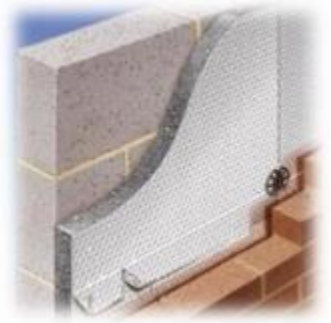
Energy Demand Reduction – ‘Be Lean’

The primary design aim is to reduce energy requirements through energy efficiency measures and good practice sustainable building services. This will result in an improvement in the building’s energy performance over and above the minimum levels stipulated within Part L of the Building Regulations.

Building Fabric Performance

The proposed buildings will be built with area weighted U-values improved upon the Current Building Regulations Part L minimum values for the building fabric and glazing elements.

New buildings are required to be pressure tested under the current Building Regulations Part L with the maximum permissible air leakage set at $8\text{ m}^3/(\text{h.m}^2)$ @ 50 Pa. It is proposed that all endeavors’ will be taken to improve the air leakage performance of the building to $8\text{ m}^3/(\text{h.m}^2)$ @ 50Pa For the main warehouse area and $5\text{ m}^3/(\text{h.m}^2)$ @ 50Pa within the ‘Treated’ office areas to further improve the energy efficiency of the building.



Heating

Circa 95-97% of the buildings are not heated or cooled ‘Treated’ we are therefore only considering the offices and associated areas.

These areas will be heated by air source heat pumps, which are considered Low carbon energy.



Cooling

Circa 95-97% of the buildings are not cooled ‘Treated’ we are therefore only considering the offices and associated areas. These areas are cooled as a by-product of the heating solution by air source heat pumps, which are a source of Low Carbon Energy.

However as per Government guidance, the cooling element of ASHPs has been included within the ‘Be Lean’ stage assessment as this is not considered renewable and therefore cannot be included within the ‘Be Green’ stage assessment.

Ventilation

Mechanical Ventilation with Heat Recovery provides fresh filtered air into a building whilst retaining most of the energy that has already been used in heating the building.

Heat Recovery Ventilation is the solution to the ventilation needs of energy efficient Buildings Mechanical Ventilation Heat Recovery (MVHR) to offices & staff areas to reduce the heating requirement and improve the quality of air for user.



Domestic Hot Water

Hot water use on site is limited to toilets and kitchenette.

Water fittings for WCs & Taps will be of low flow high efficiency and heated by high efficiency high temperature (up to 70°C) Air to water heat pumps.

Lighting

LED Luminaires with an efficiency at least 40% better than Building Regulations (2013) Circa 110lm/w linked to Presence Control detectors.

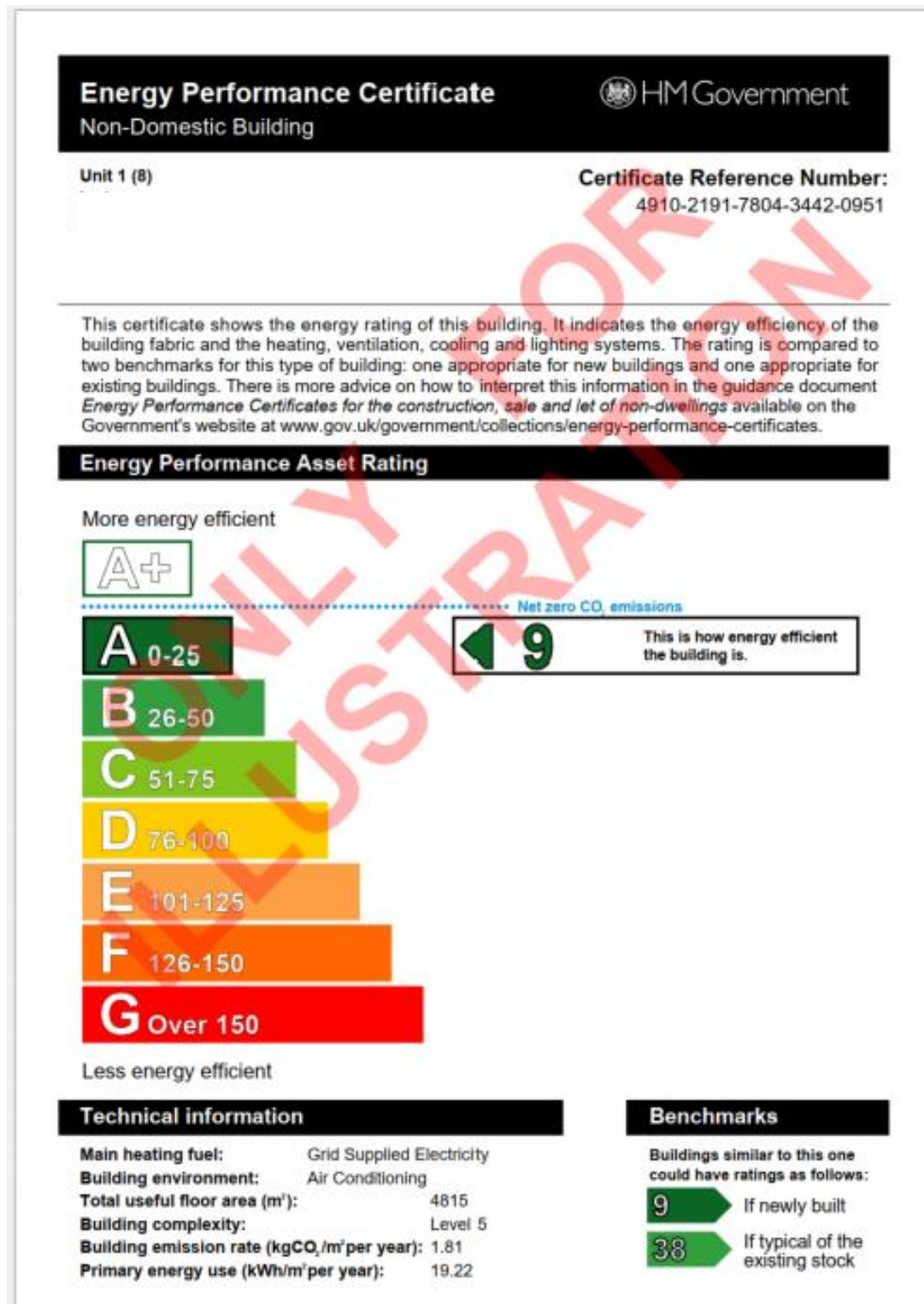
LED luminaires will also be 50,000 hour rated reducing future maintenance & replacement.



Project Design Stage EPC

Much like the multi-coloured sticker on new appliances, EPCs tell you how energy efficient a building is and give it a rating from A (very efficient) to G (inefficient). They let the person who will use the building know how costly it will be to heat and light, and what its carbon dioxide emissions are likely to be. EPCs are generated using UK Government Approved Software by qualified Low Carbon Energy Assessors – example below.

EPCs will be carried out post planning consent at the commencement of the detailed design stage for all buildings and will target an 'A' rating



Administrative information

This is an Energy Performance Certificate as defined in the Energy Performance of Buildings Regulations 2012 as amended.

Assessment Software:	TAS v9.5.4 - using calculation engine: TAS v9.5.4
Property Reference:	UPRN-123456789012
Assessor Name:	Paul Cowley
Assessor Number:	LCEA141452
Accreditation Scheme:	CIBSE Certification Limited
Assessor Qualifications:	NOSS
Employer/Trading Name:	Synergy Building Services Solutions Ltd
Employer/Trading Address:	Synergy Building Services Solutions, Ground Floor, Kings Ride Court, Kings Ride, Ascot, SL5 7JR
Issue Date:	18 Oct 2022
Valid Until:	17 Oct 2032 (unless superseded by a later certificate)
Related Party Disclosure:	Not related to the owner

Recommendations for improving the energy performance of the building are contained in the associated Recommendation Report: 7637-8426-1415-5618-1554

About this document and the data in it

This document has been produced following an energy assessment undertaken by a qualified Energy Assessor, accredited by CIBSE Certification Limited. You can obtain contact details of the Accreditation Scheme at www.cibsecertification.com.

A copy of this certificate has been lodged on a national register as a requirement under the Energy Performance of Buildings Regulations 2012 as amended. It will be made available via the online search function at www.ndepcregister.com. The certificate (including the building address) and other data about the building collected during the energy assessment but not shown on the certificate, for instance heating system data, will be made publicly available at www.opendatacommunities.org.

This certificate and other data about the building may be shared with other bodies (including government departments and enforcement agencies) for research, statistical and enforcement purposes. For further information about how data about the property are used, please visit www.ndepcregister.com. To opt out of having information about your building made publicly available, please visit www.ndepcregister.com/optout.

There is more information in the guidance document *Energy Performance Certificates for the construction, sale and let of non-dwellings* available on the Government website at: www.gov.uk/government/collections/energy-performance-certificates. It explains the content and use of this document and advises on how to identify the authenticity of a certificate and how to make a complaint.

Opportunity to benefit from a Green Deal on this property

The Green Deal can help you cut your energy bills by making energy efficiency improvements at no upfront costs. Use the Green Deal to find trusted advisors who will come to your property, recommend measures that are right for you and help you access a range of accredited installers. Responsibility for repayments stays with the property - whoever pays the energy bills benefits so they are responsible for the payments.

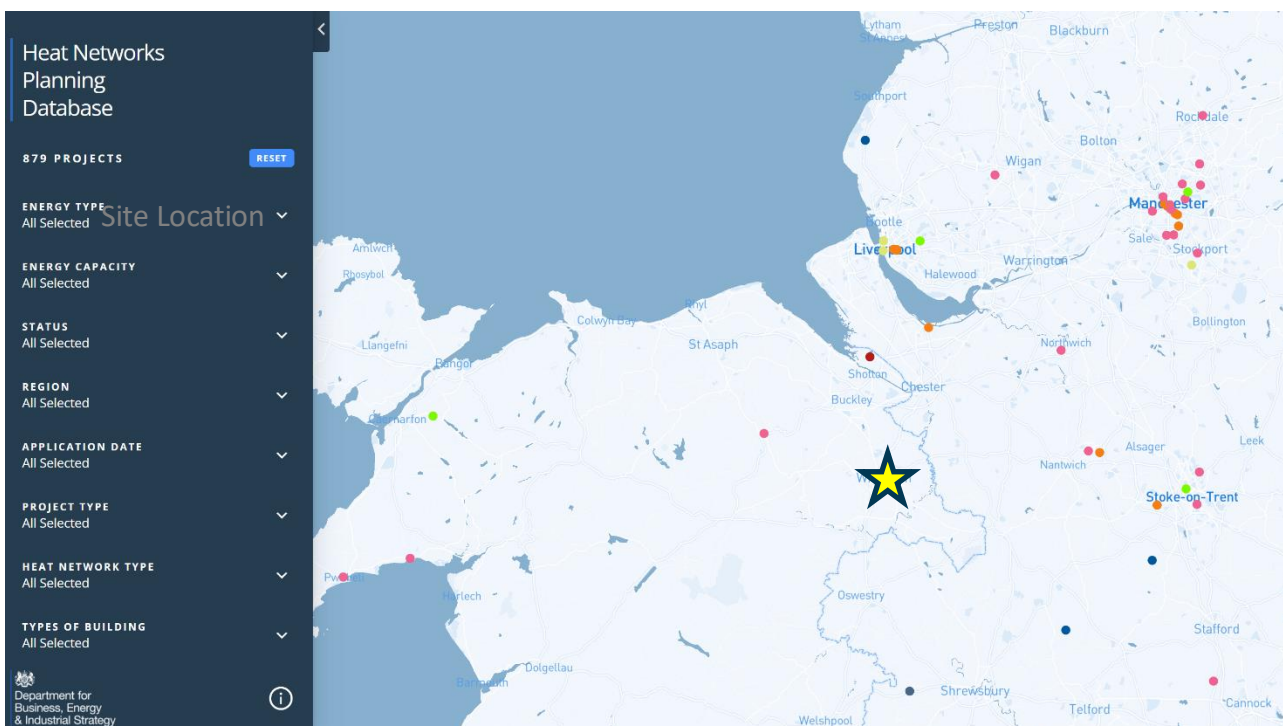
To find out how you could use Green Deal finance to improve your property please call 0300 123 1234.

Decentralised Renewable Low Carbon Energy – ‘Be Clean’

https://data.barbour-abi.com/smart-map/repd/beis/?type=heat_network

In accordance with ‘The Energy Hierarchy – Be Clean’ we have carried out a review of available resources and Heat Map tools has been used to determine if there are any existing or proposed district heating schemes in close proximity for the development.

From the maps and information received, there is no suitable existing communal or district heating scheme in close proximity to the site at this time, the nearest being ‘Shotton (21 miles)’ or ‘Ruthin (23 miles)’ However regardless of this the current building heat demand is very low as the ‘Treated’ areas of these types of building typically make up only 3-5%% of the gross building areas, therefore connection to any Heat Network would not offer any significant carbon saving.



On Site Renewable – Low Carbon Energy – ‘Be Green’

To achieve compliance with the latest now current Part L Building Regulations Renewable Energy Generation will be provided. This will likely be a roof mounted Solar Thermal or Photovoltaic Arrays. The details will be confirmed at the Detailed Design Stage . Details of the arrangement of solar panels can be secured via a suitably worded planning condition.

Appendix A

Renewable Energy Generation Technologies Overview

Renewable Energy Generation Technologies Overview							
Technology	Characteristics	Functionality	Cost Effectiveness	Reliability	Maintenance Requirement	CO ₂ Saving Potential	Suitability for this project Suitability is explored in more detail in Appendix B on a technology by technology basis
Absorption cooling	Requires no mechanical vapour compression. Activated by external heat source	High. Waste heat from CHP source used to provide cooling source for air conditioning	Medium. More expensive than conventional chillers but uses waste heat	High. Few moving parts	Low	Medium - High	Low
Biomass	Uses plant-derived organic material (relatively carbon neutral). Can produce heat or biogas depending on the type of technology	Uses plant-derived organic material (relatively carbon neutral). Can produce heat or biogas depending on the type of technology	Medium. More expensive than conventional boilers	High for direct combustion systems. Anaerobic digestion and gasification systems can be problematic	Medium/high Direct combustion systems are partially self cleaning	High	Low
CHP (Combined Heat & Power)	Generates both electricity and heat using fossil or renewable fuels	High. Requires predictable and relatively constant loads for best performance	Medium. Requires full utilisation of waste heat	Medium. Proven technology	Medium. Requires regular planned maintenance	Medium. Can be improved if biomass fuel is used	Low
Fuel Cells	Potential CO ₂ savings can be improved if biomass is used to generate the fuel	High, same as CHP	Low. Limited range of commercially available fuel cells, and expensive	Emerging Technology therefore unknown	Medium. Few moving parts. Fuel cell stack has finite life	Low	Low

Renewable Energy Generation Technologies Overview							
Technology	Characteristics	Functionality	Cost Effectiveness	Reliability	Maintenance Requirement	CO ₂ Saving Potential	Suitability for this project
Grey Water Recovery	Reuses waste water (bathing, washing, laundry) for toilet flushing, irrigation, and other non-potable uses	Medium. Requires match between waste water source and use	Low. Installation and on-going costs may not justify savings	Medium. Pumps, filters, and sensors can present problems	Medium. Requires planned maintenance regime to cover health risks	Low	Low
Ground source systems – air	Uses heat from the ground to pre-condition the supply air to a building	High. Can pre-cool air in summer and pre-heat it in winter	Medium. Depends on cost of drilling or excavation to install pipes	High, no moving parts	Low. Providing steps are taken to pre-filter air and avoid water ingress	Medium	Low
Ground source systems – water	Makes use of water from aquifers (either directly or indirectly) to provide cooling in summer	High. Can be combined with heat pump technology. Heat source can pre-heat ventilation air	Medium. Depends on cost of boreholes.	High. However, open-loop systems are susceptible to blockages and biological fouling	Low for closed-loop systems	Medium	Low
Ground source heat pumps	Takes up heat from ground and releases it at higher temperatures. Heat can be used for space heating and domestic hot water	High. Systems can be run in cooling mode	Medium	High. Relatively few moving parts. Proven technology	Low	Medium. High Coefficient Of Performance dependant on relatively low supply temperatures in heating mode	Low

Renewable Energy Generation Technologies Overview							
Technology	Characteristics	Functionality	Cost Effectiveness	Reliability	Maintenance Requirement	CO ₂ Saving Potential	Suitability for this project
Photovoltaics	Converts sunlight directly to DC electrical power. Requires inverter to convert to AC	Medium. Requires careful positioning for optimum performance. Wide range of installation options	Low. However, costs are predicted to improve	Medium. Associated inverters can cause problems	Low, but specialist	Low. Relative to high cost	High
Rainwater recovery	Collects and stores rainwater from roofs and other catchment areas for toilet flushing	Medium. Requires a balance between collected water and its use. Large storage tanks may be required	Low. Installation and on-going costs may not justify savings	Medium. Pumps, filters, and sensors can present problems	Medium. Requires inclusion in a planned maintenance regime	Low	Low
Solar air heating	Collects solar energy to heat supply air. Can also heat re-circulated air	Medium. Relatively large number of techniques. Can also pre-heat domestic hot water	Medium. Solar collectors can be an integral part of the building fabric	High	Medium. Solar collectors can be an integral part of the building fabric	Low – medium. Requires fan power, however this could be provided by photovoltaics	Low

Renewable Energy Generation Technologies Overview							
Technology	Characteristics	Functionality	Cost Effectiveness	Reliability	Maintenance Requirement	CO ₂ Saving Potential	Suitability for this project
Solar Cooling	Solar thermal energy used to drive absorption, adsorption or desiccant cooling	Medium. Requires matching of solar collector temperature with chiller operating temperature.	Low. Relatively high cost of absorption chillers and solar collectors	High	Low. Absorption chiller is low maintenance	Low-Medium	Low
Solar water heating	Solar energy used to heat water, usually for domestic hot water purposes	Medium. Proven technology with a range of collectors for different operational requirements	Medium	Medium – high. Circulation pump and valves are relatively reliable	Low	Medium. Circulating pumps can be PV powered	Medium
Surface water cooling	Uses pumped water from the sea, lakes or rivers to provide a cooling medium	Low. Relatively few buildings close to suitable water sources	Low – medium. Depends on the length of piping required	Medium – high. Filtration required to prevent heat exchanger fouling	Low	Medium. Depends on the pumping power required	Low

Renewable Energy Generation Technologies Overview							
Technology	Characteristics	Functionality	Cost Effectiveness	Reliability	Maintenance Requirement	CO ₂ Saving potential	Suitability for this project
Water Conservation	Methods of reducing water usage by specification of water using/controlling devices	Can depend on the pumping power required. Can be used in a wide range of applications and building types	Medium. Depends on device	Generally reliable, but some devices may be susceptible to hard water	Low – medium. Waterless urinals require regular and correct maintenance	Low	High
Wind	Turbine/ generator converts wind energy to electrical power	Best performance in open, non-urban locations. Can be installed on, or integrated into, a building	Low. Depends greatly on available wind conditions. Actual power output likely to be much less than the rated output	Medium. Turbulent air conditions associated with urban locations may reduce lifespan of components	Medium. Requires regular maintenance. Access may be an issue	Low – medium. Large sized turbines in non-urban or off-shore locations will be more effective	Low
Natural ventilation	Openable vents to allow purging of hot air and to allow fresh cooler air to enter.	Can be used in warehouses or offices. If they are roof mounted then rain sensors will be required and vents cannot be placed above stock.	May use smoke vents by addition of manual controls. Otherwise expensive to install if not already present. More builderswork.	Generally reliable. Rain sensor will need to be regularly checked.	Medium. Access required onto roof.	Medium	Low

Appendix B

Detailed Review of All Renewable Energy Generation Technologies

Absorption Cooling		
Absorption cooling can be considered as an alternative to traditional chillers if one of the following factors applies:	Comment on Suitability for this project	Potential for this project
If an existing combined heat and power (CHP) unit is present and not all of the waste heat is being used	No existing CHP present	Low
A new CHP installation could considered	CHP is best utilised where there is a requirement for a constant heat source e.g. large hot water use, swimming pools etc. CHP will not be suitable as there is no constant heat requirement, in which case Absorption Cooling unlikely	
Waste heat is available from a process	No significant waste heat available from processes – prospective tenant processes are unknown	
Renewable fuel sources can be used such as landfill gas.	Site Specific – none available	
The available heat source will determine the type of absorption chiller that is suitable for a specific application. Typical sources of heat include:		
Gas turbine CHP	Not applicable	
Reciprocating engine CHP	Not applicable	
Waste heat	None available - as usually associated with building process	
Hot water and steam.	None available - as usually associated with building process	

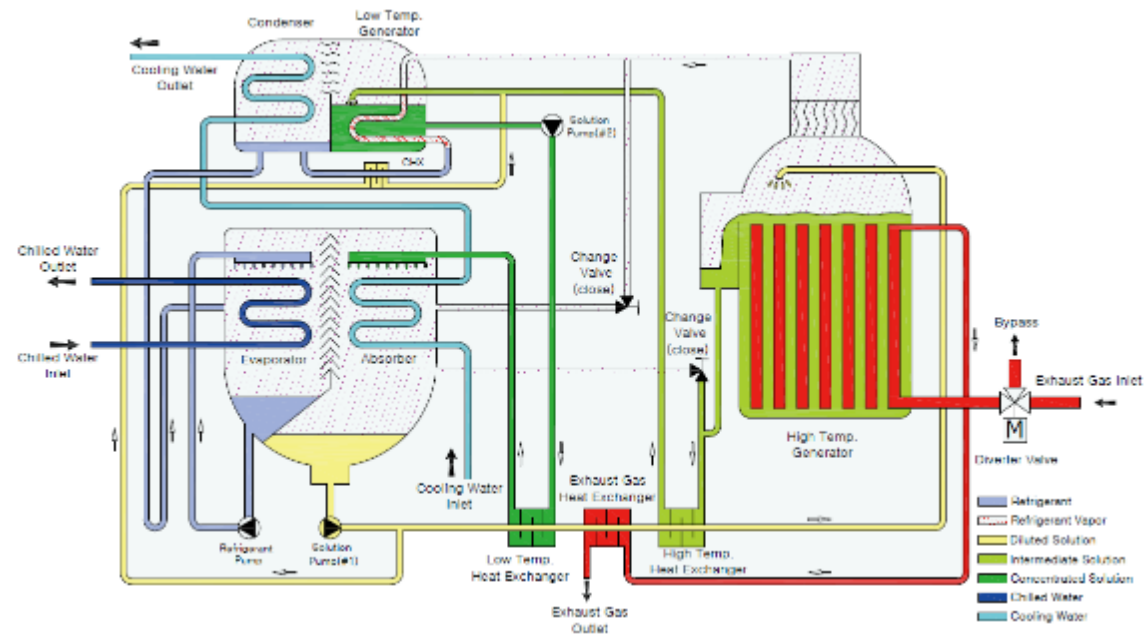
Absorption Cooling

Benefits

- Can make use of waste heat
- Refrigerants used have no global warming potential
- Quiet and vibration-free
- Reliable
- Relatively low maintenance costs

Limitations

- Low efficiency, and low coefficient of performance compared to conventional chillers
- Relatively high cost compared to vapour compressors
- Larger heat-rejection plant than conventional chillers
- Slower to start up and slower to respond to changing loads



In a conventional vapour-compression chiller an electric motor is used to drive a compressor. In an absorption chiller a heat source drives the cooling process. Heat sources can include hot water, steam, hot air or hot products of combustion (exhaust gases) from the burning of fuel.

Allied technologies

- CHP
- Industrial processes producing waste heat
- Renewable sources producing heat

Biomass		
Biomass can be considered as an alternative to traditional Boilers if the following applies	Comment on Suitability for this project	Potential for this project
Ideally a consistent requirement for a steady heat load is present	Biomass is best utilised where there is a requirement for a constant heat source e.g. large hot water use, swimming pools etc. as boilers are not efficient at modulating loads This development does not have a requirement for constant heat	Low
Sustainable ethical Biomass fuel source is available e.g. • Wood • Wood pellet • Wood chip • Vegetable oil • Bioethanol • Biogas • Biodiesel	Not investigated as technology not suitable for this development	
Renewable fuel sources can be used such as landfill gas or anaerobic digestion.	Site Specific – none available	
Space available for fuel transportation and storage	Space is available	
Can meet the demand of sustainability targets and local legislation with regard to NOx emissions	UK Government NOx emission targets are getting more stringent and on-site combustion is being discouraged in lieu of green electricity	
Increased maintenance Maintenance of biomass boilers is significant – near daily	Will be required as part of the maintenance regime	

Biomass
Benefits
Biomass-fuels can be used to produce energy on a continuous basis (unlike renewables such as wind or solar energy)
Biomass can be an economic alternative to fossil fuels
Biomass is a potential source of both heat and electricity
Biomass technology is flexible and scaleable, from a single boiler to a power station
Limitations
Biomass fuels have a lower energy density compared to fossil fuels
Biomass systems have particular design management and maintenance requirements associated with sourcing, transportation and storage
Biomass can be less convenient to operate than mains-supplied fuels such as natural gas
Slower to start up and slower to respond to changing loads
Biomass systems are more management intensive and require expertise in facilities management
Sources of biomass can fluctuate, so boilers should be specified to operate on a variety of fuels without risk of overheating or tripping out
Use of land for growing fuel is questionable
Any form of on-site combustion will need to comply with increasingly stringent Gov/Local Authority emissions criteria



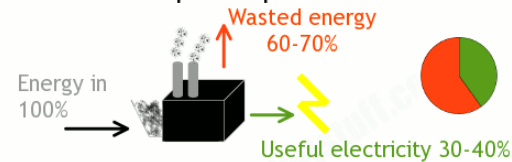
System description

Biomass is any plant-derived organic material that renews itself over a short period. Biomass energy systems are based on either the direct or indirect combustion of fuels derived from those plant sources. The most common form of biomass is the direct combustion of wood in treated or untreated forms. Other possibilities include the production and subsequent combustion of biogas produced by either gasification or anaerobic digestion of plant materials. Liquid biofuels such as bioethanol can also be used. The use of biomass is becoming increasingly common in some European countries (some countries such as Austria are heavily dependent on biomass). The environmental benefits relate to the significantly lower amounts of energy used in biomass production and processing compared to the energy released when they are burnt. This can range from a four-fold return for biodiesel to an approximate 20-fold energy return for woody biomass.

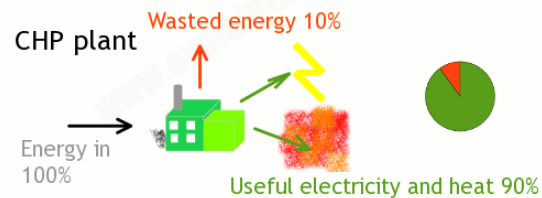
CHP Combined Heat & Power (CHP)		
CHP can be considered either as an alternative or supplementary to traditional mains fed gas and electricity for heat and power	Comment on Suitability for this project	Potential for this project
A consistent requirement for a steady electricity base load and heat load is present	CHP is best utilised where there is a requirement for a constant heat source e.g. large hot water use, swimming pools etc CHP is not suitable for this project in which case Absorption Cooling also not suitable	Low
The hot water produced by a CHP unit can be used for a range of applications in buildings. These include: • Space heating • Domestic hot water for washing and cleaning uses • Water heating of swimming and leisure pools • Space cooling using absorption cooling	Circa 3 - 5% of the building area is treated (heated) therefore CHP is not suitable	
Efficiency will be optimised if the CHP unit can be heat-led, and the generated heat is maximised	Technology not suitable	
Renewable fuel sources can be used such as landfill gas.	Site Specific – none available	
Typical units are Gas turbine CHP	Suitable gas supply is not available on-site without infrastructure upgrade	
Can meet the demand of sustainability targets and local legislation with regard to NOx emissions	Any form of on-site combustion will need to comply with increasingly stringent Gov/Local Authority emissions criteria, this technology is generally being discouraged	
Increased maintenance	Will be required as part of the maintenance regime	

CHP
Combined Heat & Power
Benefits
Can produce electricity and heat
Can be powered using biofuels
High operating efficiencies can be achieved if heat generated is fully utilised
Can improve the quantity of the mains power supply by stabilising supply currents and voltages and providing independent supplies
Provides a continuous supply of electricity
Heat generated can be used to power absorption chillers
Limitations
Requires predictable and relatively constant loads for optimum performance
Requires full use of generated heat for optimum efficiency
Biomass can be less convenient to operate than mains-supplied fuels such as natural gas
Requires regular planned maintenance
Rarely installed to provide electricity or heat exclusively (usually provides heat load)
Typically, to be cost-effective, CHP systems will require to be operated for a minimum of four to five thousand hours per annum

Conventional power plant



CHP plant



System description

Combined heat and power (CHP), also known as co-generation, is the simultaneous generation of both usable heat and electrical power from the same source. CHP systems can be used in applications where there is a significant year-round demand for heating in addition to the electricity generated. A CHP unit comprises an engine (referred to as the prime mover) in which fuel is combusted. The mechanical power produced by the engine is used to generate electricity using an integral electrical generator. The heat emitted from the engine (waste heat) is used to provide space heating or domestic hot water. The waste heat can also be used to provide space cooling when passed through an absorption chiller.

Fuel Cells		
Fuel can be considered either as an alternative or supplementary to traditional mains fed electricity	Comment on Suitability for this project	Potential for this project
Fuel; Cells can operate in parallel with the local utility while supplying power to a building's power distribution system. Maximum efficiency will be achieved when all the output from the fuel cell is used, and when mains power is only used for peak demands	Fuel Cells are not current standard product	Low
Heat is generated as part of the fuel cell operation which could be used within the building/services The grade of heat depends upon the type of cell	Subject to tenant energy use profiles	
Fuel cell dimensions, coupled with free space requirements, will dictate the area required for a fuel cell installation. Fuel cells vary in size, but they are not small. As an example, commercial 200 kW phosphoric-acid fuel cells measure 3.0 m by 5.5 m with a 2.4 m spacing requirement on each side.	Subject to tenant site planning	
Relatively new technology for use in buildings	Technology being refined for use in commercial projects, use in mainstream cars now available e.g. Toyota Mirai	
Source of hydrogen gas	Ideally fuel cells should be powered by hydrogen production as a by-product of the site operation otherwise the hydrogen gas will have to be transported to site which currently has limited opportunity within the UK	

Fuel Cells
Benefits
Direct energy conversion (non-combustion)
No moving parts in the fuel-cell stack
Quiet operation. When compared with similar systems, such as CHP based on internal combustion engine technology, fuel cells are significantly quieter, enabling them to be positioned adjacent to occupied areas
Siting ability. Due to the reduced noise and emissions, compared with internal combustion engine CHP for example, fuel cells can be sited closer to the building. This enables shorter pipe runs for the services from the fuel cells
Fuel flexibility
Good performance at part load
Modular installation to match load and increase reliability
Suitable for remote/unattended operation



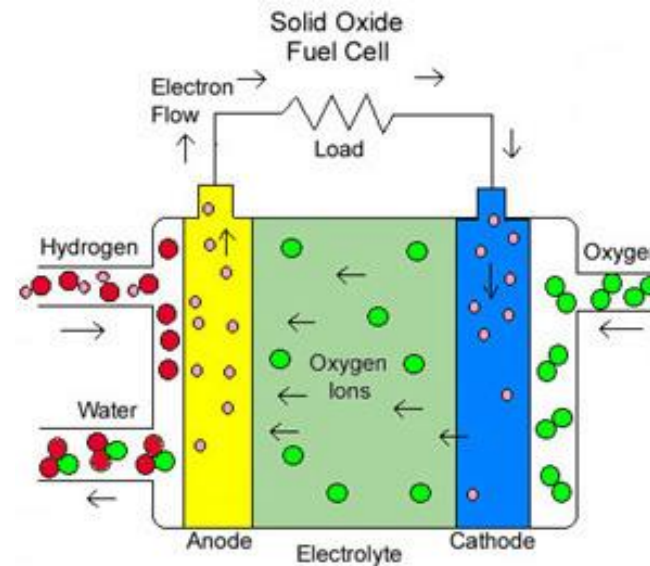
Fuel Cells
Limitations
High market entry cost. As the technology improves and becomes more commercially mature, so costs will fall and be less of a disadvantage. Fuel cells can be compared with current CHP units. While CHP is an ideal application for fuel cells, standard CHP units are not cheap (in terms of capital cost) and fuel cells are significantly more expensive. So cost will be an issue for some time to come
Unfamiliar technology. The need for infrastructure grows with greater uptake of the technology. All new technology causes problems, but with greater uptake the technology will become more familiar and systems will be put in place to cater for fuel cells
No infrastructure. There is no hydrogen infrastructure in the UK, although there is a very good natural gas infrastructure hence the majority of fuel cells are operated using natural gas. Currently limited expertise available to maintain
High maintenance cost. This is partially due to the technology being new; in the future this would be less of an issue
Short stack life. Much development work is in progress to increase the life of the stack
Sensitivity to pollutants - very small quantities of carbon monoxide or sulphur have the potential to cause failure of the fuel cell stack

Fuel Cell System description

A fuel cell is an electrochemical device that converts the chemical energy of a reaction into electrical energy, with heat produced as a by-product.

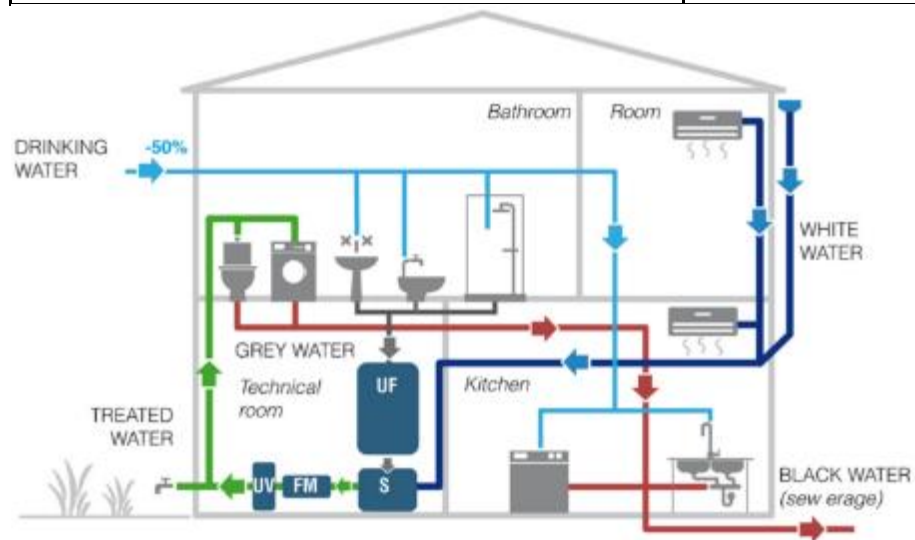
The basic components of a fuel cell are an electrolyte, an anode, and a cathode. Gaseous fuels are fed continuously to the anode while an oxidant (oxygen from the air) is fed continuously to the cathode. The anode and cathode are separated by the electrolyte. Ions flow through the electrolyte between the anode and cathode. Electrons generated at the anode flow through an external load to the cathode, completing the electrical circuit. Although all forms of fuel cells use similar technologies, there are differences between the various types.

The primary fuel source for fuel cells is hydrogen. This can be obtained (using a reformer) from a wide range of fuel supplies including natural gas, coal gas, methanol, landfill gas, biogas and other fuels containing hydrogen

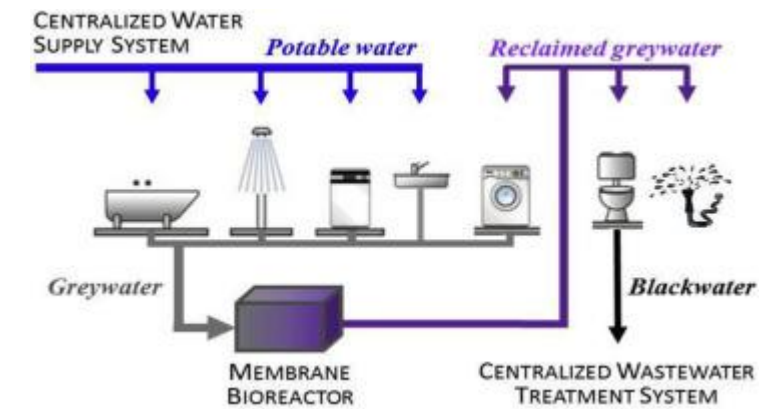


Grey Water Recovery

Grey Water can be considered either as supplementary to traditional mains fed water for certain limited applications	Comment on Suitability for this project	Potential for this project
Grey Water is water recovered on-site from water already used for; • Washing • Bathing/Shower • Laundry • Other water process	Hand wash only on this project	Low
Grey Water can be collected, stored and treated, then used for toilet flushing or irrigation of non-edible plants.	Insufficient grey water turnover requirement	
Increased maintenance	Will be required as part of the maintenance regime	



Grey Water Recovery
Benefits
Re-use of waste water for toilet flushing and other non-potable uses
Can be used for single building or communal schemes
Wide range of water filtration techniques available
Limitations
Greywater must be treated before use
Greywater must not be stored for more than 24 hours untreated and for not more than three days after treatment
Providing sufficient greywater storage capacity may present problems
More suited to new build applications than retrofit
Installation and on-going costs may not justify savings
Pumps, filters and sensors can present operational problems



Ground Source Systems - Air		
Ground Source Systems - Air can be considered as supplementary to traditional heating and cooling system	Comment on Suitability for this project	Potential for this project
Also referred to as; • Earth Coupled Systems • Earth Tubes • Earth ducts	Circa 3 - 5% of the building area is treated (cooled) therefore technology is not suitable – no measurable difference over Air Source Heat Pumps for this size type of building arrangement	Low
Can be constructed from prefabricated piping/ductwork, cement, cement fibre, steel, or plastics	Not applicable	
Significant amount of underground infrastructure required to achieve savings.	Calculation and cost comparisons will be required Energy use profile does not warrant the system	

Ground Source Systems - Air	
Benefits	
Can pre-heat air in winter and pre-cool air in summer	
Reduces or negates need for mechanical cooling – mechanical cooling may still be needed in addition to this system	
Reliable – few (if any) moving parts	
Low maintenance requirements, providing steps are taken to pre-filter air and avoid water ingress	
Limitations	
Costs of excavation in order to install pipes may be prohibitive	
Water penetration may be an issue if the design and installation of the system is not correct	
Sufficient space is required for the buried pipes	



System description

Ground-coupled air systems are primarily used for pre-conditioning outdoor-air prior to heating and cooling. Ground-coupled air systems can comprise a length of piping placed underground, often under the foundations of the building. The piping is connected to an outdoor air intake within the site boundary and to the building ventilation system at the other end. During the summer, heat-transfer to the surrounding ground cools warm outside-air, while during the winter, cold outside-air is warmed. The cooled air can also be used for cooling the building's thermal mass within the building structure. The cooling/heating effect provided by the thermal mass of the ground can significantly reduce (or even remove) the need for mechanical cooling or space heating. However, temperature control within the building is not always possible.

Ground Source Systems - Water		
Ground Source Systems - Water can be considered as supplementary to traditional heating and cooling system	Comment on Suitability for this project	Potential for this project
A water source is required, typically an underground aquifer, or a river or lake.	Circa 3 - 5% of the building area is treated (heat/cooled) therefore technology is not suitable – no measurable difference over Air Source Heat Pumps for this size type of building arrangement	Low
A license is required to extract water from the source and return it after passing through the heat exchanger.	Local Statutory Authority licenses have to be renewed on an annual basis and could be withdrawn at any time – therefore significant risk	
The water can be used to provide heat (heat source) or to provide cooling by rejecting heat (heat sink)		
A large number of boreholes may be required when using aquifers.	Calculation and cost comparisons will be required Dependent upon Building User energy use profiles	

Ground Source Systems - Water

Benefits

Cool water from aquifers can be used to provide cooling.

Reduces or negates the need for mechanical cooling.

Can be combined with heat pump technology.

Low grade heating/cooling to the building can be provided directly, or used to reduce energy when producing higher temperatures (e.g. domestic hot water).

Limitations

The water source or favorable ground conditions may not be available.

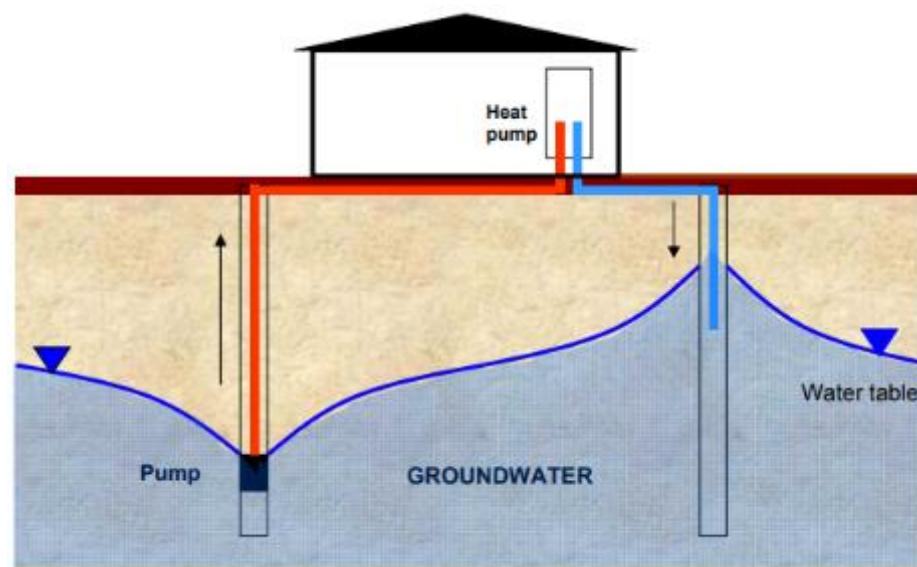
Borehole costs may be high.

Consents and/or licenses are required.

Consequences of a leak into the water source causing environmental damage can be serious.

There are risks of biological fouling, blockages or silting up.

Ground conditions may change, affecting quality and quantity of water available.



System description

Ground water cooling through the use of aquifers makes use of the relatively stable ground/water temperature. Aquifers are water-yielding rock strata, either in unconsolidated (gravel, sand and other friable rocks) or consolidated permeable or porous rocks. At a depth of around 50 m the ground temperature is approximately the same as the mean ambient air temperature (11-12°C). The cold water in aquifers can be used to provide space cooling within buildings or as a source of heat for preheating ventilation air. Water from aquifers can be pumped directly or indirectly to cooling systems and used as a heat source or sink for heat pumps.

Water sources may also be obtained from rivers, lakes or the sea (see Surface Water Cooling later in this report).

Ground Source Systems		
Ground Source Systems - can be considered as supplementary to traditional heating and cooling system	Comment on Suitability for this project	Potential for this project
A large area is required for the buried pipes.	Circa 3 - 5% of the building area is treated (heat/cooled) therefore technology is not suitable – no measurable difference over Air Source Heat Pumps for this size type of building arrangement	Low
Significant amount of underground infrastructure required to achieve savings.	Calculation and cost comparisons will be required	

Ground Source Systems
Benefits
Can be used for space heating or cooling, and to reduce energy consumption for domestic hot water.
Reversible to provide cooling.
Relatively few moving parts, no exposure to weather – high reliability.
Proven technology.
Long life expectancy – equipment up to 25 years, coils up to 50 years.
Low noise (no external condensers).
Limitations
Achieving high Coefficient Of Performance/Energy Efficiency Ratio will only provide relatively low temperatures in heating mode.
The cost of installing the ground pipes may be high.
A lot of space is required for the ground pipes.
Ground conditions may not be suitable.
Most effective heating mode (high COP) when used with underfloor heating or low temperature radiators.



System description

Ground-source heat pumps (GSHP) extract or reject heat from/to the ground using a closed loop water coil, using the year-round stable temperatures below ground (>2m deep) as a heat source (heating mode) or heat sink (cooling mode). The water is used in a heat exchanger, or may be used as the heat source/sink for a heat pump system. They are classified as either water-to-air or water-to-water units depending on whether the heat distribution system in the building uses air or water.

Photovoltaics		
Used to generate electricity from solar radiation	Comment on Suitability for this project	Potential for this project
A large area is required for the solar PV panels, typically 7-8m ² per 1kW. Approximately 750kWh will be generated per annum per 1kW of installed PV.	The building end users are currently unknown but likely that a significant proportion of building services will be electric, therefore PV is compatible	High
The local electricity network will need to be assessed by the DNO to ensure they can accept the connection of the solar PV generation.	Given size of array and building load it may not be beneficial to connect to grid, consideration during detailed design stage required	
If roof-mounted panels are proposed then the roof structure needs to be sufficiently strong to support the weight. Personnel access and safety at roof level needs to be considered.	Roof mounted is most likely.	
Flat roofs (or near-flat) allow the best aiming of solar PV arrays typically 20-30 degrees.	A typical warehouse roof is suitable, particularly when designed from new so that the PV roof loading can be considered	

Photovoltaics
Benefits
Wide range of installation options – roof-mounted, ground mounted, facades or solar shading.
Can be connected to the building electrical installation to offset costs of importing electricity.
Low maintenance.
May be used in conjunction with electricity storage systems.
Limitations
Space is required for the system, and roof mounted systems require sufficiently strong structure and safe access arrangements. Requires the correct angle/positioning.
Most effective use is when the system is tailored to the building load.
Inverters may cause reliability issues so access should be considered
Approval is needed from the DNO if grid connected or not isolated
Relatively high cost.
PV panels may require regular cleaning.
CO ₂ saving has reduced in recent years as the grid electricity becomes “greener”.



System description

Photovoltaic (PV) modules convert sunlight directly to D.C. electricity. The solar cells consist of a thin piece of semiconductor material, in most cases using silicon, mounted in a weatherproof panel and attached to mounting frames. The PV panels are arranged in an array, at the optimum angle to collect as much daylight.

The D.C. output of the PV panels is converted to A.C.. mains voltage and connected to the building's electrical distribution system.

The electrical energy generated is consumed by the building and any surplus can be exported to the external electricity grid.

Rainwater Recovery Systems		
Comment	Comment on Suitability for this project	Potential for this project
Rainwater can be collected for uses where clean water is required but is not used for consumption.	Large roof area and new construction makes this technology feasible However low water consumption anticipated dictate other water efficiency measures are more suitable	Low
Rainwater is typically collected from the roof where it is cleaner, but may also be collected from ground level.		

Rainwater Recovery Systems

Benefits

The use of rainwater for flushing and washing, irrigation and vehicle cleaning reduces the consumption of treated water.

May reduce surface water run-off and risk of flooding.

Limitations

The water is non-potable.

The collected water requires filtration and treatment. Roof condition will affect quality of water available.

Large storage tanks may be required.

The system requires maintenance to pumps, filters and sensors. Regular cleaning is required to remove debris to prevent contamination.



System description

Rainwater can be collected from rooftops where there is less contamination and stored for a range of applications such as flushing toilets, washing machines, irrigation, cleaning vehicles, etc.

Storage tanks may be below or at ground level, relying on pumps, or at high level and relying on gravity.

Pumped systems either transfer the water to a header tank which acts as a gravity feed, or directly pump the water in a pressurised system.

The water is filtered and treated (e.g. ultraviolet sterilisation).

A mains water supply is still required to top up the tanks in periods of low rainfall.

An overflow drain is required for excess.

Header Tank Systems
Benefits
High reliability – water is provided by gravity if the pump fails, with top-up from mains water when running low.
Low cost pump and controller only required to keep header tank topped up.
Energy efficient – pump only runs when needed, at full flow.
Limitations
Low pressure if insufficient header tank height – WCs cisterns may fill slowly.
Space required for header tank.
Not a large range of suppliers for this type of system.

Direct Pumped Systems
Benefits
Good pressure.
Space not required for header tank.
Limitations
Water supply to WCs, washing, etc is not available if the pump fails.
Mains top-up controls can be complicated.

Solar Air Heating Systems		
Comment	Comment on Suitability for this project	Potential for this project
The ideal orientation for a solar air-heating system is due south as this provides maximum potential solar gain. However, a south-east or south-west orientation will also provide worthwhile solar gain	With a large roof area solar air heating is feasible albeit the development has a low heat/hot water demand This may change subject to tenant requirements, therefore space has been allocated for this technology	Low

Solar Air Heating Systems

Benefits

Due to low thermal inertia of air (compared to water) the solar collectors can heat up quickly even with low levels of solar radiation.

The collectors can provide thermal buffering between the internal and external conditions.

Limitations

Low heat capacity of air means that thermal storage has to be achieved indirectly— either through the building fabric or a dedicated thermal store.

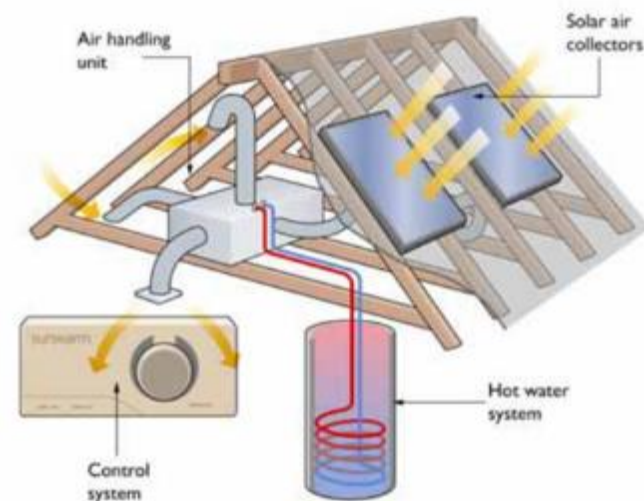
Poor heat transfer between the collector and the air.

A large volume and airflow rate are required, requiring electrical power to operate the fans.

They only work in direct sunlight, limiting the locations available. Facing due south is best, although south-east or south-west will also provide benefit.

They do not work at night or in poor weather, so an alternative heating system is still required.

Roof access and personnel safety needs to be considered. Additional roof loading.



System description

Solar air systems collect solar energy to heat air. The air can be used to pre-heat ventilation air, heat air inside a building, or to heat water. A basic system comprises a solar collector and a hot air distribution system. Solar air systems can also incorporate thermal storage using either the thermal mass of the building or dedicated thermal stores, such as a rock store. The solar collectors can be purpose-built panels or a glazed cavity over an existing façade.

Solar Cooling Systems		
Comment	Comment on Suitability for this project	Potential for this project
There are three main type of solar cooling: absorption, adsorption and desiccant. All rely on the use of a solar collector to provide a heat source to drive the cooling process.	With a large roof area solar air heating is feasible albeit the development has a low heat/hot water demand	Low

Solar Cooling Systems

Benefits

Solar thermal energy can be used to drive the cooling process.

Peak building load generally occurs at the same time as peak solar energy is being experienced.

Absorption chillers require low maintenance.

Limitations

Matching of the solar collector temperature and the chiller operating temperature is required. Higher temperatures are required for better performance.

Very limited experience in the UK.

High cost of equipment.



System description

There are three main type of solar cooling: absorption, adsorption and desiccant. All rely on the use of a solar collector to provide a heat source to drive the cooling process.

Absorption coolers require higher temperatures, using evacuated tube or parabolic reflector solar collectors.

Adsorption chillers require lower temperatures and can use cheaper flat plate solar collectors.

Desiccant cooling uses solar heat as part of an overall cooling process using a desiccant wheel in the ventilation system.

Solar Water Heating Systems

Comment	Comment on Suitability for this project	Potential for this project
Solar water heating systems use the energy from the sun to heat water, most commonly for hot water needs (such as washing and cleaning requirements). Solar heating systems use a heat collector that is usually mounted on a roof in which a fluid is heated by the sun. This fluid is used to heat water that is stored in either a separate hot water cylinder or in a twin-coil hot water cylinder (the second coil is used to provide additional heating from a boiler or other heat source).	Low water requirement and circa 3 - 5% of the building area is treated (heat/cooled) therefore technology is not suitable	Low

System description

Solar water heating systems use the energy from the sun to heat water, most commonly for hot water needs (such as washing and cleaning requirements). Solar heating systems use a heat collector that is usually mounted on a roof in which a fluid is heated by the sun. This fluid is used to heat water that is stored in either a separate hot water cylinder or in a twin-coil hot water cylinder (the second coil is used to provide additional heating from a boiler or other heat source).

There are two main types of solar collector: flat-plate or evacuated tube.

The system is installed with a mixture of antifreeze and water circulating through the collectors and a heat exchanger in the domestic hot water tank. The indirectly-heated water in the tank is then supplied to outlets such as taps and showers. A controller compares the temperature of the water in the collectors with the temperature of the water in the cylinder and activates a circulating pump whenever the water in the collectors is hotter. A conventional boiler is used to boost the stored hot water when required.

The energy savings from a solar heating system will depend on a large range of factors. The Energy Efficiency Commitment Scheme bases savings from solar water heating on an average figure of 454 kWh/m² per annum for flat-plate collectors and 582 kWh/m² per annum for evacuated tube systems.

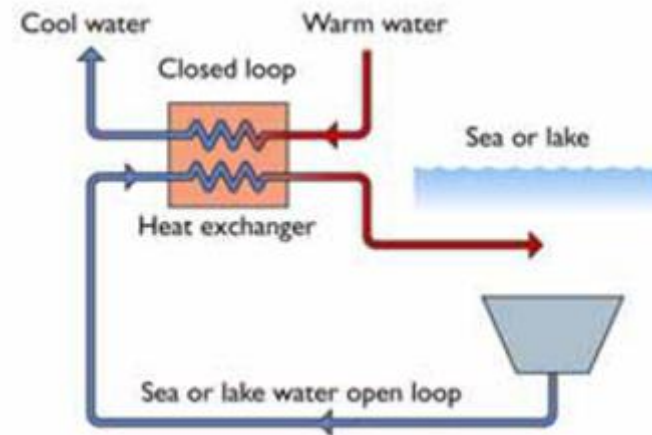


Glazed Flat-plate Systems
Benefits
Simple and robust design.
Well developed technology.
Cheaper than evacuated tube collectors.
Good price to performance ratio.
Wide range of mounting options.
The flat glazed surface is more visually acceptable than the corrugated/ribbed appearance of the evacuated tube collector.
Limitations
Lower efficiency than evacuated tube collectors.
Requires more space than evacuated tube collectors.
Provides lower water temperature than evacuated tube system.
Additional roof loading.
Roof access and personnel safety needs to be considered.
Traditional water heaters are still required for when the system is not working or receiving insufficient energy.

Evacuated Tube Systems
Benefits
Higher temperatures can be achieved than flat-plate collectors.
High efficiencies are possible.
The collectors are smaller and lighter than flat-plate collectors for the same energy collection.
Direct through-flow collectors can be mounted horizontally.
Can produce electricity and heat
Limitations
Potential very high stagnation temperatures which can affect adjacent equipment or building fabric.
More expensive than flat-plate collectors.
Cannot be embedded in the building fabric.
If the evacuated tube system also includes heat pipes then they must be angled at no less than 25° above horizontal.
Additional roof loading.
Roof access and personnel safety needs to be considered.
Traditional water heaters are still required for when the system is not working or receiving insufficient energy.

Surface Water Cooling Systems		
Comment	Comment on Suitability for this project	Potential for this project
Not Applicable as no source available		
		Low

Surface Water Cooling Systems
Benefits
Reduces the requirement for mechanical cooling.
Can be used to pre-heat ventilation during the heating system.
Can be used as a heat source or heat sink for a heat-pump system.
Limitations
Relatively few buildings are close to suitable water sources.
Water needs to be deep enough to provide water that remains sufficiently cool.
Cost of piping may be prohibitive.
Filtration may be required to prevent the heat exchanger from blocking.



System description

Surface water cooling involves pumping water from the sea, lakes or water courses and using it to provide some or all of a building's cooling requirements. Such systems are open loop, where water is extracted, passed through a heat exchanger then returned to the water source. The cooled water from the heat exchanger can be used for a range of cooling purposes:

- Supplying cooling, via a heat exchanger, to fan coils, chilled ceilings or beams, or to a slab cooling system
- To pre-cool return chilled water prior to further cooling by other techniques
- As a source of cooled water for the condenser of a mechanical vapour compression chiller or absorption chiller
- As a heat source or sink for a heat pump.

During the winter the water can be used to pre-heat ventilation air.

Water Conservation Systems		
Comment	Comment on Suitability for this project	Potential for this project
Different methods of reducing water usage are available:	All systems are suitable for use subject to project detailed design	High
• Waterless urinals		
• Spray taps		
• Water-efficient WCs		
• Waterless and vacuum WCs		
• Water saving shower heads		

Water Conservation Systems
Benefits
Reduced water consumption.
Some devices are easy to install (e.g. spray taps, water efficient WCs, waterless urinals, water saving shower heads).
Limitations
Some devices require regular maintenance (e.g. waterless urinal cartridge replacement).

System description

Various devices can be fitted at the point-of-use to reduce the water flow and reduce water usage (e.g. showers or taps) or use less water on each operation (e.g. water efficient WCs).



Wind Power		
Comment	Comment on Suitability for this project	Potential for this project
Space is required for the wind turbine and associated switchgear at the base (large units are normally free standing).	Existing constricted site– not suitable	Low
Planning permission will be required. Proximity to airports or military may prevent installation.		
Agreement must be reached with the electricity networks operator to allow the output of the turbine to be connected to the grid.		
It may be possible to enter an arrangement with an energy company who will build and operate the turbine – the land owner has less responsibility and outlay, but also has a reduced return.		

System description

Wind turbines convert the kinetic energy in wind into mechanical energy that is then converted to electricity. Turbines are available in a range of sizes and designs and can either be free-standing, mounted on a building or integrated into a building structure. There are two basic groups of wind turbines: horizontal-axis design and vertical-axis design.

Horizontal-axis wind turbines are the most common type and can range in size from a few hundred Watts to several megawatts. This type of turbine has a horizontal rotor shaft and generator typically located at the top of a tower. Propeller-type blades are used (usually three, although two can be used) and these are orientated into the wind, using a wind vane (yaw control) for small turbines, or wind sensors used in conjunction with servomotors for larger turbines. Vertical-axis turbines have a rotor shaft orientated vertically. This avoids the need for a tower and the generator is located at ground level. Another advantage is that no yaw mechanism is required to turn the rotor into the wind. The main disadvantages of vertical-axis turbines are that the efficiencies are lower than horizontal-axis turbines and they are not self-starting.

A turbine system will include the following:

- A rotor, or blades, which convert the wind's energy into rotational shaft energy
- A nacelle containing a drive train, usually including a gearbox (some turbines operate without a gearbox)
- A tower to support the rotor and drive train
- Electronic equipment such as controls, electrical cables, ground support equipment, and inter-connection equipment.

Wind turbines can provide electrical power either directly to a load or via a battery system.

Wind Power
Benefits
Allows for on-site generation of electricity.
Can be grid connected.
Turbines can be free standing, building mounted or building augmented.
Limitations
Best performance will be obtained in non-urban locations e.g. off-shore
Actual electrical power generated may be considerably less than the rotated output of the turbine.
Building mounted turbines may create structural, vibration and noise implications.
Potentially damaging air turbulence may be created.
Access for maintenance or replacement of components may be an issue.
Costs can be high in relation to the electricity generated.
There may be environmental or Planning issues.



Natural Ventilation		
Comment	Comment on Suitability for this project	Potential for this project
Can be installed in the roof or walls.	Speculative warehouse cannot predict required environmental conditions for future operator	Low
Allows for “free” cooling by allowing natural ventilation.		

System description

Openable vents are used to allow hot air to escape through natural convection, and cooler external air into the building.

In a warehouse these are normally in the roof or at high level in the walls. Other vents may be required at low level to allow cool air to enter at low level.

These can be automatically controlled, with rain sensors, or manually operated using override switches.

For offices a cross flow path is best , requiring vents at opposite ends of the room.

Systems for offices require more complicated controls to maintain comfortable conditions – they may be best used for overnight purging which limits their use to warmer times of the year.



Natural Ventilation	
Benefits	
Allows for free cooling/purging of hot air.	
Most economical if vent equipment is existing and can be utilised by additional override controls, e.g. smoke venting louvres.	
Very low energy use.	
Limitations	
Additional builderswork and equipment required if not already present (e.g. smoke vents).	
Control is difficult and the system may not provide adequate ventilation rates without supplementary fans, or may allow draughts.	
Needs to be controlled to prevent AC/heating operating at the same time.	
Requires favorable external conditions.	
Access for maintenance or replacement of components may be an issue, requiring roof access.	
Rain sensors required. Vents are best if not positioned over stock/sensitive areas.	
Bird mesh required. Low level vent may require additional security bars.	

