Cais am Dendrau | Request for Tenders

LC-CAE-09

Lleihau Carbon | Carbon Reduction

Eglwys Cybi Sant ac Eglwys y Bedd, Caergybi
St Cybi's Church and Eglwys y Bedd, Holyhead

[Mae fersiwn Gymraeg o'r ddogfen hon ar gael ar gais.]

1 Summary

Following the success of the Isle of Anglesey County Council (IACC) bid for UK Government 'Levelling-up' (LUF) funding, Bangor Diocesan Board of Finance wishes to appoint either an architect or an engineer specialising in carbon reduction technologies to design, develop and oversee implementation of a carbon reduction scheme for both the church and the adjacent Eglwys y Bedd in line with the main scheme of reordering of the church and extension and conversion of the Eglwys of Bedd.

Plans for these buildings originally included deployment of photovoltaic panels on the south-facing roof of the church and the installation of air-sourced heat pumps to feed newly-installed underfloor heating. However, it was not possible to work these plans up to RIBA 03 standard in time to include them in the main permissions applications when they were made prior to the grant application.

However, these plans remain an important part of the deliverables of the LUF-funded project and the objectives of Llefa'r Cerrig | Stones Shout Out as a whole (in line with the Church in Wales' commitment to NET-zero by 2030) and so we are seeking to appoint an additional architectural or engineering professional to complete these plans in parallel with the on-going development of the main plans.

2 Brief

2.1 Overview

This request for tender is for work to be undertaken in the context of the "Holyhead: a culture and heritage driven transformation" plans produced by IACC and as part of the "Llefa'r Cerrig | Stones Shout Out" scheme, which is a project run by Bangor Diocesan Board of Finance (BDBF) on behalf of the Diocese of Bangor in collaboration with Bro

Cybi Ministry Area. The following section contains background information about this project and its objectives generally, along with an appraisal of the site.

The work of the project is being undertaken under the UK government LUF programme, and timescales, budgets and deadlines are defined by the government and IACC, as well as procurement and transparency requirements.

2.2 Holyhead: a culture and heritage driven transformation

(from IACC briefing document)

Holyhead's histor y, culture and outstanding natural setting are strengths that serve its local community well. They mean the town is well-placed to capture the benefits of being one of the UK's busiest ports, with direct connections to both Dublin and via rail to London, and the gateway to a world-famous tourist destination. But to do so, the town centre needs to be fit for visitors, and public investment in this now will make an immediate visible difference, leveraging private investment and visitor spending, to the benefit of local communities. This bid brings together strong local partners and a coherent, comprehensive package of well-chosen interventions. Together they will put the town on a new and more sustainable path. As one of the most deprived places in Wales, and the top-ranked priority Level 2 area in Round 2 of the Levelling Up Fund, the opportunity to make a difference here is huge, and urgent.

Ynys Môn faces multiple economic challenges, with low productivity and income, as well as high unemployment - it is ranked as the top priority of all Level 2 areas in Wales. The island's largest town, Holyhead, is the one most in need of investment, with some of the worst-deprived neighbourhoods in Wales. This is more and more visible in the town centre, with vacancy rates as high as 26%, over double the average of the Island's four other town centres. Empty properties are blighting Holyhead and deterring visitors, while low rents make refurbishment and redevelopment unviable. Public investment is urgently needed to tackle market failure, bringing activity back to Holyhead and kickstarting private sector investment.

There is an enormous opportunity for change in Holyhead – with great underlying strengths waiting to be unlocked. Its history and culture make it an ideal destination for visitors, if the investment is made. And those visitors are already here – Holyhead is well connected compared to most peripheral coastal communities. A direct train to London and a direct ferry to Dublin, as well as a cruise port, mean two million visitors pass through the town each year. It is a tourism gateway for Snowdonia and North Wales, while Ynys Môn itself is already a much-loved tourist destination in its own right. Holyhead, as its largest town, should be a natural stop for visitors, our plans will give visitors a reason to do so. There is enormous civic pride in Holyhead, but the community's spirit is let down by the fading fabric of the town centre. Investment will change this, making pride of place a visible reality.

Residents and tourists alike will benefit from the co-ordinated investment plan from the Levelling Up Fund. Reducing vacancy rates and attracting new uses will provide jobs for local residents and improved options for eating, drinking, shopping and leisure. It will also boost tourism and take advantage of the growth of cruise ships visiting the port. The natural beauty of Ynys Môn and North Wales needs attractive town centres to complete the all-weather visitor experience. We will do that in Holyhead by combining improvements to the cultural and heritage offer, better access to the seafront, and a package of changes to bring activity and a facelift to create a town centre less dependent on retail. The new spending and employment opportunities will revitalise a failing local economy and town centre, re-use assets and reduce crime. The community improvements will bring visible change for local people.

2.2 Llefa'r Cerrig | Stones Shout Out

The Diocese of Bangor is responsible for over 170 church buildings ranging in size from tiny single-room chapels to the medieval Cathedral in Bangor, and in age from buildings originating in the 12th century to those built in the last 30 years. The care and maintenance of these buildings is a continuously ongoing process, with small and larger works being carried out as part of the quinquennial inspection process led by the Ministry Area Architects and governed by the Church in Wales Faculty system.

However, this process is by its very nature reactive, identifying structural and safety issues within the churches and rectifying them where possible, generally with 'like-for-like' replacements where an item has become damaged or with 'quick win' solutions requiring minimum cost and disruption where a change is required. It is much more difficult in the context of this process to implement pro-active works to enhance the buildings, both in relation to the changing wants and needs of society, and in terms of leveraging modern technologies to present these buildings in their best, most sustainable forms.

While it would be wonderful to be able to carry out such a programme of works across our entire estate, we recognise that this would not be feasible and so we have taken the strategic decision to concentrate initially on five of our largest, most historically significant churches, as these are the places in which such works will realise the maximum benefit in the immediate term.

The churches selected for this project are large (relatively speaking), ancient and significant both historically and in terms of the role they have within their larger communities. All have been centres of pilgrimage in the past, or at least major stopping points on pilgrimages, and all have been, and should continue to be, important cultural, community and civic resources.

Crucially, all of these churches are currently experiencing major issues in terms of structural integrity, accessibility and overall ease of use which are restricting their ability to be used as social and historical resources in the way they should be and require significant investment to restore them to this role.

2.2 The Site

St Cybi's is the civic church of the town of Holyhead and the mother church of the Ministry Area of Bro Cybi which covers the whole of Holy Island with three other churches in Morawelon, Trearddur Bay and Rhoscolyn. The current Ministry Area Leader is Rev Rob Wardle. The church is situated in the centre of the town of Holyhead within the ancient Roman fortlet, enjoying expansive views across the port.

Holyhead is a Town community, with a town council and a mayor. The community had a population of 7,620 in 2011 and approximately 50% of the population can speak Welsh. The town is home to a large commercial and passenger port and was formerly quite industrial, though much of the industry is no longer active. Some of the census output areas within the community fall within the most deprived 20% in Wales. In 2018 the Ministry Area as a whole reported a weekly congregation of about 150 people.

As the civic church, the local population of the town must be considered the key consumers of the church's resources. In general, the townscape of Holyhead is in need of urban regeneration and the church and the surrounding fortlet should form a key part of these regeneration efforts. In addition, the port generates a significant transient population in the form of sailors, ferry passengers and cruise ship passengers. The church is also at the Western end of the pilgrimage route across Anglesey.

2.3 The Requirement

During the initial planning phase, plans were created by PegwA Ltd on the basis of a report by KGA Ltd to implement various carbon-reduction technologies at the church and adjacent chapel, principally:

- The installation of a heated floor and new heaters compatible with heat-pump technology.
- The installation of air-sourced heat pumps for both buildings at an appropriate location in the churchyard.
- The installation of photovoltaic panels on the south-facing roof of the main church.

Due to the tight schedule required in the run up to the LUF bid deadline, when objections were raised by Cadw to the plans as they currently stood, it was decided to 'uncouple' the PV panels from the remainder of the plans. Subsequently it has also become clear that the heat pumps have not been included in submitted plans as had been expected. The underfloor heating is included in the submitted plans and should go ahead as originally intended.

The original report by KGA Ltd is attached, along with a site plan with possible location of technologies indicated. Due to the sensitivity of the site and the concerns already raised, the following will need to be taken into account in the initial stages of planning:

- Use of imitation slate PV panels rather than standard units (see attached example specification)
- Positioning of air-sourced heat pumps in the lower churchyard or another non-visible location to avoid affecting the Roman wall (a scheduled ancient monument) aesthetically.
- Use of existing utility paths to avoid disturbing buried archaeology in the churchyard.

The appointed contractor will be expected to produce a scheme in collaboration with the architect appointed for the other works on site, Cadw, and other statutory bodes, and then develop these plans through RIBA Stage 03 and 04, including providing documentation for permissions applications, technical specifications and schemes of work for the tender process. Following the appointment of contractors, the work will become part of the total package of works on site, supervised by the main architect. In accordance with the LUF agreement, all LUF-funded works are required to be complete by the end of March 2025. The following outline programme is currently proposed:

Development of scheme – April to May 2023
Contractor Engagement – May to July 2023
RIBA Stage 04 – July to October 2023
Contractor Engagement – November to December 2023
[work re-joins critical path of main project at this point]
Mobilisation – January 2024
On-site Implementation – February 2024 to February 2025
Snagging and Handover – March 2025

Due to the tightness of the programme required by UK Government, all tenderers will need to demonstrate that they have sufficient business resilience to meet deadlines even in the case of staff illness or other absence, and tenders from sole traders will only be considered if the proposal makes specific reference to the engagement of additional support staff to ensure this.

3 Methodology

The appointed architect will be expected to follow the RIBA project delivery framework, with any appropriate variations as required.

4 Outputs and Deliverables

Standard RIBA outputs and deliverables apply, including technical specifications and details for contractors and briefs for additional professionals (QS, M&E Engineer, Structural Engineer etc.).

Due to government requirements, all procurement is required to be via competitive tender and this should be taken into account in the proposed programme.

5 Contract Management

The appointed architect will enter into a contract directly with Bangor Diocesan Board of Finance with a fixed sum agreed for the specified scheme of works. Fees should be invoiced separately at the end of each RIBA stage, or according to another mutually-agreed schedule. BDBF will pay all invoices in the first instance, and then receive reimbursement from UK Government via IACC, thus the timely submission of invoices will be a priority in this project.

The maximum budget anticipated for this contract is £15,000, to include all expenses and VAT.

The main client contact at Bangor Diocesan Board of Finance will be Simon Ogdon, Conservation and Development Project Manager.

6 Award Criteria

A proposal for undertaking the work should include:

- details of staff allocated to the project, with the lead contact identified
- an outline of the internal responsibilities and liaisons where more than one member of staff is involved
- details of the experience of the contractor and staff members in carrying out similar projects
- an expanded programme of proposed activities based, as far as possible, on the timescales above
- an overall cost for the work, broken down into the price for each stage

Proposals will be assessed by the Project Advisory Board (PAB) and the Senior Suppliers Committee (SSC) on the basis of cost, appropriateness of proposed methodology, evidence of relevant experience, and, if relevant, the proposed structuring and management of the contract team.

7 Procurement Process

Proposals should be returned via email to simonogdon@churchinwales.org.uk along with any supporting documentation. Large files can be sent via WeTransfer or any other equivalent online service.

The deadline for the return of proposals is 12 noon on Thursday 16th March 2023.

Bangor Diocesan Board of Finance will notify bidders of the procurement decision by email week commencing Monday 27th March 2023.

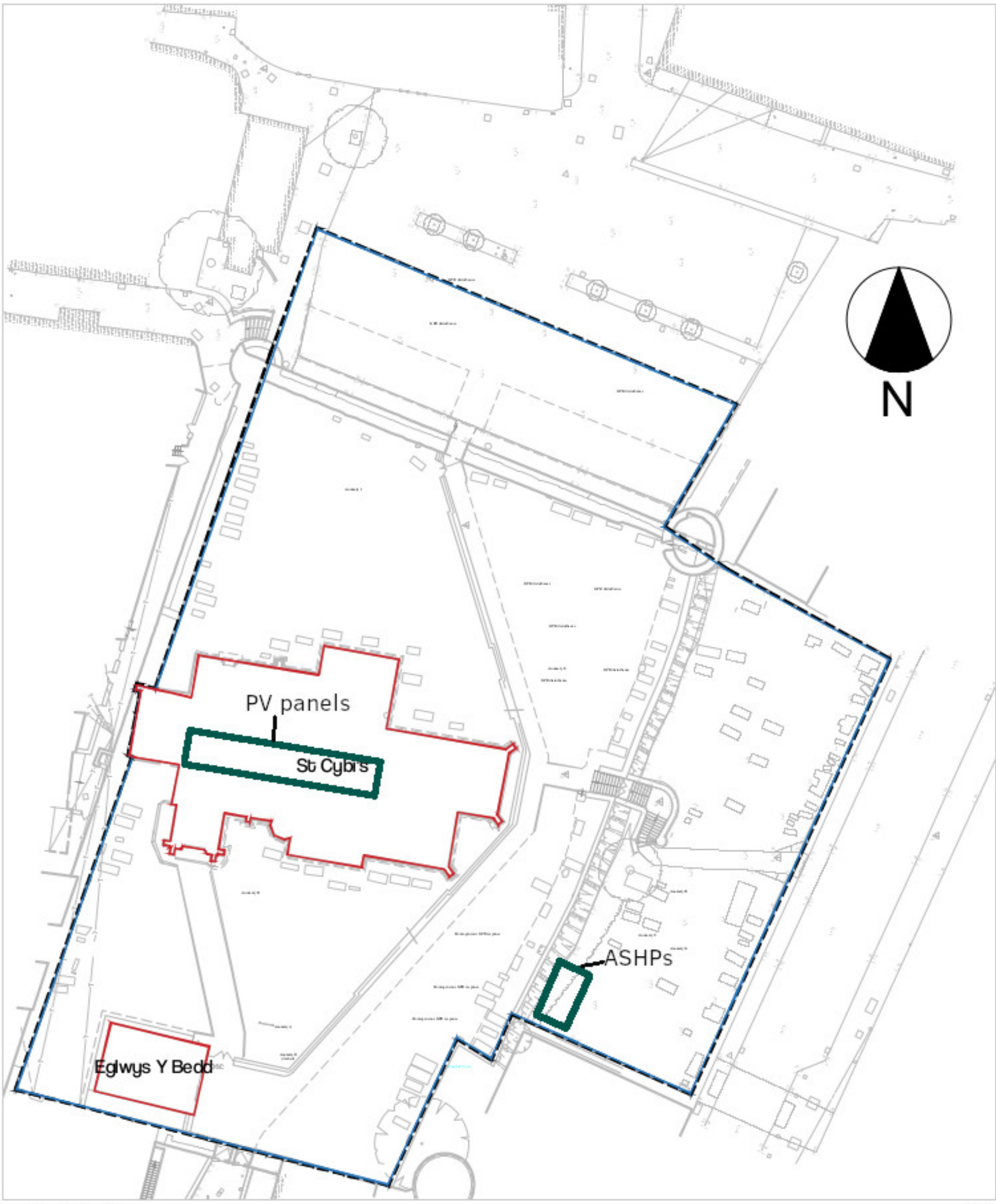
8 Contact Details

Any queries regarding this document should be addressed via email to simonogdon@churchinwales.org.uk.

9 Copyright and Acknowledgements

Bangor Diocesan Board of Finance would like to acknowledge assistance of the above bodies, the Dean and Chapter of Bangor Cathedral, Bro Cybi Ministry Area and Apsidal Heritage Ltd in the preparation of these documents.

Appendix I – Site Plans



Location & Site Plan

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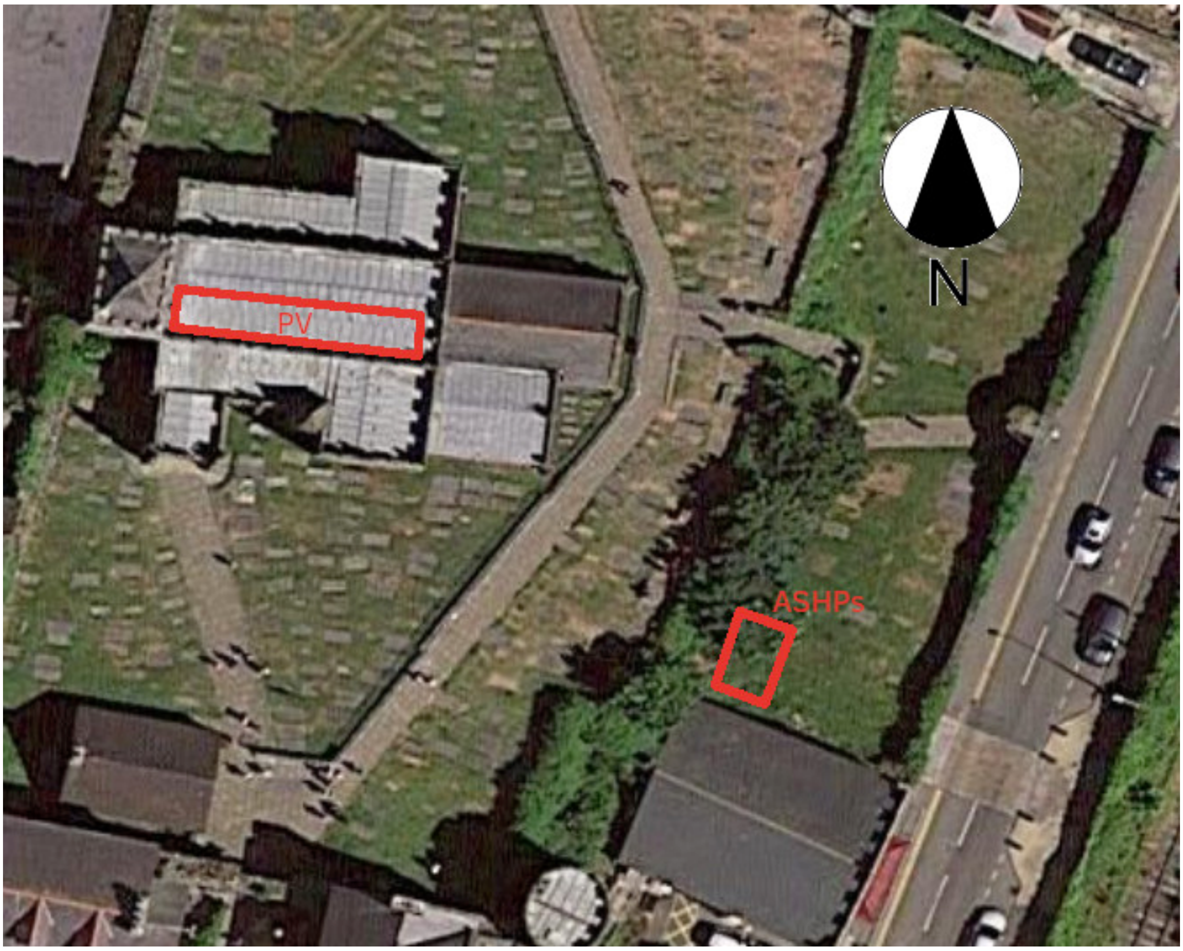
N
PV
ASHPs

KGA (UK) Ltd

Chartered Building Services Consulting Engineers

K
G
A

LZC Sustainability Assessment

Project

St Cybi's Church off Market Square Holyhead, LL65 1BU

5250-KGA-00-XX-RP-M-0003
Mechanical LZC Sustainability Report

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February 2021

Revision	Date of issue	Comments	Prepared By	Checked By
-	01/02/2021	First Issue	AW	PS

Should you have any queries relating to this document please contact:

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Contents

1. EXECUTIVE SUMMARY

KGA have been instructed by Bangor Diocese to undertake an LZC assessment for St Cybi's Church off Market Square Holyhead, LL65 1BU

This report considers current Low and Zero Carbon (LZC) technology for the site and outlines suitable technology/recommendations to be considered as part of the decarbonisation strategy adopted by the Bangor Diocese.

This report provides an initial mechanical and electrical strategy for the Stones Shout Out scheme.

Based on assumption in this report when considering the expected increased in energy consumption of the Church, the Church could be able to reduce there carbon emissions by 190.8T.CO_2 over 15 years by incorporating heat pump technology along side PV panels.

1.1 ENERGY AND CARBON TARGETS

The development will be designed to target the most onerous requirements applicable for this proposal.

On that basis, the implications of the relevant targets for the proposed development can be summarised as follows:

- General Synod has called upon all parts of the Church of England to work to achieve year-on-year reductions in carbon emissions in order to reach net zero by 2030.

1.2 ENERGY STRATEGY

This energy statement has been structured in line with the energy hierarchy: Be Lean, Be Clean, Be Green.

The proposals for the scheme have been developed in accordance with the desire to achieve an energy efficient and sustainable solution whilst also considering the visual impact at the site. The development will be designed to achieve optimum energy performance and should incorporate the following design features:

- All areas of the building will include low energy lighting and lighting control.
- Natural ventilation within habitable areas
- Make use of the high thermal mass of the church for summertime cooling.
- De-centralized extract ventilation shall be incorporated within WC, shower Tea rooms in accordance with Building Regulations Part F.

The building will be served by a centralised heating system. Heating to the Naive shall be supplied by LTHW heating via underfloor heating and the existing radiator heating system should be extended to serve the proposed extension.

This report assesses the suitability of the following LCZ technology:

- Combined Heat and Power (CHP)
- Air Source Heat Pump (ASHP)
- Ground Source Heat Pump (GSHP)
- Biomass

- Photovoltaic Panels (PV)

Based on the assumptions in this report, considering installation costs, payback, and carbon emission savings, it is recommended that the following systems are considered for the detailed design stage:

- System 3 – ASHP
- System 4 – PV.

We would recommend that the following assessments are undertaken in order to confirm the final size of the ASHP and PV arrangement.

- Acoustic noise assessment
- Structural assessment of the roof to accommodate the PV array and plinth for the ASHP.

Note costs included within this report are associated with the integration of systems 3 and 4 listed about. Mechanical and electrical costs associated with the internal modification works associated with the Stones Shout Out scheme are not included.

Table 1-1 Summary Of Considered Systems For Primary Heat Source Only.

REF	SYSTEM DESCRIPTION	SERVING	INSTALLATION COSTS	RUNNING COST	15 YEAR LIFECYCLE COST	CARBON EMISSIONS REDUCTION OVER 15 YEARS
3	ASHP	General Heating,	£101,000	£5500+821	£209,839	159 T.CO2

Table 1-2 Summary of Considered Systems For Electric Generation Only.

REF	SYSTEM DESCRIPTION	SERVING	INSTALLATION COSTS	RUNNING COST	15 YEAR LIFECYCLE COST	CARBON EMISSIONS REDUCTION OVER 15 YEARS
4	PV	Electrical offset	£17,160	-£1,641	-£7,455	31.8 T.CO_2

Table 1-3 Summary of Plant Space Required.

REF	SYSTEM DESCRIPTION	SERVING	PLANT SPACE REQUIRED
3	ASHP	General Heating,	St Cybi 9m^2 Internal Plantroom + 10m^2 external plant area for ASHP Eglwys Y Bedd 2m^2 Internal Plantroom

			+ $2m^2$ external plant area for ASHP
4	PV	Electrical offset	$52m^2$ South Facing Pitch Roof

2. PROJECT BACKGROUND

2.1 DEVELOPMENT DESCRIPTION

St Cybi's Church off Market Square Holyhead, LL65 1BU, defined by the red line boundary on the site location plan below (Figure 2-1) comprises an existing Church of approximately $4225m^2$. The site is accessed via Swift Square and Market Street.

The site is surrounded by residential property. The church is visible from the main road high street to the south, east and west of the site. There appears to be no nearby properties that overlook or cast a significant shadow on the property however Egwlys Y Bedd appears to be in the shadow of the adjoining property.

It is proposed that St Cybi is considered part of a decarbonization strategy to establish a the most suitable services to achieve the desired carbon reduction. The design strategy is to be lean be, be green and be clean.

Figure 2-1 Site Location Map for the Proposed Development (Site Boundary Within Red Line)

3. ESTIMATING ENERGY CONSUMPTION

Local Planning Authorities will expect development to:

- comply with any development plan policies or local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
- take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

3.1 CALCULATING BASELINE ENERGY CONSUMPTION

Using CIBSE Technical Memorandum 46: Energy Benchmarks, the annual carbon emission and energy consumption of the building can be estimated.

Table 3-1 Benchmark Energy Consumption

CATEGORY	AREA TYPE	ELECTRICAL TYPICAL BENCHMARK	FOSSIL – THERMAL TYPICAL BENCHMARKS
1	Public Buildings With Light Usage (Churches)	20 kW.h/m^2	105 kW.h/m^2

Table 3-2 Estimate Baseline Energy Consumption

CATEGORY	AREA TYPE	AREA	ELECTRICAL TYPICAL BENCHMARK	FOSSIL – THERMAL TYPICAL BENCHMARKS
1	Public Buildings With Light Usage (Churches)	465	9,300 kW.h	48,825 kW.h

Table 3-3 Benchmark Carbon Emission

CATEGORY	AREA TYPE	ELECTRICAL TYPICAL BENCHMARK	FOSSIL – THERMAL TYPICAL BENCHMARKS
1	Public Buildings With Light Usage (Churches)	10.3 kg.CO_2/m^2	20.8 kg.CO_2/m^2

Table 3-4 Estimate Baseline Carbon Emissions

CATEGORY	AREA TYPE	AREA	ELECTRICAL CARBON EMISSIONS	FOSSIL – THERMAL CARBON EMISSIONS
1	Public Buildings With Light Usage (Churches)	405	2,168 kg.CO_2	9,948 kg.CO_2

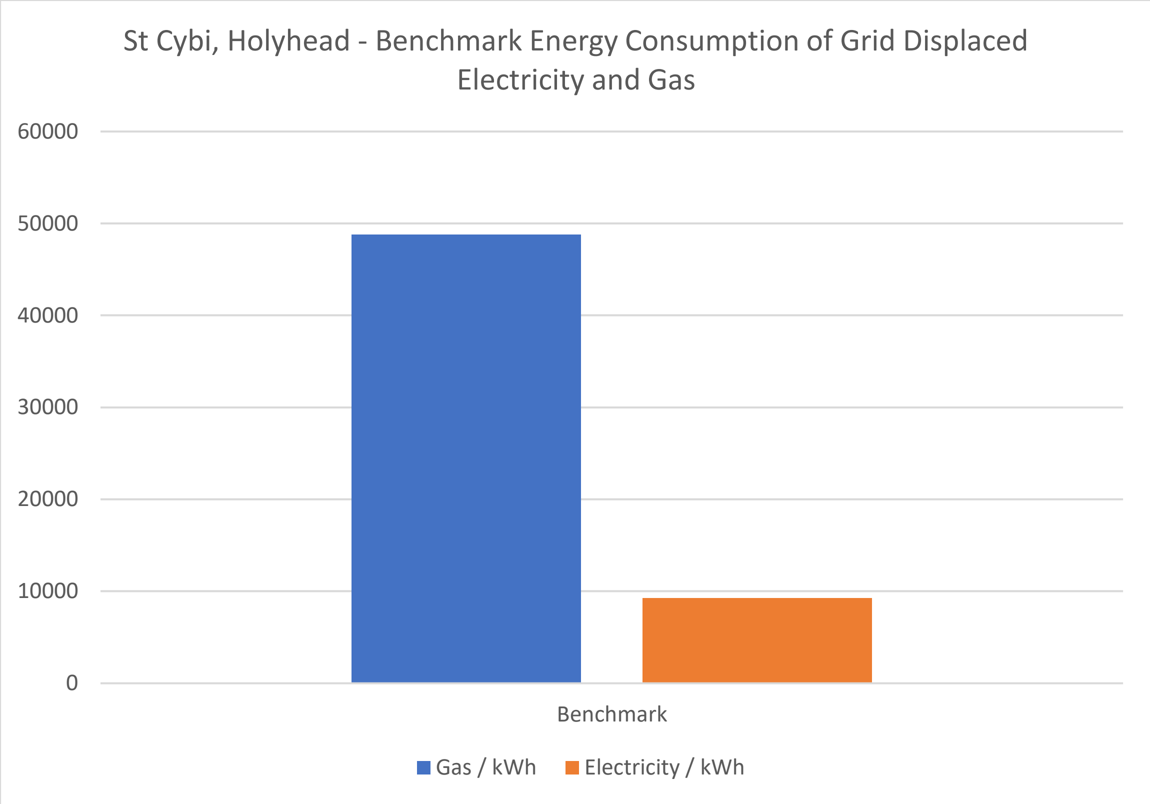

Figure 3-1 St Cybi, Holyhead - Benchmark Energy Consumption of Grid Displaced Electricity and Gas

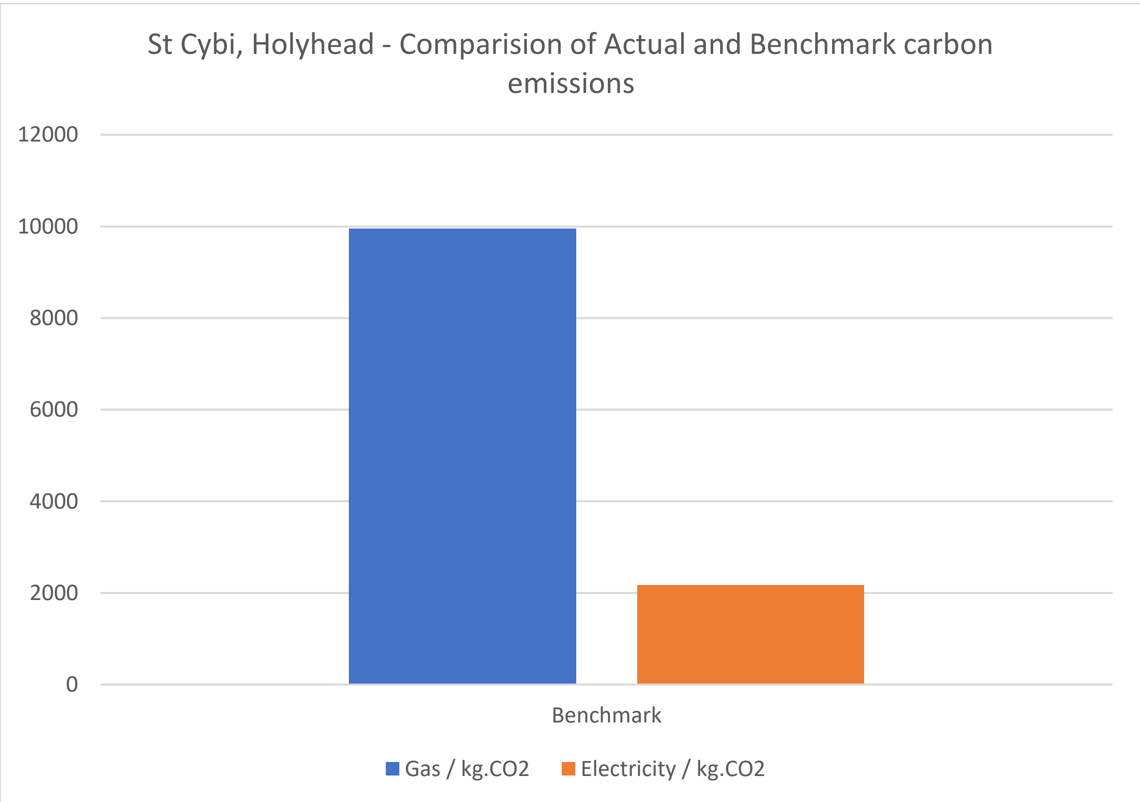

Figure 3-2 St Cybi, Holyhead - Benchmark Carbon Emission of Grid Displaced Electricity and Gas

Using CIBSE Technical Memorandum 46: Energy Benchmarks, the annual carbon emission and energy consumption of the building can be estimated.

As part of the Stones Shout out scheme it is anticipated that the church usage will increased. To provide a realistic energy consumption of the Church following the successful implementation of the Stones Shout out scheme, a factor of 2.5 has been applied to the Benchmark usage to determine the future energy consumption of the site. This assumes that the Church usage will be 5 days a week.

Table 3-6 Predicted Future Baseline Carbon Emissions

CATEGORY	AREA TYPE	AREA	ELECTRICAL ENERGY CONSUMPTION	GAS CONSUMPTION
1	St Cybi, Holyhead	465	23,250 kW.h	122,062 kW.h

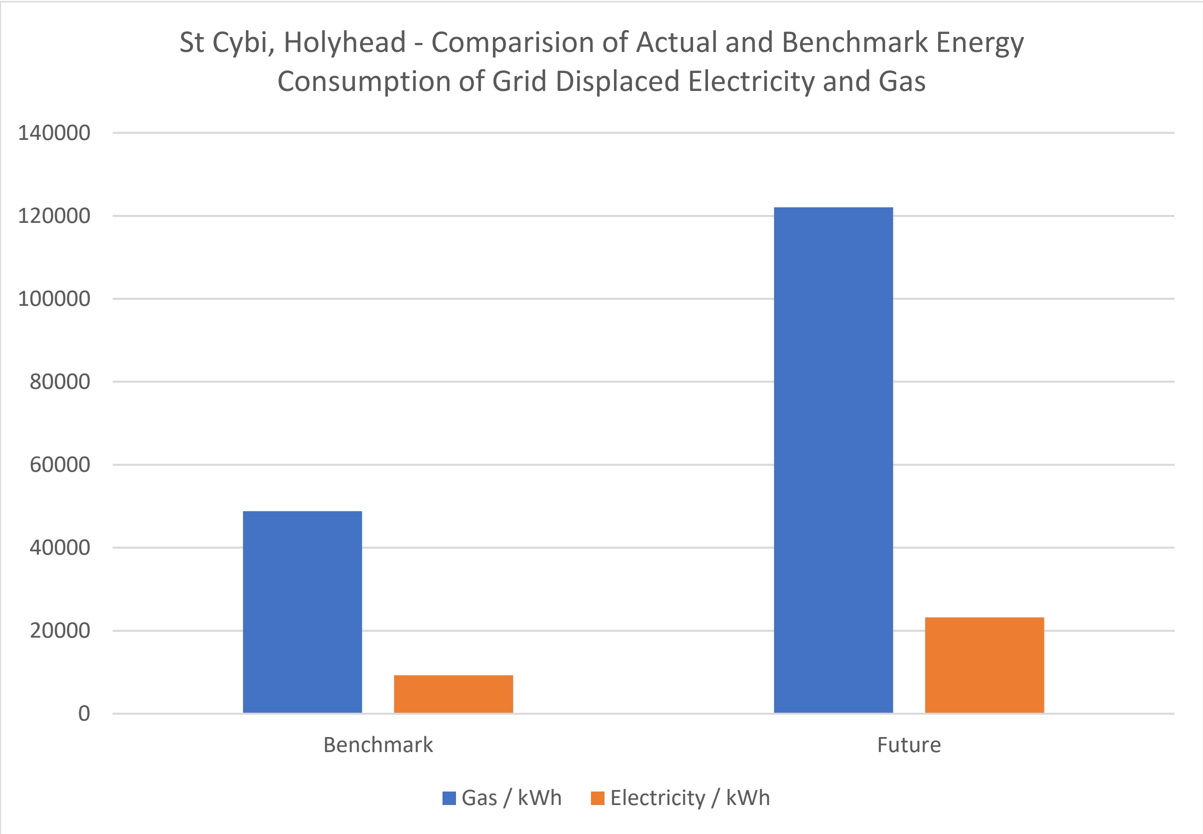

Figure 3-3 St Cybi, Holyhead - Comparison of Benchmark and Future Energy Consumption of Grid Displaced Electricity and Gas

3.2 ENERGY HEIRARCHY

In line with an energy hierarchy, this strategy considers the need to reduce energy use first, then use LZC technologies and finally use clean, efficient non-LZC systems for the remaining energy requirements.

The following energy hierarchy has been used for this development:

1. **Be lean**: use less energy
2. **Be clean**: supply energy efficiently
3. **Be green**: use renewable energy

This can be achieved through a combination of energy efficiency measures, incorporation of on-site low carbon and renewable technologies, connection to a local, decentralized, renewable or low carbon energy supply.

The CO2 Emissions and Energy savings within the report are based on CIBSE Guide F and TM48 Energy Benchmarking. This assessment does not represent actual energy consumption or saving, which would be confirmed at the detailed design process however the principles and scale of consumption/ savings are comparable.

The costs given are based on 'rules of thumb' and provided as an indication of comparison only since the actual costs could significantly change as they are dependent on site conditions, technology used, and scale of installation.

4. BE LEAN: REDUCE ENERGY DEMAND

The measures associated with reducing demand can be termed as 'Energy Efficiency Measures'.

The Proposed Development will incorporate a number of relevant energy conservation measures the benefits of which are discussed below. In summary the following measures will be included:

- Improved air tightness;
- High performance building fabric (New construction only);
- High performance glazing (new glazing only);
- 100% low energy lighting and controls throughout;

4.1 BUILDING FABRIC

New glazing should be specified to achieve a g-value of around 0.6 for north, east and west elevation. Glazing to the south elevation shall achieve a U value of 0.4. This is considered to provide an appropriate year-round balance between maximising daylighting and beneficial wintertime solar gain, and minimising summertime solar gains to reduce the overheating risk and need for comfort cooling.

The current proposals for the building fabric performance for the Proposed extension are summarised in Table 4-1. Values are to be agreed between by the Architect at detailed design stage.

Table 4-1 Fabric Performance Targets

ELEMENT	PROPOSED FABRIC PERFORMANCE
External Wall U-value (W/m2K)	0.18
Party wall U-value (W/m2K)	0.18
Ground floor U-value (W/m2K)	0.12
Roof U-value (W/m2K)	0.09
Curtain Wall / Glazing U-value (W/m2K)	1.4U / G0.6 & 0.4 / LT 0.7
Roof Lights / Glazing G-value	1.4U / G0.6 / LT 0.7
Air permeability (m3/hr.m2 @ 50 Pa)	3.0

4.2 BUILDING SERVICES

A high performance and energy efficient MEP building services is proposed for the scheme. Table 4-2 lists the general specification for the heating system, lighting and ventilation strategy for the proposed commercial units.

Table 4-2 General Heating, Cooling, Ventilation, And Lighting Specification For Dwellings

ELEMENT	GENERAL SPECIFICATION
Ventilation	WC, Shower and Kitchen – Decentralised extract fan is installed
Internal lighting	100% low energy LED light fittings
Primary heat source	Heat supplied by centralised heating plant with low temperature hot water (LTHW) distribution. Heat to be supplied by condensing boilers with a minimum 91% seasonal efficiency (Benchmark)

Heating controls	Optimum, including weather compensation
Heat emitters	Underfloor heating and low temperature radiators
Overheating control / cooling	Thermal Mass

4.3 IMPROVEMENT OVER BENCHMARK FIGURES

Future figures are calculated based on data extrapolated from CIBSE Guide F. Energy emissions in Guide F are based on record information dating back to early 2000's. Therefore, by incorporating improved construction materials, technology and systems outlined in the Be Clean strategy, it is estimated that the building energy and carbon emission will be 70% of the estimated benchmark figures. Table 4-3 outlines the estimated revised energy usage applied to thermal energy use only.

Table 4-3 Improvement over Future Energy Consumption

CATEGORY	AREA TYPE	ELECTRIC FUTURE USAGE	GAS FUTURE USAGE
1	Public Buildings With Light Usage (Churches)	17,408 kW.h	85,443 kW.h

Table 4-4 Improvement over Future Carbon Emission

CATEGORY	AREA TYPE	FUTURE ELECTRIC CARBON EMISSIONS	FUTURE GAS CARBON EMISSION
1	Public Buildings With Light Usage (Churches)	3,794 kg.CO_2	12,185 kg.CO_2

5. BE CLEAN: SUPPLY ENERGY EFFICIENTLY

After consumption has been reduced through the application of energy efficiency measures, the next step is to consider low carbon technologies in order to provide further reduction in carbon dioxide emissions.

The following low carbon technologies have been investigated for the proposed development.

- District heating network;
- Combined Heat and Power (CHP);
- Ground Source Heat Pump;
- Air Source Heat Pump.

5.1 DISTRICT HEATING NETWORK

There are no existing district heating networks in the vicinity of the development.

Therefore, connection for District Heating has not been considered viable for this scheme.

5.2 COMBINED HEAT AND POWER (CHP)

On the basis that the development cannot be supplied directly from a district heating network, the use of CHP led LTHW heating system has been considered. CHP systems are generators which produce on site generated electricity and use the waste heat within the development. To operate at maximum efficiency CHP systems require a constant steady state and heat load within the development.

Primarily a public building with low usage, domestic hot water consumption will make up a small proportion of the total heat demand, heating however will provide a significant position of total heat demand which means the CHP unit will be inactive during the summer late spring, summer and early autumn months.

Electrical energy generated via the CHP could be used to offset the electrical consumption of the lighting. Using an MCS certified scheme, surpless electrical energy could be used for veichle charging or exporting to the grid via the Smart Export Garentee (SEG) scheme.

The selection of the CHP should be carefully considered as a CHP which is too small will be limited in onsite electrical generation and an oversized CHP will have reduced running hours typically during the summer time periods, due to reduced heating loads. A utility assessment should be undertaken in order to assess the suitability of the surrounding infastructure and incorporate any strengthening works to accommodate the CHP.

Advantages of CHP include;

- Waste heat can be utilized for the church heating
- Can also provide domestic hot water
- Reasonable payback

Disadvantages of CHP include:

- High maintenance costs

- Acoustic assessment and treatment required to control noise breakout
- Large internal space require to house CHP and buffer vessel.
- High initial capital cost
- Frequent maintenance required

Due to the low annual heating load and disadvantages listed above the use of CHP would not be viable and has therefore not been considered for this scheme.

5.4 GROUND SOURCE HEAT PUMP (GSHP)

Ground Source Heat Pump (GSHP) technology is widely used in the UK. Diverse applications include space heating, water heating and heat recovery in residential and commercial sectors.

The technology makes use of the energy stored in the Earth coming mainly from solar radiation. Essentially, heat pumps take up heat at a certain temperature and release it at a higher temperature. This is achieved by means of ground collectors (coils), in which a heat exchange fluid circulates and transfers heat via a heat exchanger to the heat pump. The cycle is driven by the temperature difference between the ground and the circulating fluid. The advantage of the using the ground as heat source rather than air, is the relatively constant temperatures of the ground throughout the year allowing the refrigerant fluid to operate optimally.

Ground source heat pumps can be categorised as having closed or open loops, and those closed can be installed in three ways: horizontally, vertically, or in a underground aquifer. The type chosen depends on the building load, available land areas and the soil and rock type at the installation site. These factors will help determine the most economical choice for installation of the ground loop.

Open loop systems are often referred to as groundwater heat pump. Ground water is pumped in the secondary loop through the heat exchanger in the heat pump and released at a lower temperature back into the ground. It may be suitable where there is a source of relatively clean water, and all local codes and regulations regarding groundwater discharge are met.

For closed loop systems, water or antifreeze solution is circulated through plastic pipes buried beneath the earth's surface. A system that would supply the full space and water heating demand of a typical house would need 200m of ground coils, and for commercial buildings this can reach thousands of metres. Different space configurations of piping are possible depending on the available land, soil conditions, and excavation costs.

- Horizontal collectors require relatively large area of land free from hard rock. They are most appropriate for small installations, and particularly for new build. The pipes are buried in trenches 1- 2m deep. Spatial optimisation is possible by laying pipes in group configurations. However, minimum distances should be maintained in order to allow for good thermal exchange.

- Vertical collectors are used where land is limited and are suitable for most soil and rock types. Vertical borehole heat exchangers could also be of various configurations (single, double, U-shaped, etc.) with typical diameters of 0.1-0.2m and between 15m and 180m deep. Minimum spacing between adjacent boreholes of 5-15m should be maintained to prevent thermal interference. Vertical boreholes are used in open loop systems to access the local water table. It should be noted that an open loop system must comply with Environmental Agency (EA) protocol.

- Parallel and series connection can be used where more than one horizontal loop or borehole are in place

Almost all heat pumps in operation are based on the vapour compression cycle, which combines efficiency, safety, and reasonable cost. A detailed ground survey, considering ground conditions and potentially other features such as sewers, tunnels and archaeology will be needed. Ground conditions will also affect ease of construction and performance of the system.

Advantages of GSHP include;

- Low maintenance requirement

- Can be easily incorporated into the building providing space is available for internal heat pumps;

- Can also provide domestic hot water;

- RHI Benefits however not available for Grant schemes;
- More suitable for heating systems with lower operating water temperatures i.e. underfloor heating systems;
- Consistent annual output over ASHP

Disadvantages of GSHP include:

- Electricity required to run heat pump;
- Space for internal condenser required and large external area.
- High initial capital cost
- More suitable for heating systems with relatively low operating temperatures i.e. underfloor heating systems;
- May result in high electrical use if not designed/specified correctly on in non-favourable external environmental conditions;

Ground source heat pumps are comparable with conventional LTHW heating system and are best suited for low temperature heating systems which utilise underfloor heating.

Therefore the use of GSHP with vertical collectors would be viable and has therefore been considered for this scheme.

5.5 CARBON EMISSIONS REDUCTION AND PAYBACK (GSHP)

The impact of servicing the site by a central GSHP energy centre on the overall carbon emissions for the development is shown in Figure 5-3.

KGA		Project No:	5473
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		Date:	01/02/2021

Calculation: GSHP Payback calculation

Reference Data

A	465	m2	Building Total Area GIA
BT	General Accommodation		Building Type
HC	0	kWh	Heating consumption per m2 for fossil fuel (wet heating system)
Q_{hot}	85443	kWh	Annual heating demand for space heating
COP	3		GSHP COP
R_q	70	kWh	Rated heat output of GSHP
Cf_e	0.2331	kgCO2/kWh	Carbon dioxide factor for grid displaced electricity
E_{con}	91%	-	Seasonal efficiency of conventional boiler
Cf_{con}	0.198	kgCO2/kWh	carbon dioxide factor for fuel supply to conventional boiler

Symbo	Units	Description	Formula	Value
Q_{hot}	kWh	Annual Heating Demand for space heating and hot wa	-	85443
M	%	Percentage of heating demand met by GSHP	-	100%
Q_h	kWh	Annual Heating supplied by micro GSHP	Qhot x M	85443
R_q	kWh	Rated heat output from GSHP	-	70
h	hours	Full run hours (equivalent)	Q_h / R_q	1221
R_f	kW	Rated fuel consumption of GSHP	-	23
Q_{GSHP}	kWh	Annual fuel consumption of GSHP	R_f x h	28481
Cf_{GSHP}	kgCO2/kWh	Carbon Dioxide factor for fuel supply for GSHP	-	0.2331
C_{GSHP}	kg	Resulting carbon dioxide emissions due to fuel consumed by micro-CHP	Q_{fgshp} x C_{fgshp}	6639
E_{con}	%	Seasonal Efficiency of conventional boiler	-	91%
Q_{con}	kWh	Annual fuel consumption of conventional boiler	Q_h / E_{con}	93893
Cf_{con}	kgCO2/kWh	Carbon dioxide factor for fuel supply to conventional boiler	-	0.198
C_{con}	kg	Resulting carbon dioxide emissions due to fuel consumed by conventional boiler	Q_{con} x Cf_{con}	18591

Figure 5-3 Be Clean: GSHP Emission Reduction and Payback 1 of 2

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Carbon dioxide emission saving resulting from the GSHP

$C_s = C_{con}$ - Cgshp = 11952 $kgCO^2$

Percentage reduction in carbon emissions due to GSHP

$C_p = C_s / (Q_{elc} \times Cf_e) + (Q_{hot} \times C_{con}) \times 100 =$ 71%

Payback

Electricity unit rate per kWh	£ 0.185
Estimate Cost of GSHP	£ 192,000.00
GSHP running cost	£ 5,268.99
RHI upto 30000 kWh	£ -
Annual RHI payback	£ -
GSHP running cost each year up 7 yr	£ 5,268.99
GSHP typical annual running cost after	£ 5,268.99
Life Cylce After 15 Years	£ 271,034.78

Figure 5-4 Be Clean: GSHP Emission Reduction and Payback 2 of 2

5.6 AIR SOURCE HEAT PUMP (ASHP)

Air Source Heat Pumps (ASHP) absorb heat from the outside air. This heat can then be used to heat radiators, underfloor heating systems, or warm air convectors.

An air source heat pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can get heat from the air even when the temperature is as low as -15° C. Heat pumps have some impact on the environment as they need electricity to run, but the heat they extract from the ground, air, or water is constantly being renewed naturally.

Unlike gas and oil boilers, heat pumps deliver heat at lower temperatures over much longer periods. During the winter, they may need to be on constantly to heat a home efficiently.

Air source heat pumps can also provide cooling via a reversible type heat pump to provide space heating and cooling using external air properties to generate heat and/or cooling via piped systems.

Advantages of ASHP include;

- Low maintenance requirement
- Can be easily incorporated into the building providing space is available for external heat pumps;
- Air Primary heat source/heat dump;
- Can also provide domestic hot water;
- Easier to install than Ground Source;
- RHI Benefits however not available on Grant schemes;
- More suitable for heating systems with lower operating water temperatures i.e. underfloor heating systems;
- Initial installation costs are considerably lower than GSHP.

Disadvantages of ASHP include:

- Electricity required to run heat pump;
- Space for external condenser required. External heat pumps and space required will be considerably larger for commercial buildings;
- Efficiencies may be lower than ground source during winter conditions;
- May result in high electrical use if not designed/specified correctly on in non-favourable external environmental conditions;
- External Noise generation

For ASHP technology to be viable as a LZC technology, consideration needs to be given to the operation of the site along with the type of heating system and/or cooling system proposed. A small external plant area is required to house the external heat pumps for a scheme of this size; this may also create external noise issue. An acoustic noise assessment should be undertaken to manage the noise generation of the unit.

Therefore the use of ASHP would be viable and has therefore been considered for this scheme.

5.7 CARBON EMISSIONS REDUCTION AND PAYBACK (ASHP)

The impact of servicing the site by a central ASHP energy centre on the overall carbon emissions for the development is shown in Figure 5-3.

KGA	Project No:	5473
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	Date:	01/02/2021

Calculation: ASHP Payback calculation

Reference Data

A	405	m2	Building Total Area GIA
BT	Public Building Low Usage		Building Type
HC	N/A	kWh	Heating consumption per m2 for fossil fuel (wet heating system)
Q_{hot}	74335	kWh	Annual heating demand for space heating and hot water
COP	2.5		ASHP COP
R_q	60	kWh	Rated heat output of ASHP
Cf_e	0.2331	kgCO2/kWh	Carbon dioxide factor for grid displaced electricity
E_{con}	91%	-	Seasonal efficiency of conventional boiler
Cf_{con}	0.198	kgCO2/kWh	carbon dioxide factor for fuel supply to conventional boiler

Symbo	Units	Description	Formula	Value
Q_{hot}	kWh	Annual Heating Demand for space heating and hot wa	-	74335
M	%	Percentage of heating demand met by ASHP	-	100%
Q_h	kWh	Annual Heating supplied by micro ASHP	Qhot x M	74335
R_q	kWh	Rated heat output from ASHP	-	60
h	hours	Full run hours (equivalent)	Q_h / R_q	1239
R_f	kW	Rated fuel consumption of ASHP	-	24
QASHP	kWh	Annual fuel consumption of ASHP	R_f x h	29734
CfASHF	kgCO2/kWh	Carbon Dioxide factor for fuel supply for ASHP	-	0.2331
CASHP	kg	Resulting carbon dioxide emissions due to fuel consumed by micro-CHP	QfASHP x Cf.	6931
E_{con}	%	Seasonal Efficiency of conventional boiler	-	91%
Q_{con}	kWh	Annual fuel consumption of conventional boiler	Q_h / E_{con}	81687
Cf_{con}	kgCO2/kWh	Carbon dioxide factor for fuel supply to conventional boiler	-	0.198
C_{con}	kg	Resulting carbon dioxide emissions due to fuel consumed by conventional boiler	Q_{con} x Cf_{con}	16174

Figure 5-5 Be Clean: St Cybi ASHP Emission Reduction and Payback 1 of 2

KGA	Project No:	5473
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Carbon dioxide emission saving resulting from the ASHP

Cs = Ccon - CASHP = 9243 $kgCO^2$

Percentage reduction in carbon emissions due to ASHP

$C_p = C_s / (Q_{elc} \times Cf_e) + (Q_{hot} \times C_{con}) \times 100 =$ 63%

Payback

Electricity unit rate per kWh	£ 0.185
Estimate Cost of ASHP	£ 101,000.00
ASHP running cost	£ 5,500.79
RHI upto 20000 kWh	£ -
Annual RHI payback	£ -
ASHP running cost each year up 7 yr	£ 5,500.79
ASHP typical annual running cost after	£ 5,500.79
Life Cylce After 15 Years	£ 183,511.85

Figure 5-6 Be Clean: St Cybi ASHP Emission Reduction and Payback 2 of 2

KGA		Project No:	5473
		Page No:	1
		Designed By:	AW
		Checked By:	
		Date:	29/01/2021

Calculation: ASHP Payback calculation

Reference Data

A	60	m2	Building Total Area GIA
BT	Public Building Low Usage		Building Type
HC	N/A	kWh	Heating consumption per m2 for fossil fuel (wet heating system)
Q_{hot}	11107	kWh	Annual heating demand for space heating and hot water
COP	2.5		ASHP COP
R_q	9	kWh	Rated heat output of ASHP
Cf_e	0.2331	kgCO2/kWh	Carbon dioxide factor for grid displaced electricity
E_{con}	91%	-	Seasonal efficiency of conventional boiler
Cf_{con}	0.198	kgCO2/kWh	carbon dioxide factor for fuel supply to conventional boiler

Symbo	Units	Description	Formula	Value
Q_{hot}	kWh	Annual Heating Demand for space heating and hot wa	-	11107
M	%	Percentage of heating demand met by ASHP	-	100%
Q_h	kWh	Annual Heating supplied by micro ASHP	Qhot x M	11107
R_q	kWh	Rated heat output from ASHP	-	9
h	hours	Full run hours (equivalent)	Q_h / R_q	1234
R_f	kW	Rated fuel consumption of ASHP	-	4
QASHP	kWh	Annual fuel consumption of ASHP	R_f x h	4443
CfASHF	kgCO2/kWh	Carbon Dioxide factor for fuel supply for ASHP	-	0.2331
CASHP	kg	Resulting carbon dioxide emissions due to fuel consumed by micro-CHP	QfASHP x Cf.	1036
E_{con}	%	Seasonal Efficiency of conventional boiler	-	91%
Q_{con}	kWh	Annual fuel consumption of conventional boiler	Q_h / E_{con}	12205
Cf_{con}	kgCO2/kWh	Carbon dioxide factor for fuel supply to conventional boiler	-	0.198
C_{con}	kg	Resulting carbon dioxide emissions due to fuel consumed by conventional boiler	Q_{con} x Cf_{con}	2417

Figure 5-7 Be Clean: Eglwys Y Bedd ASHP Emission Reduction and Payback 1 of 2

KGA	Project No:	5473
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Carbon dioxide emission saving resulting from the ASHP

Cs = Ccon - CASHP = 1381 kgCO^2

Percentage reduction in carbon emissions due to ASHP

$C_p = C_s / (Q_{elc} \times Cf_e) + (Q_{hot} \times C_{con}) \times 100 =$ 63%

Payback

Electricity unit rate per kWh	£	0.185
Estimate Cost of ASHP	£	14,000.00
ASHP running cost	£	821.92
RHI upto 20000 kWh	£	-
Annual RHI payback	£	-
ASHP running cost each year up 7 yr	£	821.92
ASHP typical annual running cost after	£	821.92
Life Cylce After 15 Years	£	26,328.77

Figure 5-8 Be Clean: Eglwys Y Bedd ASHP Emission Reduction and Payback 2 of 2

6. BE GREEN: RENEWABLE ENERGY TECHNOLOGIES

Renewable Energy Technologies are those listed below which can provide a source of energy onsite that is not primarily based on the consumption of fossil fuels or grid electricity and/or utilises a heat source that is renewable such as ground source and solar thermal systems.

- Wind Power;
- Biomass Boiler;
- Solar Thermal Hot Water Heating;
- Photovoltaic Panels.

We have evaluated a number of renewable energy technologies and outlined how they may be applied to the development.

6.1 WIND POWER

Harnessing the kinetic energy of wind can provide a renewable source of on-site electricity generation. Wind turbines need to be positioned where a frequent and steady source of wind is available that is not too turbulent or uneven in direction. Typically wind turbines are positioned on the roof of buildings that are significantly higher than their surroundings and or located in open areas where there is minimum disruption to prevailing winds.

The development is located within an urban environment with numerous adjacent buildings of similar height providing turbulent wind conditions unsuitable for wind power generation.

In addition, wind turbines are not considered to be appropriate in townscape and architectural terms to provide wind turbines on top of the building. On that basis they wind power is not proposed for the St Cybi.

6.2 BIOMASS HEATING

Biomass heating has embodied environmental impacts from transport and fuel combustion which makes it less desirable in Air Quality Management Areas (AQMAs). A review of the potential impact on air quality from increased wood fuelled biomass use in London has been carried out by AEA Energy & Environment, and was published in December 2007. Whilst the development is not within a London Borough the assessment indicates that potentially increasing the contribution from small-scale wood fuelled biomass combustion may lead to a substantial increase in nitrogen dioxide and particulate matter concentrations.

However there are several technologies such as ceramic filters, electrostatic precipitators or bag filters which can all be used to significantly reduce the emissions to air and have successfully been used on biomass systems located within AQMAs Solid biomass relies on a reliable fuel supply which must be delivered and stored on site. Sites using biomass solutions therefore require good access routes both of which are viable on this site. Biomass boilers also have weekly maintenance requirements and relatively high fuel costs compared to gas.

Due to the heating requirments of the building the demand for heating and hot water is relatively low in comparision to heavily occupied commercial builds. There is also little space on site avaialbel for a biomass store and deliveries. Further consideration is required for the delivery and movement of fuel on the site.

Advantages of Biomass include;

- Significant reduction in carbon emission over gas fired heating

- Can also provide domestic hot water;
- RHI Benefits (not available for Grant Schemes);

Disadvantages of Biomass include:

- Large plant area required for boiler plant and fuel storage
- Frequent deliveries of fuel
- High initial capital cost
- Backup boilers required
- High fuel costs
- Frequent maintenance required;

On this basis the use of Biomass heating has not been been considered for the site.

6.4 SOLAR THERMAL

Solar thermal (ST) generation involves capturing solar radiant heat to preheat or heat domestic hot water. Correctly located and orientated, solar thermal systems can meet a proportion of a building's domestic hot water dependent on the expected demand profile and available space for locating ST collectors.

The development's centralised heating system will be served by the Boiler heating system. A solar thermal hot water system would offset some proportion of the baseline load throughout the summer months if provided. Although there is available roof space, there will not be a significant steady demand for hot water throughout the day and would cause the solar thermal system to deactivate during high solar low water consumption periods.

Usage of solar thermal is limited to hot water production only. A significant portion of heat energy attributed to the building will be for space heating. The use of roof space would be best suited for the production of electricity through solar photovoltaic panels. On that basis solar thermal is not proposed for the Allerton Road scheme.

6.5 PHOTOVOLTAIC PANELS

The feasibility of providing photovoltaic (PV) panels has been assessed for this scheme. Solar PV panels located on the top roof areas can be used to provide electricity generation which can contribute to the electricity demand all year round.

Photovoltaic (PV) modules convert sunlight into DC electricity and can be integrated into buildings. PV is distinct from other renewable energy technologies since it has no moving parts to be maintained and is silent. PV systems can be incorporated into buildings in various ways; on sloped roofs and flat roofs, on facades, atria and as shading devices.

Table 6.1 Three most common types of photovoltaic cell

Property	Monocrystalline Silicon	Polycrystalline Silicon	Thin Film Amorphous Silicon
			
Cell efficiency at standard test conditions	15-21%	14-15%	8-12%
Module efficiency	13-18%	12-14%	5-7%
Advantages/Disadvantages	Most efficient but highest cost	Less expensive than monocrystalline but slightly less efficient	Considerably cheaper but approximately half the efficiency of a typical monocrystalline panel

Since PV's generate DC output, an inverter and other equipment is needed to deliver the power to a building or the grid in an acceptable AC form. The cost of the inverter and these 'balance of system' (BOS) components can approach 50% of the total cost of a PV system.

There are several issues which will need to be considered further if one or more photovoltaic arrays are to be included. Consideration must be given to any over-shading provided by surrounding buildings as well as orientation and elevation of the panels.

A particular advantage of solar PV, over other types of LZC technology, is that the running costs are very low (requires no fossil fuel for operation) and since there are no moving parts, very little maintenance is required. The suitability of this technology for the site is dependent on space availability for panel mounting. For the church, the available area is a south facing roof of the Nave and Chapel, South and West Facing roof of the South Transept.

A PV system would offset some proportion of the baseline load if provided. The available roof space and the high electrical load and percentage of electrical load attributed to lighting and heating throughout the day should a heat pump be incorporated.

Table 6-2 Estimate Site PV Site Energy Profile / MWh

Date	St Cybi Simulation.aps
Jan 01-31	-0.2805
Feb 01-28	-0.371
Mar 01-31	-0.7383
Apr 01-30	-0.8267
May 01-31	-1.3602
Jun 01-30	-1.092
Jul 01-31	-1.3668
Aug 01-31	-1.1812
Sep 01-30	-0.7921
Oct 01-31	-0.6456
Nov 01-30	-0.2602
Dec 01-31	-0.2044
Summed total	-9.1189

Table 6-3 Estimate CO2 saving attributed to PV Output

	St Cybi Simulation.aps
Summed total	-9.1189
Carbon Emission Factor of Grid Displaced Electricity	0.23314 kg.CO2
Total CO_2 savings	-2,125 kg.CO2

Table 6-4 Estimate PV Payback

ESTIMATED ANNUAL GENERATION AND CO2 SAVING BASED ON AN UNSHADED PV SYSTEM R2	
Installed Capacity of PV System	8.745kWp
Orientation of the PV System	South Facing (Pitched Slate and lead Roof)
Inclination of the PV System	Variable °
Module Efficiency	20%
System Efficiency	14.5%
Shading Factor (SF)	1
Estimated kWh's per annum	9,118 kWh's per annum
Estimated Co2 Savings	2,125 kg's per annum
Cost of Installation £325/m^2	£17,160
Annual Payback assuming 100% site utilization	£1,641 @18p/kWh
Time of payback	10.4 Years
Saving over 15 year period	£7,455
CO2 Saving over 15 Year Period	31.8 T.CO2

6.6 SUITABILITY APPRAISAL

All renewable energy technologies which may be considered feasible for the scheme have been assessed and summarised in table 6.5.

Table 6.5 Renewable Technology Suitability Appraisal

TECHNOLOGY	**APPRAISAL**
Wind	Not suitable at this site
Biomass	Not suitable at this site
Solar Thermal	Note suitable. Limited to HWS demand only. Significant portion of heating is attributed to space heating. Effective roof space is limited and a significant are of solar thermal panels would be required to meet the DHW load,
Photovoltaic Panels	Potentially suitable at this site subject to the primary heating method i.e. GSHP/ ASHP and electrical consumption within daylight hours.

7. RESULTS

The three principal steps taken; Be Lean (Use Less Energy), Be Clean (Supply Energy Efficiently) and finally Be Green (Renewable Technology measures) are summarised below.

7.1 SUMMARY OF LZC TECHNOLOGY

Through the application of the measures identified in Section 5, 6 and 7, table 7-1 summarises the payback and carbon emission reduction of each system,

Table 7-1 Summary Of Considered Systems For Primary Heat Source Only.

REF	SYSTEM DESCRIPTION	SERVING	INSTALLATION COSTS	RUNNING COST	15 YEAR LIFECYCLE COST	CARBON EMISSIONS REDUCTION OVER 15 YEARS
1	LTHW Condensing Boiler	General Heating	£0 existing boiler retained	£3,844	£57,674	0
2	GSHP	General Heating,	£192,000	£5,268	£271,034	179 T.CO2
3	ASHP	General Heating,	£101,000	£5500+821	£209,839	159 T.CO2

Table 7-2 Summary of Considered Systems For Electric Generation Only.

REF	SYSTEM DESCRIPTION	SERVING	INSTALLATION COSTS	RUNNING COST	15 YEAR LIFECYCLE COST	CARBON EMISSIONS REDUCTION OVER 15 YEARS
4	PV	Electrical offset	£17,160	-£1,641	-£7,455	31.8 $T.CO_2$

Table 7-3 Summary of Plant Space Required.

REF	SYSTEM DESCRIPTION	SERVING	PLANT SPACE REQUIRED
1	LTHW Condensing Boiler	General Heating,	$9m^2$ Internal Plantroom
2	GSHP	General Heating,	$10m^2$ internal plantroom + $512m^2$ external plant area for Boreholes
3	ASHP	General Heating,	St Cybi $9m^2$ Internal Plantroom + $10m^2$ external plant area for ASHP Eglwys Y Bedd $2m^2$ Internal Plantroom

			+ $2m^2$ external plant area for ASHP
4	PV	Electrical offset	$52m^2$ South Facing Pitch Roof

7.2 DISCUSSION

The application of low carbon technologies has been explored. Our finding indicates that air source heat pumps are a viable alternative to conventional gas fired heating systems. The key advantage of using a ASHP technology is the reduction in carbon emission. The carbon emissions would also improve over time as the electrical emission factors of the grid reduce due to the incorporating of renewable technology to the energy mix.

The running cost of the GSHP is comparable to ASHP system. However, the large capital outlay required for GSHP technology do not make the system a viable option with regards to payback. Additionally the external area require for the GSHP bore holes would significantly impact

For both the ASHP and GSHP options it is recommended that the incoming supply to the site is reinforced from 100Amp 1Ph to 100Amp 3Ph. Costs for upgrading the incoming supply have been included within the installation costs at £12,000.

PV appears to be a low-cost system solution for generating a portion of on site electricity, The payback of the system is acceptable.

7.3 RECOMMENDATION

Based on the assumption in this report, considering installation costs, payback and carbon emission saving, it is recommended that the following systems are considered for the detailed design stage:

- System 3 – ASHP
- System 4 – PV.

We would recommend that the following assessments are undertaken in order to confirm the final size of the ASHP and PV arrangement.

- Acoustic noise assessment
- Structural assessment of the roof to accommodate the PV array and plinth for the ASHP.

Note costs included within this report are associated with the integration of systems 3 and 4 listed about. Mechanical and electrical costs associated with the internal modification works associated with the Stones Shout Out scheme are not included.

APPENDIX A – SOLAR PV YEILD

Figure 1: Annual PV Generation Breakdown

APPENDIX B – SUN PATH ANALYSIS SCREEN SHOTS

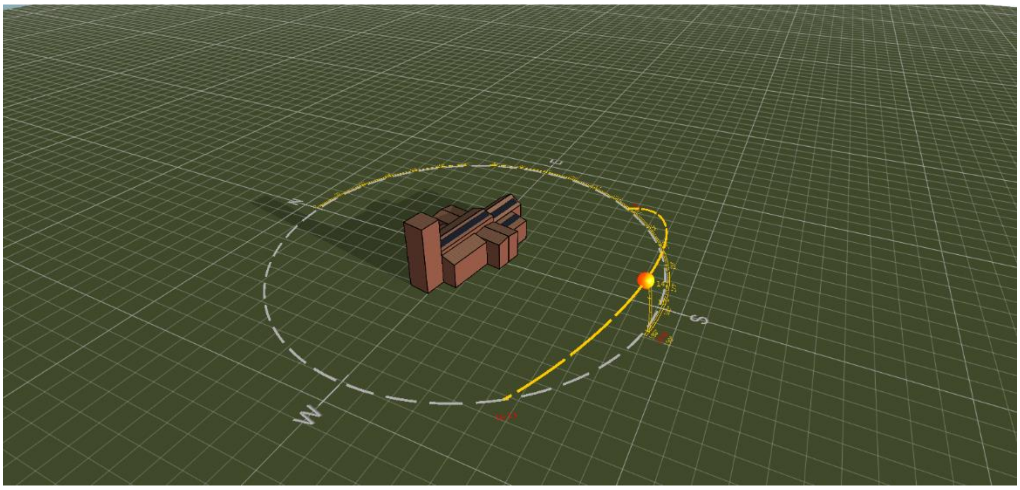


Figure 2: Solar Tracking January 15th 1pm

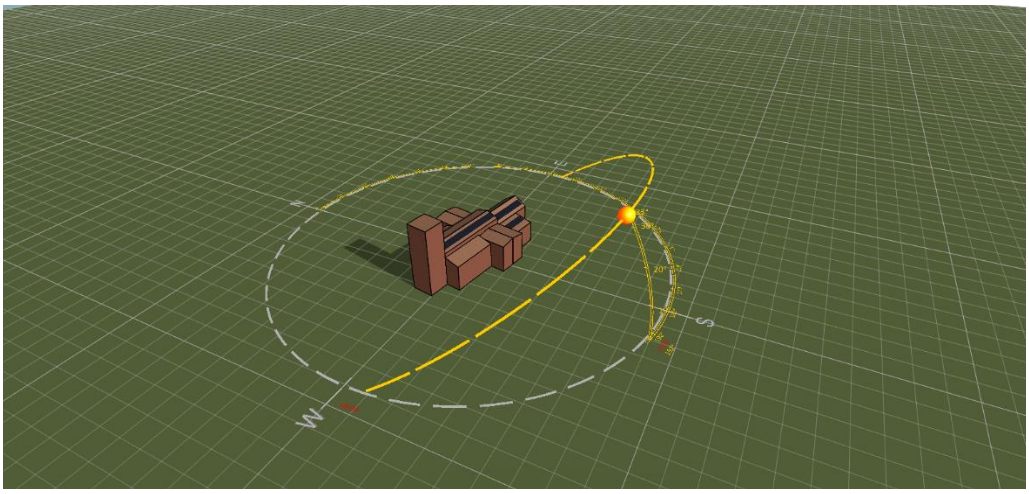


Figure 2: Solar Tracking January 15th 1pm

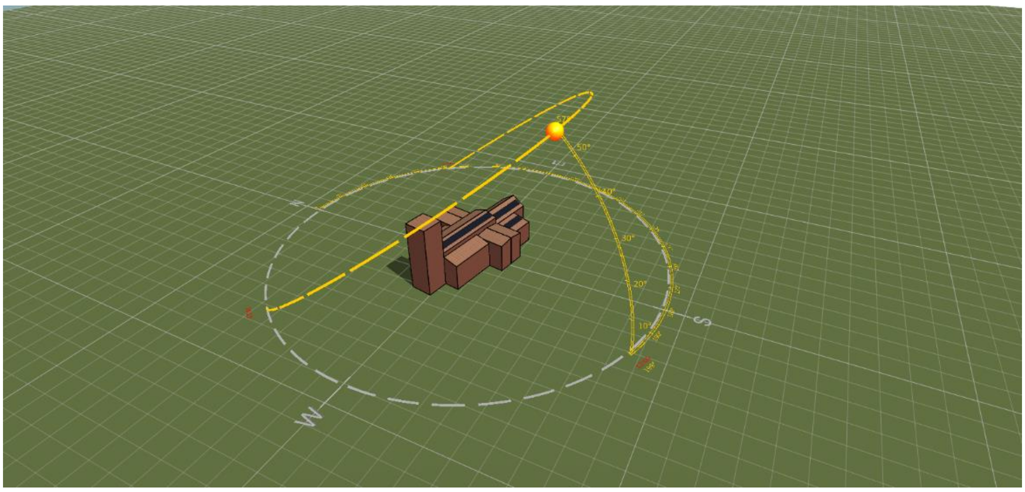


Figure 3: Solar Tracking July 15th 1pm

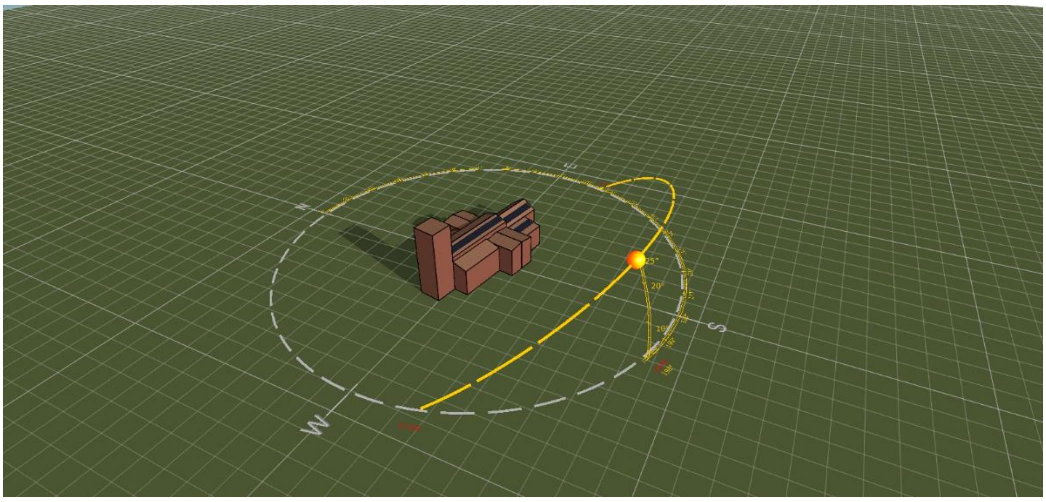


Figure 4: Solar Tracking October 15th 1pm

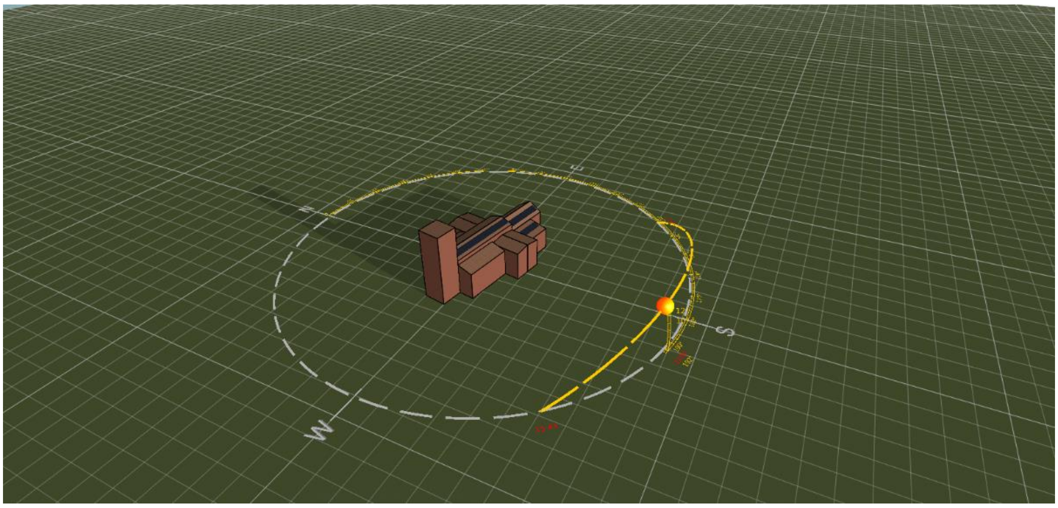


Figure 5: Solar Tracking December 15th 1pm

PV SLATE
by GB·Sol

Solar slates for beautiful solar roofs

GB-Sol's PV Slate is a discreet solar panel with the appearance of a natural slate tile while also generating solar electricity.

If you are already going to the expense of building or replacing your roof, why not fit a solar roof that will make your house more energy efficient and reduce your energy bills? There is no cheaper time to fit solar than when you already have the scaffolding up and a roofer at work.

- **Compatible** with traditional slates
- **Traditional** appearance for conservation areas & listed buildings
- **Robust** for all the UK weather can throw at it
- **British manufactured** in our spacious factory north of Cardiff
- **Lightweight** up to 50% less weight than traditional slates
- **Stronger** than traditional slates
- **Warranty** 25 years

GB·SOL
ARCHITECTURAL SOLAR POWER

PV Slate technical details:

Seamless solar for sensitive aesthetics

The PV Slate is a small solar panel that looks like a row of 3 or 4 natural slates. PV Slates can be installed by an experienced roofer once trained. Each unit has a robust metal frame which interlocks with the surrounding slates for waterproofing and is fitted to traditional roof battens with stainless steel screws.

Electrically, the PV Slates are connected together using industry standard MC4 connectors and then wired back to the inverter for conversion to mains power, like any other solar installation. PV Slates can provide a peak solar output of 1kW from a roof area of around 6.5 square metres.

Compatible with natural slates

PV Slates are compatible with traditional slates, so they can be fitted into a traditional roof construction without any extra roofing accessories. This is cost-effective and enables you to choose how much of your roof you would like to invest in solar, with remainder as traditional slate.

PV Slates are suitable for conservation areas and have also been successfully used in AONBs and on listed buildings. No additional planning permission is necessary over that required for a traditional slate roof. For the best colour matching, we recommend light grey or blue grey 6mm natural slates. Please see our website for an up to date list of compatible slates.

Also available edge-to-edge

Slate looks even more amazing when taken edge-to-edge by using the same materials to make the surrounding "infill" slates. You would never know it wasn't a natural slate roof. Please contact us for more details.

Each PV Slate comes with a comprehensive **25 year warranty on product, performance and weatherproofing.**

MCS accredited

PV Slates are accredited under the Microgeneration Certification Scheme, so they can help reduce the official EPC rating of your property and be a cost-effective way to comply with Part L of the Building Regulations. MCS accreditation also means that any surplus power from your PV Slates qualifies for extra income under the Smart Export Guarantee scheme.

Battery storage systems

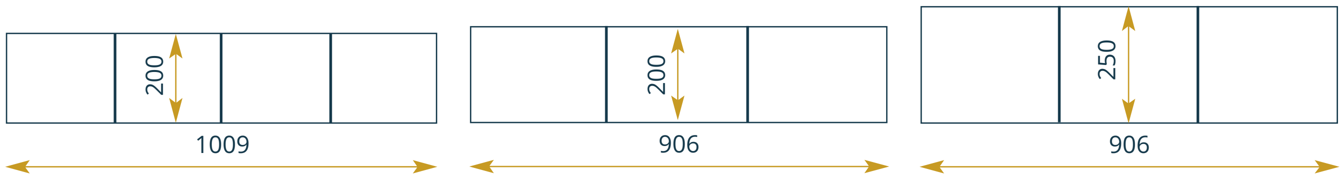
Like any other solar panels, PV Slates are compatible with battery storage systems from a wide range of manufacturers, whether it is to increase the use of the solar energy you generate or to provide protection from power cuts.

PV SLATE
by GB·Sol

Roofing & Mechanical Data:

	PV Slate 500x250	PV Slate 500x300	PV Slate 600x300
Natural Slate Compatibility	500mm x 250mm x 6mm	500mm x 300mm x 6mm	600mm x 300mm x 6mm
Natural Slates Replaced	4	3	3
Nominal Output	27.5 Wp	25.0Wp	35.0 Wp
Wp per m2 Roof Area*	136 Wp	138 Wp	155 Wp
Dimensions (Length x Width) - Visible on Roof	1009mm x 200mm	906mm x 200mm	906mm x 250mm
Weight	3.2Kg	3.0Kg	3.8Kg
Minimum Natural Slates on Roof	Two natural slates are required around all edges of the roof and features such as roof windows.		
Natural Slate Colour Compatibility	Use light grey or blue-grey slates for the best colour match. Please see our website for an up to date list of suggested makes & models.		
Batten Gauge	200mm	200mm	250mm
Roof Pitch (Typical)	22.5°-90° - Dependent on location - contact us for more details		

PV Slate 500x250 **PV Slate 500x300** **PV Slate 600x300**



Dimensions show the visible area of a single PV Slate unit on the roof.

Electrical Data:

	PV Slate 500x250	PV Slate 500x300	PV Slate 600x300
Nominal Output	27.5 Wp (+/-5%)	25.0 Wp (+/-5%)	35.0 Wp (+/-5%)
Short Circuit Current	4.3 A	4.3 A	6.8 A
Open Circuit Voltage	8.1 V	7.4 V	6.8 V
MPP Current	4.1 A	4.1 A	6.5 A
MPP Voltage	6.6 V	6.2 V	5.5 V
Temperature Coefficient of Power	-0.40%/K	-0.40%/K	-0.40%/K
Temperature Coefficient of Voltage	-0.32%/K	-0.32%/K	-0.32%/K
Temperature Coefficient of Current	-0.042%/K	-0.042%/K	-0.042%/K
Maximum Permissible System Voltage	600 V	600 V	600 V

General Data:

Weatherproofing Warranty	25 Years
Product Warranty	25 Years
Power Output Warranty	90% of nominal power output for 10 years and 80% for 25 years
Product Certification & Testing	MCS 012 (BABT 8752-02) & MCS 005 (BABT 8501-15), EN 15601:2015 (Weathertightness), EN 13501-5:2005 (Fire), CEN/TS 1187:2012 (Fire), BS 476-3:2004 (Fire - EXT.S.AA Rating), BS EN 14437:2004 (Wind Uplift)

GB·SOL
ARCHITECTURAL SOLAR POWER

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#pvslate

Please note that visits to our premises are by appointment only.

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