ARUP

WEPCo | Cardiff and Vale Colleges (CAVC)

Barry Waterfront Campus (BWC)

BWC Energy Statement Report

Reference: VG0201-ARP-XX-XX-RP-N-00006

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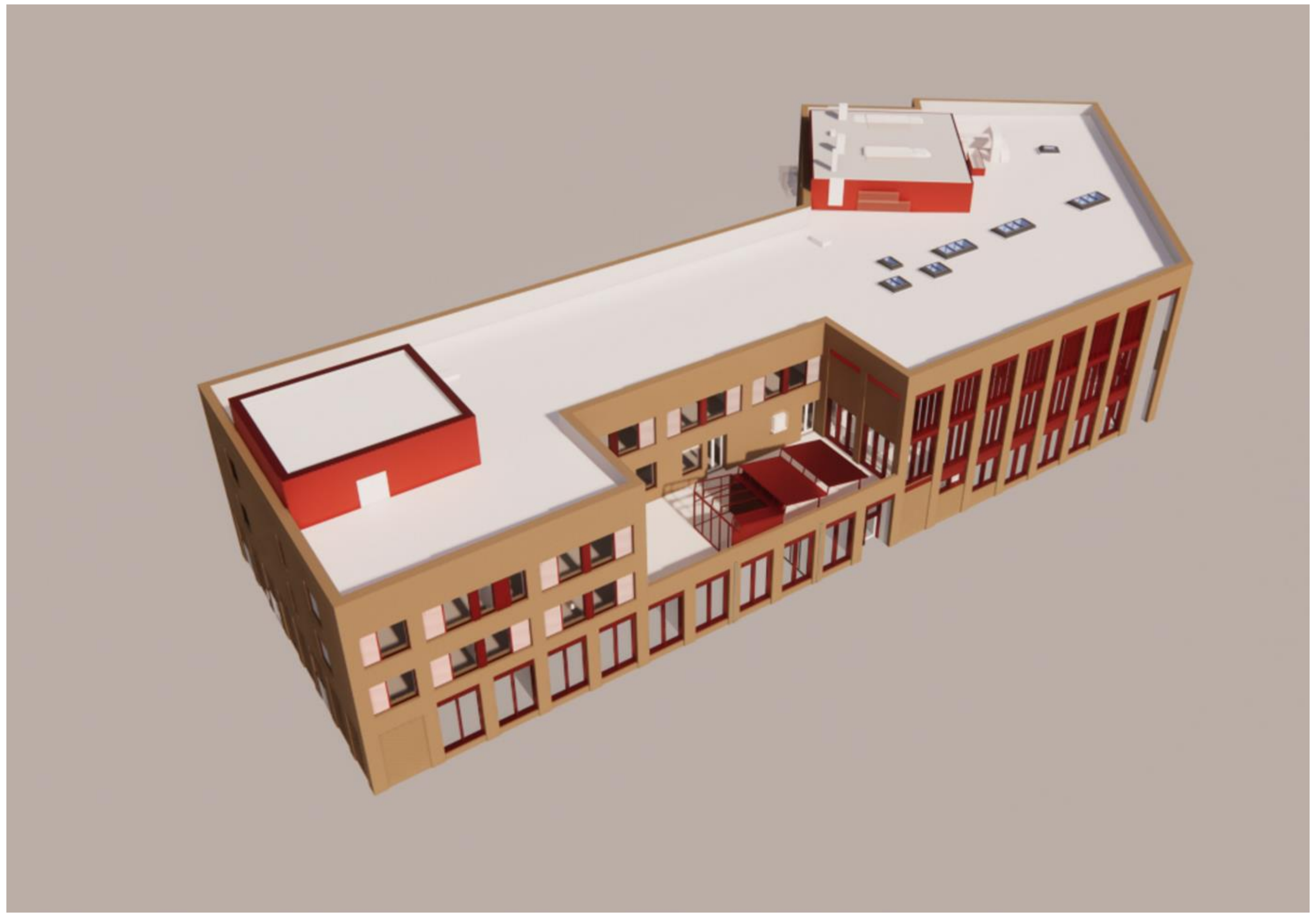

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 287279-00

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1. Introduction

This Energy assessment has been prepared by Arup on behalf of Cardiff & Vale College to provide statements in relation to the design of the new Barry waterfront Centre (BWC) development in Barry. It forms part of the planning application for the site with the aim of informing Vale of Glamorgan Council of the design intent for the building in relation to energy efficiency.

1.1 Development Details

The proposed site for the new Cardiff and Vale College – Barry Waterfront Campus will be located on a new site to the West of Barry Docks off Ffordd Y Mileniwm. The campus will specialise in vocational skills including Hair & Beauty, catering, hospitality, IT, science and arts. The proposed building will also include facilities to support the students and staff during the college day.

The report will refer to this proposed development as BWC.

2. Planning Policy Context

This section provides an overview of the relevant planning policy and guidance from both a national and local perspective.

2.1 Detailed Planning Policy

Section 70(2) of the Town and Country Planning Act 1990 and Section 38(6) of the Planning and Compulsory Purchase Act 2004 require that 'planning applications are to be determined in accordance with the Development Plan unless material considerations indicate otherwise.'

The 'Development Plan' is defined by Section 38(3) of the Planning and Compulsory Purchase Act 2004 as 'the regional spatial strategy for the region in which the area is situated (if there is one) and the development plan documents (taken as a whole) which have been adopted or approved in relation to that area.'

2.2 National Planning Policy

National Planning Policy in Wales includes the following key documents: Planning Policy Wales (PPW), Technical Advice Notes (TANs), Minerals Technical Advice Notes (MTANs) and Policy Clarification Letters (PCLs). The primary objective of these documents is to ensure that the planning system contributes towards the delivery of sustainable development and improves the social, economic, environmental and cultural well-being of Wales, as required by the Planning (Wales) Act 2015, the Well-being of Future Generations (Wales) Act 2015 and other key legislation and resultant duties such as the Socio-economic Duty.

All planning decisions must align with the above documents and decisions must seek to promote sustainable development and support the well-being of people and communities across Wales.

2.3 Practice Guidance (Planning for Sustainable Buildings)

PPW (4.4.3, 4.7, and 4.12) sets out the Welsh Government's land use planning policies in respect of planning for sustainable buildings in development plans and development management. It does not establish a higher national building standard than Building Regulations, but encourages local planning authorities (LPAs) to seek opportunities to do so on strategic sites. TAN 12: Design, is the primary guide to achieving good quality sustainable design.

2.4 Technical Advice Note 12 – Objectives of Good Design

TAN 12 defines five key Objectives of Good Design: Access, Character, Community Safety, Environmental Sustainability, Movement. Environmental Sustainability is defined as "achieving efficient use and protection of natural resources; enhancing biodiversity; designing for change". To achieve Environmental Sustainability in design TAN 12 suggests that developments seek to minimise energy demand and carbon emissions through the implementation of energy hierarchy and zero carbon standards.

2.5 The Development Plan

The Development Plan for the application comprises the following:
- Vale of Glamorgan Local Development Plan 2011 – 2026 – Written Statement (2017); and
- Vale of Glamorgan Local Development Plan 2011 – 2026 – Proposals Map (2017); and
- Vale of Glamorgan Local Development Plan 2011 – 2026 – Constraints Map (2017);
- Future Wales – The National Plan 2040 – National Development Framework (2021)

2.6 Vale of Glamorgan Local Development Plan

The Vale of Glamorgan LDP was adopted in 2017 and has a plan period of 2011-2026. It comprises a Written Statement with associated proposals and constraints map.

The aim of the LDP is to provide a framework for making rational and consistent decisions on planning applications and to guide development to appropriate locations. It contains strategic, management and development management policies which should be taken into consideration in the formation of the proposed development and planning application. The policies of most relevance to the proposed development are set out in .

The council is preparing a new LDP to replace the existing adopted LDP. The new plan will be called the Replacement Local Development Plan (RLDP) 2021 – 2036.

The LDP Policy MD19 deals with proposals for the generation of low carbon and renewable energy. The policy details that they will be permitted where it can be demonstrated that there is no unacceptable impact on the interests of several factors outlined in the policy. In assessing such proposals, the cumulative impacts of renewable energy schemes will be an important consideration. Favourable consideration will be given to proposals that provide opportunities for renewable and low carbon energy and/or heat generation to be utilised within the local community.

2.7 Emerging Local Development Plan

As noted, the council is currently preparing a Replacement Local Development Plan (RLDP) 2021-36. In November 2023, the council published the RDLP Preferred Strategy, which presents the first statutory consultation stage for the RLDP preparation process, which is subject to a statutory 6-week public consultation process. This provides a more detailed overview of the emerging policies and their alignment with national policy in Wales.

Vale of Glamorgan RDLP Vision by 2036
"The Council will have achieved its target of becoming zero carbon by 2030. It has adopted innovative techniques and efficient resource use to mitigate its impact on the environment, and exemplar zero carbon projects including schools and district heating networks have been implemented. Development of the Cardiff Capital Region Aberthaw Green Energy Park has established the Vale of Glamorgan as a regional hub for innovation in renewable and green energy and zero carbon manufacturing. All development within the Vale of Glamorgan is now built to the highest standards of environmental design and performance, incorporating measures to mitigate and adapt to the impacts of Climate Change."

The RLDP Strategic vision is set out as one that "looks forward 15 years to 2036 and shows how growth will contribute towards making the Vale a healthier, connected, and sustainable place where people want to live and work". This is guided by 10 strategic objectives (SOs) which expand the RLDP vision into 9 themes for Vale of Glamorgan's continued sustainable development. They are listed below:

Objective 1 - Mitigating and Adapting to Climate Change
Objective 2 - Improving Mental and Physical Health and Well-being
Objective 3 - Homes for All
Objective 4 – Placemaking
Objective 5 – Protecting and Enhancing the Natural Environment

Objective 6 - Embracing Culture and Heritage
Objective 7 - Fostering Diverse, Vibrant, and Connected Communities
Objective 8 - Promoting Active and Sustainable Travel Choices
Objective 9 - Building a Prosperous and Green Economy
Objective 10 – Promoting Sustainable Tourism

Following these SOs, the RLDP Preferred Strategy is consulting on a range of growth options, which compare the adopted LDP strategy to three other alternative strategies. This exercise as part of the statutory consultation is being undertaken to see if the adopted LDP approach remains appropriate within the current and emerging policy context in Wales, and provide optioning for future scenarios for the Vale of Glamorgan. The four strategy options are as follows:

Option 1 – Continuation of the adopted LDP Growth Strategy.
Option 2 – Dispersed Growth.
Option 3 – Focused Growth.
Option 4 – Sustainable Transport Oriented Growth.

These options all aim to be realistic and "result in different distributions of growth for housing and other forms of development", whilst continuing to follow the aligned strategic objectives of sustainable development.
In relation to energy-specific emerging policy, the Preferred Strategy provides details on Policy SP15: Climate Change Mitigation and Adaptation – key points listed below:

SP15: CLIMATE CHANGE MITIGATION AND ADAPTATION

All development proposals must respond to the challenges of climate change by both mitigating its causes and adapting to its impacts. The causes of climate change will be mitigated by ensuring new development proposals:
A. Contribute to decarbonisation in their siting, design, construction, mixture of uses and, by following placemaking principles.
B. Promote the principles of a circular economy by prioritising the reuse of existing buildings and the construction of more adaptable and durable buildings.
C. Maximise resource efficiency and sustainable construction techniques, including sourcing materials locally.
D. Include sustainable building design principles, incorporating passive building techniques where possible.
E. Maximise the opportunities for carbon sequestration from green infrastructure.
F. Maximise the opportunities for renewable energy development, specifically in local search areas, to provide 70% of projected electricity demand by 2036.
G. Promote the optimisation of energy supply and distribution options, including the provision of district heat networks.

New development proposals will adapt to the impacts of climate change by:
H. Being designed to respond to a warmer climate.
I. Promoting urban shading and cooling through the provision of green infrastructure.
J. Maximising water efficiency and minimise adverse impacts upon quality of water resource.
K. Redirecting development away from areas of flood risk and ensure that new development suitably controls surface water run-off through the use of sustainable drainage systems and nature-based solutions.
L. Redirecting development away from areas of coastal erosion.

3. Energy Statement

The Client & Project Team have the following aspirations for the project in relation to the energy strategy:

- Provide a functional and comfortable environment for both students, visitors and staff alike.
- Provide a sustainable development and achieve a BREEAM Excellent rating under the 2018 Education assessment.
- Recognising the energy usage of the facility, review and adopt practical energy efficient solutions across all MEP systems in order to minimise operational energy consumption and achieve stringent energy targets.
- Achieve Net Zero Carbon (NZC) in operation and meet an embodied carbon target of 800kgCO_2/m².

3.1 Building Research Establishment Environmental Assessment Method

In line with the Client's requirements the college will be assessed for its sustainability using the Building Research Establishment Environmental Assessment Method (BREEAM).

BREEAM is the BRE (Building Research Establishment) Environmental Assessment Method which has a number of different schemes for differing building types.

breeam

Building projects are assessed at the design and post-construction stages using a system of environmental issues grouped within the following categories: Management, Health and Well Being, Energy, Transport, Water, Materials, Waste, Land Use and Ecology, and Pollution.

A BREEAM pre-assessment workshop has been held to set out the scoring strategy to achieve a rating of Excellent.

The *Net Zero Carbon* scenario reflects the baseline score, but with additional Energy and Materials credits resulting from studies and performance associated with achieving net zero.

The *Potential* scenario identifies credits which could feasibly be achieved by the project, but which are likely to result in additional cost uplift and/or Contractor risk, or where current site information (e.g. Pol 03 Surface Water Run-off) is insufficient for these credits to robustly sit in the baseline scenario.

The baseline and potential credits should also be reviewed by relevant specialists to ensure that the scoring strategy is robust and feasible, and to identify any opportunities for scoring uplift. A scoring margin of 5% over the required rating threshold should be targeted and maintained.

The table below provides an overview of target scoring.

Table 1 - CAVC BWC Target BREEAM Scoring

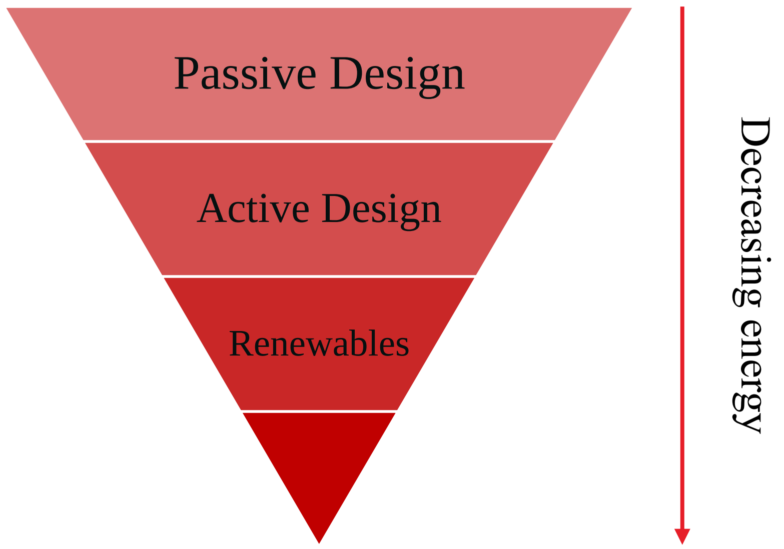
Target	Potential
76.57%	93.84%
Excellent	*Outstanding*

Refer to the MIMWEP Stage 1 Report for details on the environmental Strategy.

3.2 Methodology

In order to minimise the buildings overall energy usage and CO_2 emissions a three-stage approach has been adopted to the design of the building and associated HVAC systems. The three stages are:

1. Passive design – reduce the need for energy
2. Active Design - supply energy efficiently and recover energy wherever practical
3. Use of renewable technologies



3.3 Passive Design

The passive design stage is crucial in helping to achieve a low energy building as it looks to reduce the need for energy to be generated in the first instance. During the early stages of design development, close attention was paid to co-ordinating and integrating the structure and the occupied areas to improve the performance of the building thermal envelope and reducing air leakage as priorities. These are significant improvements on Part L Building Regulations minimum standards as can be shown in Table 3.

Table 2 - Passive Design Features

	Attribute Detail:	*CAVC Specification*	*Part L 2022 Minimum*	*% Improvement*
U-value (W/m².K)	***Roof***	*0.10*	*0.20*	***50%***
	Wall	*0.13*	*0.26*	***62%***
	Ground	*0.10*	*0.22*	***32%***
	Windows (inc frame)	*1.2 (double glazed) [g-value 0.4]*	*1.60*	***25%***
	Window to wall ratio	*To meet daylight criteria*	*N/A*	***N/A***
	Air permeability (m³/(m².hr) @50Pa	*1*	*8*	***88%***

3.4 Active Design

Systems that allow the generation and delivery of energy in an efficient way have been incorporated into the design, strategies include:

- High efficiency lighting systems.
- Use of LED lighting
- Lighting controls with perimeter areas switched separately from internal areas possibly with daylight linking.
- Absence detection for lighting control rather than presence detection.
- Low velocity pipework and ductwork where possible to reduce fan and pump power consumption.
- High efficiency motors with variable speed drives.

- Specification of high-performance MEP plant where required.
- Local control of heating systems to prevent overheating.
- Equipment will be zoned in such a way as to allow plant to be turned off or enable out of hours setback in appropriate unoccupied spaces.
- Heat recovery systems on mechanical ventilation systems and heat scavenging from ICT servers/transformers/ will be implemented. This will also consider advantages of recovering heat against acoustic, fire and contributing to overheating in summer modes. An exercise will be undertaken to prove that they are economically viable at next stage.
- Separate metering on power and lighting systems.
- Central building management control system (BMS) with monitoring of key system parameters.

3.5 Low and zero carbon technologies

This section of the report discusses the potential renewable technologies and low-carbon technologies that could be included within this site.

3.5.1 Potential Renewable Technologies

An initial study of a wide variety of renewable technologies has been carried out at stage 2 and the executive summary of the considered technologies are shown in the following table:

Table 3 - Comparison of LZC technologies. A positive Life Cycle Saving means money saved compared to a similar non-LZC technology

Technology	Recommended?	Annual Energy Generated	Annual CO2 saved	Simple Payback	Life Cycle Saving	£ per tCO2 saved
		(kWh)	(tonnes)	(years)	(30 years)	
Solar Hot Water	No	64,951	12	>30	-£119,909	£606
Biomass	No	320,873	119	Never	-£1,852,746	£164
Photovoltaic Panels	Yes	591,154	125	8	£4,504,440	£204
Ground Source Heat Pumps	No	845,000	119	Never	-£928,701	£439
Air Source Heat Pumps	Yes	739,375	99	>30	-£728,412	£388
Wind Turbine	No	100,887	21	11	£823,509	£266
Combined Heat & Power	No	378,138	None	7	£903,527	None
Small scale Hydropower	No	192,192	41	5	£1,783,212	£165

3.5.1.1

3.5.1.1 Solar Hot Water

Solar water heating systems utilise solar collectors to gather solar radiation. The solar energy absorbed by the collectors is most widely used for the generation of domestic hot water in commercial, industrial, and domestic applications.

For the volume of domestic hot water that will be required the most appropriate system will be to integrate the solar water heating system with the main domestic hot water generation plant to provide pre-heating of the incoming cold feed supply via a secondary hot water storage calorifier (or calorifiers). During periods of high solar radiation, the solar water heating system should be capable of providing most of the domestic hot water with little need for temperature boost from the main storage plant.

Domestic hot water needs to be generated and stored at 60°C - 65°C to eliminate the growth of legionella bacteria. Solar collectors cannot generate water at such temperatures all year round and need to be backed up with low-temperature hot water, oil, or gas-fired water heaters/calorifiers.

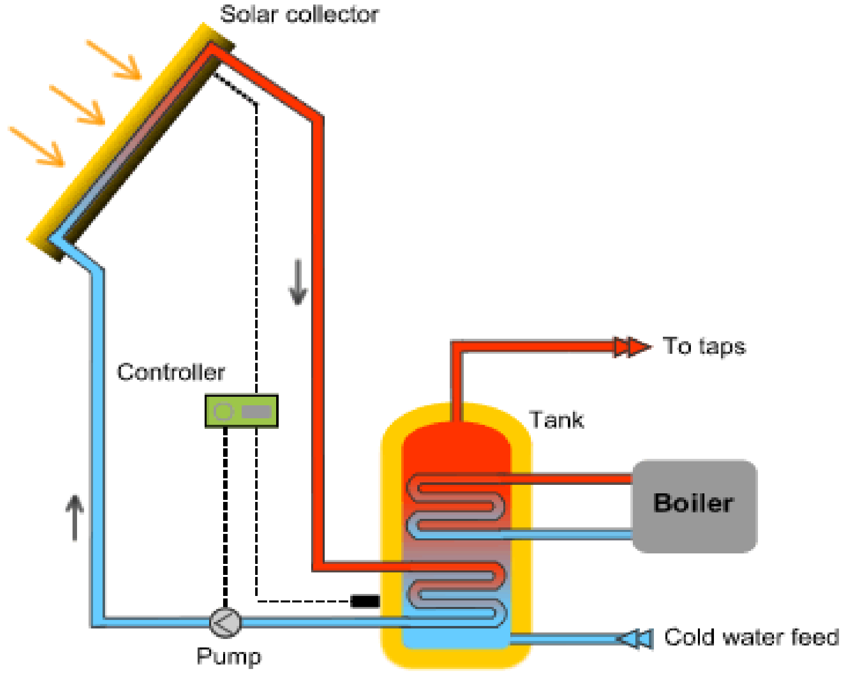


Figure 1 - Example of a typical hot water system © Payless Solar System

3.5.1.2 Biomass

Biomass is the burning of biological matter to produce heat and/or power. Biomass is considered carbon neutral since the carbon emitted when the fuel is burned is re-established during the growing cycle of new plant material via the process of photosynthesis.

Figure 2 - Typical Biomass Boiler and Auger © Hoval

Carbon emissions associated with cultivating, harvesting, and transporting biomass need to be considered and minimised, where possible, in order to ensure carbon neutrality.

Capital costs associated with the installation of biomass plant can be high in comparison with traditional gas-fired or oil-fired boilers. These costs are not recovered when compared to traditional gas boilers, however when compared to oil fired boilers the difference in fuel price can recover the capital cost within the lifetime of the boiler system.

3.5.1.3 Photovoltaic Panels

Solar photovoltaic systems enable sunlight to be transformed directly into electrical power. The photovoltaic effect or interaction between radiating sunlight and the semiconductor material of the solar cell makes this transformation. This generates electrical charges that are conducted away by metal contacts. The direct current produced can be transformed into alternating current by connecting a DC/AC inverter. The most important element of a photovoltaic generator is the solar photovoltaic cell. Several solar cells are combined in series or parallel into an electrical unit, solar module. Due to the low efficiency of PV cells, generally large areas of PV are required to generate a substantial proportion of energy when compared to the building's energy consumption.

The solar irradiance (W/m^2) from the sunlight is the greatest within the summer months, shown in Figure 3 - Energy output from a possible PV array for , with the greatly increased energy output in the summer months. There is a great reliance on storing electricity generated by the solar PV in batteries, or to export the excess electricity, to reach a good utilisation of the energy produced.

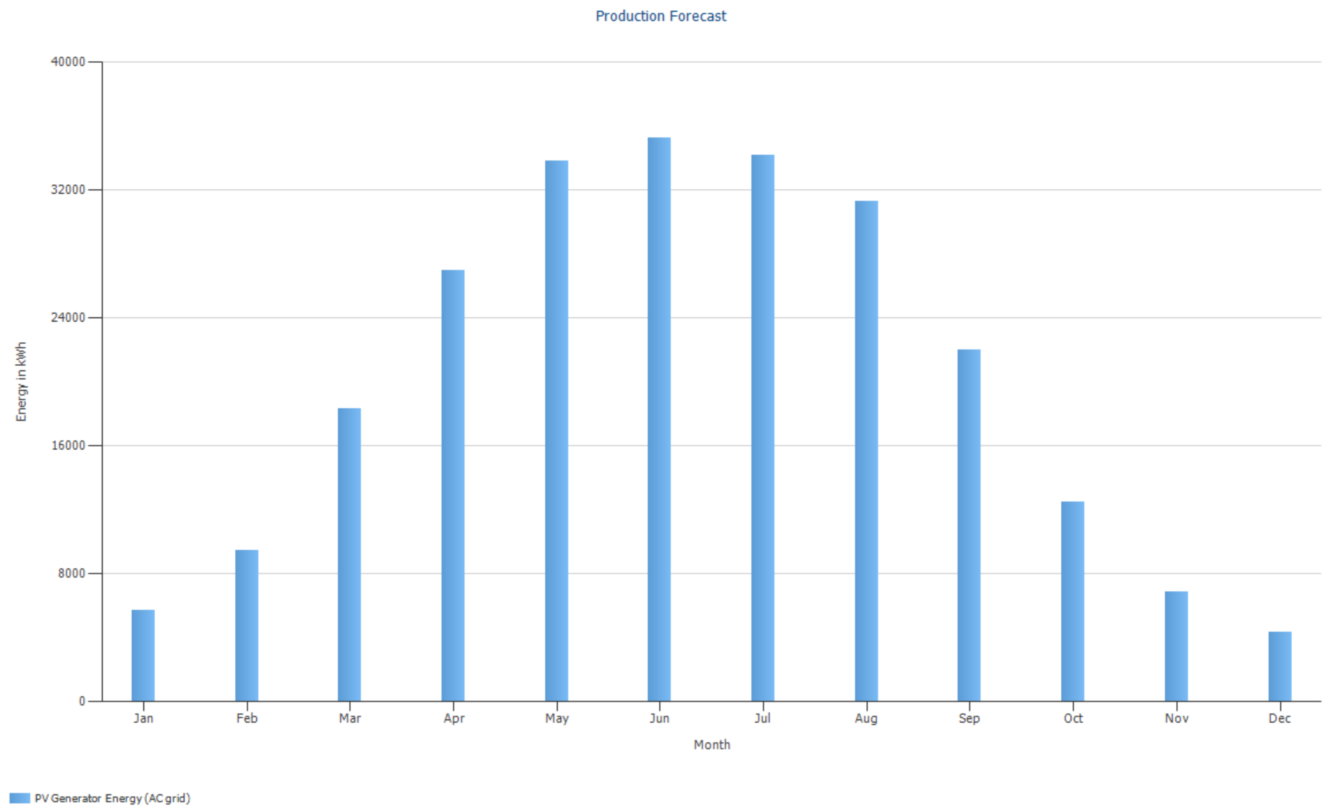


Figure 3 - Energy output from a possible PV array for BWC

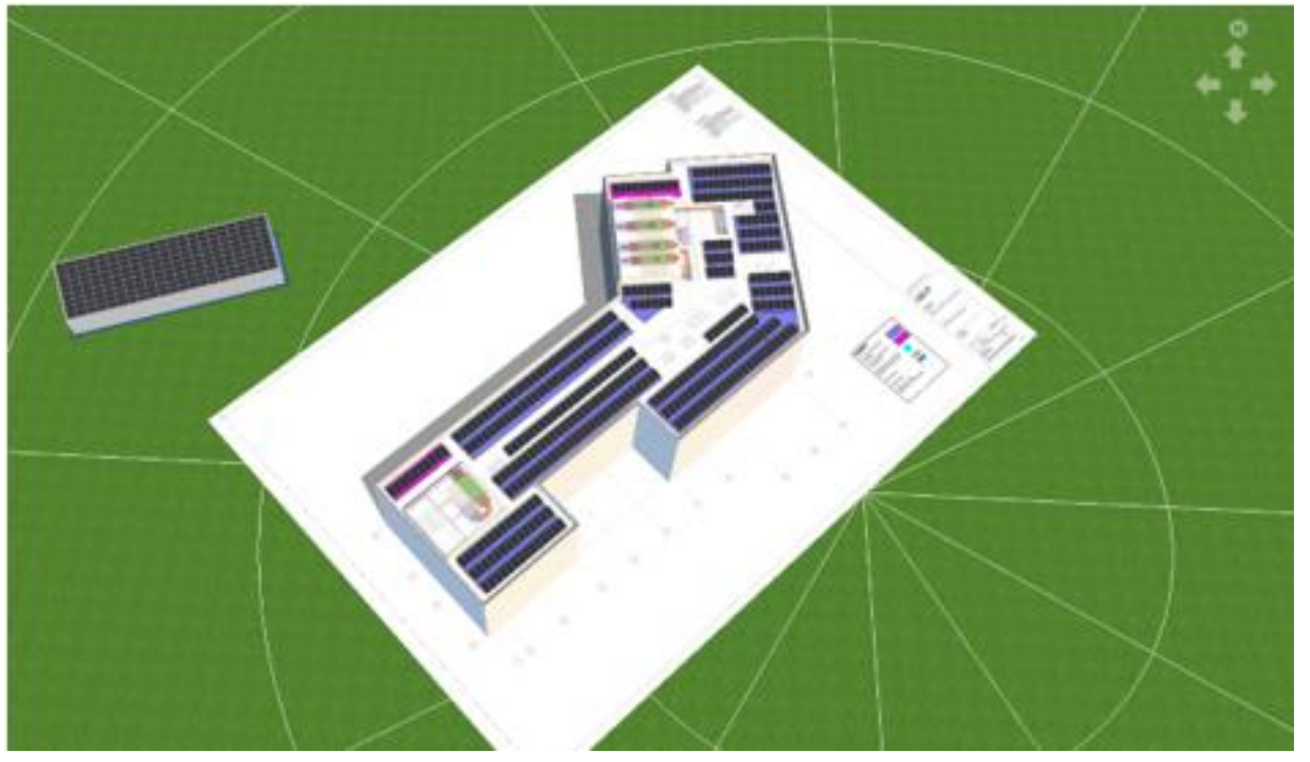


Figure 4 - Example of a possible PV layout for BWC

3.5.1.4 Ground Source Heat Pumps

Ground Source Heat Pumps (GSHP) can be used to provide heating and cooling to buildings by transferring heat to / from the ground / groundwater. There are two main types, open loop systems and closed loop systems (see below).

Ground energy systems comprise two main elements:

- The sub-surface heat exchanger or collector, which transfers heat to/ from the ground, and
- The heat pump, which concentrate the extracted heat energy and raises/lowers the temperature of the circulating fluid inside the building.

Ground-coupled heat pump systems are generally used in conjunction with open/closed loop pipework installed depending upon particular site ground conditions.

Open loop systems are generally more efficient and cost effective than closed loop systems because fewer boreholes are needed per unit energy. They utilise groundwater as a heat sink or heat source. Therefore, they require specific ground conditions to function, more specifically, an aquifer capable of sustainable abstraction and discharge of groundwater.

Closed loop systems circulate a thermal exchange fluid through tubing placed in the ground. Heat transfer occurs by conduction between the ground and the thermal exchange fluid within the pipework. The performance of closed loop systems is governed by conduction of heat to and from the ground. The closed loop systems can be installed either horizontally or vertically depending upon site conditions.

Horizontal closed loop systems utilise a coil of continuous loop (also known as a slinky) or straight pipe which is filled with a thermal fluid installed. The loops (or straight pipe) are buried beneath the ground surface at depths of around 1.5m. Whereas, vertical closed loop systems involve circulating a thermal exchange fluid through tubing placed in vertical boreholes. Ground investigations including an in-situ thermal test in a deep borehole would be required to assess the capacity of such a system on the site. Boreholes can range in depth to suit the energy requirements and space available but are typically between 30m and 200m deep and spaced a minimum of 8m apart.

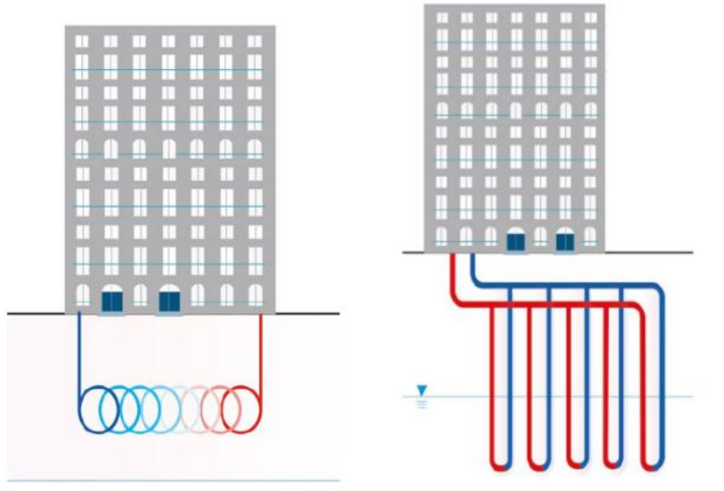


Figure 5 – Diagram of a Horizontal and Vertical GSHP System

3.5.1.5 Air Source Heat Pumps

Air source heat pumps (ASHP) operate by absorbing energy from outside air and utilising the refrigeration cycle to boost the recovered energy as heat. This heat can then be used to meet the building heating demand or provide a pre-heat to domestic hot water.

The key consideration when selecting an ASHP over a traditional boiler is that typically in an air to water heat pump the heat tends to be of low grade and as such requires internal heat emitters to be oversized. Furthermore, for DHW applications an additional boost (either via electric, gas or smaller ASHP) is required to overcome legionella risk and deliver at higher temperatures (reducing the overall system efficiency).

If an ASHP system was employed for DHW, it is likely that the system would be kept separate from the space heating system to ensure operating temperatures can be optimised.

Figure 6 - Euroklimat HERA ASHP range

3.5.1.6 Wind Turbines

A Wind turbine is a machine that converts kinetic energy (wind) into mechanical energy. Modern wind turbines are tough durable machines and efficient at transferring the energy from a natural source. If the mechanical energy is used directly i.e. to turn wheels etc it would be known as a windmill. However, if the kinetic energy was used to generate electricity it is known as a wind generator or wind turbine.

Wind turbines have the potential to provide large benefits in the form of carbon savings from either supplying the building with power, or simply selling back to the grid. However, turbines within 30km of a safeguarded aerodrome need to provide the aerodrome to comment on the proposed development to ensure the turbine does not impact on the aerodrome's operation so there can be planning complications.

3.5.1.7 Combined Heat and Power

Combined Heat and Power (CHP) is the generation of electricity and useful heat in one process. CHP plants generate electricity using fossil fuels while using the waste heat to provide heating and hot water.

Combined Heat and Power plant use a single piece of equipment to generate heat and electrical power. In order for the CHP solution to be sustainable and cost effective it must be used all year around at full (or close to full) capacity. As a result, the CHP plant is usually sized at the heating base load. Electrical power is produced, which may be used by the College, removing the need to purchase electricity from the grid.

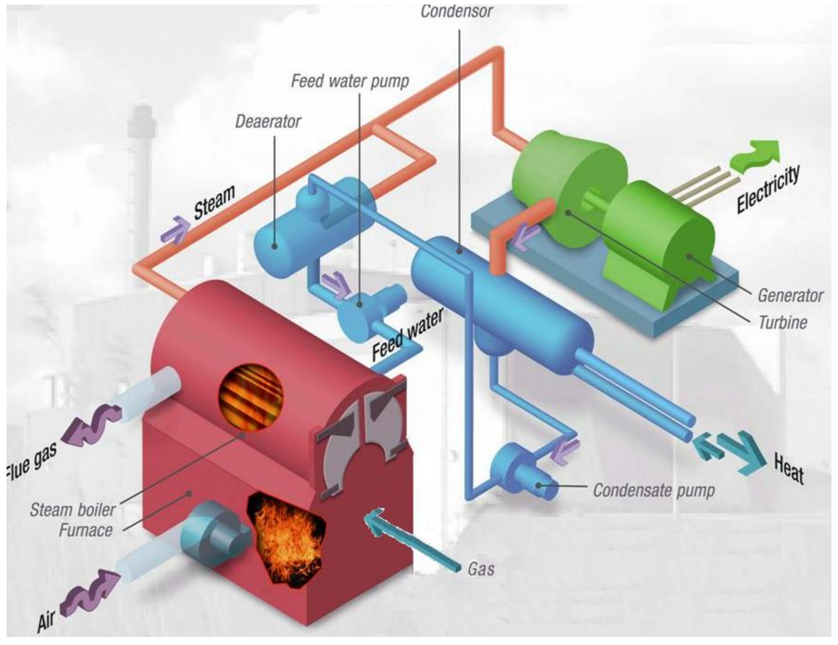


Figure 7 - Typical Gas Fired CHP Plant providing both Electricity and Heating

3.5.1.8 Small Scale Hydropower

Hydro turbines like their wind counterparts generate electricity from momentum. In this instance the momentum comes from naturally flowing rivers or streams. Hydroelectric turbines are a well-established technology with lower maintenance costs than some of the alternatives. However suitable waterways with appropriate head and flow rates rarely pass through a development site.

3.5.2 Preferred Low Carbon Technology

Considering project requirements, PV and air source heat pumps (ASHPs) are considered the most viable low carbon technology solution for this project and have been progressed within the RIBA Stage 3 Issue of BWC. A separate document detailing the proposed PV options has been issued for RIBA Stage 3 presenting various options to CAVC for consideration. ASHPs have been selected and specified as part of the RIBA Stage 3 Issue to meet the building heating load and with n+1 redundancy.

3.6 Benchmarking

A significant energy benchmarking study has been conducted based on existing CAVC properties to assist in developing the NZC in operation strategy. This was combined with energy predictions for the design to give the following benchmarks:

- BWC 556,000 kWh/year 92.7 kWh/m²/year

3.7 Net Zero Carbon Aspirations

Following on from the above energy benchmarking and PV design studies, BWC has an aspirational net zero carbon in operation target, whereby all operational energy consumed on site (both regulated and unregulated) shall be offset through a combination of energy generated by roof mounted solar photovoltaic arrays , PV canopies within the car park, and additional offsetting measures (currently being developed).

These arrays shall offset a significant portion of the carbon emissions annually for the energy usage of the building, with the arrays being developed so that the buildings have high utilisation of the energy generated, it is anticipated that the remainder will be topped up with additional measures thus meeting 'net zero carbon' in operation in line with the UKGBC definition.

In addition, the college has been designed to minimise energy demands through extensive modelling and assessment of the building (in line with contract requirements, the BREEAM assessment and a detailed energy prediction study).

In addition, the team recognises the importance of embodied carbon, and thus a target of 800kgCO_2/m² is a prerequisite within the brief.

4. Building Services Strategy

The following MEP services have been specified for the site of BWC:

Ventilation	-	Value	Units
	System Type	MVHR	
	Vent details	VES (Model dependant on room)	
	SFP (if applicable.)	1.1-1.5	W/l/s
	Heat Recovery Efficiency	80	%
	Max Flow Rate	0.27 – 0.7	m^3/s

Ventilation	-	Value	Units
	System Type	HVHR	
	Vent details	Monodraught (HVR Zero)	
	SFP (if applicable.)	0.21	W/l/s
	Heat Recovery Efficiency	42	%
	Max Flow Rate	0.25	m^3/s

Ventilation	-	Value	Units
	System Type	Centralised AHU	
	Vent details	Swegon (Gold RX HC IASHP AHU)	
	SFP (if applicable.)	1.12 – 1.34	W/l/s
	Heat Recovery Efficiency	80	%
	Max Flow Rate	1.7 – 2.1	m^3/s

Ventilation	-	Value	Units
	System Type	Kitchen AHU	
	Vent details	Halton	
	SFP (if applicable.)	1.74	W/l/s
	Heat Recovery Efficiency	45	%
	Max Flow Rate	3.2	m^3/s

Heating	-	Value
	Heating Source	ASHP
	Proposed Unit details	Strebel_Euroklimat - HERA H *P/XL/**/EC/II 195-2-2 PV 125kW ASHP

Lighting	Efficiency (lm/W)	Controls Strategy
	100	To include daylight dimming where appropriate plus presence/absence detection in suitable spaces

Domestic Hot Water	-	Value	Units
	Water Heating Served by	C02 Heat Pump	
	Hot Water Buffer Vessel Volume	1500	litres

5. Conclusion

This report has set out to clarify the predicted energy demand of the proposed development and the degree to which the development meets current energy efficient standards and therefore compliant with relevant national regulations and the Vale of Glamorgan planning policies. The proposal seeks to deliver opportunities for renewable and low carbon energy within the development parcel and therefore accords with the principles outlined in policy MD19, Technical Advice Note 12. and PPW.

A BREEAM score of >75% (for Excellent) is being targeted at the design stage submission which demonstrates the environmental ambitions and credentials of the project.

The Part L analysis figures have been summarised in Table 5 below. Notably they show compliance with these policies due to the NZC targets of the overall scheme (note, the negative numbers indicate energy generation in excess of the regulated energy consumption).

Table 4 - Part L Compliance Results

Scheme	BER ($kgCO_2/m^2/yr$)	TER ($kgCO_2/m^2/yr$)	Improvement	BPER ($kWhPE/m^2/yr$)	TPER ($kWhPE/m^2/yr$)	Improvement	EPC Grade
BWC	-0.3	8.3	104%	-8.23	52.61	116%	'A+'