MAX FORDHAM

St Mary Magdalene, Stockland Bristol

Heating and Energy Study

Issue 2

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ISSUE HISTORY

Issue	Date	Description
1	17/10/24	Draft for discussion
2	25/11/24	Reissue incorporating Client comments

MAX FORDHAM LLP TEAM CONTRIBUTORS

Engineer (Initials)	Role
SRW	Principal Engineer
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CONTENTS

1.0 INTRODUCTION

Max Fordham LLP (MF) have been commissioned by St. Mary Magdalene Church, Stockland Bristol to undertake a study into options for heat sources and heat delivery at the Church and to investigate the options for on-site generation at the site.

For the report we have conducted a heat loss assessment of the existing church using industry standard calculation methods and provided a summary on the impact of fabric performance improvements. These are used to determine the required heating capacities for two scenarios: Heating the church as a whole and heating the North Aisle and adjacent spaces separately, to consider a heat zoning strategy for a potential new community space within the church.

Options for heating the church are compared and recommendations made. We consulted the following sources for guidance on fuel sources for heating:

- *The Church of England Routemap to Net Zero Carbon by 2030* clearly states the prerogative for churches to 'include, as a minimum, low-carbon heating options to replace fossil-fuel heating…such as heat pumps or far infra-red heating panels' as part of their net zero carbon action plans.
- *The National Lottery Heritage Fund environmental sustainability good practice guidance* asks applicants to demonstrate reduction in operational carbon footprint through effective energy management and renewable energy sources.

Besides the clear guidance on the avoidance of fossil-fuel based heating systems, there is no existing mains gas connection in the village. For these reasons, we have discounted fossil-fuel based systems and focused only on electricity-based systems. The C of E Routemap recommends that electricity is supplied from cleaner sources by switching to 'green' tariffs. For the purposes of net zero carbon, the church's current approach is that a 'green' tariff is 100% renewable.

C of E Routemap to Net Zero Carbon by 2030 diagram recommending avoidance of fossil fuels

The impact of different electric heating systems are compared by annual energy use, carbon emissions and cost.

We have investigated the existing electrical supply and set out the required electrical capacity increases and infrastructure costs needed to achieve an improved electric heating installation at the church. National Grid have provided a budget estimate which is described in more detail within the report and included in the report appendices. Heating control options are reviewed.

We provide an options feasibility analysis for on-site generation to the church. Recommendations for further Client consideration are provided and manufacturer proposals are included in the report appendices.

Recommendations

- New mains water supply. The client should obtain a quotation from Wessex Water for a new connection.

- Electrical supply upgrade. Any new electric heating system is likely to require an upgrade to the electrical supply to the church. National Grid, the local electricity Distribution Network Operator, have provided a budget estimate for an upgraded three-phase 69kVA supply. This supply would be sufficient for the highest-case peak load of future installation and is expected to cost in the region of £22,500. The budget estimate is included in the report appendices.

- Legacy heating system. All existing legacy heating system plant, pipework and heat emitters should be removed.

- New heating system:

    - If the Client proceeds with the community space this area should be zoned separately to the main church.

    - North Aisle heating. Due to the expected occupancy pattern of shorter and unpredictable visits for the North Aisle community space, we recommend an infra-red radiant heating system (Herschel HALOs) is installed. The HALO system is quick to respond, easily controllable and provides comfort to occupants rather than heating the whole space.

    - As part of the proposed community space works we recommend the installation of underfloor heating pipework at low cost in the North Aisle floor to allow for future Air Source Heat Pump (ASHP) connection if the space successfully develops a constant occupancy profile.

    - Main Church heating. We recommend that the infra-red HALO system also be installed in the main church space, if financially feasible. This would provide an increased level of comfort compared to the existing under-pew heaters.
    - If under-pew heaters are retained we recommend they are replaced with newer, modern versions.

- Control Options. We understand that the church wishes to operate a 'pay-as-you-use' type control and billing system to allow diverse groups to use the North Aisle space heating without incurring a financial/administrative burden. The simplest, most-user friendly and flexible strategy for this is likely to be the use of a contactless payment timer which allows church users to pay on the spot for a given amount of heating time with a bank card. The church sets the rate charged, which may incorporate the £10/month charge associated with this type of payment timer.

- Fabric Upgrades:

    - We recommend that fabric upgrades (floor and roof insulation, draught-proofing) are undertaken as part of the proposed works to the North Aisle. This has less of an impact on energy use with an infrared heating system than a heat pump based system; but has an impact on comfort and fabric conservation.

    - We recommend that the proposed partition screen between the North Aisle and main nave is designed with as low a U-value as achievable in the context, to reduce heat loss to the main church during zoned heating.

    - We recommend that fabric upgrades (floor and roof insulation, draught-proofing) are undertaken in the main church where practically and financially feasible.

- On site generation options:

  - Solar Photovoltaics (PV). Based on advice from photovoltaic specialists Solarsense, we recommend that the option of PV panel installation on the main South roof of the church should be explored further if the location is acceptable in heritage and planning terms and if issues around the extent of on-site power demand can be better understood. An array on the South roof should pay back within 20 years in the worst use-case. Other roof areas are available on the church but due to small area allowances and/or overshading PV arrays in these locations aren't considered feasible.

  - Wind Turbines. Based on analysis from wind specialists RYSE energy, we recommend that the church explores further the feasibility of wind turbine installation in the field to the Northwest of the churchyard, subject to permissions and landownership. A larger wind-turbine installed here could be a financially viable project if energy generated could be mostly used concurrently on site and/or co-ordinated as a community energy scheme within the village utilising battery storage in conjunction with favourable peak-export tariffs.

Next Steps

- Receive and incorporate comments on this report from the Client.

- Review capital and fuel cost assumptions with Client and suppliers.

- Discuss and agree a preferred approach with the Client, and reissue this report with additional next steps before proceeding with the development phase and the detailed MEP design.

2.0 THE EXISTING CHURCH

2.1 Client Brief and Available Information

Max Fordham LLP visited the site on 2nd September 2024 to attend a briefing meeting with local Church members and Chantrey Conservations Architects (CCA). A visual inspection of existing services at the Church was also held.

The briefing meeting provided a background to the Church; how it is currently used, the proposed upcoming works and the vision for its future use. A new community space within the North Aisle and new WC within the Vestry was presented. Zoning of the community space, proposed new services (heating, lighting, water supplies, metering, internet) and operational requirements were discussed.

We have been provided with the most recent April 2024 Quinquennial report (CCA) and survey drawings (Survey Solutions) of the Church. Drawings of the proposed works have also been provided (CCA). The current asbestos management plan and survey reports have been provided to assist with risk assessments. The client has also provided recent electricity bills and wiring certificates.

2.2 Background

St. Mary Magdalene Church is situated in the village of Stockland Bristol on the Steart peninsula approximately 5 miles North East of Bridgwater, postcode TA5 2PZ. The current Church was constructed in 1865, replacing the pre-existing medieval Church.

The Church comprises chancel, nave, North aisle, North vestry, South porch, South chapel and West tower. It is Grade II listed, although not within a conservation area. The Church is on Historic England's 'at risk' register.

St. Mary Magdalene Church boundary and context

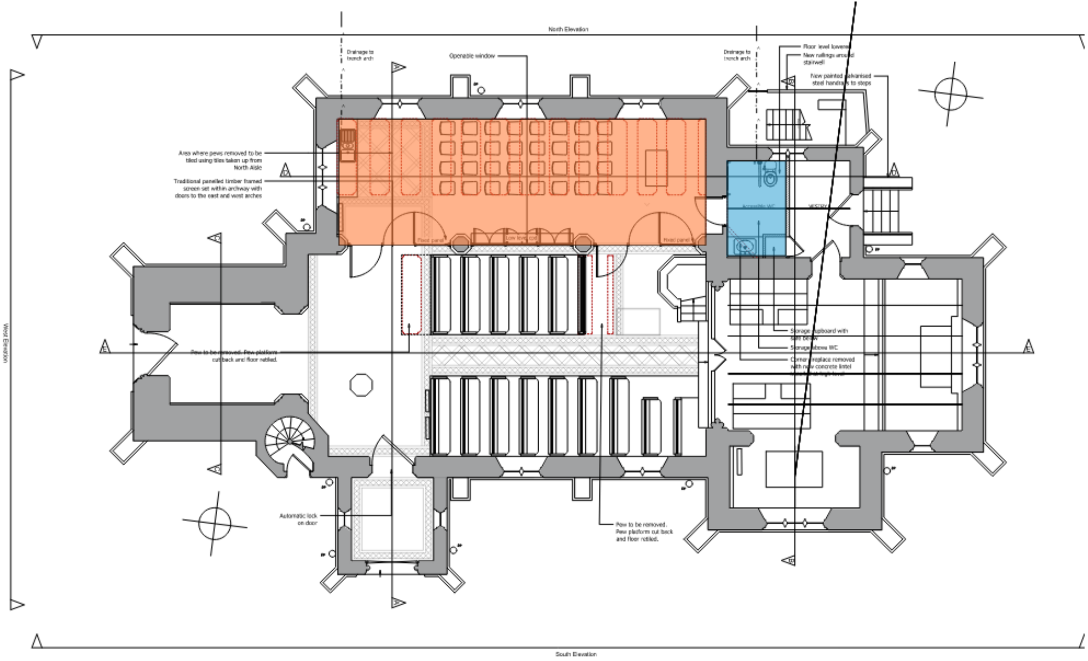
The village of Stockland Bristol is relatively isolated on the Steart peninsula, with the Hinkley Point power station development 3.5km to the West. The village lacks a communal space for residents to meet and conduct group activities outside of the private sphere.

The nearby Steart marshes are a wetland reserve, drawing groups of ecology students/school groups, while the nearby coast path attracts walkers. There is no provision for either of these groups to shelter or gather at the village.

A client group has formed which is seeking to combine much-needed repair works with a project to screen off the North Aisle of the Church to use as a Community space and transform a section of the vestry into an accessible WC. This will be intended to serve the needs of:

- The Church Community.
- Local village activity groups.
- Bookings by visiting student/school groups.
- Refuge for walkers.

North Aisle Community Space



Proposed plan of the Church with new North Aisle community space (orange) and new accessible WC (blue)

It is intended that a screen will be constructed which thermally separates the North Aisle space from the rest of the Church. This is shown as a traditional panelled timber framed screen set within the archways with doors to the East and West arches with openable windows to the main Church in the central arch.

The existing pews are to be removed and replaced with movable seating. A kitchenette is intended to be included at the West end of the North aisle. This may include tea/coffee making facilities and possibly a hot drink vending machine. A water supply will be required to this location and an electrical supply for point-of-use water heating.

We understand that a projector would be desired to project content upon a screen on the East wall during group activities.

North Aisle (pews to be removed)

New partition to be introduced within the arches to North Aisle

Vestry Accessible WC
To accommodate groups, the Church is seeking to convert a section of the East Vestry floor space into an accessible WC. This will require both a cold water service to this section of the building and an electrical supply with sufficient capacity for point-of-use water heating.

Area of the Vestry where new Accessible WC is to be introduced

2.3 Summary of Existing Systems

Legacy Heating System

The Church was once heated by an old fossil fuel boiler (assumed coal) located in the basement boiler room beneath the vestry. Access to the boiler room is via a slippery external staircase covered in vegetation and the room itself is a hazardous site littered with rusting remains. It is understood the work to the vestry will involve lowering the vaulted ceiling of the boiler room. The asbestos report on the Church highlights the likelihood of asbestos content at the gasket on top of the redundant boiler, which should be considered in the event of dismantling of the existing pipework.

Old boiler located in boiler room beneath vestry

The boiler served surface mounted pipes and cast-iron radiators in the main body of the Church. These radiators and pipework are still present in the Church, but no longer operational. Some of the large diameter pipework runs through floor voids with grates.

Old cast-iron radiators and pipework running in trenches

We recommend that all the existing heating installation plant, radiators and pipework is removed in advance of any future works. Preparation for removal works will have to account for the likely presence of asbestos in several of the existing plant locations.

Existing Heating System
The existing heating system is delivered using electrical heat emitters. There are currently 2no. 180W direct electric under-pew heaters beneath each pew in the central nave. We understand the total number to be **28no. under-pew heaters,** with a total heating capacity of **5.04 kW.** We understand these to be controlled at the wall by the main door with a separate switch for the two rows of pews. The response from community members as to the effectiveness of the heating was that it is easy to control and quick to respond; switching on an hour or two before occupancy; but performs poorly in terms of comfort 'enough to warm the trouser legs'.

Existing 180W under-pew direct electric heaters with dual zone wall control

There is currently no mains gas connection to the Church. We understand there is no mains gas infrastructure within the village and that no future plans to extend to the village exist.

Existing Electrical Supply

The main incoming electric supply enters the Churchyard above ground on the Southwest corner of the Church, attaching to the vice turret. A pair of cables then run down to the distribution boards which are located inside the South porch. The quinquennial inspection report states that an upgrading of the electrical supply may be required.

Incoming electrical supply from transformer in neighbouring field entering into the porch

Existing electrical cutout, meter and distribution board

The incoming supply is 230V single phase. Two distribution boards are located next to the cutout and meter. The fuse is rated at 100A, with a maximum demand (load) of 60A. The earthing arrangement is TT, meaning that there is an earthing rod local to the Church. This is located to the West of the porch. The 2023 wiring report indicates that the earth electrode enclosure is damaged and requires replacement.

Distribution Board 1 has 7 ways, supplying two 6A lighting circuits, a 16A circuit for the porch light, a 16A circuit for the porch and entrance sockets, and a 10A circuit for the organ and outside socket. There are 2 spare ways.

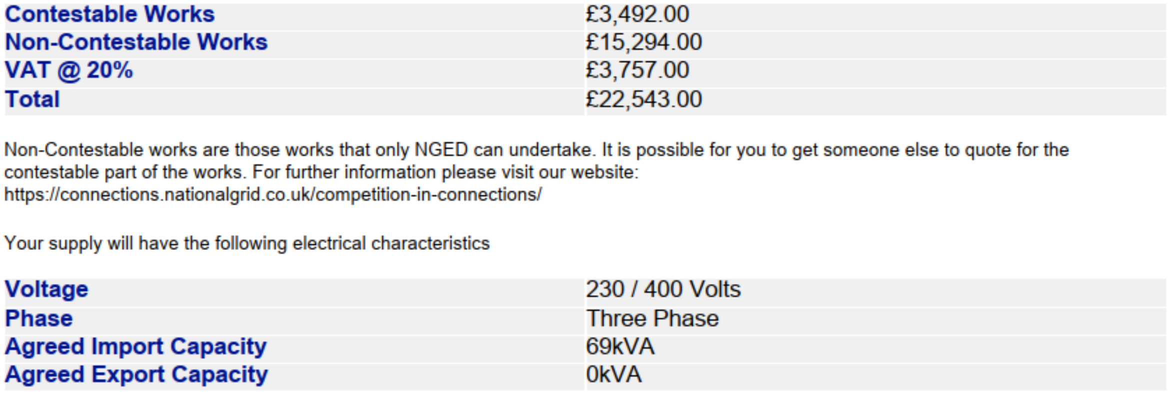
Distribution Board 2 has 3 ways. There are 2no. 16A circuits for the heaters on each side, and a 2A circuit for controls.

It is likely that for any scenario which involves satisfactory or improved comfort levels through additional heating to the Church will require an upgraded electrical supply, whether that is via a direct electric system or through the use of heat pumps. Any upgrade to the supply should account for projected future uses and installations.

If a heat pump is installed either now or in the future, and in order to meet the required Church heat load, it is likely to be of a size that requires a 3-phase supply. It is understood that there is an existing 3-phase supply to the nearby Vicarage Nursing home.

We have made contact with the local District Network Operator (National Grid) in order to obtain a budget quotation for a supply which accounts for the highest load scenario.

The total cost of National Grid's Budget quotation is £22,543. This accounts for contestable and non-contestable works for a three-phase connection with an agreed import capacity of 69kVA. See *Appendices National Grid Budget Estimate* for the full estimate and explanatory summary.



Contestable Works	£3,492.00
Non-Contestable Works	£15,294.00
VAT @ 20%	£3,757.00
Total	£22,543.00

Non-Contestable works are those works that only NGED can undertake. It is possible for you to get someone else to quote for the contestable part of the works. For further information please visit our website: https://connections.nationalgrid.co.uk/competition-in-connections/

Your supply will have the following electrical characteristics

Voltage	230 / 400 Volts
Phase	Three Phase
Agreed Import Capacity	69kVA
Agreed Export Capacity	0kVA

National Grid Budget Estimate for upgrading electricity supply to a 3-Phase 69KVA supply

The existing power supply to the village has been known to experience numerous power cuts. The reasons for this extend beyond the scope of this report, but the issue may need to be explored further with SSEN.

We understand the existing external electrical supply is used for seasonal events. This should be retained for use alongside any general electrical upgrade.

Existing Lighting System

Lighting within the Church is currently achieved through a number of luminaires mounted at height on the side walls, which generally flood the walls and shine into the space. These create some experience of glare within the church. We are not currently aware of the age of the current system, but modern LED lighting systems have made great improvements in efficiency. A new lighting system could benefit from using much less electricity and an improvement could be made to the lighting contribution to the Church aesthetic.

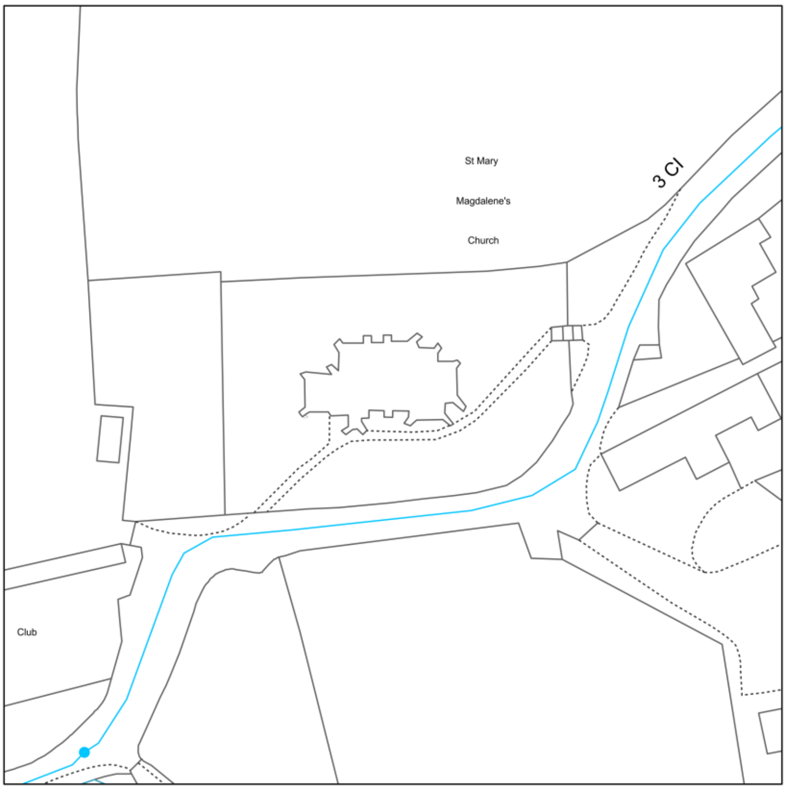
Existing electric lighting within the Church

Before the current electric lighting system, the Church has been lit by gas lamps. Small-bore gas pipework can be seen running along the piers and arches to gas lamps on the piers. These no longer work, but there may be some scope to reuse the existing pipework routes for wiring and to *re-candle* the lamps with LEDs. New mineral insulated copper cable (MICC) could be used for future power supplies, with the external coloured sheathing removed to leave the copper conduit on view.

Legacy gas lamps and pipework on piers at St. Mary Magdalene; Examples of Mineral Insulated Copper Cable (MICC) specified by MF in heritage buildings: (St. Mary Magdalene church, Paddington), (Wiltons Music Hall)

Existing Water Services/ Drainage
There is currently no mains water supply to the Church. Rainwater is collected in a butt for external use. Wessex Water asset maps indicate a water main running adjacent to the Church beneath the main road. A new connection will be required to serve the proposed kitchenette sink, WC and an external tap. There is an administration cost of around £150 associated with the application for a new connection. The client should obtain a budget quotation for a new mains water supply.

Existing water butt at the back of the Church



Wessex Water Asset map showing water main in the road.

There is currently no foul water drainage from the site. New drainage connections will be required for the kitchenette in the North Aisle and sanitaryware in the accessible WC. Design of drainage systems for the building is beyond MF scope. Please refer to architect's proposals for site foul water drainage.

2.4 Existing Building Fabric

The Church is Grade II listed and on Historic England's 'at risk' register. The Church is primarily Blue Lias stone with ~600mm thick walls. The roofs over the main nave and North aisle are uninsulated timber structures with timber boards and clay tiles above. Much of the glazing is lead beaded stained glass, but the glazing is not stained in the North Aisle. The floor is generally ceramic tiles over an unknown substrate, with some trenches. The pew areas include an additional raised timber floor. We have made assumptions on the thermal performance of the existing fabric, which are discussed in later sections.

The assumptions could begin to be validated with an airtightness pressure test and a thermographic survey, if these are agreed to be useful as the design progresses. If new internal insulation is to be considered, then we recommend consideration of appointing a specialist to undertake a structural moisture survey. Currently wall insulation has been assumed very unlikely to be progressed.

3.0 HEAT LOSS ASSESSMENT

3.1 Modelling the Existing Building

Peak power demands are only required to be met for a few hours each year. The running cost and carbon emissions of a building relate to the annual energy demands (in kWh), which depend not just on the worst-case but also on how the building is used through the year.

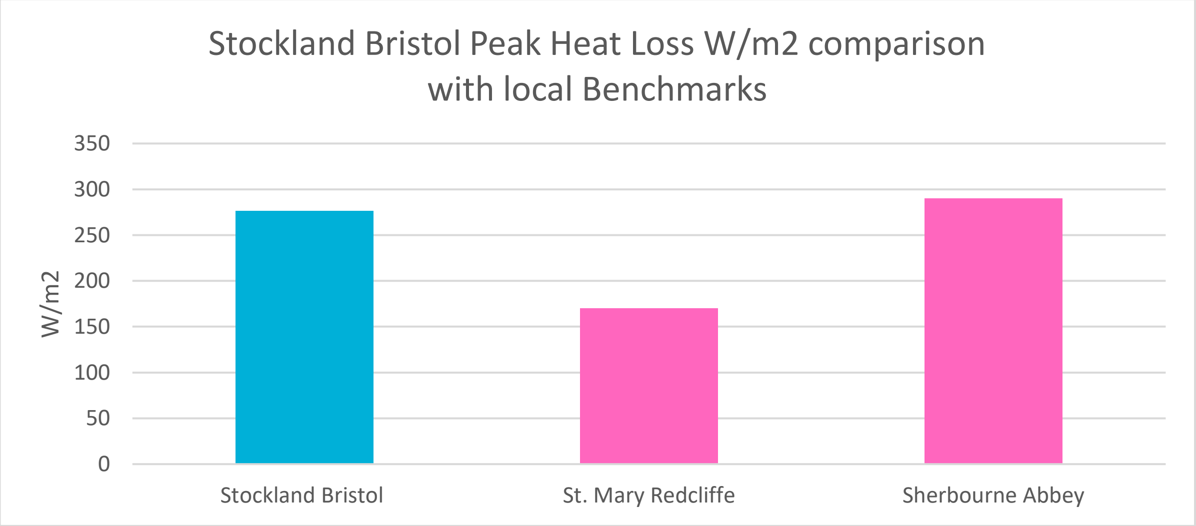
The Church has provided us with billing information for the periods from January 2021, from which we have aggregated approximate annual totals for the Church's current electricity usage. For both 2021 and 2022, this has been in the region of 400 kWh.

As a benchmark for energy use, we propose that about 250kWh/m^2 fossil fuel usage per unit floor area is appropriate for a medieval Church, which is based on 2000 hours of operation per year (from CIBSE TM46 which whilst outdated is still relevant for some older building types). St. Mary Magdalene is using around 2kWh/m^2 annually. This is extremely low usage in comparison, due to the relatively very low usage of the Church and the underpowered existing heating system which only provides a small degree of comfort heating, rather than heating the whole space, or providing genuine occupant comfort.

The current electricity use figures do not provide a reliable guide for the heat loss of the Church. Any new system should look to provide a comfortable environment for occupants through either heating the building to meet its peak heat loss, or increasing the extent of *point of use* radiant/infra-red heating emitters to achieve occupant comfort. Therefore the overall heat demand to heat the building will be significantly higher than the current system's heating output.

We have modelled the heating of the building (using the CIBSE TM41 accumulated degree day method) making assumptions on heat loss ('U-values'), airtightness and internal heat gains from equipment and people.

Using those assumptions the model predicts a peak heat loss of around 50kW for the whole Church. This is to maintain an internal temperature of 18C at -2C externally, and includes a 10% warm-up margin, set out in the *input parameters* section. This is around 10x higher than the current under-pew system can produce and corresponds to a peak heat loss of around 260 W/m^2. From similar Church buildings we have found benchmark heat loss figures to be between 170 and 290 W/m^2 , so this appears to be on the slightly on the higher side of what might be expected. Fabric improvements, such as roof insulation could significantly reduce this figure.



3.2 Modelling Proposed Refurbishments and Annual Use

A new heating system is required in conjunction with the overall project to encourage greater community use of the space. Therefore the annual use profile of any new system is likely to be significantly different from the current use. We have therefore assumed a prospective ‘successful-case’ weekly occupancy profile with more frequent use than current to predict annual heating use. This is detailed in the *input parameters* section.

If the whole Church were to be heated to meet occupant comfort levels during all occupied periods throughout the year (external temperature is accounted for in the degree days method), then this would result in an annual heating energy requirement of around 180kWh/m^2 annually, for around 1000 hours of use (heat-up periods are incorporated into each use). Accounting for the difference in occupancy profile this is higher than the 250kWh/m^2 benchmark based on 2000 hours.

All buildings are used in different ways and subject to subtleties which a model cannot foresee, so all of these numbers should be regarded as guidelines only.

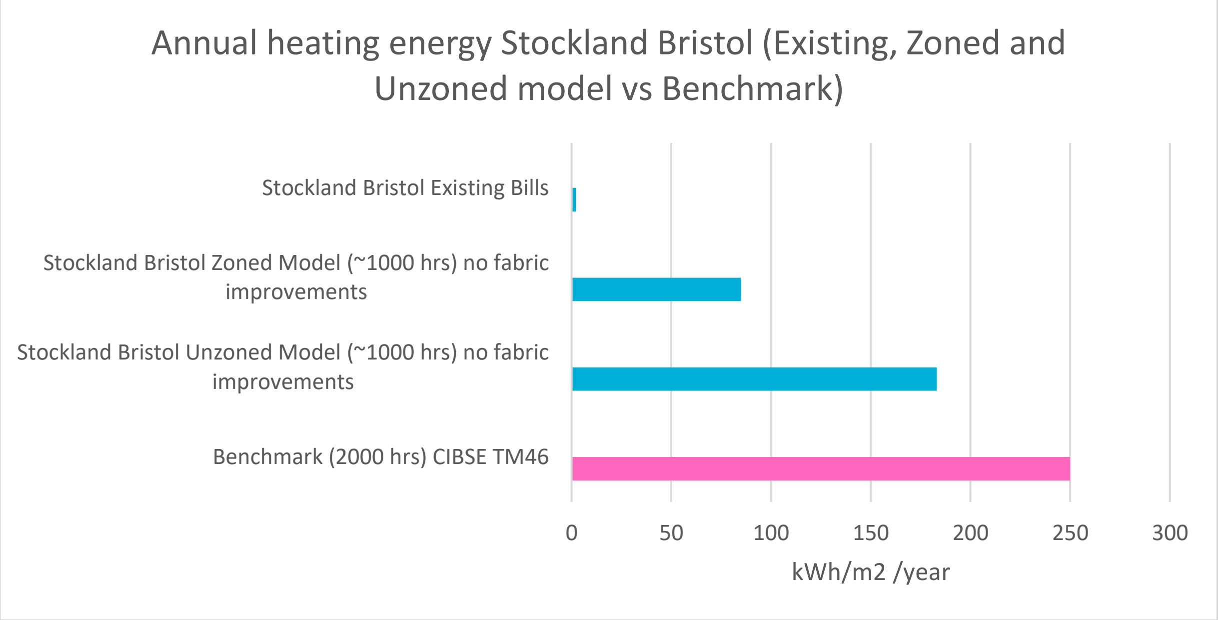
Zoning Heating Areas

The intended future use of the Church includes activities in either the newly-screened off North Aisle and separately at different times in the main Church space. We don’t envisage currently that both spaces will be used simultaneously on a regular basis.

It would clearly be wasteful to heat the whole Church on each occasion, so we have considered a scenario in which the screen between the North Aisle and the Main Church thermally separates the two areas, and so each area is zoned, with the requirement only to heat each space on its own in conjunction with its proposed occupancy pattern.

In this scenario, the new panelled screen acts as an additional heat loss surface: from a heated North Aisle to a cold Church and vice-versa. However, there is a clear reduction in energy requirement if heating is targeted only at the zone in use at the time.

In a zoned scenario, the annual heating energy required is reduced to around 85kWh/m2. Accounting for the difference in occupancy profile, this is an improvement on the typical benchmark figure.



3.3 Hot Water Usage & Cooking

Currently the Church has no mains water service, or hot water heating. Part of the proposed project is to incorporate a small kitchenette space into the North Aisle Community space, with hot water to the sink, in addition to the hot water for a wash hand basin in the new Accessible WC.

Hot water usage is assumed to be relatively low – associated only with limited Kitchenette and WC use. The proposed hot water strategy assumes:

- Instantaneous hot water to WC wash hand basin.
- Semi Instantaneous (limited hot water storage) to kitchenette sink.
- No permanent cooking facilities to be provided.
- Kettle to provide hot drinks.

This additional electricity usage for hot water applies across all the prospective heating scenarios. It has been omitted from the heating options comparison model for this reason, but it should be noted that it implies an additional electrical load to those that are presented for heating only.

It is difficult to predict how much energy might be used in the generation of hot water, as it is entirely dependent on an unpredictable usage pattern and so will fluctuate with occupancy levels. A peak non-diversified (all electrical items in use at once) load is used to inform the new increased electrical supply requirements.

4.0 ENERGY OPTIONS – TECHNICAL FEASIBILITY

The following paragraphs outline the main aspects affecting feasibility and suitability of different heating & energy approaches, in order to discount inappropriate systems and focus on comparing options only for systems which are feasible and suitable for the site.

4.1 Heating Options

Retain Existing Under-Pew Heaters – Low impact, low comfort option for main Church space.
The current existing heating system comprises of pairs of 180W under-pew heaters under each pew in the central and South aisles of the main Church. This system provides a small amount of heat, 'enough to heat the trouser legs' which is targeted at the occupant, without the requirement to heat up the whole Church. It is controlled at the wall, with a separate switch and dial for each zone, enabling the central aisle and South aisle to be turned on separately if required.

This is a simple system and is already in-situ, requiring no upfront costs to install, no maintenance costs and is intuitive and well-understood by the Church users. The total output of the heaters is very low in comparison to the Church's peak heat loss, so will not successfully heat the space in very cold weather. They are low-output and widely distributed, so although more targeted than a centralised wet system, there is still only a small amount of heat arriving at each occupant. It is understood that congregations which fill up the whole aisle are rare, so there is plenty of heat going to waste where not required. A new/supplementary system would be required to achieve genuine occupant comfort in the main part of the Church, but it is workable as an existing system in an environment where occupants expect a degree of discomfort, should a whole-building-wide solution not be feasible.

There is no pre-existing installation in the North Aisle. It is understood that the pews in the North Aisle are to be removed, so this is not a suitable option for that space as a new system.

Existing Under Pew Heaters

Zoned Control for Central and South Aisle

180W output rating per heater

Biomass – Not suitable
It is judged intuitively that a biomass boiler installation is unsuited to the Church. Due to the need for regular deliveries, external storage space and a high maintenance burden, this is not seen as a suitable option.

Direct Electric Heating – Possible supplement to efficient heat pump system
Heating buildings using e.g. electric storage heaters, direct radiant panels or electric boilers (immersion heaters) has often been regarded as unacceptable due to the historical carbon emissions of grid electricity. This is changing, and direct electric space or hot water heating is now in some situations the best solution.

It is cheap to install and maintain, quiet, relatively un-obtrusive and controllable. However, the running costs in the near future will be high compared with a heat pump or boiler, and there is a risk that it may compromise compliance with planning or Building Regulations (less of a constraint where a listed building is being refurbished).

Direct electric heating may however be desirable to provide direct occupant heating and comfort and/or as a supplement to a more efficient heat pump system, only used on the coldest days of the year.

Direct Electric - Infrared Heating – Suitable option for targeted heating and flexible control with high electrical requirement

Infrared (radiant) heating systems directly heat objects and people in a space as opposed to heating the air in the space as a whole. When employed in a space with a large volume, such as a warehouse, sports hall or indeed a Church, this enables energy savings by only providing the amount of heat that is required for occupant comfort. These systems provide comfort heating almost immediately and so negate the need for long warm-up periods.

Infrared/radiant heating has traditionally had poor aesthetic reputation due to the emitter designs and strong orange visual glow of the elements. This glow is associated with short-wave infrared heating from high surface temperatures. This type of infrared heater can also cause discomfort due to the uneven temperature gradient experienced across the body as people experience ‘hot heads and cold feet’. These products are generally suitable for external heating, with air movement and very cold surroundings.

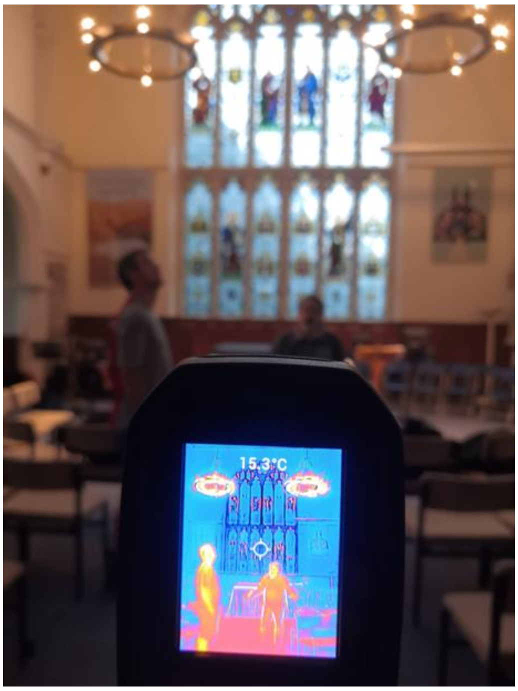
Newer products are employing medium and long wave radiation, with a lower surface temperature. This type of radiation is more easily absorbed by humans. These products are designed to provide comfort heating in large internal spaces, with lower air movement compared to externally. The units do not emit a visible glow, and the heat experienced by occupants is less direct, with reflected radiation from surfaces, e.g. the floor contributing to a ‘bubble of heat’ effect which is designed to reduce the uneven gradient of temperature across the body. Products such as the Herschel HALO have been designed with an aesthetic and practicality specifically with heritage Church buildings in mind, with chandelier, under-pew and wall-hung models. Although a fairly novel technology, these have been trialled in Churches with positive feedback on comfort and energy costs.

A system such as this brings some benefits in terms of controls and additional costs. Controls can be simply adjusted by occupants to vary output to the level required for comfort, with instant experiential feedback, or can be automatically controlled with a ‘radiant thermostat’ which modulates output to meet the comfort threshold without overshooting. These systems have no moving parts and so have a long life expectancy with no maintenance burden or additional costs. They are also silent.

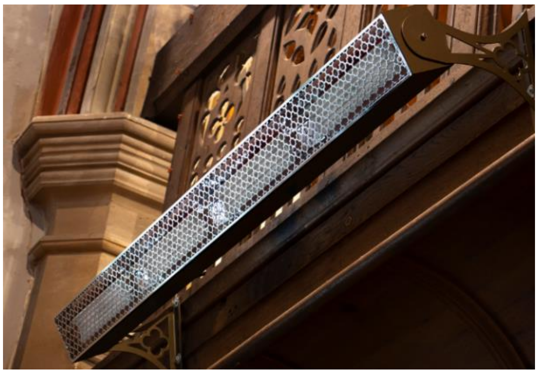
Infrared systems use the same amount of electricity as the amount of heat they emit, compared to heat pumps which can produce around 3x as much heat as the electricity they use. For this reason a higher peak electrical demand is experienced if the whole Church is fully heated simultaneously. This means that the supply capacity required from the utility would be higher than that of an heat pump system with equivalent heat output. In any case the use of infra-red heating at the Church is likely to trigger the requirement for an increased supply capacity from the utility with some additional upfront costs.

This can be considered a suitable system for St. Mary Magdalene, particularly as the benefits of control flexibility may

Herschel HALO Long-wave Infra-red Heater



HALOs in St. Matthew’s Church, Cotham, Bristol, seen through thermal imaging camera.



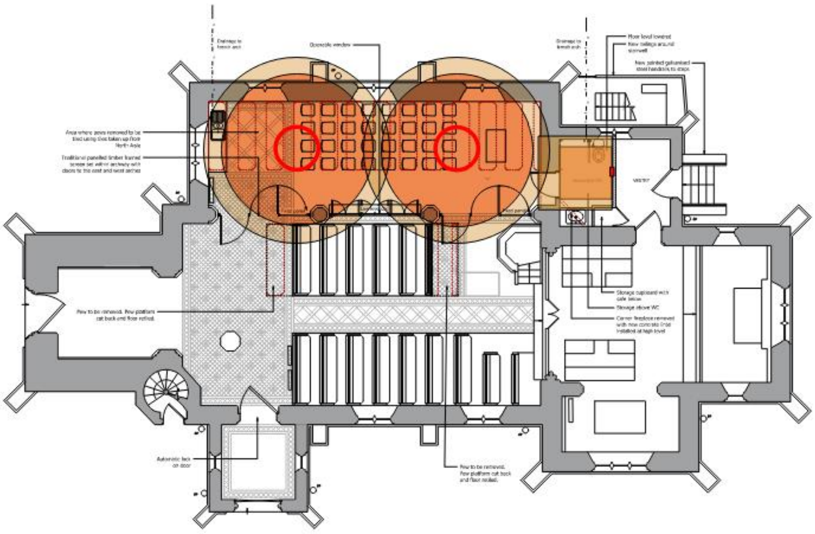
Herschel HORIZON Long-wave Infra-red Heater for Churches tally with a pay-as-you-heat at point of use metering system to cater for the unpredictable usage pattern and desire to allow use of the Church to disparate groups without incurring an additional payment or billing administration burden.

An initial trial of the HALO heaters took place in 2022 at St. Matthew’s Church, Cotham, Bristol. The heaters have been well-received and remain in place. We understand it has now been adopted by around 40 churches in the country. We have been to see the system and experience it in use, and discussed with Simon Pugh-Jones, chair of Bristol DAC, who has been instrumental in driving the development of the product with Herschel.

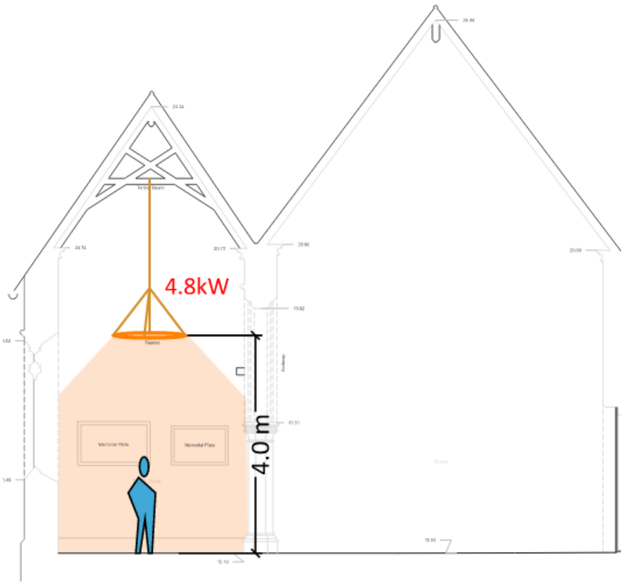
We recommend that the client visits the existing installation of this system at St. Matthew’s Church, Bristol.

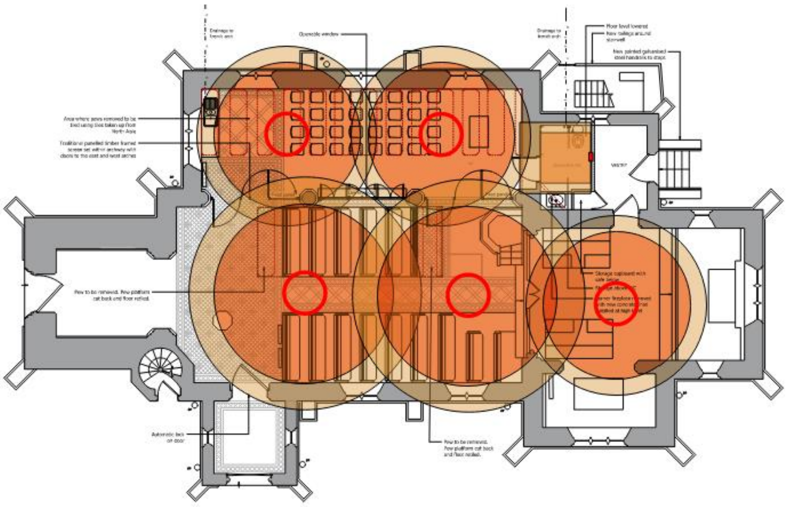
Infrared Heating (HALO) options at St. Mary Magdalene

Rather than being sized to meet the heat loss of a space, the HALO heaters are designed to achieve comfort within a zone and to the occupants in particular. Such a system should be installed so that the spaces where occupants are likely to be stationary falls within the zone or overlap of systems. Our high-level initial estimate of what might be required for the North Aisle only and for the whole church are shown below. The recommended height of installation is around 3.5m to 4m for a 4.8kW heater (shown in the North Aisle) and 4m to 5m for a 7.8kW heater (shown in the Main Nave). The heaters weigh around 25kg, so hanging them from the roof timbers requires structural consideration.

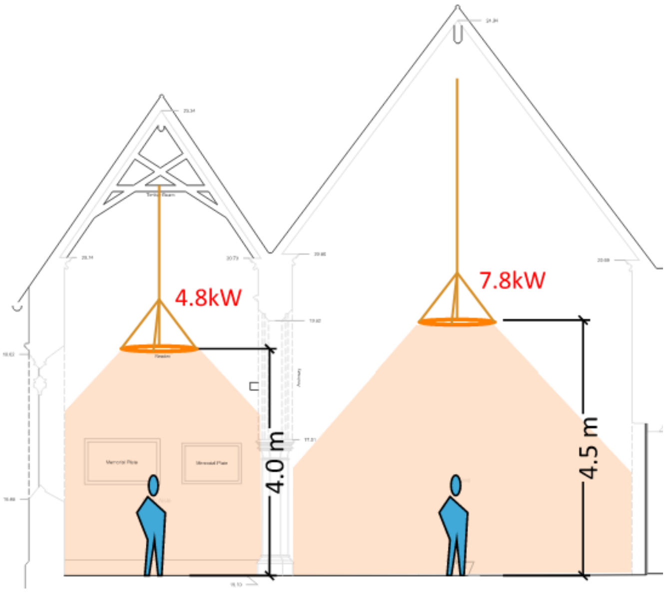


Herschel HALO Infra-red Heaters: 2x 4.8kW heaters in North Aisle (+ small local infra-red heater in WC), shown in mock-up below hanging at 4m height.





Herschel HALO Infra-red Heaters for whole church: As shown in North Aisle, plus 2x 7.8kW heaters in Main Nave (+ additional 4.8kW heater at altar), shown in mock-up below hanging at 4.5m height.



Air, Ground and Water Heat Pumps – Options

Heat pumps use electricity to move heat from one place to another. I.e. they 'pump' heat, they do not generate it.

Heat pump systems operate with between 200 and >400% efficiency depending on the type and the weather. They are all much more efficient than combustion (boilers).

They are physically most effective if the heat they are moving is delivered at a 'warm' but not 'hot' temperature, e.g. 35-45ºC rather than the 60-80ºC of a gas boiler. This means that radiators are relatively cooler and become larger for the same kW output. So Underfloor Heating (UFH) is well-suited to heat pumps as the whole floor is a large heat emitter. The lower temperatures are also beneficial for reducing heat loss if circulating water over significant distances. A lot of surface area is required to meet the heat loss of a space such as a Church, and even a system with underfloor heating emitters may require additional supplementary emitters to achieve comfort temperatures.

All heat pump options require an electricity supply of course. Any heat pump system employed at the Church is likely to trigger the requirement for an increased supply capacity from the utility with some additional upfront costs. This being said, the efficiencies involved reduce the amount of electricity required to meet peak heat loss, so it may be that a smaller capacity is required than with a direct electric system such as infra-red heating.

Heat pumps use the energy from the ground, water or the air to provide useful heat energy for buildings. These generation options are discussed below.

Ground Source Heat Pumps (GSHPs) – Not financially viable/practically efficient with Church heat demand

A Ground Source Heat Pump (GSHP) moves heat from the ground into the building. As the heat source temperature (the ground) is stable year-round a GSHP can have a better annual efficiency than that of an air source heat pump. This requires a significant area of land to lay horizontal pipework, or comes with the significant expense of drilling vertical boreholes. While land around the Church may be theoretically available, GSHPs require a consistent, reliable load in order to function efficiently without repeated on/off cycling. The high capital outlay required must also be justified by a high heating requirement where the efficiency gains of the GSHP offset its upfront costs and associated embodied carbon. It is not envisaged that the heating requirement of St. Mary Magdalene is either high or consistent enough to justify such a system. Drilling of GSHP boreholes in land adjacent the Church may also be ruled out by local archaeology.

Ground Source Heat Pump (Vertical)

Water Source Heat Pumps (WSHPs) – Not practically feasible/financially viable with Church heat demand

Water Source Heat Pumps (WSHP) are similar, taking heat from a body of water: a local river, canal or a below-ground aquifer accessed by an open well or borehole. There is no convenient reliable water source at ground level close to the Church. If abstracting water directly from below the ground, a licence would need to be obtained from the Environment Agency, which controls the amount of water taken per day, and any temperature or chemical changes resulting from use in a system. A common rule of thumb is that the heating system should not change the temperature of the water by more than 3ºC. The capital cost of boreholes for a below-ground water source heat pump are not likely to be justified by the low and inconsistent heat requirements of the Church.

Water Source Heat Pump

Air Source Heat Pumps (ASHPs) – Suitable option for efficient space heating with slow response.

Air Source Heat Pumps (ASHPs) take heat from the air around the building and deliver it indoors. They therefore reject very cold (e.g. -10ºC) air locally using fans, which quickly mixes into the surrounding atmosphere. In order to do this they need easy access to outdoor air and are typically sited outside. In the middle of winter the outdoor air is already very cold, so the efficiency of ASHPs reduces in the colder months.

Air Source Heat Pump (Domestic scale unit)

One of the downsides of a heat-pump run system is that the relatively low heating system flow temperatures and requirement to heat the space rather than the occupants means that the system must be turned on some time in advance to allow the space to heat up to comfort levels. This means that every use of the Church requiring heating requires an additional number of hours of pre-heating time as well-as a certain amount of heat that 'goes to waste' after the period of use. For this reason, a heat pump system would be ideal for a situation with long and predictable periods of occupancy, with minimal switching on and off – a scenario which also reduces the lifespan of the heat pump and increases the risk of faults.

In the situation at St. Mary Magdalene Church, this additional pre-heating time requirement is a counter-balance to the high efficiency of the heat pump. For a heat pump system, the increased time of operation and greater heating area requirement at higher efficiency has to be compared to a reduced operational time with more targeted heating at lower efficiency of a direct electric system. Which system is more efficient overall is partly a function of the eventual real use profile of the Church.

The control set-up of a heat pump system is key to its efficient operation. As the system requires a significant amount of time to bring a space up to comfortable temperature and isn't conducive to a quick switch on and off control regime, this system is unlikely to be particularly compatible with the desire to accommodate a 'pay-as-you-heat' point of use billing system to allow use of the Church to disparate groups without incurring an additional payment or billing administration burden.

All types of Heat Pump system will require a regular inspection and maintenance schedule to be established and adhered to in order to ensure that systems are kept in good working order and efficiencies are maintained. Ensuring that the units are kept clean and that the airflow is not being obstructed is likely a task that can be added to the duties of current relevant Church staff, as it involves checking/cleaning the filters approximately every 3 months. However, Heat Pumps often also require annual or twice-yearly servicing in order to maintain warranties which would need to be conducted by a specialist contractor, therefore some additional annual cost would need to be allowed for in the relevant budget.

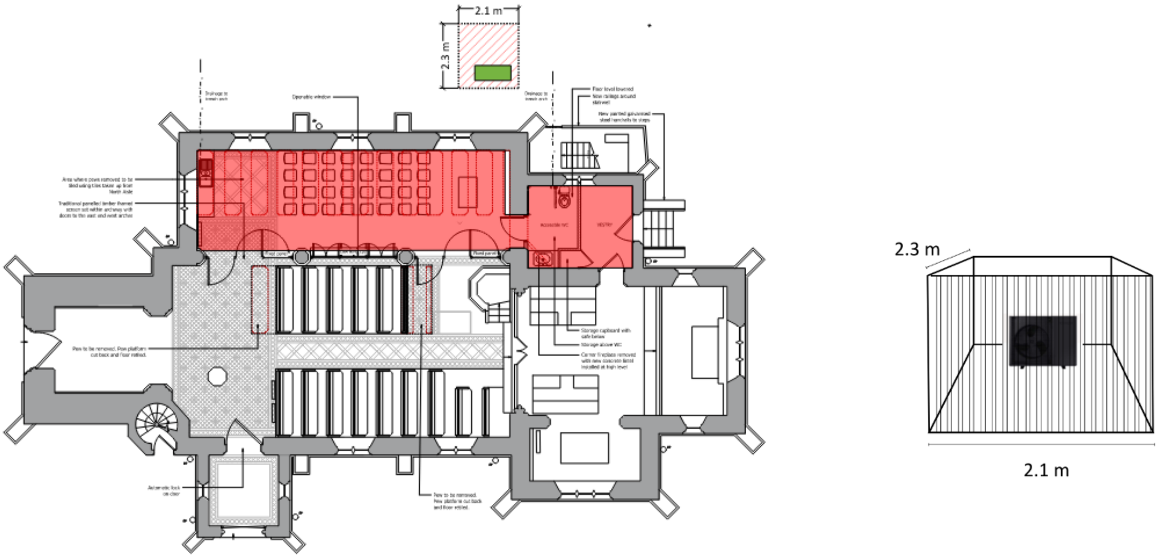
External Plant at St. Mary Magdalene for ASHP system

Air Source Heat Pumps function best when running consistently over a long period to meet a constant heat demand. If the demand falls below the minimum requirement, the heat pump will switch off, the space will cool, and the heat pump will need to switch on again soon afterwards. This 'cycling' process is detrimental to the efficiency of the heat pump, reduces its expected lifespan and increases risk of failure. For this reason it is often better to install multiples of smaller domestic-style heat pumps in a cascaded system rather than one single larger-capacity unit. At reduced load, this allows the unit(s) to run consistently at optimum performance, with the additional units switching on to meet higher demand when needed, rather than one unit constantly turning off and on again.

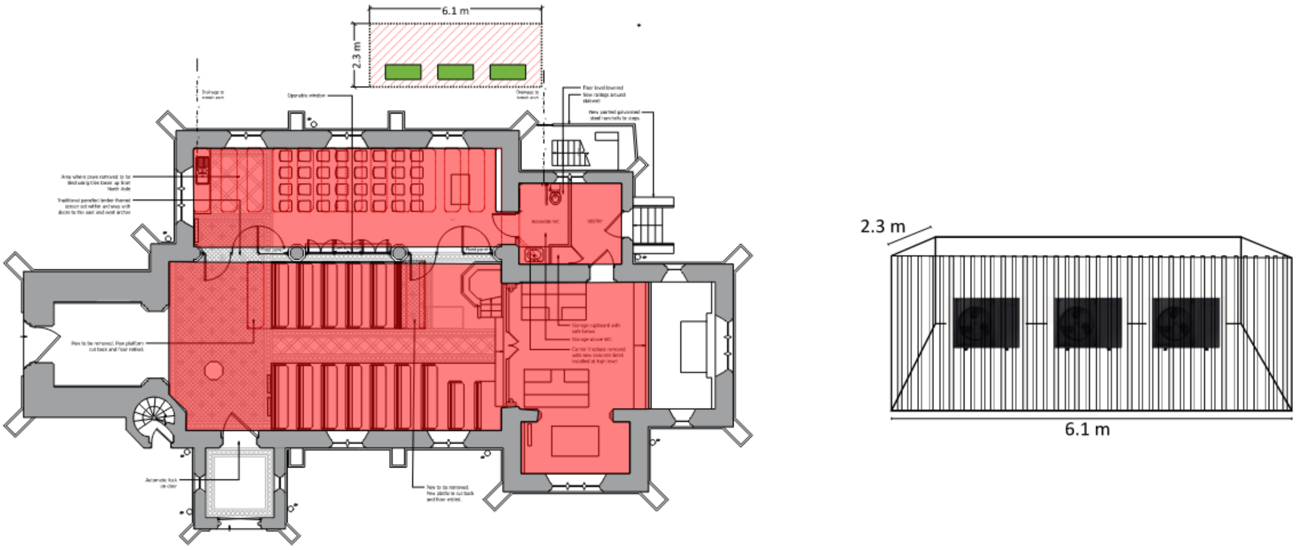
Additionally, noise from external heat pump installations is often a concern, with planning restrictions around acceptable levels of noise at nearby occupied windows. Multiple smaller units tend to be quieter than single larger units.

It is desirable to contain ASHPs within a compound to avoid any issues with access and tampering, to provide visual screening and to provide a certain amount of acoustic attenuation. Any compound needs to adhere to the manufacturers clearance requirements to provide space for maintenance and ensure the heat pump has access to the necessary airflow.

We anticipate that it would require one domestic sized ASHP to meet the current peak heat loss of the North Aisle, and three similar units to meet the peak heat loss of the whole church. A compound should be located as close as possible to the church. The North East of the church, away from the general public access, would probably be preferable. The below images show indicative sizes for a compound for ASHPs for the North Aisle only and for the whole church, based on high level estimates.



North Aisle Heated Zone: One ASHP with indicative compound size next to church at North East.



Whole Church Heated Zone: One ASHP with indicative compound size next to church at North East.

Heat Emitters for Heat Pump System - Options

A heat pump extracts heat from an external source to warm up a fluid (usually water) which can be moved around a building to heat emitters which are designed to maximise the release of the heat in the water into the surrounding space. Traditionally, heat emitters for water-based systems are usually radiators. However, due to the lower system water temperatures with heat pump systems compared to fossil-fuel based systems, the surface area of emitter required is typically significantly larger in order to release the necessary amount of heat into the space.

Underfloor Heating – Suitable emitter for ASHP system with possible requirement for supplementary emitters. Future-proofing underfloor pipework in North Aisle recommended.

Underfloor heating is a suitable option to provide a larger surface area. This typically results in a good comfort experience as occupants experience radiant heat from the floor as well as an increase in air temperature through convective effect, with a 'warm feet, cool head' effect generally experienced as more comfortable than its opposite.

Even allowing for the full available floor area in both the North Aisle and the main Church, the output in W/m^2 of underfloor heating is unlikely to be sufficient to fully meet the peak heat loss of the space, with a resulting possible requirement for additional emitters. This could be supplemented with additional wet-system radiators, by fan-assisted wet-system trench heating emitters within the existing grated trenches (see below), or by a separate 'in extremes' supplementary direct electric system.

The Church is to undergo fabric alterations to the North Aisle floor as part of the proposed plan of works. Much of the cost of underfloor heating is due to the installation process. It is recommended that whatever the heating system proposed and installed in the current phase of works, (even if this is not a heat pump based system), the opportunity should be taken to lay the pipework for an underfloor system concurrently with these works, alongside some fabric insulation beneath. This is a sensible and low-risk future-proofing measure which would allow for simple connection to a future heat pump system should one not be installed now but required at a later date.

Underfloor Heating

Traditional radiators – Standard but intrusive option for additional emitter surface area

Large traditional radiators have been commonplace in Churches for many years and provide a reliable way to release heat into a space. Much of the heat output is convective and rises to high level without contributing to occupant comfort until the full space is heated. They may be very large and take up valuable wall space or be visually intrusive when employed at lower flow temperatures with heat pumps.

Traditional Radiators

Fan-Assisted Trench Heaters

Fan-Assisted Trench Heating – Possible inconspicuous supplementary emitters

The heat emitted by a radiant surface can be *boosted* by forcing air to flow over it more quickly with the help of a fan. Products such as Jaga's DBE system allow for heating coils to be installed in trenches with small fan attachments improving the distribution of heat into the space, and reducing the requirement for heat emitters with additional surface area. This can be customised to suit the situation, such as at St. Mary Magdalene, where there are existing grated trenches. This would have the advantage of being architecturally inobtrusive, with a small amount of noise and the requirement for a small electrical supply for the fans.

Low Surface Temperature Panel Heaters – Appropriate/Required for Accessible WC.

An LST or low surface temperature radiator is a radiator that is specifically designed to not exceed a surface temperature of 43°C. Complying with the NHS Health Guidance (1998), which provides information of safe surface temperature of objects, LSTs are designed and manufactured as a barrier between the heat emitter and anyone in the environment. For accessible bathrooms, these should be used if an emitter cannot be mounted outside of occupant reach.

Heating Options to Explore Further

- **Infra-red heating system** (quick response, easy to use, no maintenance, high cost per kWh of heat delivered)
- **ASHP system with underfloor heating/fan-assisted trench heating** (slow response, maintenance, heats whole space, low cost per kWh of heat delivered).

4.2 Ventilation Options

Accessible WC Extract fan - Recommended

A dedicated extract fan should be provided within the new accessible WC space in the vestry. Continuous background rate controlled by PIR, with timed run-on, and boost rate controlled by local humid-stat.

North Aisle window opening – Envisaged as sufficient to manage moisture

With large amounts of people with potentially wet clothing and the use of a kitchenette, there is some risk of moisture buildup in the community space, with associated risk of condensation deposit on cold surfaces.

Infra-red heating would help to keep surfaces above dew point while in occupation, but there is a risk of condensation build up on the roof structure or on cold surfaces after occupation. This can be mitigated through sufficient ventilation. It is currently envisaged that openable windows in the space will provide sufficient airflow. In conjunction with an infra-red system, this would not have the same detrimental effect on comfort due to heated air loss as in a space-heating system. If condensation risk is deemed to be a greater risk, a dedicated mechanical extract system may be installed.

4.3 Renewable Energy Options

Solar Thermal Hot Water – Unlikely to be Suitable

The heat from the sun can be harvested directly into a water store and used for space heating or domestic hot water. The need for space heating occurs when the sun is least likely to be shining, so use for showers and baths is more relevant. The water store needs to be within a reasonable distance of the solar cells – so for use at St Mary Magdalene the cells would need to be on top of the Church itself, which may not be acceptable to the conservation officer or Historic England, or if it is, would compete with area for electrical generation using PV's (see below). The requirement for hot water is unlikely to be large or regular enough to justify the installation of a solar thermal system. This could be tested in conversation but we assume that it is unlikely this approach could be taken forward.

Solar Thermal Collectors

Photovoltaic (PV) Panels – Feasible, Subject to Conservation Concerns and yield limits

Solar photovoltaic (PV) panels convert solar radiation into electricity, providing a carbon free source of electricity for use in buildings. PVs can be integrated into glazing or roof systems. An inverter and controller are used to convert and synchronise the power with the grid allowing energy to be imported and exported over a standard electricity connection with the addition of an import export meter. PVs are simple installations with little ongoing maintenance. On the other hand, they have a relatively low efficiency with a current maximum of approximately 23%; however due to their low cost they have a good payback time when compared to other technologies. This is somewhat dependent on the ability to use the generated power directly on site concurrent with its generation, otherwise generated energy must be either stored or exported to the grid at low rates.

Church-mounted PV

A location for the DC/AC inverter and cable routes needs to be agreed and confirmed by a specialist if a PV array proposal were to be taken forward. We have explored in further depth the feasibility of PV installation at three different locations on the Church roof alongside PV specialists. This is outlined later in the report in *Section 8*: *Photovoltaic Options.*

Batteries and Other Storage – Alongside PV's

Storing electrical energy at the site has the following main potential uses:

- energy arbitrage between the grid and the Church, driven by cost and/or carbon emissions,
- maximising local use of the energy generated on site e.g. by PV's, wind turbines.
- reducing the peak demand from the grid by 'smoothing out' short term peaks.

With an electrically-heated scheme, the electricity use is at its lowest in summer - when the PV's are generating the majority of their power.

Tesla Powerpack

A battery sized to store energy *seasonally* would be unfeasibly large and expensive, but a more sensibly-sized battery could store daytime energy for use the following night, which could suit heating and lighting requirements well. Batteries are not considered in this heating study but are recommended for future consideration and discussed in further detail in the PV section.

Wind Power – Feasible, Subject to Conservation Concerns and yield limits

Small-scale wind turbine

The Churchyard itself is unlikely to be a suitable space for a wind turbine, due to the surrounding trees. There may be a suitable location near the Church in the fields to the North West of the Church, where access to wind is not inhibited by topographical/natural barriers in front of or behind the prevailing wind direction. A wide wind corridor is also required for efficient operation. It is not believed that the fields to the North belong to the Church, or whether there is scope to reach agreement with the landowner.

An alternative option may feasibly be to install a very small turbine at the top of the Church tower, where access to wind is likely to be consistent. This would however be subject to planning and conservation issues as well as structural and practical installation and maintenance concerns to address.

Similarly to a PV system, if the energy generated by wind power cannot be used on-site concurrently with generation, then it must be either stored or exported.

One possible solution to this issue is for a wind turbine to form part of a community energy scenario, with the whole village providing the base load for electricity generated by turbines.

We have explored in further depth the feasibility of Wind Power alongside wind power specialists. This is outlined later in the report in *Section 9: Electricity generation through wind power*.

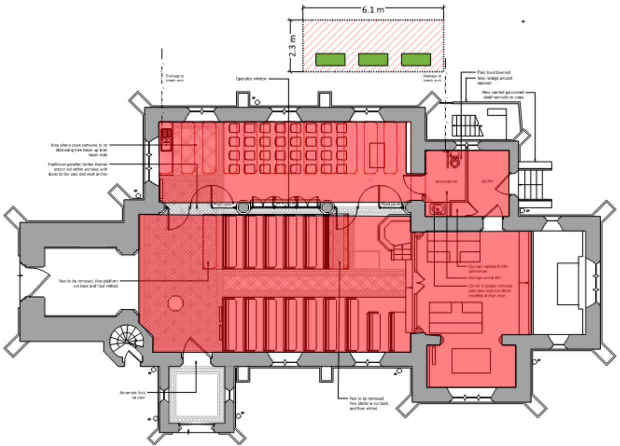
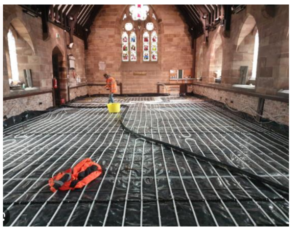
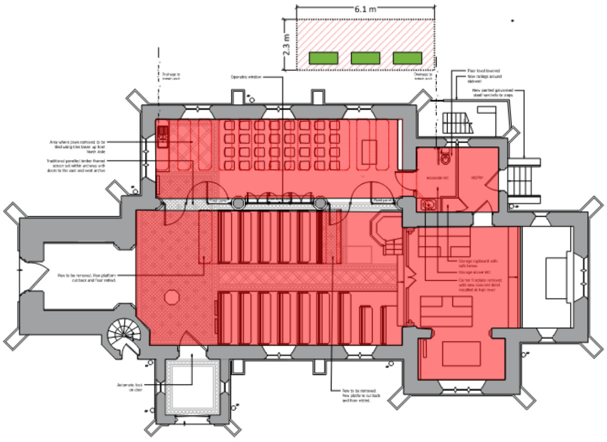
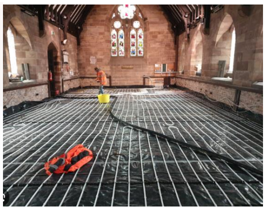
Renewable Energy Options to Explore Further

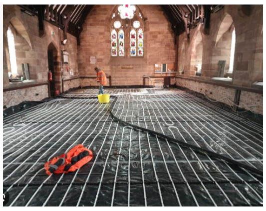
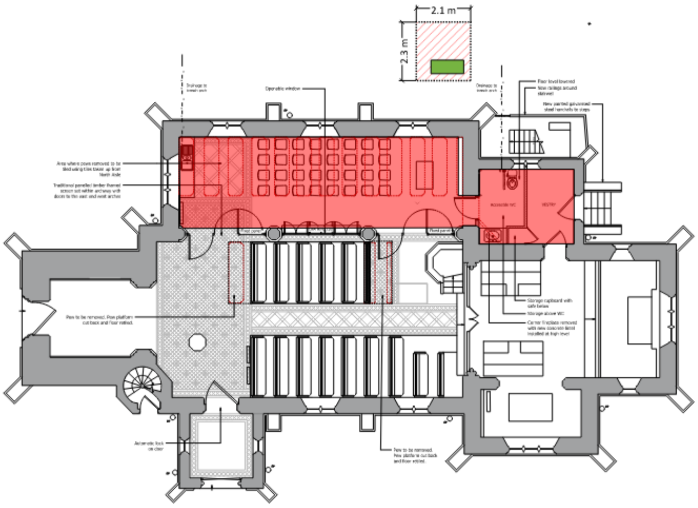
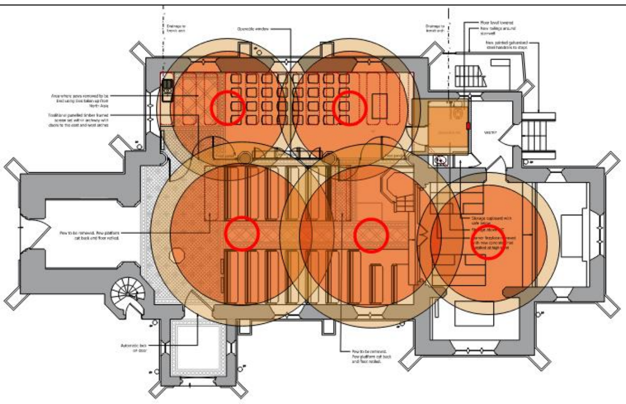
- Solar PV (if financially feasible and possible with planning/ heritage)
- Wind generation (possible generation in neighbouring fields/top of tower)

5.0 HEATING OPTIONS COMPARISON

5.1 Scenarios

With consideration of the options presented in previous sections, alongside the different possible use profiles of the Church, we have proposed five different scenarios and applied these to the model of the existing building to explore the effects in terms of energy use, costs and carbon:

Scenario	Description	Scenario New Heating Zones
1	**Heating the whole Church, using ASHPs and underfloor heating.** Fabric improvements: None. North Aisle Strategy: ASHPs and underfloor heating. Main Church Strategy: ASHPs and underfloor heating. Note. Underfloor heating on its own will not meet the full buildings heat loss, meaning additional supplementary emitters may be needed – Client to confirm aspirations prior to detailed design.	 6.1 m 2.3 m  
2	**Heating the whole Church, using ASHPs and underfloor heating, with fabric improvements.** Fabric improvements: Throughout: (improved roof insulation, improved floor insulation, improved draughtproofing) North Aisle Strategy: ASHPs and underfloor heating. Main Church Strategy: ASHPs and underfloor heating. Note. Underfloor heating on its own will not meet the full buildings heat loss, meaning additional supplementary emitters may be needed – Client to confirm aspirations prior to detailed design.	 6.1 m 2.3 m   

3	**Heating the whole Church, using ASHPs and underfloor heating to the North aisle and retaining under-pew heating to the central aisles.** Fabric improvements: To North Aisle Only: (improved roof insulation, improved floor insulation, improved draughtproofing) North Aisle Strategy: ASHPs and underfloor heating. Main Church Strategy: Retain Existing Under-Pew Heating Note: Underfloor heating on its own will not meet the full buildings heat loss, meaning additional supplementary emitters may be needed – Client to confirm aspirations prior to detailed design Fabric improvements to the North aisle only (improved roof insulation, improved floor insulation, improved draughtproofing) Additional Note: Retention of existing system in main church is insufficient for full comfort in the main space.	    
4	**Heating the whole Church, using Halo infra-red heaters throughout.** Fabric improvements: Throughout: (improved roof insulation, improved floor insulation, improved draughtproofing) North Aisle Strategy: HALO-style Infra-Red Heating Main Church Strategy: HALO-style Infra-Red Heating	  

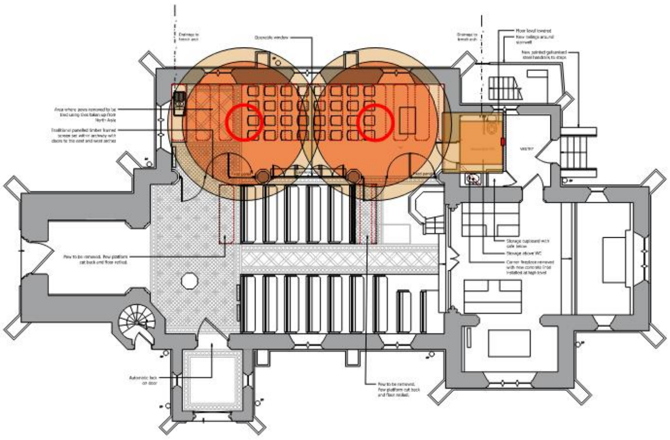
5

Heating the whole Church, using Halo infra-red heaters to the North aisle and retaining under-pew heating to the central aisles.

Fabric improvements:
North Aisle Only: (improved roof insulation, improved floor insulation, improved draughtproofing)

North Aisle Strategy:
HALO-style Infra-Red Heating

Main Church Strategy:
Retain Existing Under-Pew Heating



5.2 Input Parameters

Fabric and external condition

Fabric Criteria	Estimated existing performance	Proposed Improved performance	Notes
External wall heat loss	2.3 W/m^{2}K	2.3 W/m^{2}K	No changes
Floor heat loss	1.2 W/m^{2}K	1.0 W/m^{2}K	**Floor Insulation**
Roof heat loss	2.5 W/m^{2}K	1.2 W/m^{2}K	**Add insulation to roof buildup**
Doors	2 W/m^{2}K	2 W/m^{2}K	No change in materials
Glazing heat loss	5.4 W/m^{2}K	5.4 W/m^{2}K	No change in materials
New Internal Aisle Panel Division	3 W/m^{2}K	1.5 W/m^{2}K	**To illustrate impact of improved performance of panel**
Glazing heat gain	g-value 0.5	g-value 0.5	No change in materials
Air permeability	1 changes/hour	0.6 changes/hour	**Draught sealing/re-hanging**
Design temperatures	-2ºC outside, 18ºC inside		
Annual weather file	Station: EGGD: Bristol/Lulsgate Heating degree days base temperature 15.5 ºC		

Systems

<table>
<tr><th>System</th><th>Efficiency</th><th>Pre-Heat Time</th><th>Annual Heating</th><th>Variable Control Factor</th><th colspan="2">Output</th></tr>
<tr><td>Existing Under-pew heaters</td><td>100%</td><td>2 Hours</td><td>26 weeks</td><td>N/A: full output assumed</td><td colspan="2">28no. 180W heaters = 5.04kW (Not sufficient for full comfort)</td></tr>
<tr><td>Air Source Heat Pump(s) with underfloor heating</td><td>270% average</td><td>4 Hours</td><td>To meet design temperature from annual weather model</td><td>Incorporated into average efficiency</td><td colspan="2">Output to meet peak heat loss</td></tr>
<tr><td rowspan="2">Infra-red Heaters</td><td rowspan="2">100%</td><td rowspan="2">0.1 Hours</td><td rowspan="2">26 weeks</td><td rowspan="2">0.65 factor assumed to account for radiant thermostat/occupant control output adjustment</td><td>North Aisle</td><td>Main Church</td></tr>
<tr><td>2x 4.8kW infrared heaters for North Aisle 1x 0.65kW infrared heater for WC</td><td>2x 7.8kW infrared heaters for main nave, 1x 4.8kW infrared heater for chancel.</td></tr>
</table>

Usage

Space	North Aisle	Main Nave
Number of visits per week	4	2
Length of visits	3	3
Number of people	10	10

Costs

Operational Costs (from current tariff)		
Price/kWh electricity	0.25	£/kWh
Daily Standing Charge	0.60	£
Predicted annual Fuel Inflation	3	%

Capital Cost estimates		
ASHP Whole Church (no fabric upgrades)	£25,000	£
ASHP Whole Church (fabric upgrades	£22,000	£
ASHP North Aisle (fabric upgrades)	£9,000	£
Underfloor heating	150	£/m^2
Infrared heater 4.8kW (no integrated lighting)	6,000	£
Infrared heater 7.8kW (no integrated lighting)	7,200	£
Infrared heater 0.65kW (no integrated lighting)	347	£
Fabric improvements: Roof insulation	70	£/m^2
Fabric improvements: Floor insulation	30	£/m^2
Fabric improvements: Draft-proofing	1500	£
Maintenance Cost estimates		
ASHP maintenance cost per year	400	£
Infra-red maintenance cost per year	0	£

5.3 Running Costs

Fuel Costs

Electricity, on many tariffs, is currently about 3 times more expensive than gas and will continue to be more expensive in the short-medium term.

Heat pumps are more efficient than boilers, which helps to redress this. Achieving a heat pump efficiency of 300-400% renders heat pumps and gas boilers running-cost equivalent with many of today's tariffs.

A direct electric system such as the infra-red heaters considered here has no system losses like those that would be found in a fuel-based system. These systems are targeted directly at building occupants and very quick to provide comfort, negating the need to heat up the full volume of air in the building, or for long pre-heat periods. While the electricity used to provide heat is greater than a heat pump, and more expensive per kWh than gas, the reduction in energy used through appropriate targeting of heat for comfort may make this option a running-cost equivalent of gas in a building with large volume and intermittent occupancy such as St. Mary Magdalene Church.

Electricity Costs

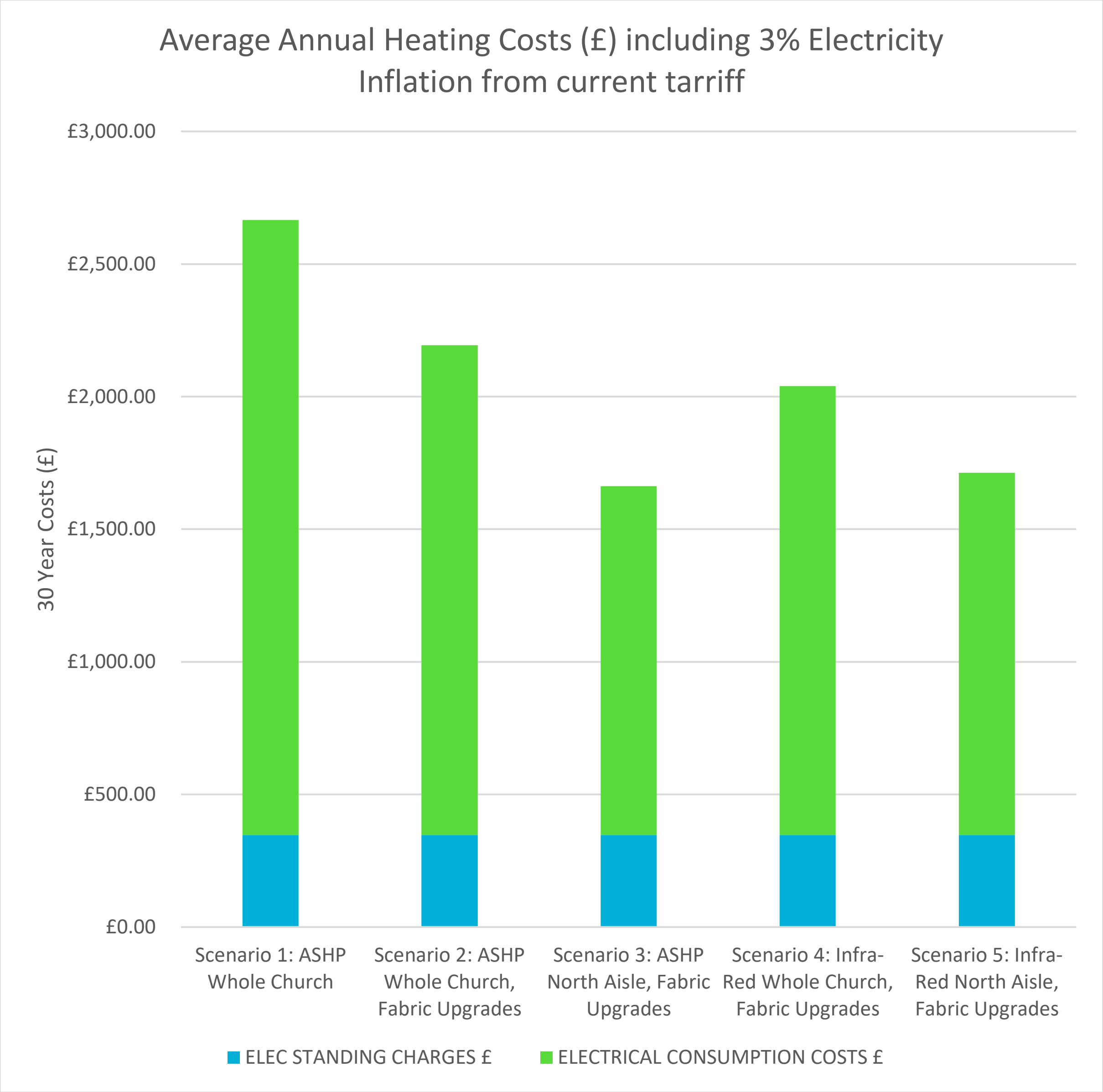
The Church appears to have recently moved tariffs. Until end of August 2024, the 'Freedom' tariff charged 27.9p/kWh of electricity with a standing charge of £1.39/day, corresponding to an overall cost of £1.61/kWh including VAT. The Church should remain attentive to their contract with EDF to ensure this extremely high standing charge figure is not applied again.

Since end of August 2024, the Church is on a more standard fixed tariff charging 24.9p/kWh, with a 60p/day standing charge, corresponding to an overall cost of £0.80/kWh. Due to the relatively low electricity usage of the Church, the standing charges still have a disproportionate impact on overall cost per kWh of electricity. This contract is set to expire on 28 August 2027.

We cannot predict how fuel prices will evolve in the medium term. Electricity costs may be subject to larger fluctuations over time, but we may speculate that fossil fuel prices will increase more than electricity prices over the coming years, in line with government stated national trajectory to discourage consumers and producers from fossil fuels. This would make an electrically based heating system such as those we have considered here more economically viable than they are currently relative to traditional fossil fuel-based systems.

For the purposes of this study, we have considered what the Church currently pays for electricity with an assumed 3% annual inflation, to help illustrate the balance of fuel cost against capital cost.

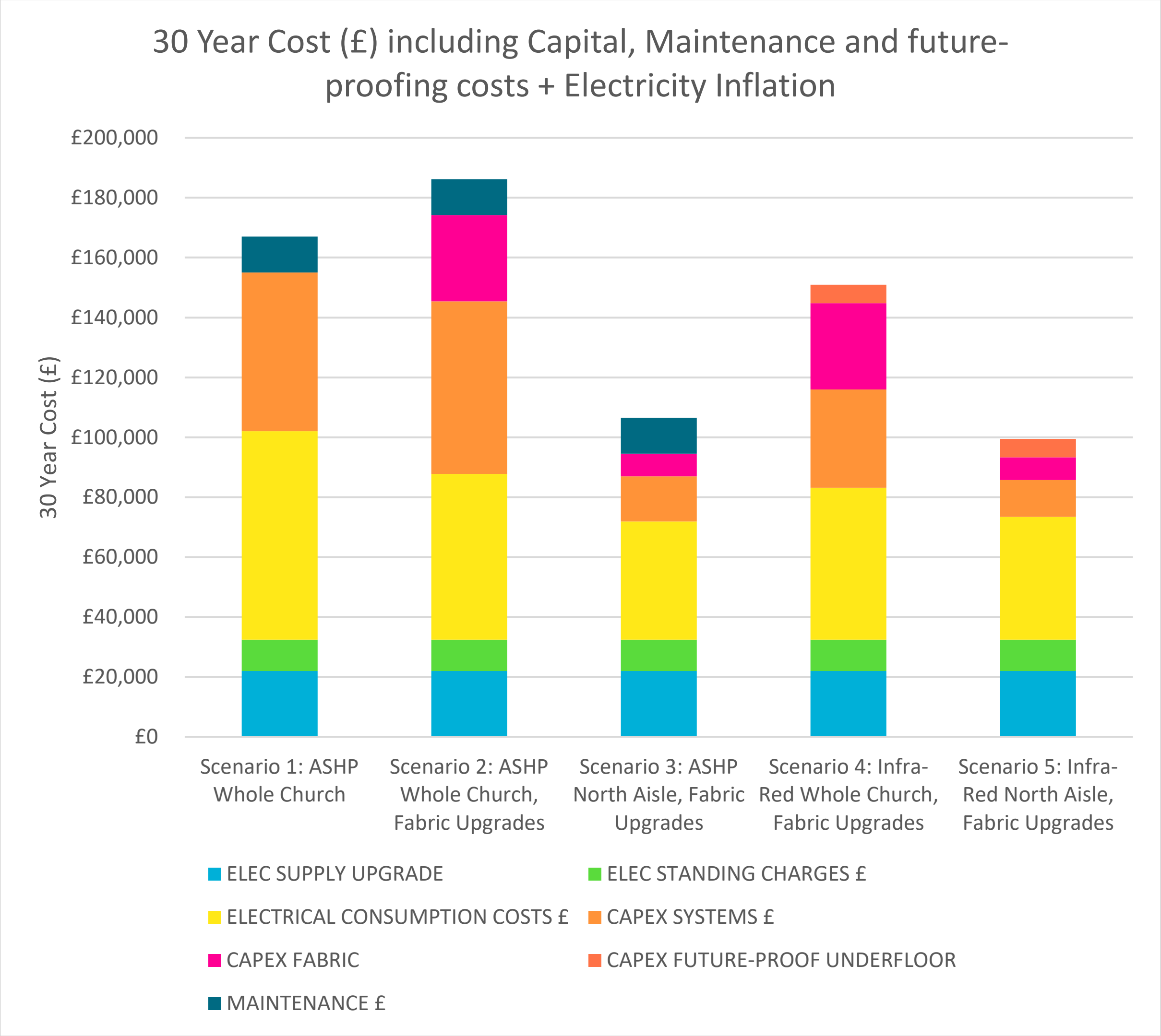
The chart below shows indicative annual electrical costs for an average year of the next 30 years with this inflation assumed applied to both standing charges and electrical consumption rates.



- The model shows that if using Air Source Heat Pumps and underfloor heating (options 1 and 2) to heat the whole Church, there is an annual saving of around £500 if fabric improvements are made to the building. The fabric improvements suggested are relatively straightforward to implement, subject to agreement with Client and Church.
- Heating the whole Church with infra-red heaters (option 4) is slightly cheaper annually compared to heating the whole Church with ASHP including fabric improvements.
- If a new heating system is brought in only for the North Aisle, and the existing under-pew heaters are retained in the main Church (options 3 and 5), then there is very little difference in annual electricity cost between employing ASHP or Infra-Red in the North Aisle.
- In options 3 and 5, no upgraded heating system is proposed for the main Church. Retaining the existing system means no improvement in occupant comfort will be achieved for the main nave.

5.4 Lifetime Costs

The annual running costs present just one aspect of the overall costs of the selected system. We have attempted to compare the overall cost of each system over a 30-year lifespan. Capital expenditure (Capex) of the heating system itself represents a considerable contribution. We have used available standard pricing where available, alongside obtained quotes and typical values. These are indicative only, for example, underfloor heating may result in a higher or lower cost per meter of coverage in the Church context than modelled. Similarly fabric upgrade costs are difficult to predict and have been based here on typical per metre values. Annual maintenance costs have been included for Air Source Heat Pump Systems, but infra-red systems do not typically require additional maintenance after installation.



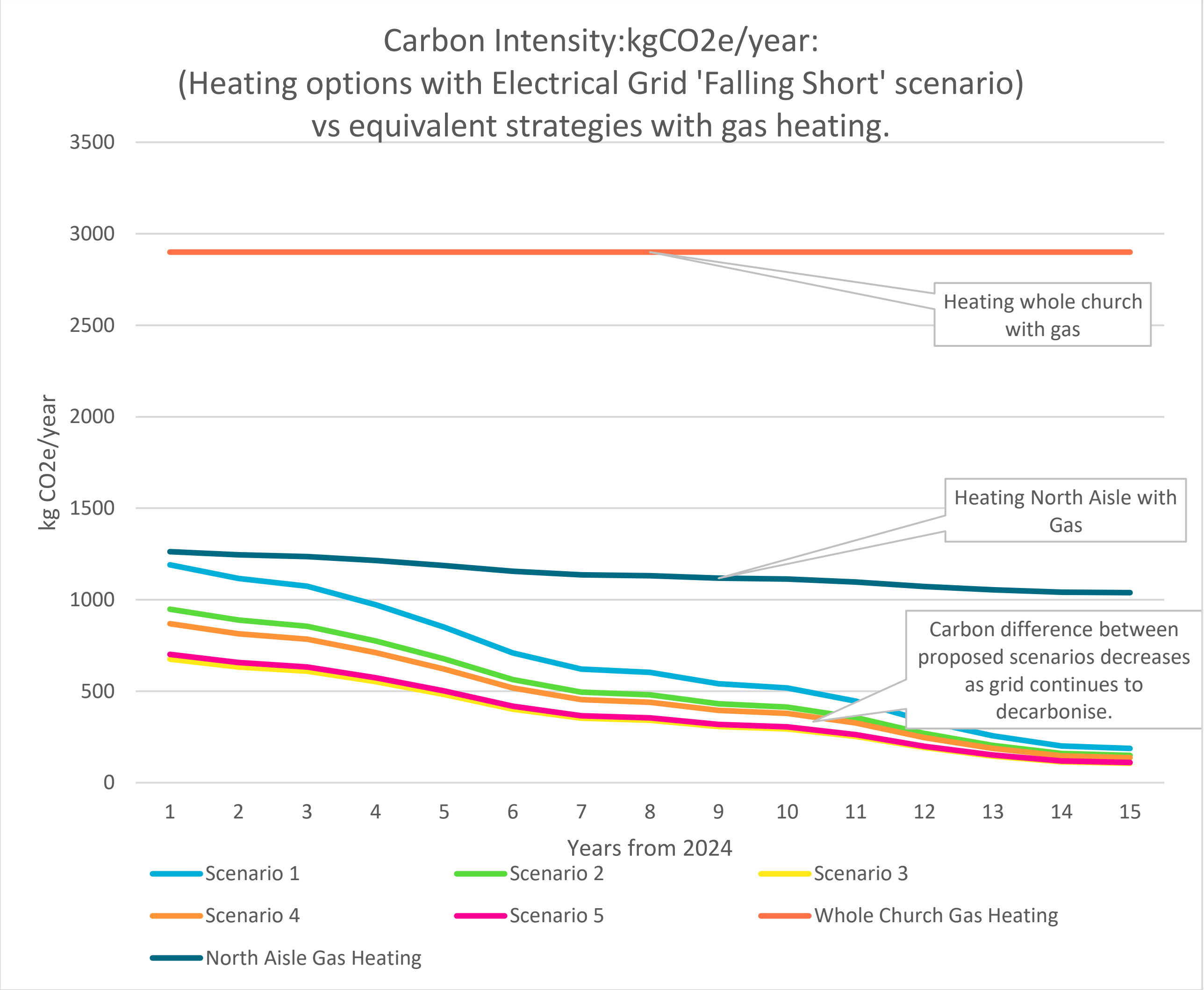
- The model shows that the expense of capital costs for an ASHP/Underfloor system may feasibly outweigh the benefits of heating efficiency gains if heating the whole Church with ASHP and underfloor heating.
- If heating the whole Church, then using infra-red heating (option 4) appears significantly more financially viable than heating the whole Church with Air Source Heat Pumps and underfloor heating (option 1 and 2).
- If providing a new heating system to the North Aisle only, then using infra-red heaters appears more financially viable than using ASHP and underfloor, due to the additional costs of maintenance and necessary fabric upgrades.

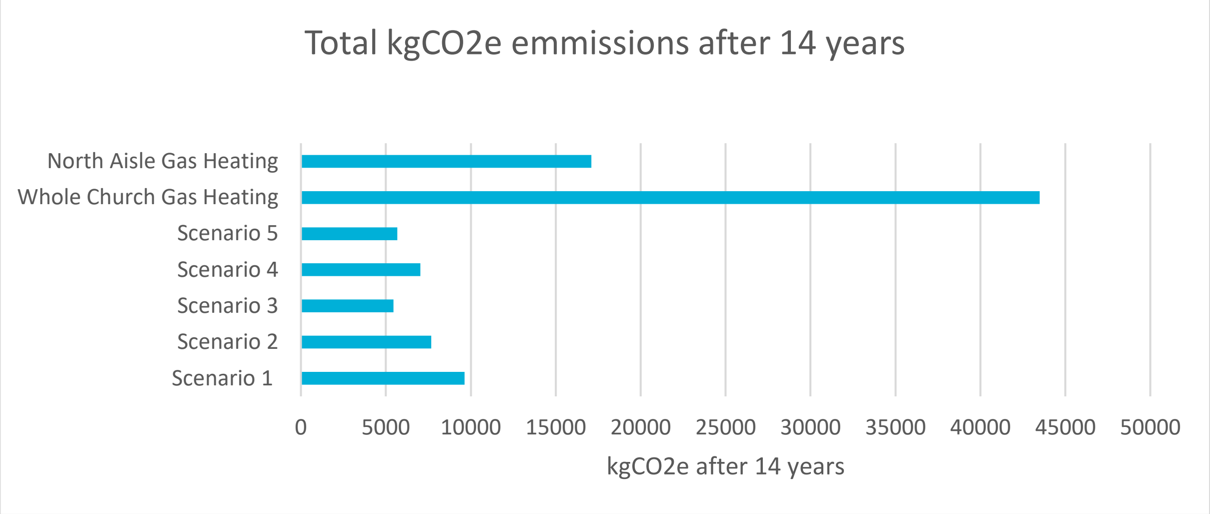
5.5 Carbon

We have used the National Grid's Future Energy Scenarios (FES) projected data for carbon intensity of grid electricity over the coming years ('falling short' scenario) to show the carbon impact of the heating choice. This has been compared against a notional gas system for the whole Church or the North Aisle only using the 2024 government conversion factors for natural gas, in order to demonstrate the improvement in terms of carbon emissions of any electrically-based heating system over the use of fossil-fuel.

The C of E Routemap recommends that electricity is supplied from cleaner sources by switching to 'green' tariffs. For the purposes of net zero carbon, the church's current approach is that a 'green' tariff is 100% renewable. In this context, any electrically based heating system would be expected not to contribute operational carbon emissions.

However, increased national peak demand impacts the National Grid's ability to provide electricity from renewable sources and increases the likelihood of fossil fuel-based generation to meet the UK's requirements, as well as an increase in embodied carbon as a result of constructing bigger plant for electricity generation. Therefore, a new system should still aim for the lowest possible electrical load in order to reduce peak demand impact on the grid.





- The difference in carbon emissions between the proposed systems decreases over time as the grid continues to decarbonise. As the carbon impact of each kWh of electricity reduces, higher use of electricity has less impact.
- If the church adopts a 100% renewable 'green' tariff as recommended by the C of E to achieve Net Zero, the difference in carbon emissions between electrical systems is negligible, but systems should be selected to reduce peak demand on the National Grid.
- Infra-red heating is the least carbon-intensive option for heating the main Church.
- There is very little difference between ASHP vs Infra-red for heating the North Aisle.
- Any of the proposed systems is a significant improvement upon a gas-based heating system.

5.6 Comparison with Existing

The Church has provided us with billing information for the periods from January 2021, from which we have aggregated approximate annual totals for the Church's current electricity usage. For both 2021 and 2022, this has been in the region of 400 kWh.

This very low usage is based on:

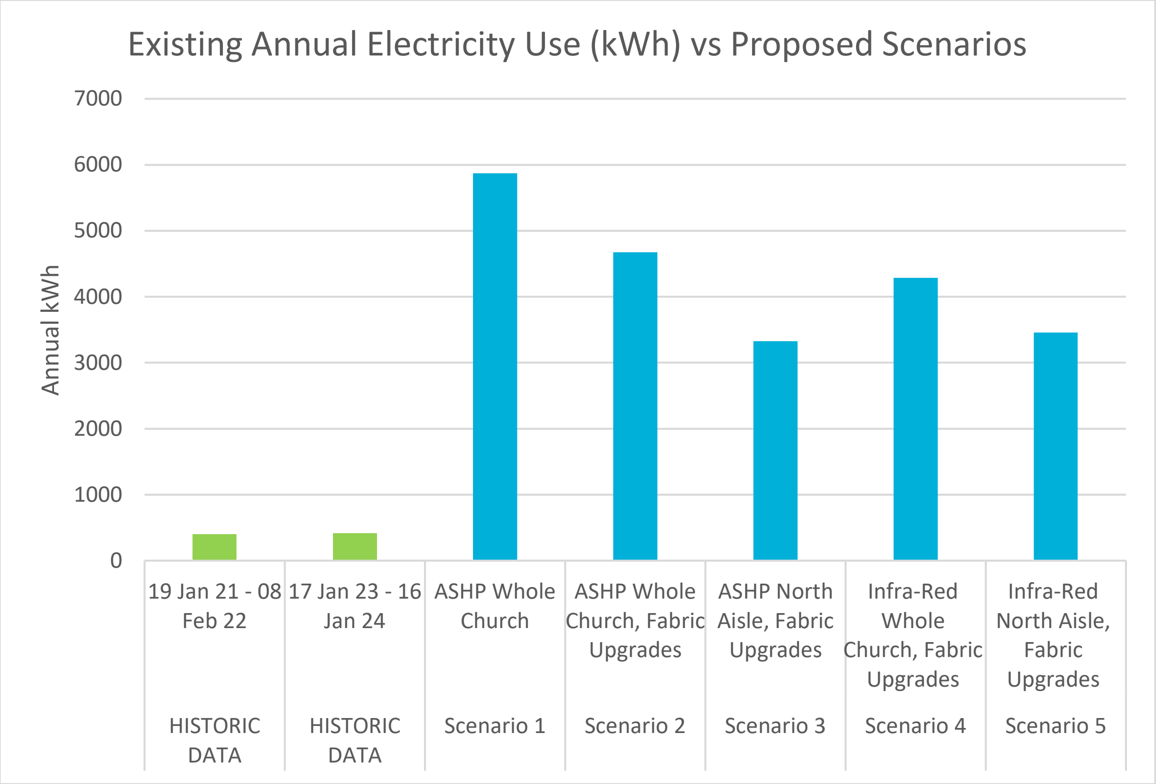
a) Low occupancy and intermittent/irregular usage pattern.
b) Current electric under-pew heaters with output of around 5kW total. There is no heating at all in the North Aisle. This system is insufficient for providing genuine occupant comfort through the colder months.
c) These electrical totals also include other loads such as lighting and plug loads, although this is understood to be insignificant.

It should be noted that in comparison to the current situation, any of the proposed scenarios represent a large increase in annual electricity usage. This is due to:

a) The intention for the Church to increase its usage and provide a space for the community and groups, representing a higher frequency and annual duration of heating use throughout the year than currently. This model has made an assumption based on a projected/hopeful weekly usage pattern, which is significantly higher than the current reality. This is for relative comparison only and the actual future use pattern may be significantly lower, reducing the uplift from current electricity use.
b) The intention is to provide a space (the North Aisle) in which occupants can be comfortable in colder weather. Currently there is no heating in the North Aisle, so any sufficient heating system for this

space will require more energy than the current level. Likewise, the current heating in the main Church is not sufficient for genuine comfort, so those scenarios which propose a new system to address this will require an uplift in electricity use.

c) None of the proposed scenarios include electricity use for lighting and small power. This is not expected to have a significant impact on overall electricity use, particularly if using energy efficient lighting with suitable controls.



Any proposal to provide comfort heating in the Church is likely to require a lot more electricity annually than currently used, because of the higher anticipated use profile and the increase in electrical demand for heating to provide genuine comfort. This is illustrative only and depends on actual use.

5.7 Fabric Improvements

Existing Church Fabric
The current Church has thick stone walls with no insulation, an uninsulated roof, an uninsulated floor and single glazing. It is also anticipated that there will be fairly high air permeability. We have modelled the building according to estimated ‘U-values’ (the rate of heat lost per m^2 per degree of temperature difference between interior and exterior) which reflect typical performance for this type of fabric buildup.

Clearly the more the external-facing surfaces of the Church are able to prevent heat from escaping the heated space, the less heat input is required to maintain a comfortable temperature, resulting in lower overall electricity use. It is generally considered good practice to reduce the amount of heat required as far as possible as a first point of call before selecting efficient systems. Therefore we recommend that fabric improvements are undertaken where possible.

The heating options analysis above shows the impact of fabric measures throughout the whole Church on the overall energy use. Fabric upgrades tend to be expensive and can be complex in a heritage environment. The proposed works to introduce a new community space to the North Aisle provide an opportunity to improve the fabric at a smaller, more targeted scale, at lower cost and greater impact in conjunction with the anticipated use of the space. For this reason, although we would recommend improvements throughout, we have focused below on the impact improvements might have on the North Aisle only.

Impact of Fabric Improvements on efficiency of different systems
The effect of reduced energy use is noted in the model when applied to an ASHP-based system which heats the space rather than the people. The impact of adding insulation to the floor and roof, and implementing draught-proofing measures is shown in the difference in annual energy requirement between scenarios 1 and 2.

If employing an infra-red based system, which is designed to heat the occupants directly, rather than the whole space, the overall energy use is simply a product of the output of the system when activated to meet occupant comfort multiplied by the amount of time it is in use. There is a factor applied for the ability to modulate down the level of heat to meet comfort in milder seasons, but the overall energy use for these systems is less affected by the fabric of the Church, as it is not a requirement to maintain an overall air temperature level within the space.

Nevertheless, in this scenario, fabric improvements will still have some impact, particularly for comfort in reducing the extremes of temperature discrepancy between the heated and unheated zones.

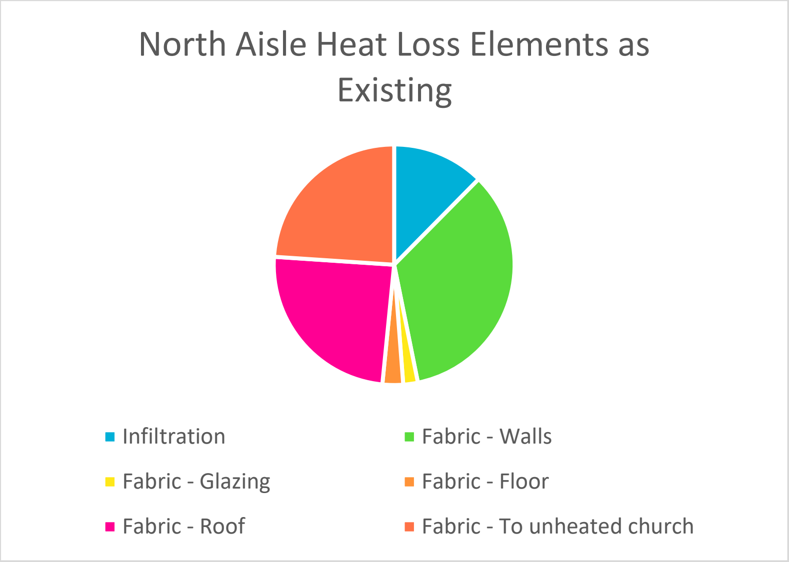
Impact of Fabric Improvements on conservation
There is also a conservation consideration to bear in mind. It is planned for slightly larger, more regular gatherings to occur in the new North Aisle space. People expel breath with moisture contained. There is also likely to be some hot water/kettle use in the space. This results in an increase in humidity in the space. The water in the air is liable to condense upon colder surfaces, such as the walls, windows or roof, causing damage to the fabric. As colder air has a lower capacity for retaining moisture than warmed air, there is a risk of this in a scenario where the air in the space is fully heated by an ASHP system and then cools down afterwards, depositing its moisture on surfaces, but also in an infra-red based system where a proportion of the air remains generally unheated.

Increased insulation can raise the temperature of these surfaces and reduce the risk of condensation buildup and fabric damage.

North Aisle
The pie chart below shows the areas of greatest heat loss from the North Aisle according to the model. It can be seen that much of the lost heat is through the walls, partly because this is the greatest surface area. It is not considered likely that insulating the walls will be feasible or desirable from a heritage point of view. Similarly there is a comparatively small amount of heat lost through the windows. In a house, for example, where the walls, roof and floor are generally insulated, heat loss through windows might be expected to be proportionally much higher. There are secondary-glazing solutions for improving the performance of windows which are suitable for heritage buildings, such as Invisitherm, which uses a reversible magnetic installation system. This

could feasibly be appropriate in North Aisle, where there is no stained glass. However, this would restrict the ability of occupants to open windows for natural ventilation and there are other insulation options with greater impact on overall heat loss at less prohibitive expense.

A significant amount of heat is lost through the uninsulated roof, and through infiltration i.e. heated air escaping through gaps in the fabric. There are achievable measures to reduce both. Similarly, heat lost to the unheated main Church through the walls and new internal panelling represents a high proportion. The floor has a lower heat loss due to the more stable temperature of the ground. However, this can represent a comfort issue. The three targets we recommend for improvement are the roof, floor and draught-proofing.




Apply insulation to roof


Apply Insulation to floors


Draught-proofing

As part of the proposed works, we understand the North Aisle floor is to be retiled. We recommend not only installing underfloor pipework while there is the opportunity to do so but also to introduce a layer of insulation below. This will have the additional effect of reducing any risk of 'cold feet/warm head' temperature gradient discomfort experienced by occupants with an infra-red system.

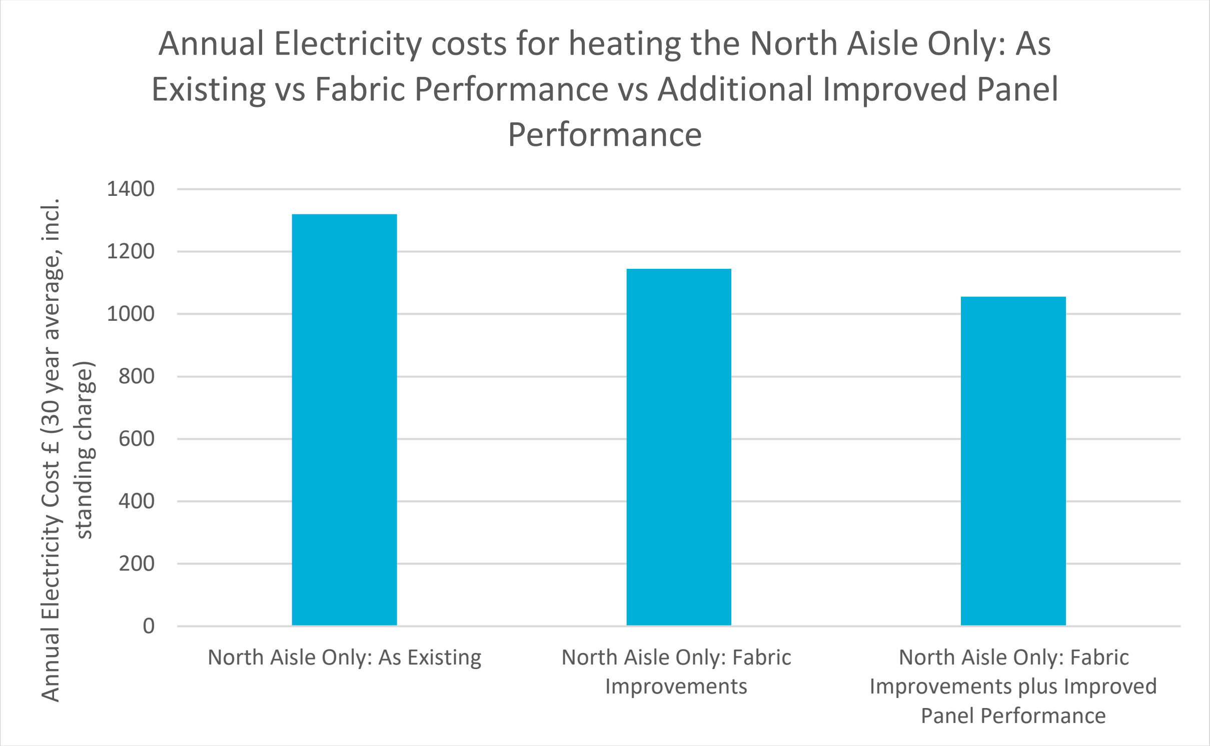
We also recommend that the performance of the roof should be improved for the North Aisle while these works take place, with a layer of insulation above the current boarding to increase the interior surface temperature. This will reduce condensation risk, but is also a sensible future-proofing measure to significantly reduce heat loss for if an ASHP-based system is deemed suitable at a later date. The impact of roof insulation is more beneficial when considering space heating as opposed to people heating with an infra-red based system. We understand that there is some evidence of bats at the site. We are not aware if this extends to nesting within the North Aisle roof structure, but this would clearly influence the feasibility of undertaking fabric improvements.

Draught-proofing is considered ‘low-hanging fruit’ in terms of fabric improvements. These could be low cost, high impact measures. This should be explored in any heating scenario, as occupant comfort can be significantly impacted by the contrast of cold air draughts in a heated space.

New Internal Panel Performance

As part of the proposed works, we understand that a new panel will be constructed within the three arches between the North Aisle and the main Church, with this currently proposed to be a composite of traditional timber panelling and single glazing. In a scenario in which the North Aisle is being used and the main Church remains unheated, this becomes a significant heat loss element from the space. As such, the proposed buildup and performance of this partition has an impact on the overall heating energy required. We have modelled an estimated current U-value for the partition, alongside an improved version with, say, double glazing and insulation between timber panelling in order to gauge the impact this might have. From an architectural point of view, we understand that single glazing is much easier with more elegant detailing.

North Aisle Impact of Improvements



- Expressed as an annual saving in electricity use for heating the North Aisle, fabric improvements to the Roof and Floor alongside draught-proofing measures could provide a saving of around £180 a year.
- A higher-performance new internal panel between the North Aisle and the Main Church (e.g. double-glazed, insulation between timber panelling), could provide an additional saving of around £90 a year.

5.8 Other Building Services Technical Considerations

1. **Complexity:** Although some options show low carbon emissions and running costs, the impact of complexity on installation, maintenance and operation should not be underestimated. A system that is less efficient but easier to maintain may ultimately be more sustainable and cheaper to run.

2. **Noise**: Air source heat pumps make noise and need to be very carefully sited and often silenced to avoid noise problems. The possible location and silencing of a heat pump are discussed later in this report.

3. **Heat distribution**: Heat pumps are best suited to underfloor heating and may result in changes required to the radiators and pipes. See elsewhere in this report for discussion of heat delivery.

4. **Space requirements/Practicality & Aesthetics**: Air Source Heat Pumps would require an external location within the Churchyard close to the building, along with a likely requirement for some internal plant space to house a buffer vessel and additional components. Additional radiators may be required to supplement underfloor heating taking up interior floor space. An infra-red system would need to be hung from the ceiling or fixed to the walls and may have a visual impact on the space.

5. **Electricity Supply**: We anticipate that any new heating system will require an upgrade to the electricity supply. We have received a budget estimate from National Grid of £22,543 to upgrade to a 69kVA, three-phase supply. This size of supply will account for the highest load case scenario.

6. **Resilience:** Many buildings rely on a single heating system. However heat pumps require maintenance, and could require a supplementary/back-up system. The existing under-pew system could be retained as supplement/back-up in the main Church. A direct electric/infra-red system is unlikely to require maintenance.

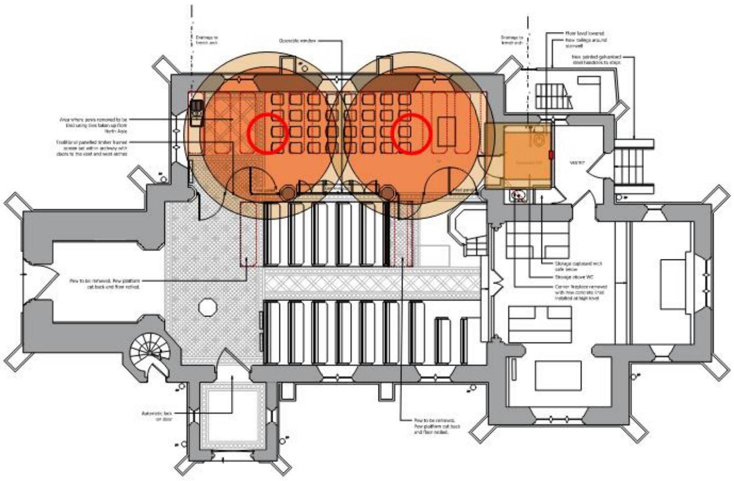
7. **Control and Billing:** We understand from talking to the Church that they intend the North Aisle to be open for general use for the community, booking groups and passers-by. An additional financial or administration burden for heating different groups is not desirable. A system which allows for quick response, and can be intuitively used and billed simply to the users themselves will satisfy this. An ASHP system is likely to have too slow a response to be appropriate without forewarning of occupancy and a dedicated person to administer and control it. An infra-red system is likely to be more immediately effective and user-friendly, with the possibility of on-the-spot billing. Controls are discussed in further detail later in this report.

8. **Humidity and Condensation:** There is some risk of moisture buildup in the North Aisle space in the event of a large number of visitors. It is currently envisaged that ventilation through openable windows will be sufficient to mitigate the risk of condensation and fabric damage, or that the provision of extract ventilation in the accessible WC will assist in the management of moisture. If the risk is deemed high, then additional extract ventilation may be considered.

5.9 Heating Recommendations

NORTH AISLE

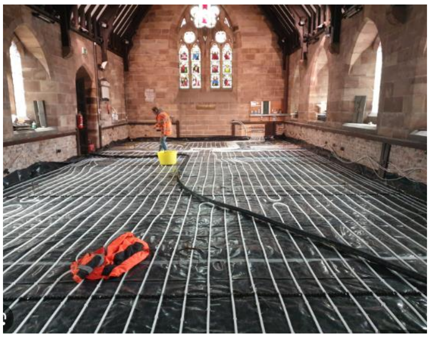
- Fabric upgrades should be undertaken to the North Aisle as part of the proposed works, allowing for floor and roof insulation and draught-proofing.
- An infra-red based system is likely the most appropriate for the space due to the quick and targeted heating, comfort perception and controllability/billability for a wide group of users.
- Should the space be successful and develop a consistent occupancy profile which warrants consistent space heating, an ASHP system may become a more efficient solution in the future.
- The opportunity should be taken to install underfloor heating pipework in the North Aisle floor in order to future-proof the space regardless if an ASHP-based heating system is not currently deemed appropriate.
- A low surface temperature heat emitter should be provided within the Accessible WC, with dedicated mechanical extract ventilation.



Indicative layout of recommended HALO infra-red heaters for North Aisle

Mock-up of visual impact in the space

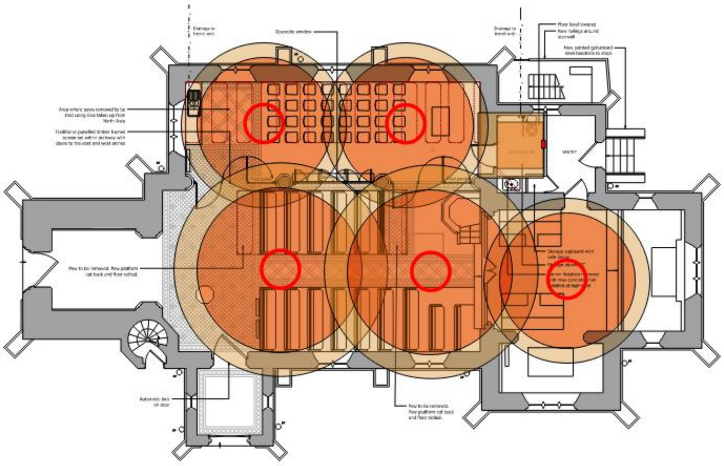
Also recommended: Fabric improvements to North Aisle and...



Install underfloor pipework for future use.

MAIN CHURCH

- If the project allows for the upfront costs, we recommend installing an infra-red based system in this area too to allow for comfort heating during services and for more effective control. Following upfront costs, there is no maintenance burden or additional cost, and due to the quick, targeted heating and variable control, electricity use is likely to be low and no more than actually needed.
- Repeating the same system throughout the Church makes for an easy user experience and consistent installation quality/style.
- The existing under-pew heaters do not create a genuinely comfortable environment during the winter months. They could however, supplement an infra-red system where reflected radiant heat from the floor is partially blocked by pews during extremely cold moments.
- We recommend that a new modern replacement under-pew heater is trialled in the main church. For example, Herschel also manufacture infra-red under-pew heaters which would offer improved comfort levels and pew-by-pew controllability.



Indicative layout of HALO infra-red heaters for Whole Church

Mock-up of visual impact in the space

Optional but recommended: Fabric improvements to Main Church supplement

Retain existing under-pew heaters as

6.0 METERING AND CONTROL OPTIONS

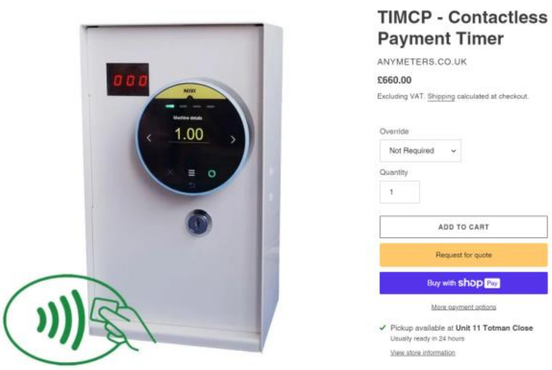
The Church would like the North Aisle community space to be open for a variety of groups and users, both booked-in-advance and ad-hoc. The Church obviously does not wish to pay for heating the space for every session. Passing the financial responsibility for heating to the users could be achieved by adding costs for electricity as part of a booking fee. However, this presents more of an issue when the space is also used on an ad-hoc basis by the community and walkers, etc. as is desired. We understand the client would like to relieve themselves as much as possible of any administrative burden, and they have expressed an interest in a 'pay-as-you-use' metering system. Some of the options available are discussed below:

6.1 Contactless Payment Timer

One option which would be very user friendly is to have system which works on contactless prepayment. This system would allow any users of the Church space to simply pay in advance with a card or smartphone for an allocated amount of time. During the time that the credit remains, the heating will become available. This system has the benefit of very easy usability for a wide group of people with no need for prior knowledge or process. All visitors to the community space are likely to have a card with them, and also this has the benefit of requiring little to no administration on the Church's part.

The amount per time would be preset by the Church. For example, to keep the North Aisle fully heated with Infra-red heating at full output will be in the region of 10kW. Using 10kW over the course of an hour is 10kWh. The Church currently pays around 25p/kWh for used electricity. If the Church wished to charge this same rate to users, then a £2.50 payment could buy an hour of full heating for the space. The rate could be adjusted to account for standing charges, and the administrative charge of the meter. The meter is customisable to offer different charging profiles: e.g. discounts for a longer session. The time can also be set from 1 to 127 minutes, so users can be very specific about the length of session they want, with limited heating wastage.

There are, however, some drawbacks. The meter itself is expensive, around £700. You also need to pay a monthly fee of £10.00 plus a fee of 3.95% on each transaction. There is additionally the issue that this type of meter is time-based only and unrelated to actual electricity use. Therefore you would pay the same pre-set amount to use the heating at a down-regulated level for an hour as to use it at full output.



TIMCP - Contactless Payment Timer

ANYMETERS.CO.UK

£660.00

Excluding VAT. Shipping calculated at checkout.

Override: Not Required

Quantity: 1

✓ Pickup available at **Unit 11 Totman Close**

Usually ready in 24 hours

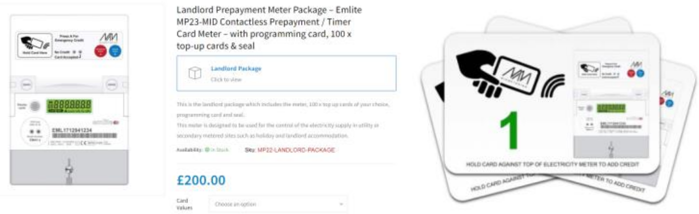
Contactless payment timer

6.2 Prepayment Card Meter

A system used in caravan parks and rental properties etc is to issue users with meter-specific prepaid cards which Church users could use to top up a meter. This would have the benefit of being a true meter as opposed to a timer, so the amount of payment taken from the card is actually linked to the amount of energy used, as opposed to simply the time available. The Church would be able to set the rate, this time at £/kWh of electricity instead of £/minute.

This meter is significantly cheaper than a contactless timer at around £200, and doesn't include monthly or transaction charges. Around 100 top-up cards are supplied with the meter. However, when the charge on these cards has been used, a new package of cards is required to be purchased at a cost of around another £200, or alternatively a card-recharging software/hardware package with a USB-laptop plugin can be purchased for around £250. Recharging the cards this way would place an additional administration burden on the Church, and is a system which is perhaps liable to lose clarity of maintenance responsibility over time.

In addition, this system requires a method of dispensing cards to the Church users. This could be done on an honesty basis, requiring an online payment for card credit used, or a dispensing machine could be set up with a card reader. This is a less intuitive system for users with added complexity and potential to become less effective over time as cards are lost/partly charged etc.



Landlord Prepayment Meter Package – Emlite MP23-MID Contactless Prepayment / Timer Card Meter – with programming card, 100 x top-up cards & seal

Landlord Package
Click to view

Availability: In Stock   Sku: MP22-LANDLORD-PACKAGE

£200.00

Card Values: Choose an option

Prepaid card meter/timer

6.3 Coin/Token Meter

This type of meter is also cheap, around £200. The amount prepaid can be linked to either the amount of energy used or the time in use. Users are unlikely to carry cash with them in all eventualities, so a dispensing mechanism would need to be employed with a system of payment to dispense. With a token meter, this could be based on an honesty system, with a collection of tokens available to use. If the meter is left unlocked, then users could use a simple card machine or online portal to pay for what they have used after their session. Again this requires a somewhat unintuitive system for users and runs the risk with additional physical components of tokens being lost over time.

RDL M-101S (£1 & £2) Coin Electric Prepayment Meter & Timer - 100A, MID

SKU: RDL-M-101S

BULK DISCOUNT 3+ UNITS

Reward Points: 175
£175.00 Ex VAT
£210.00 inc VAT

In Stock

Qty	Per Unit	Saving
1-2	£175.00	-
3-4	£169.75	Save 3%
5+	£166.25	Save 5%

1 Add to Basket

Advice & Support   Call 01642 931329 or contact us

Price Match   We won't be beaten, let us know

RDL MT-101 Token Electric Prepayment Meter & Timer - 100A, MID

SKU: RDL-MT-101

Reward Points: 175
£175.00 Ex VAT
£210.00 inc VAT

In Stock

1 Add to Basket

Advice & Support   Call 01642 931329 or contact us

Price Match   We won't be beaten, let us know

Coin/Token Meter

- The contactless timer is by far the most intuitive and customisable system for users. It is also the most 'future-proofed' solution with no extra components which may become lost or unclear over time, or administrative burden upon the Church. Paying for time rather than energy used is unlikely to disincentivise users as they can be very specific about session length.
- It brings with it a higher upfront cost, plus a monthly and transaction fee, which may be incorporated into the rates charged.

7.0 LIGHTING

A new lighting system is required as part of the proposed works.

Lighting
HALO infra-red heaters have the option of integrated LED lighting, acting visually as a chandelier, with a combination of up and down lights. This is an option which could be very effective in both the North Aisle and Main Space at St. Mary Magdalene, and may be strategically used to highlight specific areas of the church, e.g. the altar.

HALO Infra-red Heaters installed at St. Matthew's, Cotham, Bristol, with integrated up/down LED lighting above altar.

There is currently microbore gas pipework to gas lamp locations on the piers. Mineral Insulated Copper Cable (MICC) bare copper cabling could be run along these routes, to reuse the locations.

Existing gas lamps and microbore gas pipework at St. Mary Magdalene (left), MF example of MICC cabled heritage lighting.

The church may also benefit from some uplighting to illuminate the very dark roof space within both spaces. This may ease any glare issues.

Existing dark ceilings at St. Mary Magdalene could benefit from illuminance.

Task Lighting

We understand that the North Aisle community space may be used by various groups for group tasks and crafting etc. Different activities of this type have different requirements in terms of lux levels, colour rendering, uniformity and glare. We understand that the likely users of the space have expressed that dedicated task lighting will be a satisfactory way of providing adequate light for the full variety of possible activities. This may be in the form of integrated 'stations' or the provision of free-standing lamps and adequate sockets.

Wayfinding Lighting within the Church

When community members and particularly new visitors enter the church, navigation should be intuitive and obvious. A PIR absence controlled system could register the entry of visitors and light up the path across the Nave to the space, with some illuminance from the community space itself. We also understand that to mitigate risk of very high moisture content and subsequent condensation risk within the North Aisle, a coat store is desired in the area beneath the tower in the main church, for example for a school group in poor weather. This should also be clear and obvious, so entry sensors should trigger illuminance of the coat store space as a first stopping point.

Ambient Lighting within the Church

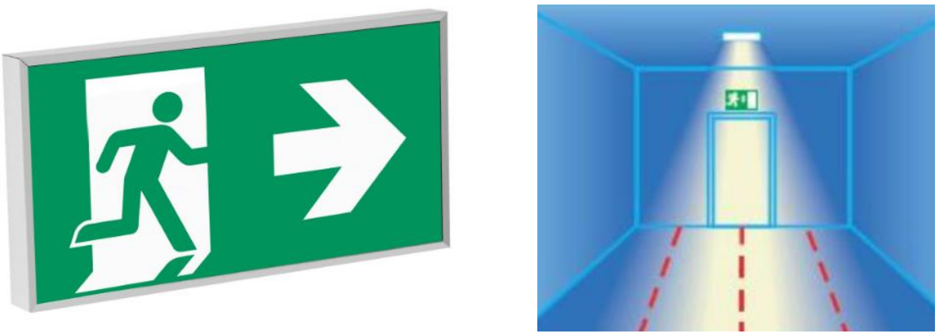
Wayfinding lighting and lighting of the North Aisle should not detract from the church as a place of worship. The client has discussed a desire for automatically triggered lighting upon entry to illuminate the chancel and highlight the altar.

Lighting to Tower and Stairs

The client has also expressed a desire to improve the lighting provision to the bell-ringing space in the tower, and in the tower stairwell. This can be provided with bulkhead fittings and switch-controlled.

Emergency Lighting

Emergency lighting and escape signage will be required to be installed to maintain emergency lighting for 3 hours and in accordance with BS 5266.



Requirement for escape signage and emergency lighting to BS 5266.

External Lighting

An improvement to the porch lighting is desired to indicate destination and improve the external aesthetic. It is also desirable to provide wayfinding external lighting along the churchyard paths. To avoid risk of disturbance to ecology, for example bats, any external lighting should keep up-spill to an absolute minimum. For this reason, bollards which can be oriented to 180 degree distribution and keep up-spill below around 2% should be used.

We understand that while the church is in use, there is a requirement from BS EN 1838 to provide external emergency illumination of around 1 lux to an external assembly point, both from the main entrance and the vestry where we understand there will be a new path. This can be switch controlled within the porch to indicate occupation. In order to fully comply, this would require emergency backup power. Some fittings, for example Thorlux Passway, offer the ability to have integrated emergency backup batteries within the fittings, avoiding the need for additional complex cabling.

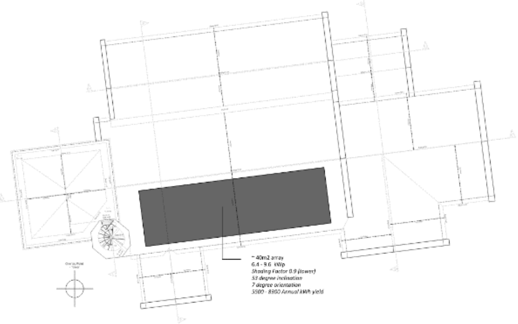
8.0 PHOTOVOLTAIC OPTIONS

We have considered the financial feasibility of options for the installation of photovoltaic panels on the church roof. PV installations require some capital cost investment and financial feasibility is in large part determined by whether or not there is a reliable on-site demand for generated power. The church roof is a visually sensitive location which will be subject to additional planning considerations. We have considered three possible locations and engaged with a PV specialist Solarsense to gain a detailed idea of predicted performance and costs. Their full report can be found in the report Appendices: Solarsense PV study.

8.1 Installation Options

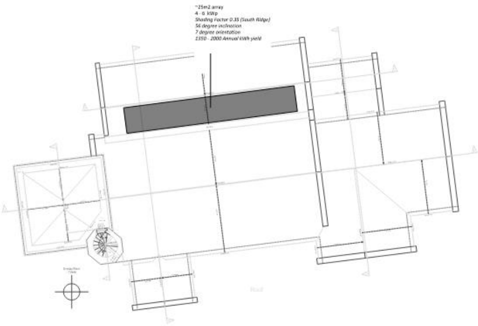
We considered three possible locations on the church roof. The pros and cons of each are outlined below.

Main Church South Roof



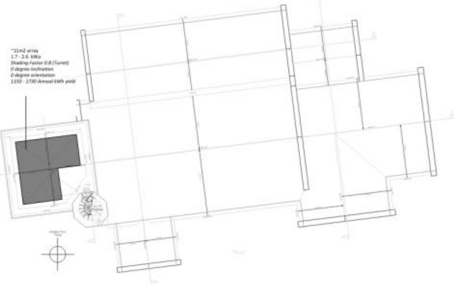
Pros	Cons
Large area: **~40m2** Relatively unshaded: Shading factor **~0.9** **55°** Inclination at **7°** orientation from South is close to optimal. Annual kWh/kWp for this condition in this region: **~964kWh/kWp** Easier access for installation than other possible locations	Large visual impact, likely planning complications. Challenging installation and maintenance due to steep roof pitch.

North Aisle South Roof



Pros	Cons
Relatively large area: **~25m2** Likely to be acceptable in terms of visual impact **55°** Inclination at **7°** orientation from South is close to optimal. Annual kWh/kWp for this condition in this region: **~964kWh/kWp**	Significant and consistent shading impact from Main Roof ridge. Shading factor estimated: **~0.35** Challenging installation and maintenance due to steep roof pitch and roof location

Tower Roof Installation



Pros	Cons
Likely to be acceptable in terms of visual impact. Relatively manageable access and maintenance one on top of the tower.	Small area: **~ 11m2** **0°** inclination (or overshading between panels if installed inclined) leads to less than optimal annual yield: **820 kWh/kWp** Significant and consistent shading impact from Overlooking tower. Shading factor estimated: **~0.7** Likely requirement for additional structure to raise mounting height to avoid additional overshading from parapet Challenging access via tower

8.2 On-site use/Export/Battery storage

When energy is generated through photovoltaics, it has to be used on site, stored, or exported to the grid. Using the energy directly on site is by far the most financially economical use of generated energy as each kWh used is a kWh saved from the electricity load that would otherwise be drawn from the grid. This translates into a saving at the same rate per kWh as paid on your electricity bill. In the church's case, this is currently 25p/kWh. However, if electricity cannot be used at the time of generation, it must be exported to the grid. The rate which is paid to the exporter is typically a much lower rate, for example, EDF's current variable export tariff offers around 6p/kWh.

As demonstrated by billing, the church's electricity use is currently very low. This may be expected to increase with the introduction of a new heating system, but most of this electrical demand will occur during the winter. Photovoltaics generate more electricity during the summer months, when there will be comparatively little power demand from the church.

Battery storage allows PV-generated power to be stored until it is required. However, batteries sized to store power across seasons are financially unfeasible and extremely large. Short term battery storage can however be used in conjunction with an incentivised export tariff such as those offered by Octopus, which offer improved export rates at times of peak demand in the grid. Alternatively, if there is not sufficient electrical demand at the church, there may be scope to incorporate the electrical demand of the village in a wider community energy scheme.

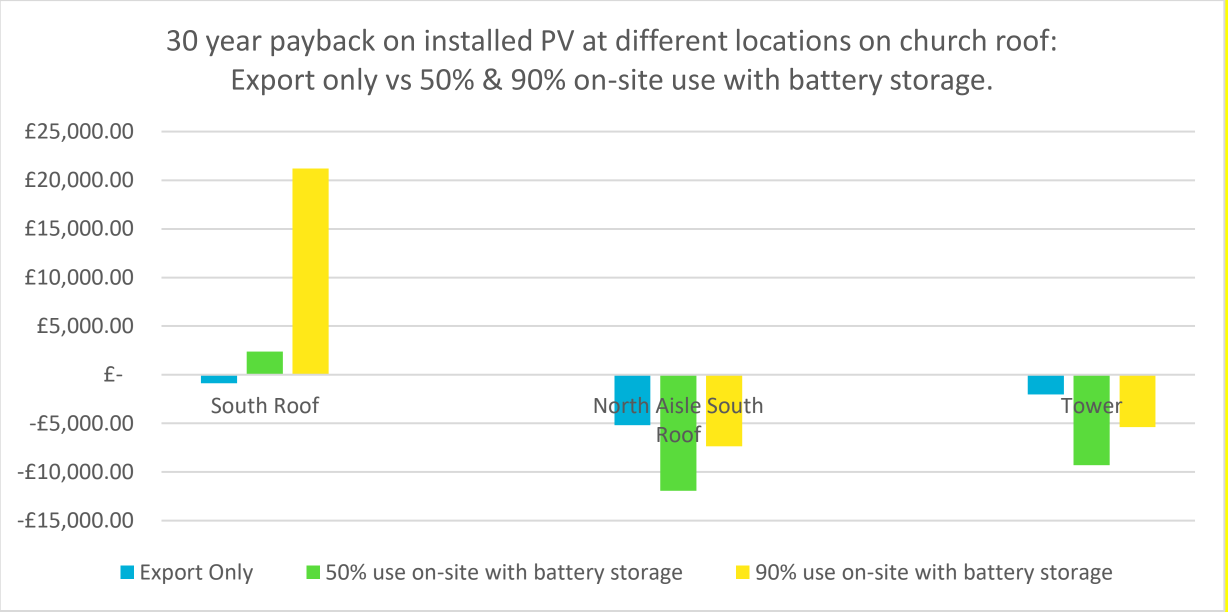
8.3 Location Financial Feasibility Comparison

We have performed initial feasibility modelling on the three locations proposed above, using estimates for potential kWp peak generation panel coverage and kWh/kWp annual yield estimates following the process set out in the MCS Guide to Photovoltaic systems which accounts for location, orientation, inclination and shading factors. We have used indicative capital and maintenance costs based on industry experience to estimate the payback of each of the three options over 30 years.

The financial viability of PV installation is largely impacted by the ability to use electricity at the same time as it is generated. We compared a scenario where all generated energy is exported to the grid with two scenarios which incorporated the capital cost of battery storage to achieve 50% and 90% on-site use respectively. The results of this comparison for the three locations is shown below.

Payback Model Inputs

UK Zone	5E (MCS, 2012)	Maintenance cost/annum	£50
Grid export price/kWh SEG	£0.056	Capital cost: 12kWh battery	£10,000
Energy saving price/kWh	£0.25	Payback test duration	30 years
Capital cost/m2 installation	£250		



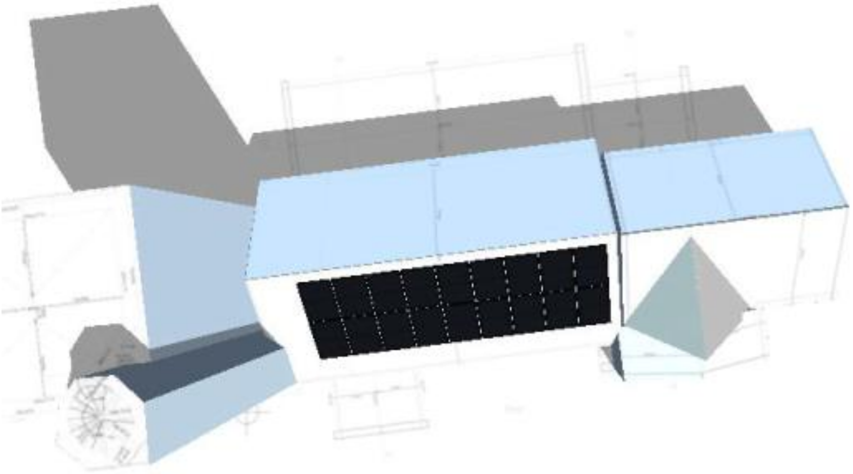
PV Location Feasibility

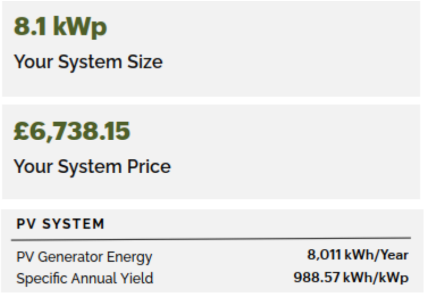
- The high-level estimate shows that only the main South roof is likely to achieve payback within 30 years, in any of the three scenarios tested (Export only vs 50% & 90% onsite use with battery storage). The North Aisle roof and tower roof are unlikely to be financially feasible.
- Financial feasibility of a PV system on the main South roof is highly dependent on the ability of the church to use power generated rather than export to grid.

8.4 Solarsense Specialist Input

Following our desktop analysis, we have engaged with Solarsense, a specialist in PV installation, to gain a more detailed idea of prospective yield and costs for a PV installation at Stockland Bristol. Their report can be found in report Appendices: Solarsense PV study.

We suggested all three installation locations mentioned above. However, Solarsense have come to the same conclusion that the main South roof is likely to be the only feasible option, despite the planning and visual impact implications. The key aspects of their proposal are outlined below.

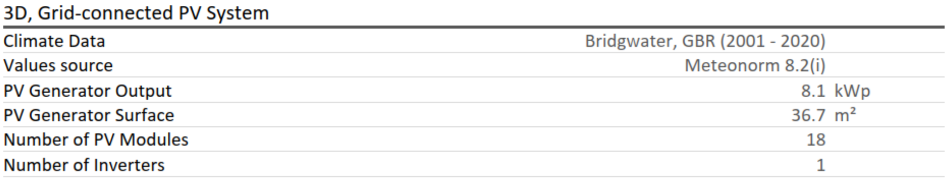




8.1 kWp
Your System Size

£6,738.15
Your System Price

PV SYSTEM	
PV Generator Energy	8,011 kWh/Year
Specific Annual Yield	988.57 kWh/kWp



3D, Grid-connected PV System	
Climate Data	Bridgwater, GBR (2001 - 2020)
Values source	Meteonorm 8.2(i)
PV Generator Output	8.1 kWp
PV Generator Surface	36.7 m²
Number of PV Modules	18
Number of Inverters	1

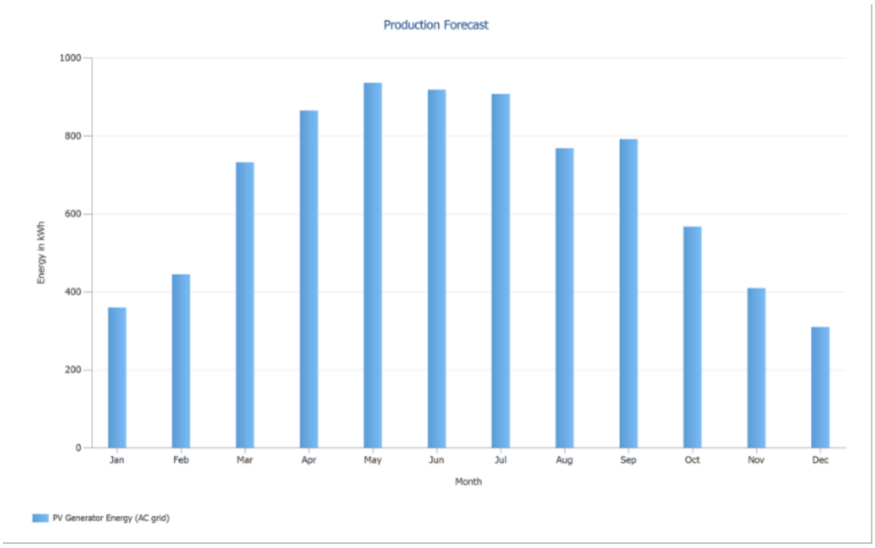
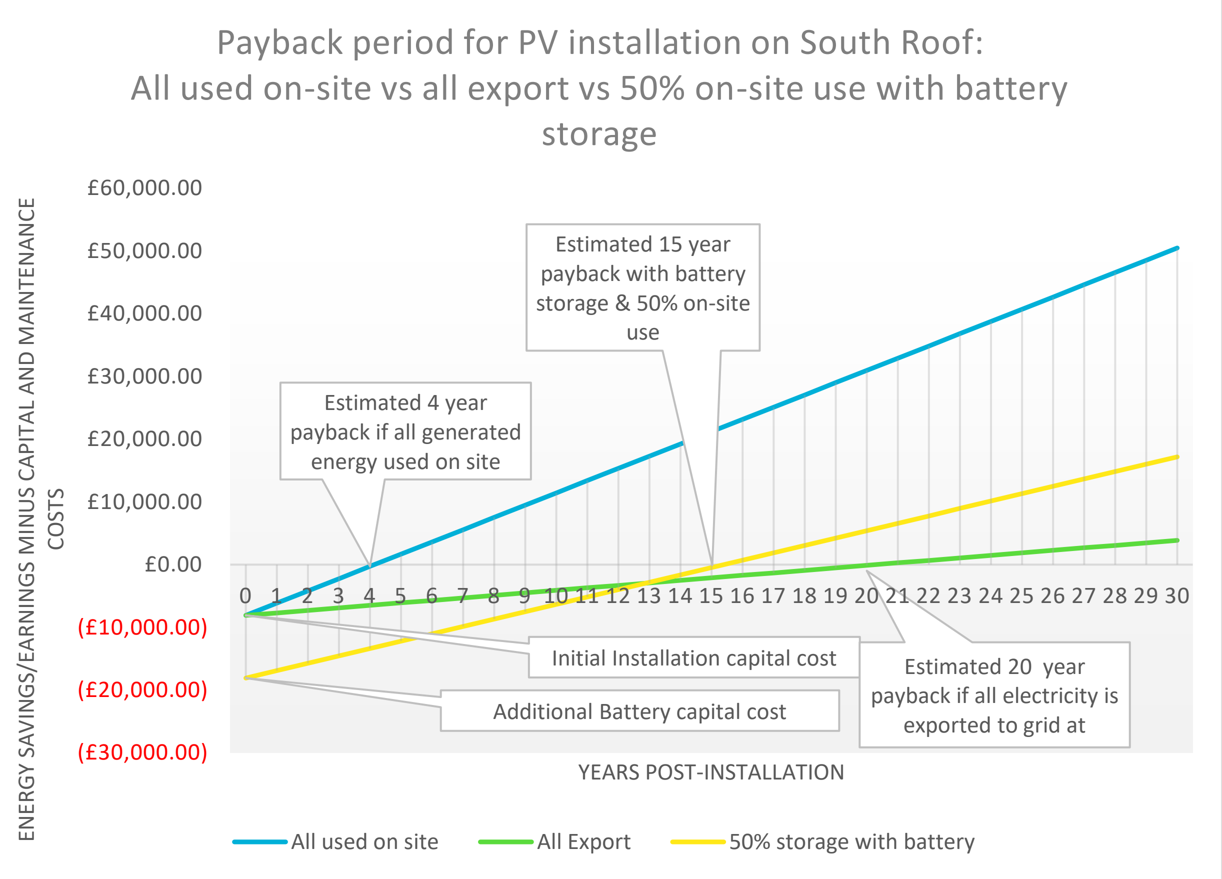


Figure: Production Forecast

- The cost of the installation of 18 panels (not including VAT) is estimated at around £6,800.
- The two proposed HALO heaters in the North Aisle would have a peak power demand of around 9kW. This would provide a load to use the full peak PV generation of 8.1kW on-site, but likely only in winter. The church is unlikely to have a similar concurrent load in the summer when much more electricity is generated.

8.5 Payback model based on Specialist design

Using the annual yield estimates and capital costs provided by Solarsense, we have retested the payback model. This uses the same tariffs and costs for maintenance and battery storage.



- A PV installation on the main South roof of the church would likely achieve a payback within 20 years in any scenario.
- The payback period is greatly improved if the energy generated can be used on site. A system which invested battery storage and achieved 50% use of electricity generated could achieve payback in 13 years.

PV Recommendation

- We recommend that installation of a photovoltaic system on the main church South roof is explored further as it has the potential to be a financially viable intervention, if the location is acceptable from a heritage and conservation point of view. Using energy directly from renewable sources reduces the overall amount of carbon associated with the church’s energy use.
- This is evidently a visually sensitive location which will require planning and heritage consideration and engagement with the local community. A structural assessment would also be required.
- The financial viability is largely dependent on the ability of the church to use energy when it is generated. It is unlikely to have this base load during peak summer generation, so alternative means to use energy on-site may be explored, such as battery storage/community energy scenarios in conjunction with the village. This requires exploration in further detail.

9.0 ELECTRICITY GENERATION THROUGH WIND POWER

Wind turbines represent one of the most cost effective types of installation to provide carbon free power. The ideal location for wind power generation is in open country, free of trees and buildings.

There is scope around the Church to position ground mounted standalone wind turbines, although the tree cover to the North, East and South of the Church makes the Churchyard unsuitable. We understand that the land directly to the North of the tree cover may feasibly be explored as an option. There is also the possibility of installing a small turbine at the top of the tower, which would receive uninhibited wind supply, but would require consideration in terms of visual and structural impact, and access for installation and maintenance.

We have been in contact with a wind energy specialist – RYSE energy - who have provided an indicative annual yield for possible wind turbine locations at Stockland Bristol. We have extrapolated the data to suggest the range of possible payback periods for the possible installations. The Reports from RYSE energy are appended to this report in the Appendices: Ryse Energy wind turbine studies.

We understand that any proposal for a wind turbine in the field directly to the North of the site would be likely to encounter planning difficulties because of the proximity of the dwellings.

9.1 Location: Field to North West of Churchyard.

RYSE energy have suggested the field to the North West of the churchyard would be the most suitable location and provided an annual yield estimate for two different possible models of turbine. This location would obviously be subject to agreements between the church, village and the landowner.

A type E-5 turbine has a capital cost of £45,000 and tower height of 15m, with a 4.3m diameter turbine. This model has an indicative yield of 8,450 kWh per year in the North West field.

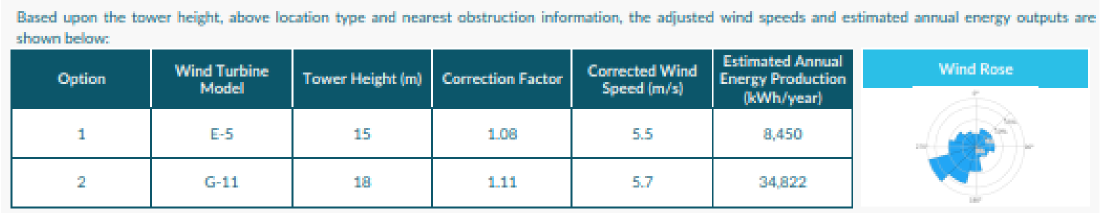
A type G-11 turbine has a capital cost of £93,000 and tower height of 18m, with a 13m diameter turbine. This model has an indicative yield of 34,822 kWh per year in the North West field.

G-11 & E-5 PROPOSED WIND TURBINE LOCATION

Location of the wind turbine technology at St. Mary Magdalen church, Stockland Bristol, TA5 2PZ

Latitude 51°11'16.16"N Longitude 3° 5'25.18"W

z



Based upon the tower height, above location type and nearest obstruction information, the adjusted wind speeds and estimated annual energy outputs are shown below:

Option	Wind Turbine Model	Tower Height (m)	Correction Factor	Corrected Wind Speed (m/s)	Estimated Annual Energy Production (kWh/year)
1	E-5	15	1.08	5.5	8,450
2	G-11	18	1.11	5.7	34,822

Possible Wind Turbine Location in field to North West of churchyard, with annual kWh yield of two different turbine models.

OPTION N°1

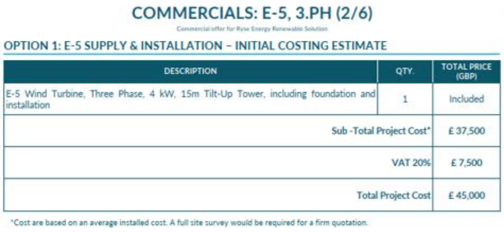
E-5 (4 kW)

- **4 kWp Horizontal Axis Wind Turbine**
- **Main Dimensions:**
  - **Swept Area:** 14.5 m²
  - **Diameter:** 4.3 m
  - **Turbine Tower:** 15 m (can be customized)
- **Operating Wind Speed:**
  - **Cut-in Wind Speed:** 2 m/s
  - **Cut-off Wind Speed:** 60 m/s
  - **Rated Wind Speed:** 11 m/s
- **Efficiency** = 77%* = C_p = 0.459

OPTION N°2

G-11 (11 kW)

- **11 kWp Horizontal Axis Wind Turbine**
- **Main Dimensions:**
  - **Swept Area:** 133 m²
  - **Diameter:** 13 m
  - **Turbine Tower:** 18 m (can be customized)
- **Operating Wind Speed:**
  - **Cut-in Wind Speed:** 3 m/s
  - **Cut-off Wind Speed:** 25 m/s
  - **Rated Wind Speed:** 11 m/s
- **Efficiency** = 44%* = C_p = 0.26



COMMERCIALS: E-5, 3.PH (2/6)

Commercial offer for Ryse Energy Renewable Solution

OPTION 1: E-5 SUPPLY & INSTALLATION – INITIAL COSTING ESTIMATE

DESCRIPTION	QTY.	TOTAL PRICE (GBP)
E-5 Wind Turbine, Three Phase, 4 kW, 15m Tilt-Up Tower, including foundation and installation	1	Included
Sub -Total Project Cost*		£ 37,500
VAT 20%		£ 7,500
Total Project Cost		£ 45,000

*Cost are based on an average installed cost. A full site survey would be required for a firm quotation.

COMMERCIALS: G-11, 3.PH (4/6)

Commercial offer for Ryse Energy Renewable Solution

OPTION 2: G-11 SUPPLY & INSTALLATION – INITIAL COSTING ESTIMATE

DESCRIPTION	QTY.	TOTAL PRICE (GBP)
G-11 Wind Turbine, Three Phase, 11 kW, 18m Lattice Tower, including foundation and installation	1	Included
Sub-Total Project Cost*		£ 77,500
VAT 20%		£ 15,500
Total Project Cost		£ 93,000

*Cost are based on an average installed cost. A full site survey would be required for a firm quotation.

Options for small and large model wind turbines for the North West Field, with capital costs.

9.2 Location: Church Tower

As the churchyard itself is too sheltered to provide a reliable source of wind energy, the only option for a wind turbine upon the church grounds is a small-scale turbine attached at the top of the tower. We have explored this option with Ryse, although there are several considerations which might prevent this from being a feasible idea to explore. Buildings of the church's age won't be designed to deal with the forces that would be applied to the turbine, so a structural assessment would likely be required prior to installation. Planning is also likely to be a challenging issue with the grade II listed church.

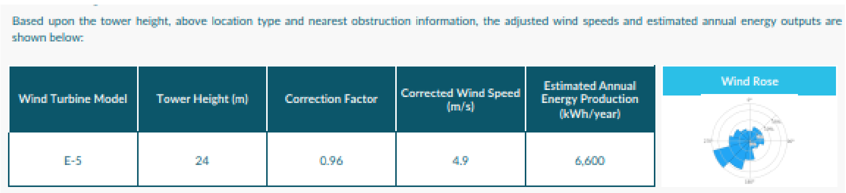
RYSE energy provided an indicative annual yield for a small E-5 type turbine (see above) of 6,600 kWh per year.

E-5 PROPOSED WIND TURBINE LOCATION

Location of the wind turbine technology at St. Mary Magdalen church, Stockland Bristol, TA5 2PZ

Latitude	51°11'16.16"N	Longitude	3° 5'25.18"W

Possible small (E-5) Wind Turbine Location at top of church tower, with annual 6,600 kWh indicative yield.



Based upon the tower height, above location type and nearest obstruction information, the adjusted wind speeds and estimated annual energy outputs are shown below:

Wind Turbine Model	Tower Height (m)	Correction Factor	Corrected Wind Speed (m/s)	Estimated Annual Energy Production (kWh/year)
E-5	24	0.96	4.9	6,600

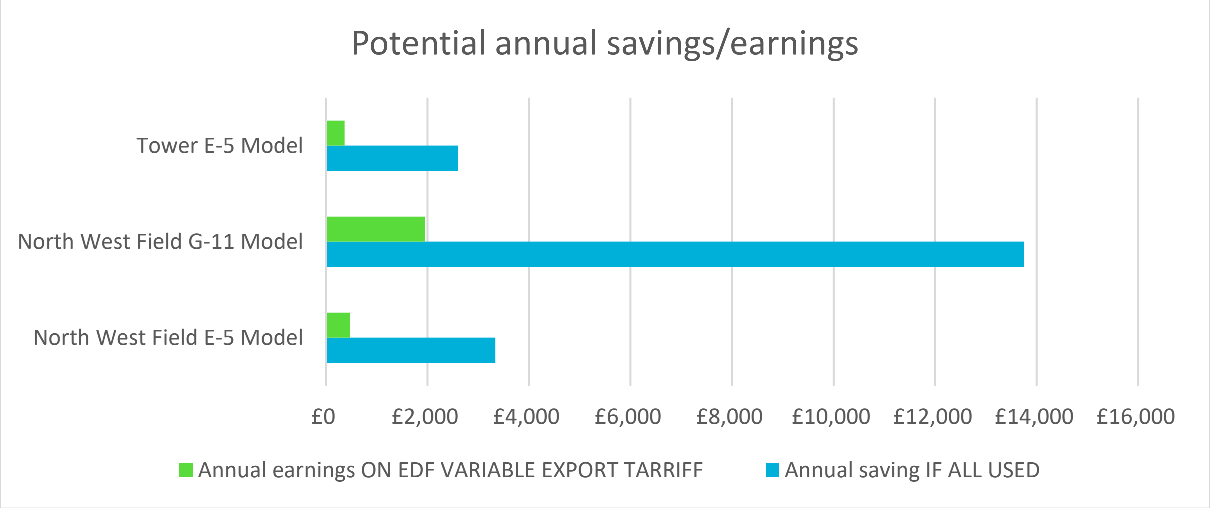
Possible small (E-5) Wind Turbine Location at top of church tower, with annual 6,600 kWh indicative yield.

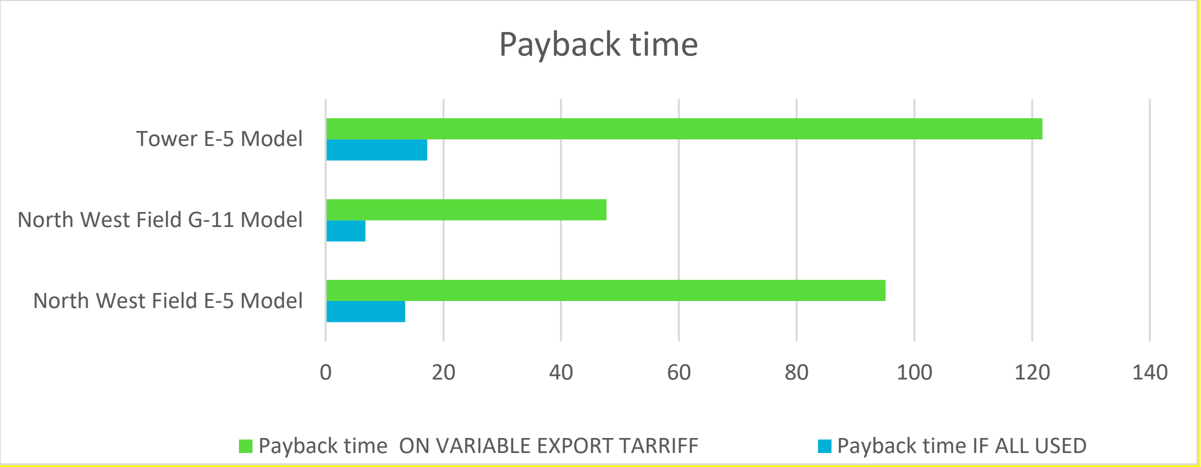
9.3 Savings/Earnings/Payback

Similar to Photovoltaics, when energy is generated through wind, it has to be used on site, stored, or exported to the grid. Using the energy directly on site is by far the most financially economical use of generated energy as each kWh used is a kWh saved from the electricity load that would otherwise be drawn from the grid. This translates into a saving at the same rate per kWh as paid on your electricity bill. In the church's case, this is currently 25p/kWh. However, if electricity cannot be used at the time of generation, it must be exported to the grid. The rate which is paid to the exporter is typically a much lower rate, for example, EDF's current variable export tariff offers around 6p/kWh. One advantage of wind-generated power over PV-generated power is that power is generated consistently throughout the year and typically peaks in the winter time, when there is a larger on-site demand for power due to heating requirements. This theoretically allows for greater on-site use of generated energy than a PV system, which mostly generates electricity during the summer when there is low demand.

While wind generation is a positive investment in terms of a continuous source of power for many years, the high capital cost of installation means that the payback period must be considered and this is evidently largely influenced by the price per kWh which is saved or earned. As can be seen in the charts below, there is a very wide range of annual savings/earnings potential dependent on whether the energy can be used on site or if there is not enough electrical demand at the time of generation.

Battery storage could be incorporated into a wind generation system to allow generated energy to be stored until there is enough demand to use it on site. There is also the possibility of incentivised tariffs from companies such as Octopus who offer improved rates per kWh exported at times of high demand throughout the grid, so storage in order to export at peak times may make this an option which merits further consideration.





- The larger G-11 model in the North-West field has a capital cost of double the smaller E-5 model, but annual generation from the North West field may be expected to be 4x greater with the larger model.
- The smaller E-5 model has a slightly faster theoretical payback time if installed on the church tower compared to the North West field, due to its greater height improving yield, but this installation location would likely present numerous practical challenges.
- If all of the electricity generated by the larger G-11 turbine in the North West field were used on site, payback could theoretically be achieved in less than 10 years. However, if all generated electricity was exported, this could rise to over 45 years.

Electricity Generation through Wind Power Recommendations

- If there is scope to explore further the option of a turbine in the field to the North West in terms of land-ownership and permission, this is an option which may merit further consideration. However, this is likely to require a consistent demand to be financially viable. Battery storage with favourable export tariffs may be an option, or community use of generated power with the wider village. Turbines can be controversial in terms of visual intrusion, so any installation would require engagement with village residents.
- Wind energy specialists expressed doubt about the practical feasibility of a small turbine on top of the church tower. The risks inherent in this location in terms of structural loads, access for maintenance and installation, planning and visual intrusion mean that it is unlikely to be a practicable option.

10.0 APPENDICES:

10.1 National Grid - Budget Estimate for increased power supply

10.2 Solarsense PV Study

- Solarsense Stockland Bristol 8.1kWp Tender
- Solarsense PVSol – Stockland Bristol Church
- Solarsense overview – Stockland Bristol Church
- Solarsense Solar PV Layout – Stockland Bristol Church
- Solarsense Solar PV = Terms and Conditions

10.3 Ryse Energy wind turbine studies - Ryse Energy E-5 & G-11 Technical & Commercial Proposal

Beacon Tower
Colston Street
Bristol
BS1 4XE

Venture Way
Priorswood Industrial Estate
Taunton
Somerset
TA2 8DE
01823 348593
smtaylor@nationalgrid.co.uk

NGED Reference: 5264603

17/09/2024

Budget Estimate

Scheme No:	1944144
Scheme Version:	1

Dear Mr B Ashby Max Fordham Llp,

Budget Estimate for electricity connection works by National Grid Electricity Distribution (South West) plc ("NGED") for a 69kVA Connection at St Mary Magdalene'S, Stockland Bristol Stockland Bristol, Bridgwater Somerset, TA5 2PZ

Thank you for your recent enquiry. I am pleased to provide an indication of NGED's likely costs to carry out the connection works for you ("the Budget Estimate"). Our estimate for this work is based upon the information you have provided and is shown below.

Estimated Connection Charge

Contestable Works	£3,492.00
Non-Contestable Works	£15,294.00
VAT @ 20%	£3,757.00
Total	£22,543.00

Non-Contestable works are those works that only NGED can undertake. It is possible for you to get someone else to quote for the contestable part of the works. For further information please visit our website: https://connections.nationalgrid.co.uk/competition-in-connections/

Your supply will have the following electrical characteristics

Voltage	230 / 400 Volts
Phase	Three Phase
Agreed Import Capacity	69kVA
Agreed Export Capacity	0kVA

Please note that the proposed works and estimated connection charge is for **guidance purposes** only and has been derived from a desk-top design exercise. It is non-binding and subject, in particular, to any legal permission, wayleaves and any other consents being successfully obtained. It is based on present day prices. It does not include the cost of any necessary on-site civil works, which should be provided by you at your expense.

Enclosures

Please also find enclosed:

- Our summary document entitled "Budget Estimates - Your Budget Estimate Explained"
- A drawing showing the indicative point of connection (POC) of the new assets to our existing distribution system, in relation to the proposed development.

National Grid Electricity Distribution (South Wales) plc. Registered in England and Wales No. 2366985
National Grid Electricity Distribution (South West) plc. Registered in England and Wales No. 2366894
National Grid Electricity Distribution (East Midlands Wales) plc. Registered in England and Wales No. 2366923
National Grid Electricity Distribution (West Midlands) plc. Registered in England and Wales No. 3600574

Competition in Connections

The Budget Estimate is based upon NGED undertaking both the contestable and non-contestable connection works. You are able to seek competitive prices for some or all of the contestable elements.

You have the option to appoint an Independent Connection Provider (ICP) or Independent Distribution Network Operator (IDNO) to carry out some of the connection works, referred to as the Contestable Connection Works. Any connection works that can only be undertaken by NGED are referred to as Non-contestable Connection Works. See our enclosed Budget Estimate guide for more information.

Proposed Connection Works

Our estimate of the connection charge is for providing the following works:

Proposed Works:

3ph supply upgrade. Meter position assumed to be staying the same. High voltage and low voltage overhead line upgrades required.

Please note that these proposals are based upon a desk top provisional investigation and no site visit or detailed study has been carried out.

The estimate does not include costs for any reinforcement or diversionary work that may be required, or for any environmental, or stability studies which may also be necessary, although these are generally only required for larger capacity connections.

Progression to Connection Offer stage

This Budget Estimate is not a legally binding contract, but sets out the amount we reasonably estimate we would require you to pay for the connection works under a formal Connection offer.

If you would like us to undertake a more detailed analysis, including an assessment of any network reinforcement required we can provide a formal Connection Offer. Further information regarding how to apply is provided in our enclosed summary guide.

Upon receipt of your application we will carry out detailed network studies to finalise the design of the connection works (and any associated reinforcement works), and provide a Connection Offer detailing the works required, the associated costs, timescales, payment terms and conditions for the connection.

If you have any queries regarding this Budget Estimate please do not hesitate to contact me via the contact details at the top of this letter.

Yours Sincerely,

Steve Taylor

Planner

Budget Estimates

Your Budget Estimate Explained

April 2024

Electricity
Distribution

nationalgrid

A guide to help you understand your Budget Estimate and to outline your options for obtaining an offer to connect to NGED's Distribution System

Thank you for requesting a Budget Estimate for a connection to our distribution system. This guide is designed to help you understand the basis upon which the Budget Estimate is prepared and to highlight the options available to you should you wish to proceed to a formal offer for connection (the 'Connection Offer').

Budget Estimate

Provision of a Budget Estimate is a free of charge service, the purpose of which is to give you an indication of the likely cost of your connection(s). We do not carry out any detailed design work and the assessment is carried out as a desktop exercise that does not take account of any site specific considerations. You should note that the estimate that we provide at this stage may vary significantly from the price subsequently calculated in any Feasibility Study or Connection Offer. This is because it does not include the costs for any necessary network reinforcement, changed circumstances, or other influencing factors that come to light when the detailed investigation is undertaken. A Budget Estimate is not a formal offer for connection and cannot be accepted by you.

Exclusions from the Budget Estimate

Costs associated with the following activities are **NOT** included in the Budget Estimate:

- The diversion of our existing assets (if any) or any third party apparatus that is required
- Any associated reinforcement works
- Any on-site excavation and reinstatement
- The inclusion of any payment required in accordance with the Electricity (Connection Charges) Regulations 2017
- Any associated civil works, for example the provision of a substation plinth
- Detailed earthing studies are your responsibility
- Permits required under the Traffic Management Act 2004
- Out-of-hours working
- Legal requirements or consents
- Disturbing loads, for example motors, welders, electric vehicle chargers, heat pumps, etc.
- Any associated disconnections
- Any associated temporary supply
- Final competitive tenders and increases in labour, contract, or material costs
- Any required surveys, including any site survey
- Testing and commissioning (where applicable) that is undertaken in accordance with Engineering Recommendation G99 that must be witnessed by us
- Any impact on the transmission system and/or NGESO requirements arising

Application of the Electricity (Connection Charges) Regulations 2017 (ECCRs)

If your new electricity connection will connect to and utilise assets installed and paid for in respect to a previous connection the ECCRs may come in to effect. The ECCRs empower us to recover from you a proportion of those costs and refund the initial connection customer. Any calculated ECCR payments will be included in your Connection Offer.

Ways to proceed

If you want to take your enquiry further there are a number of ways you can proceed. You can request:

- A Feasibility Study; or
- A formal Connection Offer; or
- A Study & Offer quotation (Distributed Energy Resources (DER) only – limitations apply)

Feasibility Study

A Feasibility Study is generally used for more complex connections and involves a more detailed assessment that may consider a number of connection options. When more than one viable option is available we will provide estimated costs for each option. Once you have decided which option you would like to progress you can apply for a Connection Offer. There is a charge associated for this work; therefore we recommend you speak to your NGED contact first to find out more.

Formal Connection Offer

If you request a Connection Offer we will undertake a more detailed assessment of the network, design the solution, including any reinforcement required and calculate the associated connection charge. The Connection

Offer will include two options for acceptance. The first option will include a price for us to undertake all the connection works.

The second option will include a price for us to undertake just the works that only we are allowed to do; the 'non-contestable works'. You can get a competitive quotation for the remaining works; the 'contestable works' and may appoint an accredited Independent Connection Provider (ICP) to undertake these works. For further information please see our section on Competitions in Connections.

The Connection Offer is open for acceptance for 90 days and includes all our terms and conditions for connection. Once accepted it will become a binding contract between us.

The Connection Offer will include charges for the costs we incur in preparing it. For those Connection Offers for capacity greater than 250kVA, that include an element of works at high voltage (11kV and above), we will charge you for the costs incurred regardless of whether or not you accept the Connection Offer (see 'Assessment & Design' Fees below).

Study & Offer Process

If you are unsure of the capacity you wish to connect, a Study & Offer quotation allows you to assess the capacity options available without submitting multiple formal applications. Please note that this option is only available for generation connections with export capacity of 5MVA and above.

Each application allows up to three different capacity options you may require. We conduct a Feasibility Study for the approximate cost and works required to connect the generation to our network. This includes an indication of any reinforcement or diversionary works that may be required.
The standard application form should be completed as well as an additional covering form for the Study & Offer process. For more information National Grid - Electricity Connection Offer Expenses Regulations

Assessment & Design Fees (A&D Fees)

If your proposed electricity connection is greater than 250kVA, and requires work at 11kV and above, we will charge you for the time we spend preparing the connection offer in accordance with the Electricity (Connection Offer Expenses) Regulations 2018, (the 'A&D Fee'). We will require payment even if you do not accept the Connection Offer. The charge covers costs we reasonably incur when assessing the impacts of the proposed connection on the distribution/transmission system, designing the connection (including any reinforcement works) and preparing the Connection Offer. Further information may be found on our website: National Grid - Electricity Connection Charges Regulation

How to apply

You can apply in writing via the following address:

National Grid Electricity Distribution (East & West Midlands)
Records Team
6th Floor
Toll End Road
Tipton
DY4 0HH
NGED.newsuppliesmids@nationalgrid.co.uk

You can also apply online: National Grid - Get connected

If you are unsure as to how to proceed you can also contact us to discuss your connection proposals further. Please see the 'Connection Appointments' section in this Guide.

If you are unsure as to how to proceed you can also contact us to discuss your connection proposals further. Please see the

Competition in Connections (CiC)

We offer a complete and comprehensive connection service but, if you wish, there are other companies you may ask to undertake some of the work known as the contestable work. (Non-contestable works are the elements of the connections work which must be completed by NGED). An Independent Connection Provider (ICP) can build electricity networks for adoption by us or by an Independent Distribution Network Operator (IDNO).

An IDNO is a company that can construct electricity networks, arranges connections to NGED's network or adopt networks built by ICPs then retains ownership of and be responsible for the operation, repair and maintenance of that new network.

The ICP must be registered with Lloyds Register EMEA under the National Electricity Registration Scheme (NERS) and they are required to work in accordance with the national framework and NGED documents that provide specifications for design, material procurement and installation and recording of assets.

The new connection (up to the start of your electrical installation) will be adopted by us (where no IDNO is involved) and become part of our electricity network on satisfactory final inspection, testing and connection. We will own the new connection from that time, and will take responsibility for future operation, repair, maintenance and replacement (subject to any guarantee requirements of the Adoption Agreement).

More information regarding Competition in Connections can be found on our website at National Grid - Information for Customers

Safety

If you are already on site, or about to move on to site, please remember to take adequate precautions to protect yourself from potential electrical hazards.

Overhead Lines

Particular care must be taken in the handling of mechanical plant, cranes, scaffolding or ladders in the vicinity of our overhead lines. You should always seek guidance before any work takes place on site from your appointed Site Manager, who will ensure that all works are carried out safely and in accordance with Health and Safety Guidance Instruction GS6 – Avoidance of Danger from Overhead Electric Power Lines. (**hse.gov.uk/pubns/gs6.htm**)

Safe Excavation

Obtain the latest copies of our cable records for the site from **linesearchbeforeudig.co.uk**. You must excavate by hand digging trial holes to establish the actual positions of all cables before any mechanical excavation works commence. Please contact your Site Manager who will help you ensure that all your works are carried out safely and in accordance with Health and Safety Guidance Instruction HSG47 – Avoiding Danger from Underground Services. (**hse.gov.uk/pubns/gs47.htm**)

Legal Permissions and Consents

We have a legal obligation to provide new electricity connections, as well as to maintain and upgrade the existing distribution system in our area. For a new connection we need land rights to install and thereafter use, maintain and renew our equipment on privately owned land. When this is necessary we secure our equipment by legal agreement (Wayleaves and/or Deeds) with landowners. This helps to ensure that the equipment stays where it has been placed and can be maintained when necessary.

All land rights/legal and consents must be in place before we install and energise a new connection to our network. It is important that customers/developers are aware that the statutory process for acquiring compulsory land rights can be time consuming, it is not guaranteed to be successful and could be extremely costly. For this reason you should be prepared and if a third party is involved in the scheme, to start the negotiations before instructing us to pursue the compulsory land rights process.

Please note that we cannot energise our equipment until land rights are legally secured.

Please see the Legal Process on our website – National Grid - Legal permissions and consents

National Grid Electricity System Operator (NGESO) – The Electricity Transmission System

Larger installations, (typically generation requiring 1MW of export capacity and above and demand requiring 10MW of import capacity and above) may have an impact on the National Grid Electricity System Operator (NGESO) transmission system. Although we may flag any existing limiting network conditions in your Budget Estimate, it does not take account of any impact of the proposed connection(s) on the transmission system, including the outcome of any modification application that we may be required to submit to NGESO.

We may be required to request a 'Statement of Works' from NGESO in accordance with section 6.5.5, or a Modification in accordance with section 6.9 of the Connection and Use of System Code (the "CUSC") in order to ascertain the effect of the proposed connection on the transmission system. On receipt of this request, NGESO will consider, in accordance with the CUSC, whether or not a formal modification application is required.

For further information concerning the Statement of Works process please see our website – National Grid - Statement of Works

Further Network Information

We have a large range of network asset data available for access by third party users through a variety of services.

Constraint Maps

The constraint map provides an overview of our EHV networks (33kV and above), highlighting those circuits which are operating at or near their limits for the connection of any further Distributed Generation (DG)
Please see the constraint maps for all four NGED areas on our website – National Grid - Distributed generation EHV constraint maps

Network Capacity Maps

The network capacity map provides an indication of the networks capability to connect large-scale developments to major substations. The network capacity map is a guide to show the network where a connection is more likely to be achieved without significant reinforcement.
The map does not replace a full Formal Application in determining network capacity.
Please see the capacity map on our website for a login – www.nationalgrid.co.uk/our-network/network-capacity-map

Alternative Connections

NGED offers alternative connections, which enable customers willing to have their capacity temporarily reduced to connect ahead of the required reinforcement without contribution. The level of curtailment experienced by the connection can be fixed or dynamic, depending on the type of alternative connection offered.
Please see alternative connections webpage – National Grid - Connection offers and agreements

Flexible Power - Flexibility

DNO's are committed to openly comparing reinforcement and market flexibility, it has become one of the new fast moving areas when it comes to managing electricity distribution networks.
Any significant reinforcement scheme once at feasibility study or formal offer stage will require a flexibility assessment.
For more information, please visit www.nationalgrid.co.uk/network-flexibility-map

Connection Appointments

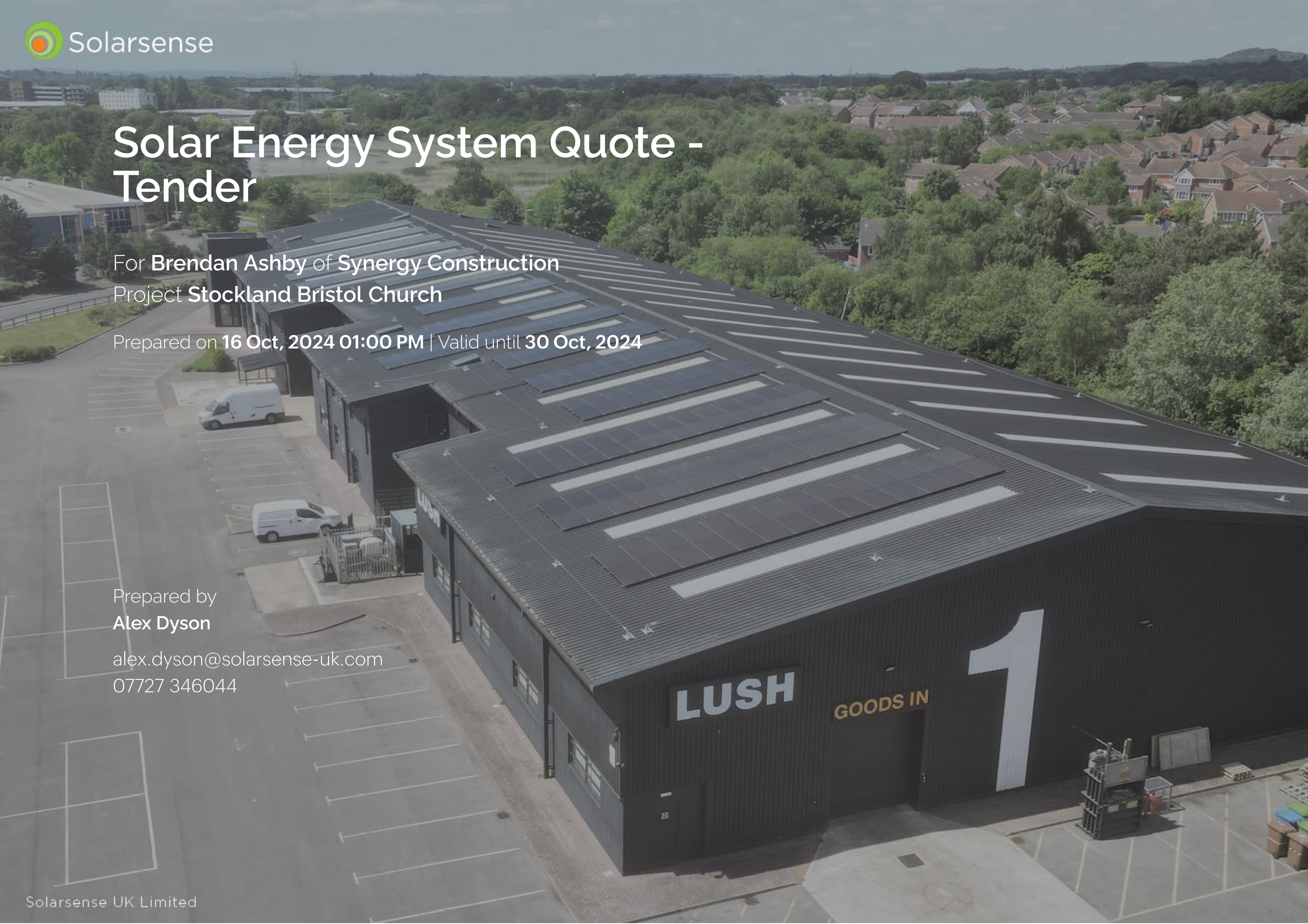
Make an appointment with an engineer to discuss your requirements and the connection process ahead of making an actual application for a connection to the network.
To find out more or make an appointment
Call;

South Wales & South West:	**0800 028 6229**
East & West Midlands:	**0800 121 4909**

Email:
NGED.connectappoint@nationalgrid.co.uk

nationalgrid

Registered Office: Avonbank, Feeder Road, Bristol BS2 0TB
nationalgrid.co.uk



Solar Energy System Quote - Tender

For **Brendan Ashby** of **Synergy Construction**
Project **Stockland Bristol Church**

Prepared on **16 Oct, 2024 01:00 PM** | Valid until **30 Oct, 2024**

Prepared by
Alex Dyson

alex.dyson@solarsense-uk.com
07727 346044

Brendan Ashby
Synergy Construction
St Mary Magdalene's Church Stockland, Bristol,
Bridgwater, TA5 2PZ

16 Oct, 2024 01:00 PM
Proposal Reference: C16240

Dear Brendan

Stockland Bristol Church - Bridgwater

Thank-you for the opportunity to tender for the above project.

Solarsense is one of the UK's leading renewable energy contractor and we provide a complete design and installation service for a wide range of clients. Established in 1995 and specialising in commercial roof, ground and carport mounted solar systems, we have completed over 20,000 installations and are responsible for powering some of the UK's top organisations, so we have the experience, expertise and knowledge to make your renewable project a success. I am delighted to provide below a quotation for a 8.1 kWp solar PV system as requested. A comprehensive specification is set out in the following pages but in brief we will provide:

- **Detailed technical design**
- **18 solar modules**
- **Framing systems**
- **PV generation meter**
- **All associated electrical DC equipment**
- **All associated electrical AC equipment from inverter to local AC isolator**
- **Full supply, installation and commissioning**
- **Handover including G99 grid connection and operation and maintenance pack**

*Please see notes on final page.

Total price: (excluding VAT) **£6,738.15**
Quotation valid until 30 Oct, 2024.

Kind Regards,

Alex Dyson

Energy Consultant
Solarsense UK Limited

alex.dyson@solarsense-uk.com | 07727 346044

01 | YOUR SYSTEM

We have been asked to provide a quotation for installing 18 solar modules on the roof at Stockland Bristol Church as shown below. Using the specification provided we propose installation of a 8.1 kWp PV system.

8.1 kWp

Your System Size

£6,738.15

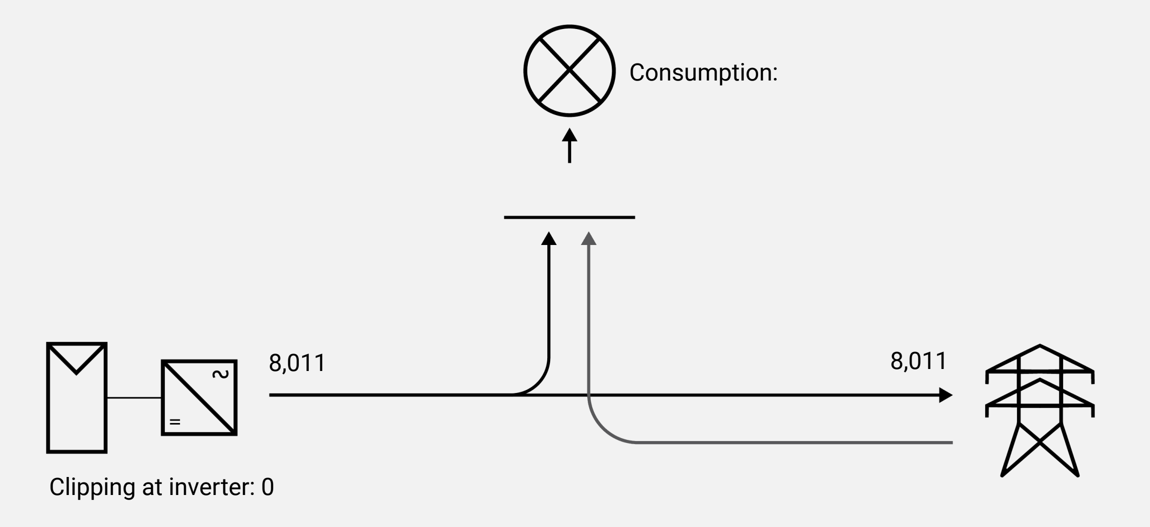
Your System Price

PV SYSTEM

PV Generator Energy	**8,011 kWh/Year**
Specific Annual Yield	**988.57 kWh/kWp**
Annual Consumption	**kWh**
Covered by PV	**kWh**
Covered by grid	**kWh**

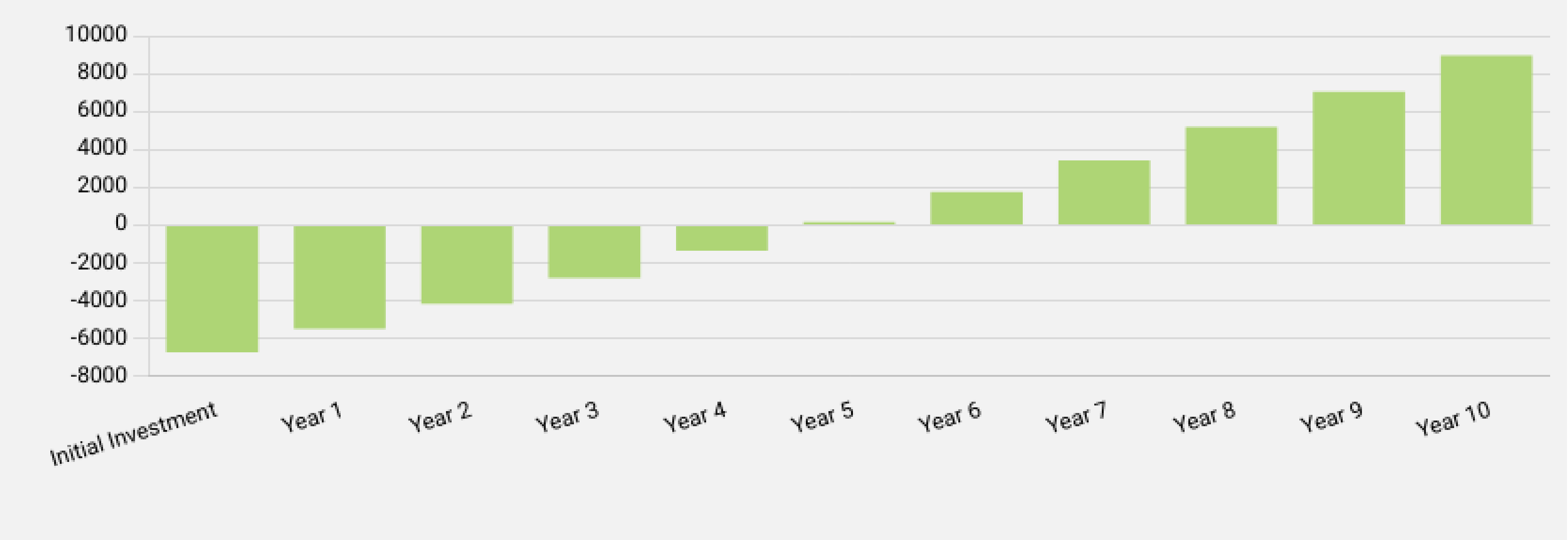
TOTAL CONSUMPTION

🟩 **Covered by PV**
🟩 **Covered by Grid**



The performance of a solar PV system is challenging to predict with any certainty due to the variability in the amount of solar radiation (sunlight) from location to location and from year to year. This estimate is given as guidance only. It should not be considered as a guarantee of performance. **For a more detailed energy analysis of your system, please refer to the PVsol provided with this quote.**

03 | RETURN ON INVESTMENT (ROI)



This illustration does not include operation and maintenance costs or module cleaning. Please ask for more information about operation and maintenance contracts.

The estimated ROI for your system will be **5.4 years.**

Estimated annual savings: **£ 1,249.72**

04 | ENVIRONMENTAL BENEFITS

Renewable energy benefits both the environment and business. It reduces reliance on fossil fuels, curbing emissions and improving air quality. Plus, it offers a profitable investment opportunity, cutting costs for businesses and off-sets your carbon footprint. **It is estimated that per annum your system will off-set the equivalent of:**

1,810

KG OF CO2 EMISSIONS

2,722

PINTS OF BEER
665g CO2

27,424

CUPS OF COFFEE
66g CO2

10,523

HOURS ON MOBILE PHONE
172g CO2

9,050,000

WEB SEARCHES MADE
0.2g CO2

As the grid decarbonises, this figure is likely to diminish over time. We have used our knowledge and experience to indicate a number which accounts for the many factors that go into this calculation but the actual number could differ depending on which energy source you are displacing.

05 | INCLUSIONS & EXCLUSIONS

Access to a highly qualified team of surveyors, designers, installers; management team focused on delivering an exceptionally high quality and customer focused service	Excluded
Optimised individual system design for your property following a site survey or by reviewing drawings or building design	Included
Structural assessment of roof for addition of solar modules, including snow and wind load assessments	Excluded
Scaffolding erection and removal, including handrail or edge protection must be in place. Work from a man-safe will incur additional installation costs.	Excluded
Risk assessment and all health and safety measures related to Solarsense operatives and equipment on site	Included
Site specific health and safety measures e.g. site inductions over 1 hours etc	Excluded
Liaise with local authority regarding development control requirements	Excluded
Building control application for both electrical and structural aspects of the works	Excluded
Application to Distribution Network Operator (DNO) for permission to connect the system to the grid.	Included
Carrying out upgrades recommended by the DNO to enable permission to connect the system to the grid	Excluded
Carrying out witness tests recommended by the DNO to enable permission to connect the system to the grid	Excluded
Offloading and distribution of kit, cranage or lifting/hoisting to roof level	Excluded
Installation and supply of PV modules and mounting equipment, inverters and DC cables	Included
Installation and supply of AC cable and containment between inverter(s) and local AC isolator (isolator provided by others within 1m of inverter)	Excluded
DC containment - Roof level only	Excluded
AC containment	Excluded
Penetration to allow cable entry into building	Excluded
Lightning protection - Survey carried out to determine if needed	Excluded
Provision of remote monitoring (subject to client providing internet connection)	Excluded
Public Display or system link to BMS	Excluded
Commission and sign off of PV system including DNO approval and any necessary G99 commissioning, witness testing and approval*	Included
Advice and assistance with Microgeneration Certification Scheme for systems up to 50kW*	Included
A 2 year workmanship guarantee provided by Solarsense; manufacturers' warranties as specified above*	Included
Provision of handover documentation including: as built drawings, schematic and operation and maintenance manual*	Included
Operations and maintenance (O&M) aftercare services (Optional packages available)	Included

Where DNO consent is required for grid connection, for systems of 50kW and over some operators reserve the right to witness the physical connection. In our experience this rarely happens, but where appropriate their fee will be charged to you at cost.

06 | ADDITIONAL INFORMATION

PROPOSAL TERMS

This quotation is valid until 30 Oct, 2024.

WARRANTIES

Your system will have the following warranties:

- **Modules**
  20 - 40 years manufacturer's warranty; 20 - 40 year performance warranty
- **Inverters**
  5 - 25 years manufacturer's warranty
- **Framework**
  10 years manufacturer's warranty
- **Solarsense**
  2 year workmanship warranty

For exact warranties of your system components, please see the data sheet provided with your quotation.

APPLICATIONS AND NOTICES

For the installation to go ahead the system has to comply with criteria set down by the Distribution Network Operator; in the SW England, Midlands, S Wales area this is National Grid Electricity Distribution.

PAYMENT SCHEDULE

We will request payments as follows: (all prices excluding VAT)

Total Price	**£6,738.15**
Less Feasibility Study	**£ 0.00**
Total Payable	**£ 6,738.15**
Initial deposit (payable with order)**:**	**£ 2,695.26**
Scheduled payment (materials on site)**:**	**£ 2,695.26**
On completion:	**£ 1,347.63**

All payments are due 30 days from date of invoice.

TERMS AND CONDITIONS

Solarsense UK - Terms and Conditions of Purchase - please view **here**

07 | THE NEXT STEPS

The next step in proceeding with this installation is for Solarsense to be appointed to complete all the necessary permissions, for the final page to be signed and initial deposit to be paid.

To discuss this further, please contact your consultant, **Alex Dyson**, on:

T: 0333 772 1800
E: alex.dyson@solarsense-uk.com

We can never fully predict the installation duration for a project, but for an estimate based on your system size, we would aim to complete within **1** week(s).

QUOTATION ACCEPTANCE

Contact: Alex Dyson
Mobile: 07727 346044
Email: alex.dyson@solarsense-uk.com

Proposal Reference: C16240
16 Oct, 2024 01:00 PM
Quotation valid until 30 Oct, 2024

Project: Stockland Bristol Church
Company: Synergy Construction
Contact: Brendan Ashby

Installation Address:
St Mary Magdalene's Church Stockland, Bristol,
Bridgwater, TA5 2PZ

Billing Address:
2 Bath Street, Bath
Bath, BA1 1SA

Tel: 0117 329 0874
Mob:
Email: B.Ashby@maxfordham.com
MPAN:

I hereby place an order for the «Quotes.System Size (kW) kWp PV system detailed in Proposal Reference C16240, as prepared for me by Solarsense on the above date: I/We, Brendan Ashby on behalf of the client, hereby instruct Solarsense UK Ltd to proceed with the installation of the solar system as designed & quoted. We confirm that the feasibility stages are complete and that DNO offer has been accepted, Planning permission obtained (if required) and structural survey report confirming suitability for the proposed system received.

Payment Details: **NatWest Bristol City Centre**
Name: **Solarsense UK Ltd**
Account: **30941563**
Sort Code: **56-00-05**
Reference: **C16240**

Formal receipt of deposit will be sent from our accounts department within 7 days.

Total Price (excluding VAT): **£6,738.15**
For details of our payment terms please refer to Section 6 above

If you would prefer to place a purchase order, please include all the information above.
I/We will BACS my deposit within the next 5 days.

Signed:

Date:

For and on behalf of: Brendan Ashby, TA5 2PZ

PLEASE CONTINUE FOR O&M PACKAGE

COMMERCIAL O&M PACKAGE (OPTIONAL)

Maintenance of your system is essential to ensure that PV systems operate efficiently and effectively throughout their lifecycle. These services are critical for maximising the energy output, ensuring safety, prolonging the life span of the solar modules and achieving financial returns on investment.

We are offering 5 years of O&M Services with the first year free, if accepted and paid for with this quotation. This will be a fixed up front price.

INCLUDED IN COST:

- Maintenance visit and service
- Visit by one service engineer on a solo basis
- Report of findings including any recommended remedial or improvements
- Production of RAMS from our standard template (bespoke RAMS charged at POA)
- Up to 1 hour of project management time (additional time charged at £60 per hour)
- Travel to and from site
- Our standard onboarding pack (sometimes called a pre-qualification questionnaire)

EXCLUDED IN COST:

- Bespoke RAMS requiring site visit (bespoke RAMS charged POA)
- Inspections of elements which are not safely or technically accessible (e.g. unguarded roof edges, some inverter logs)
- Access machinery, netting, scaffolding etc if required to enable safe access
- Companion operative where required (unless specifically mentioned above)
- Costs of overnight stays etc if visit exceeds one day
- Further remedial and project management
- Panel/array cleaning (bespoke priced cleaning POA)
- Bespoke PQQ completion for customer (POA, see our onboarding pack for inclusive option)

Contact: Stockland Bristol Church

Company: Synergy Construction

Site: St Mary Magdalene's Church
Stockland
Bristol,
Bridgwater
TA5 2PZ

Date: 14 Oct, 2024 04:47 PM

Ref: C16240

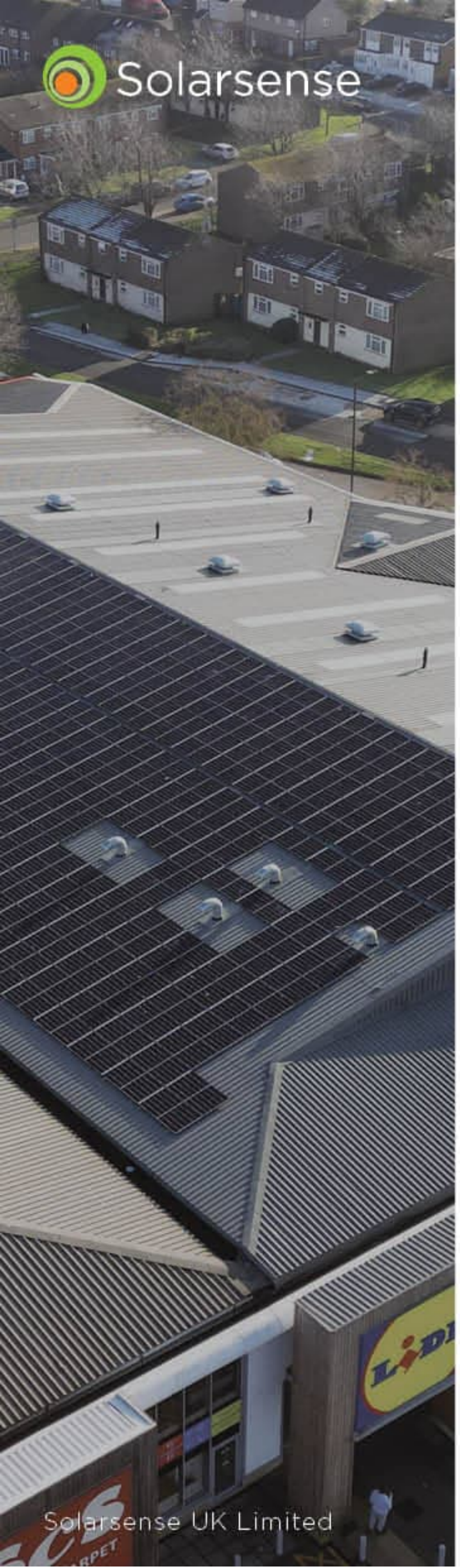
O&M Price PA: (exc. VAT)	**£ 91.44**
Total, inc. VAT:	**£ 109.73**
O&M Package Price: (exc. VAT)	**£ 365.76**
Total, inc. VAT:	**£ 438.91**

ACCEPTANCE OF O&M PACKAGE

To accept the O&M package and proceed with the services above, please check the tick box below and return along with your accepted quotation, this will then be processed by our accounts department. Upon receipt the visit date will be confirmed, and the deposit will be invoiced. By doing so you acknowledge that you have read, understood, and agreed to our terms and conditions.

Please sign below for acceptance of the O&M package.

Signed:



*SYSTEM NOTES

Proposal based on information provided. A site survey and final design will be required to confirm the tender proposal. Please be aware DNO (Distribution Network Operator) have significantly long lead times between 90 and 120 days, therefore in order to meet an installation start date please send order through well in advance of the DNO dates. Please see attached to this email a LOA which needs to be completed by the client and returned in order for Solarsense to carry out DNO application upon your behalf.

Solarsense UK Ltd
Unit 1A Tweed Road
Industrial Estate
Clevedon, BS21 6RR

Contact person:
Monika Vitaite (Design Support)

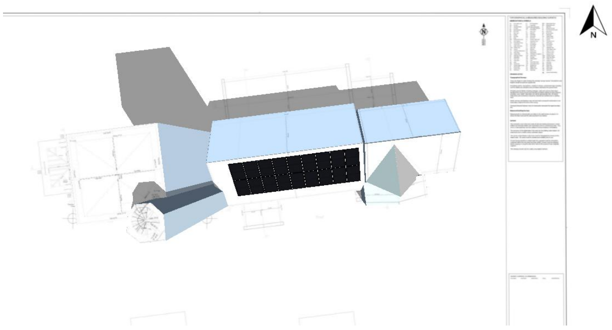
Project Name: Stockland Bristol Church
Offer no.: 16240

16/10/2024

Your PV system from Solarsense UK Ltd

Address of Installation

St Mary Magdalene's Church
Stockland Bristol, Bridgwater TA5 2PZ



Project Description:

Remote roof top solar PV design, subject to feasibility study.

Created with PV*SOL premium 2024 (R8)
Valentin Software GmbH

Project Overview

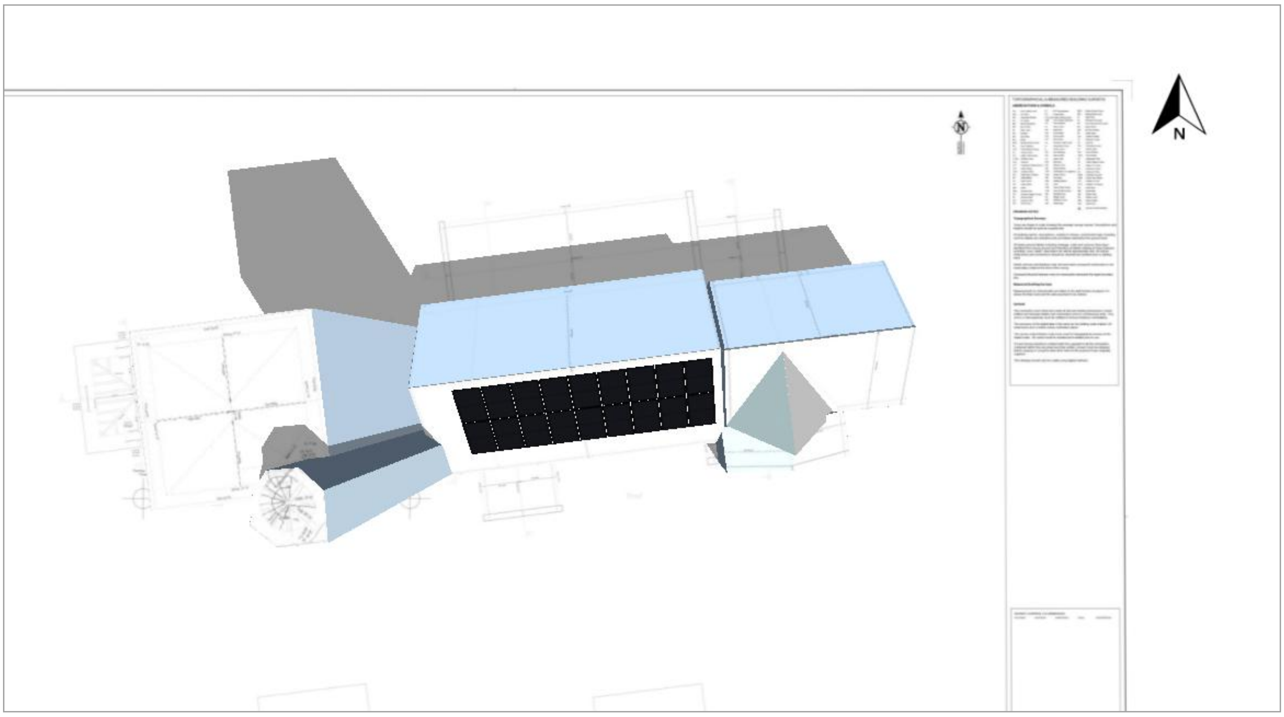


Figure: Overview Image, 3D Design

PV System

3D, Grid-connected PV System

Climate Data	Bridgwater, GBR (2001 - 2020)
Values source	Meteonorm 8.2(i)
PV Generator Output	8.1 kWp
PV Generator Surface	36.7 m²
Number of PV Modules	18
Number of Inverters	1

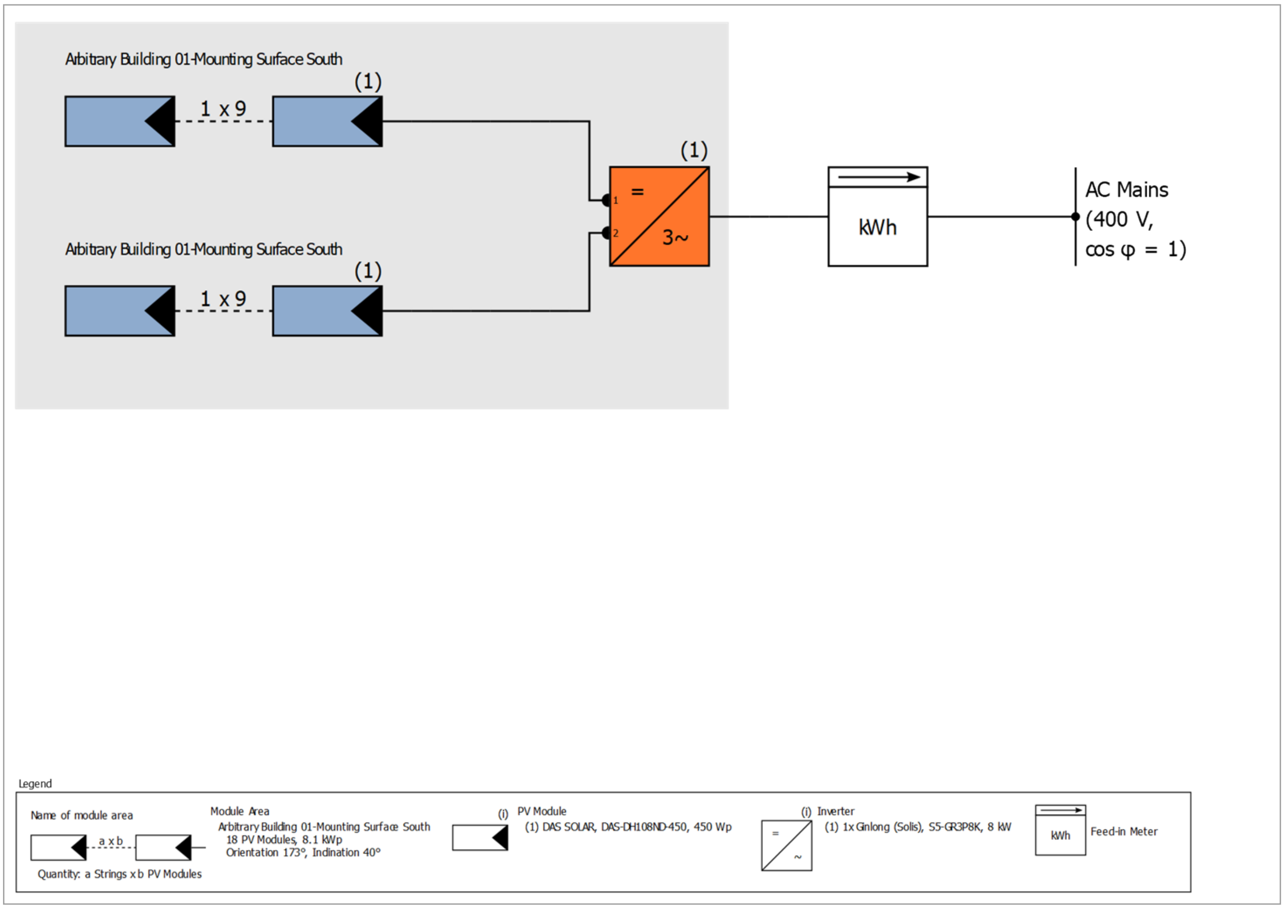


Figure: Schematic diagram

Production Forecast

Production Forecast	
PV Generator Output	8.10 kWp
Spec. Annual Yield	988.57 kWh/kWp
Performance Ratio (PR)	79.91 %
Yield Reduction due to Shading	18.8 %
Grid Export	8,011 kWh/Year
Grid Export in the first year (incl. module degradation)	7,999 kWh/Year
Standby Consumption (Inverter)	4 kWh/Year
CO_2 Emissions avoided	1,810 kg / year

Set-up of the System

Overview

System Data	
Type of System	3D, Grid-connected PV System

Module Areas

1. Module Area - Arbitrary Building 01-Mounting Surface South

PV Generator, 1. Module Area - Arbitrary Building 01-Mounting Surface South	
Name	Arbitrary Building 01-Mounting Surface South
PV Modules	18 x DAS-DH108ND-450 (v1)
Manufacturer	DAS SOLAR
Inclination	40 °
Orientation	South 173 °
Installation Type	Roof parallel
PV Generator Surface	36.7 m²

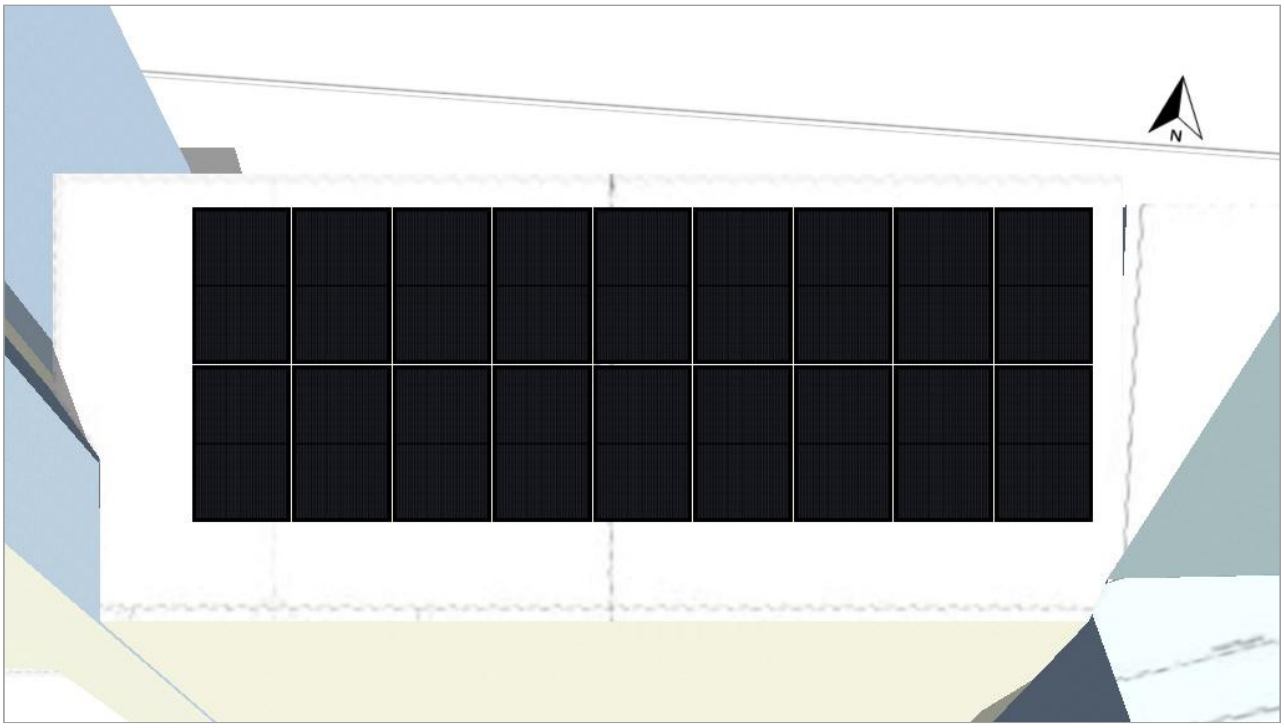


Figure: 1. Module Area - Arbitrary Building 01-Mounting Surface South

Simulation Results

Results Total System

PV System

PV Generator Output	8.10	kWp
Spec. Annual Yield	988.57	kWh/kWp
Performance Ratio (PR)	79.91	%
Yield Reduction due to Shading	18.8	%
Grid Export	8,011	kWh/Year
Grid Export in the first year (incl. module degradation)	7,999	kWh/Year
Standby Consumption (Inverter)	4	kWh/Year
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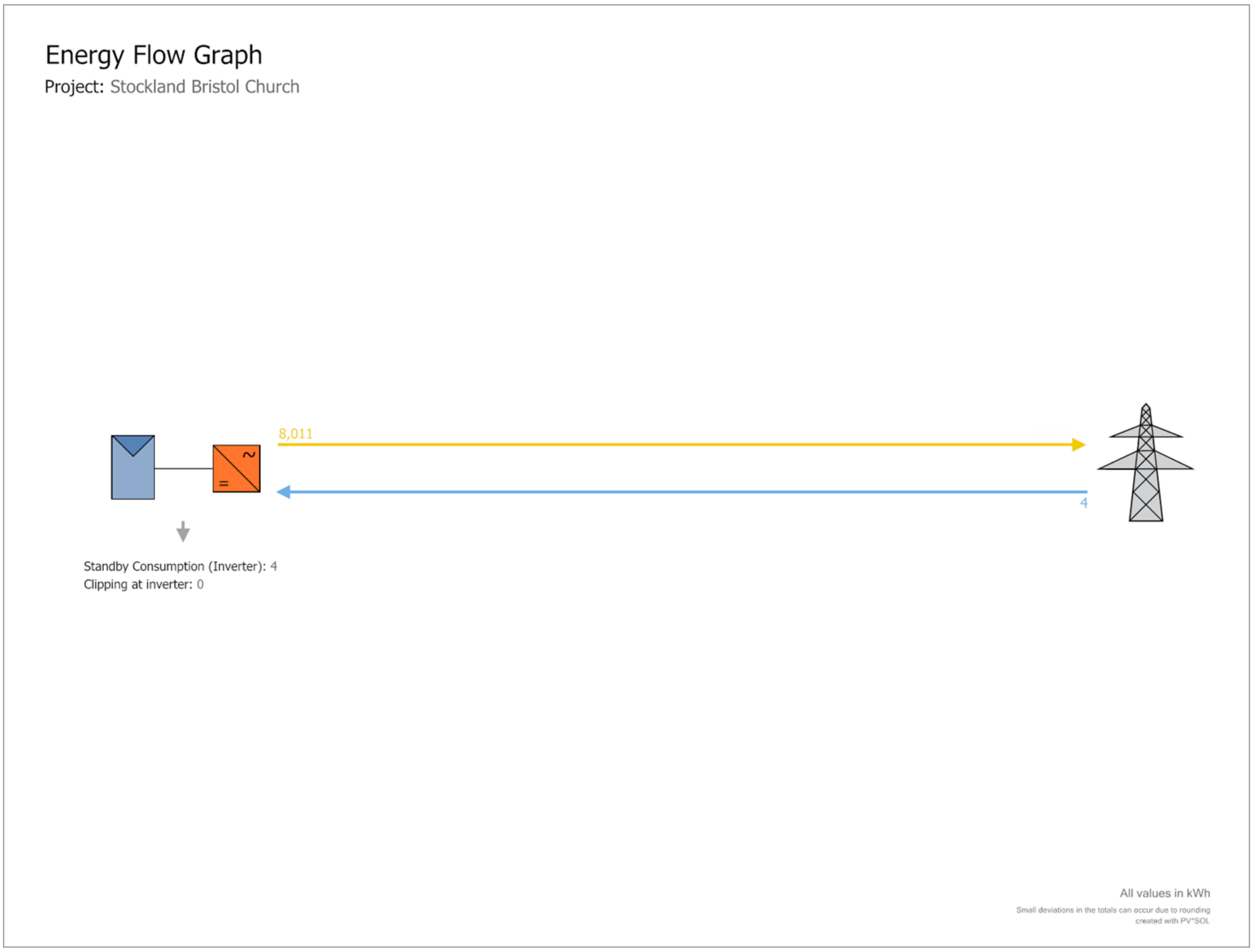


Figure: Energy flow

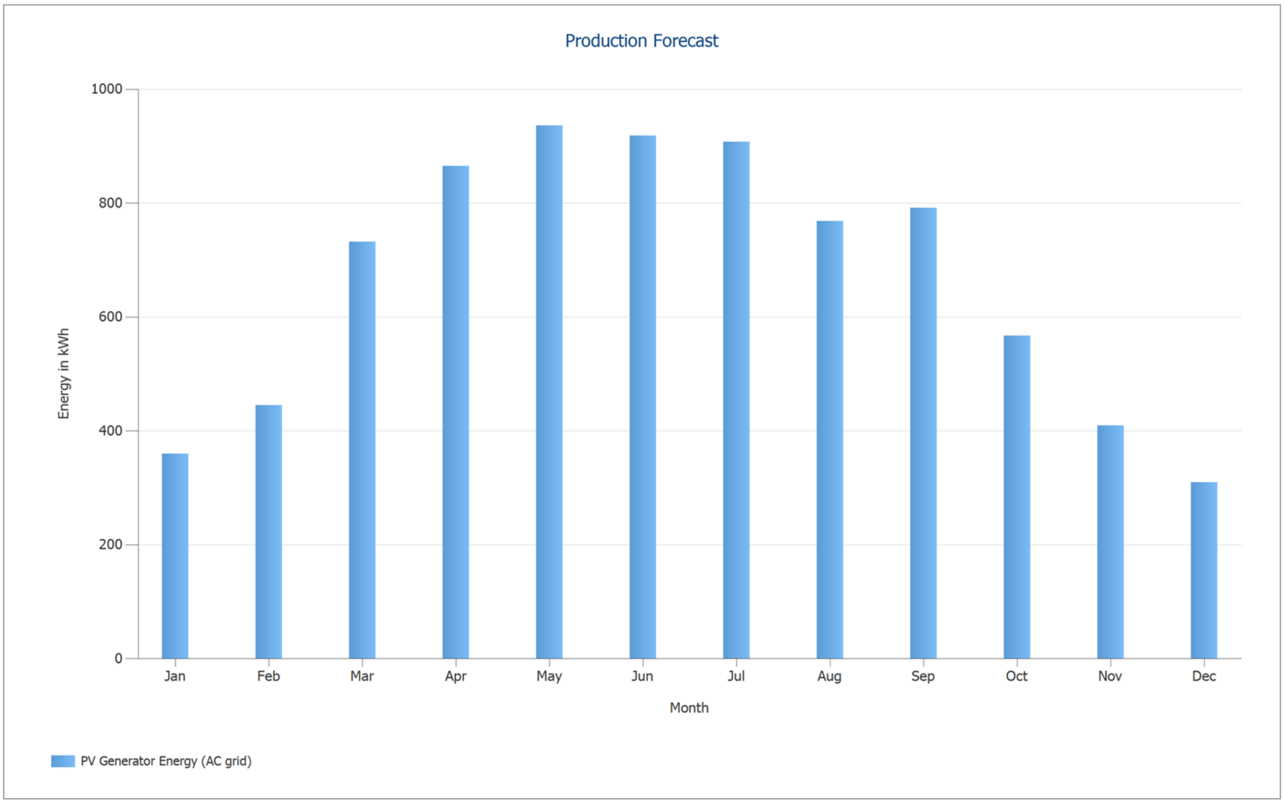


Figure: Production Forecast

Results per Module Area

Arbitrary Building 01-Mounting Surface South		
PV Generator Output	8.10	kWp
PV Generator Surface	36.74	m²
Global Radiation at the Module	1233.94	kWh/m²
Global Radiation on Module without reflection	1237.09	kWh/m²
Performance Ratio (PR)	79.94	%
PV Generator Energy (AC grid)	8011.30	kWh/Year
Spec. Annual Yield	989.05	kWh/kWp

Plans and parts list

Overview plan

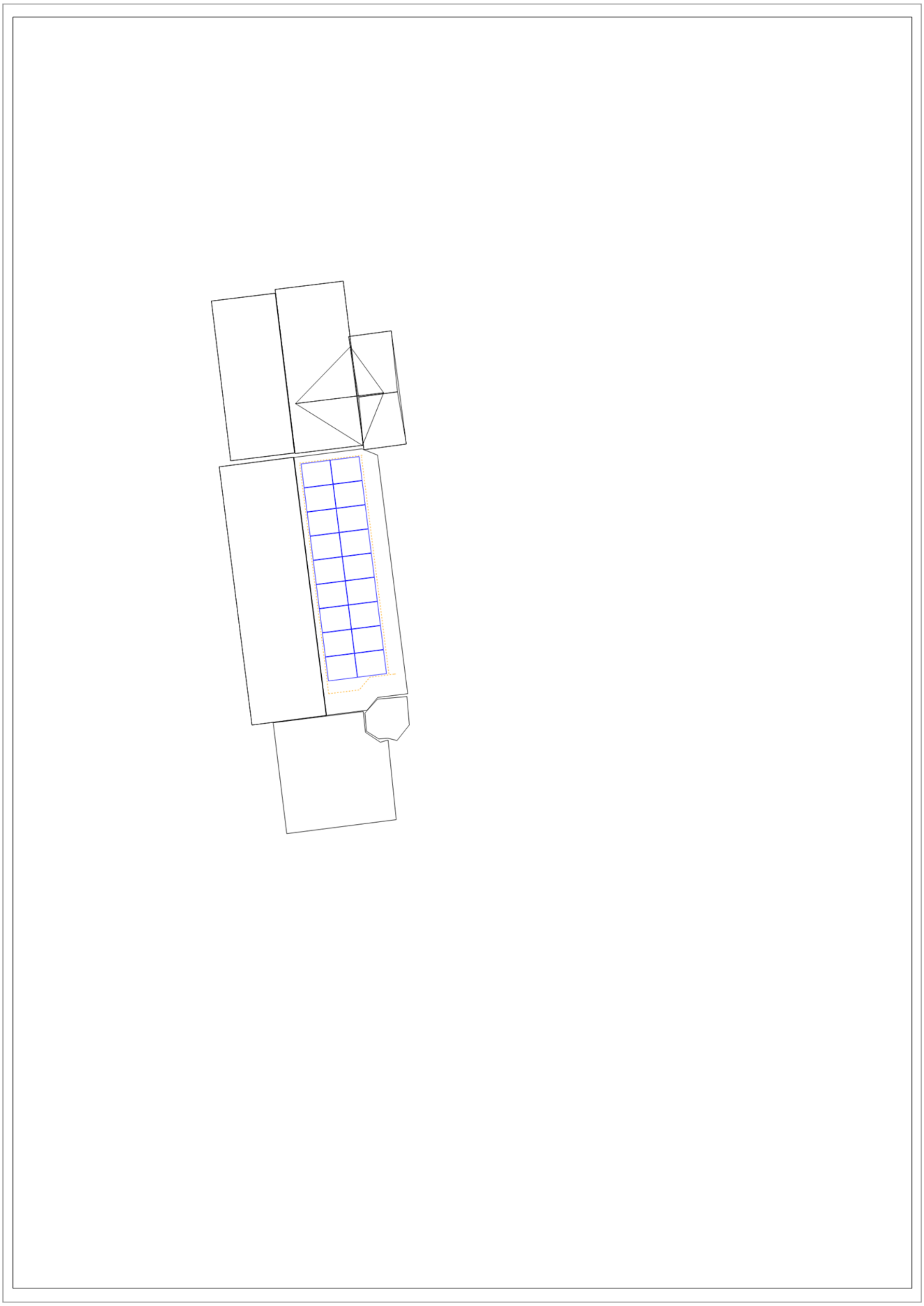


Figure: Overview plan

Dimensioning Plan

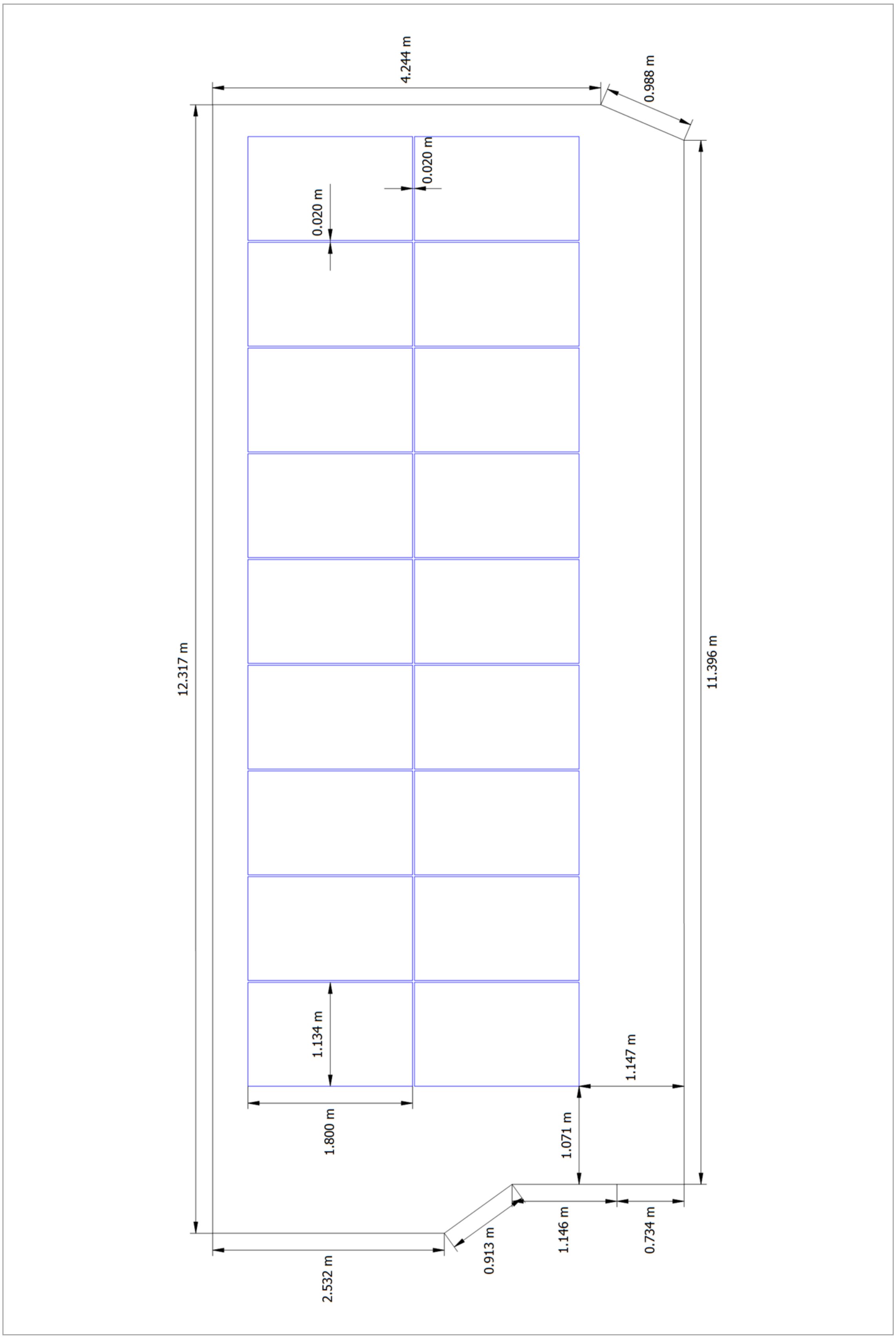


Figure: Arbitrary Building 01 - Mounting Surface South

Parts list

Parts list

#	Type	Item number	Manufacturer	Name	Quantity	Unit
1	PV Module		DAS SOLAR	DAS-DH108ND-450	18	Piece
2	Inverter		Ginlong (Solis)	S5-GR3P8K	1	Piece

Screenshots, 3D Design

Environment

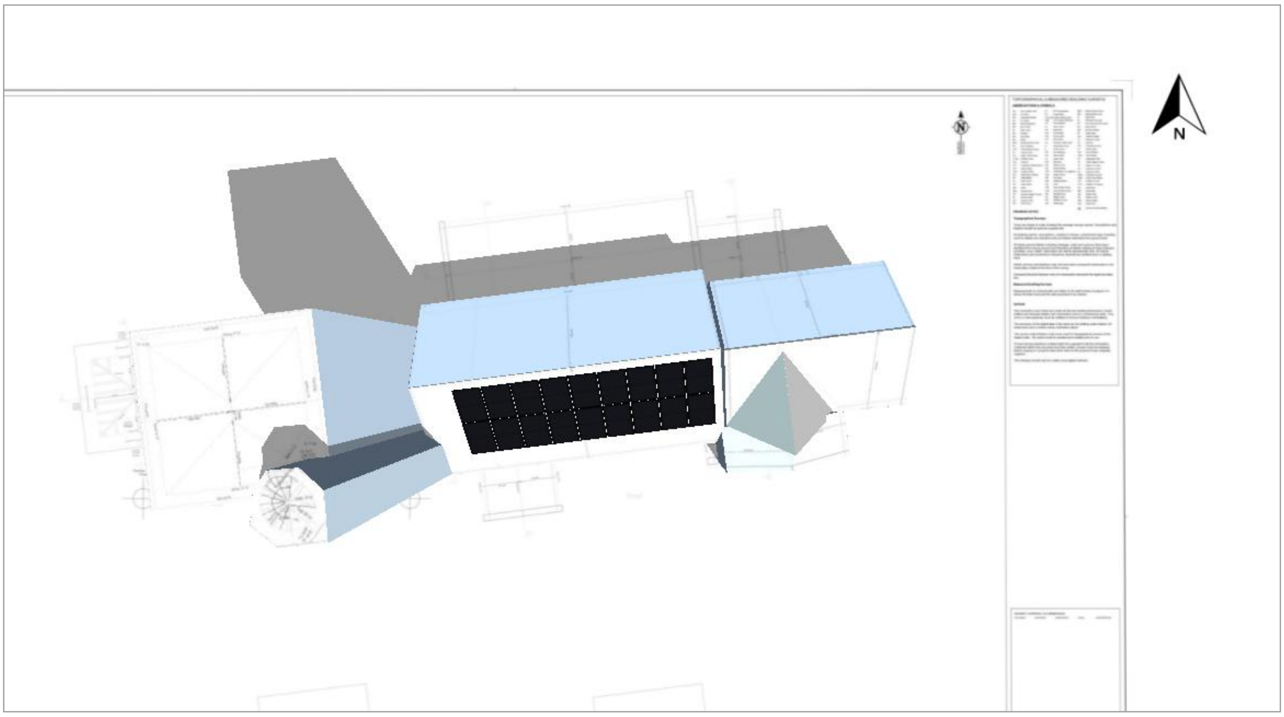
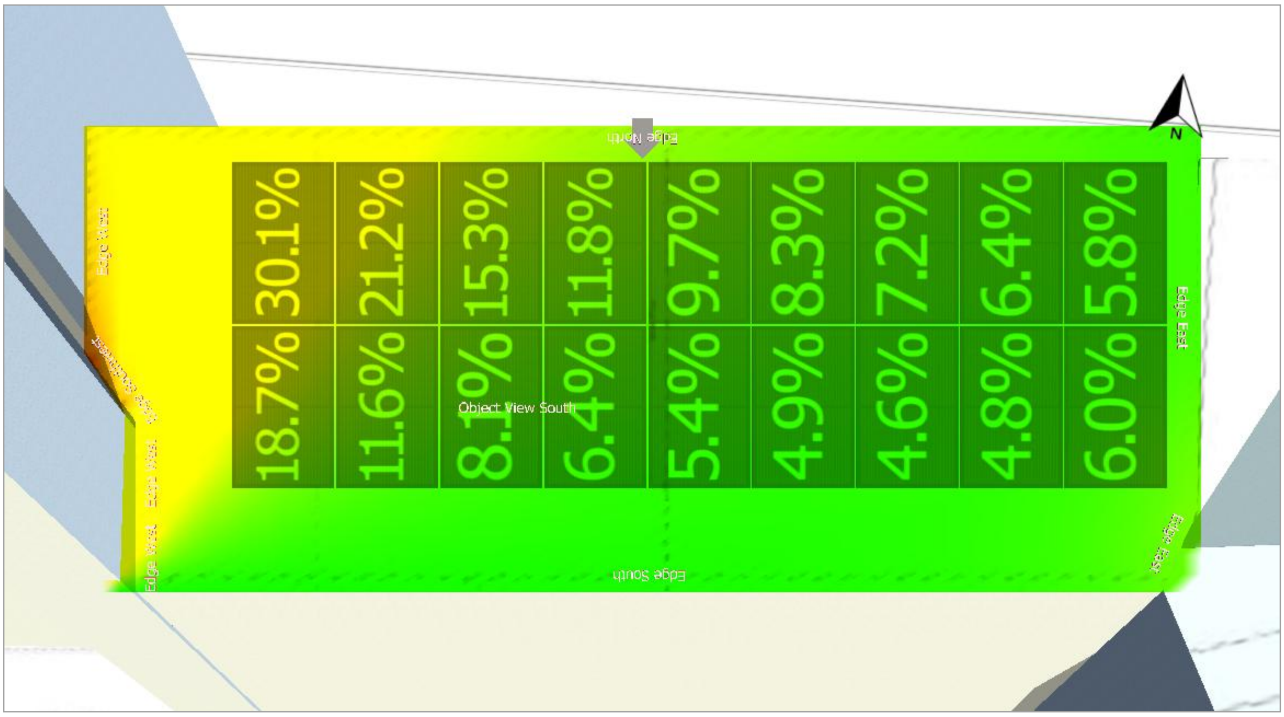


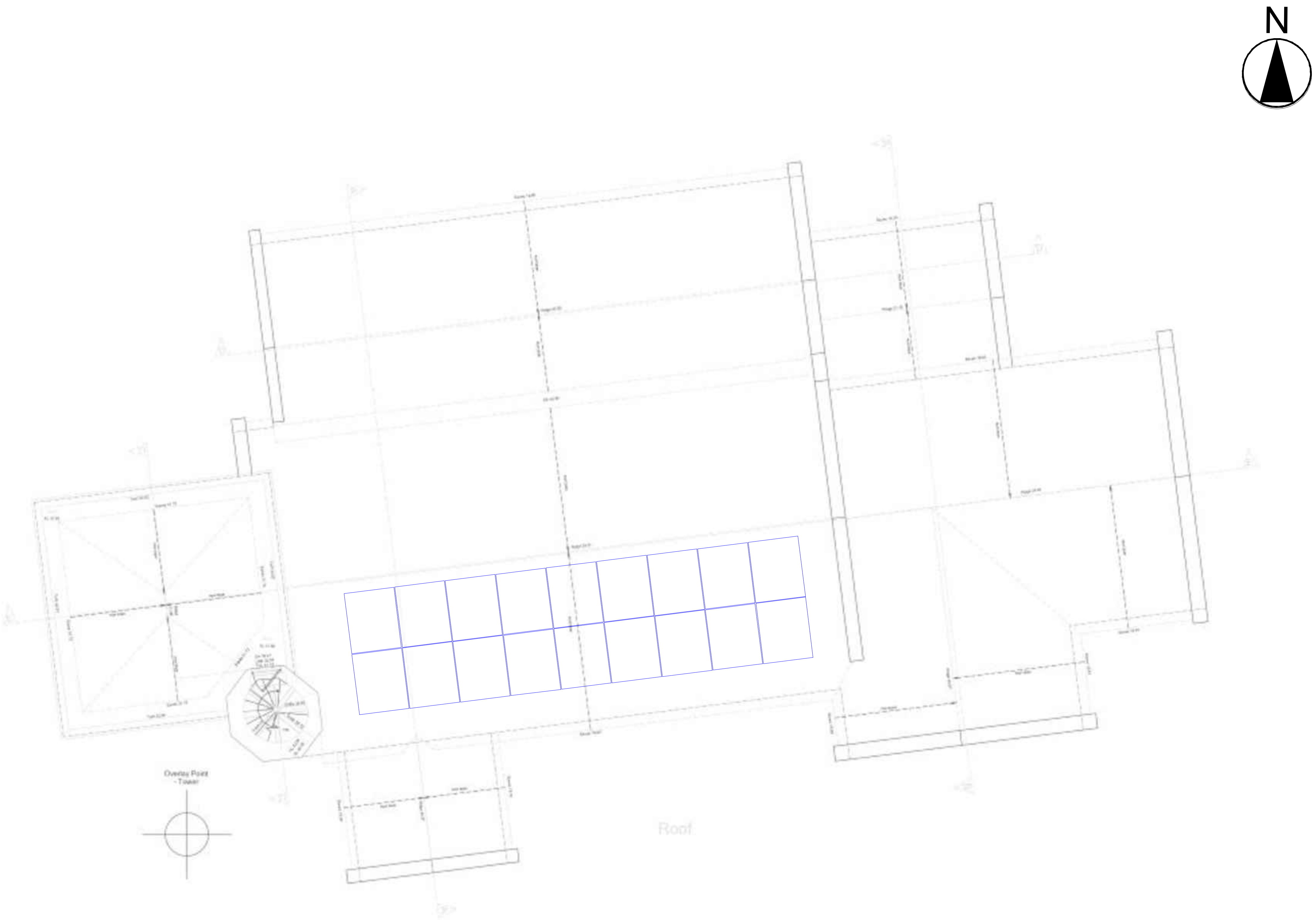
Figure: Overview

Shading



30.1%	21.2%	15.3%	11.8%	9.7%	8.3%	7.2%	6.4%	5.8%
18.7%	11.6%	8.1%	6.4%	5.4%	4.9%	4.6%	4.8%	6.0%

Figure: Shading



Notes:

🟦 DAS SOLAR DAS-DH108ND-450
Monocrystalline Module

18No. DAS SOLAR DAS-DH108ND-450

Total installed capacity 8.1kWp

PROPOSED
DRAWINGS

Rev	Description	Date	

Solarsense
Solarsense UK Ltd
Unit 1A, Tweed Road Industrial Estate, Clevedon BS21 6RR
tel: 01275 461800 e: info@solarsense-uk.com

Client: Stockland Bristol Church

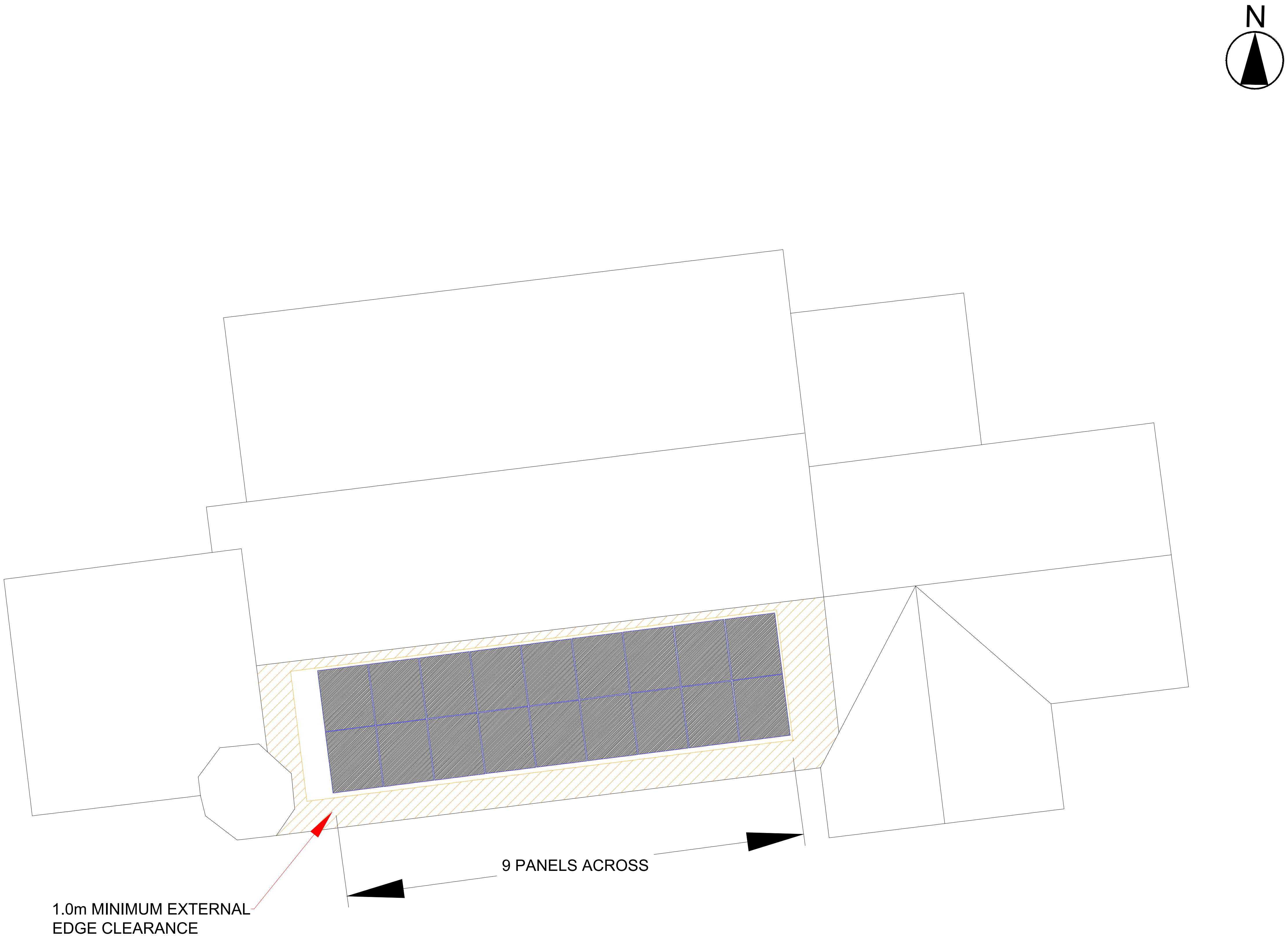
Project: Stockland Bristol Church
Roof Mounted Solar PV System

Drawing: Overview

Scale: NTS
Drawn by: MV

Date: 16/10/2024
Checked by:

Drawing Number: TS16240A 01
Revision: A



Notes:

🟦 DAS SOLAR DAS-DH108ND-450
Monocrystalline Module

18No. DAS SOLAR DAS-DH108ND-450

Total installed capacity 8.1kWp

Panels are 1800mm x 1134mm x 30mm

PROPOSED
DRAWINGS

Rev	Description	Date

Solarsense

Solarsense UK Ltd
Unit 1A, Tweed Road Industrial Estate, Clevedon BS21 6RR
tel: 01275 461800 e: info@solarsense-uk.com

Client: Stockland Bristol Church

Project: Stockland Bristol Church
Roof Mounted Solar PV System

Drawing: Solar PV Layout Plan

Scale: NTS
Drawn by: MV

Date: 16/10/2024
Checked by:

Drawing Number: TS16240A 02
Revision: A

SOLARSENSE UK LTD – TERMS & CONDITIONS (v16_11_2023)

1. DEFINITIONS

1.1. Customer means the party identified as the Customer in this Agreement and any other documents pertaining to it with whom the Supplier may agree to supply Products in accordance with these terms and conditions.

1.2. Supplier means Solarsense (UK) Ltd registered 03925802 in England & Wales at Woodlands Grange, Woodlands Lane, Bradley Stoke, Bristol BS32 4JY and trading at Unit 1A Tweed Road Industrial Estate, Tweed Road, Clevedon BS21 6RR.

1.3. Products means goods and/or services provided by the Supplier to the Customer in accordance with these terms and conditions.

2. ORDER ACCEPTANCE

2.1. All orders placed with the Supplier by the Customer for Products shall constitute an offer to the Supplier under these terms and conditions, subject to availability of the products and to acceptance of the order by the Supplier’s authorised representative.

2.2. All orders are accepted, and Products supplied subject to these express terms and conditions only. No amendment to these terms and conditions will be valid unless confirmed in writing on or after the date hereof by the Supplier’s authorised representative.

2.3. It is agreed that these terms and conditions prevail over the Customer's terms and conditions of purchase unless these latter terms and conditions are amended by the Supplier in writing and signed by the Supplier’s authorised representative. In this event, the review and agreement of the Customers terms and conditions may attract additional charges.

2.4. A deposit will be required from the Customer once the Order has been placed, and the offer will not be considered for acceptance by the Supplier until the deposit payment is received in the Supplier’s bank.

2.5. The amount of deposit and subsequent payments required is set out in section 8 below, unless expressly varied in writing.

2.6. Solarsense reserve the right to cancel any order and return any deposit without penalty.

3. INDEPENDENT CONTRACTOR

3.1. The relationship between the Supplier and Customer is that of Independent Contractor. Neither party is the agent of each other, nor has any authority to make any contract or make any obligation expressly or implied in the name of the other party, without that party's prior written consent for express purposes connected with the performance of this Agreement.

4. DELIVERY & INSTALLATION

4.1. Any dates and times quoted for delivery and installation are provisional and may be affected by conditions or circumstances beyond the Supplier’s reasonable control. In no event shall the Supplier be liable for any damages or penalty for delay in installation or delivery.

4.2. Unless other security arrangements have been made or the works are carried out under the accepted terms of a construction contract, the Customer is solely responsible for the safeguarding of goods and materials the Supplier delivers to site for incorporation into the works and for ensuring that installation work in progress is protected from damage by persons either known or unknown. It is assumed by the Supplier that the Customer will notify his insurers of the nature, extent and value of the works and pay any additional premium to his buildings insurance policy that may be required to insure the works.

4.3. The Supplier will take reasonable precautions to protect unfixed goods and materials on site to the Customer’s reasonable satisfaction and undertakes to carry out the installation in a safe and well-ordered manner consistent with industry codes of practice currently in force.

4.4. The Supplier undertakes to leave the site in a tidy and safe condition at the end of each working day and to make the Customer aware of any circumstances or conditions that may have health & safety implications for the Customer.

4.5. The Supplier is not responsible for any work over and above that which is mentioned in the Scope of Works agreed between the parties, in particular work to ensure that the existing electrical installation at the customer’s premises meets regulations and is safe to work on that is discovered at survey, or during installation. Such work may include but is not limited to earth bonding, incoming supply main switches and fuses, consumer unit, and wiring, sockets and switches. The customer will be liable to pay for any such work which has to be carried out to enable a compliant installation of the Products.

4.6. The Supplier is not responsible for additional labour, parts and third-party costs and any other rectification costs incurred when connecting a PV system where the voltages and other electrical characteristics of such a PV system are later found to be unsuitable for the existing electrical system. Examples include nuisance tripping due to pre-existing earth leakage, and tripping of pre-existing equipment which cannot accommodate the higher voltages of a PV system.

5. PLANNING CONSENT, GRID CONNECTION AND OWNERSHIP

5.1. Unless an alternative intention is mentioned in writing, it will remain the Customer’s responsibility to obtain any statutory consent such as planning or listed building consent that may be required in order for the Products to be installed on the Customer’s building or buildings.

5.2. Where the Supplier has undertaken to obtain such permission at the Customer’s request, the Supplier will not be responsible for any delays or errors or losses resulting from them.

5.3. The Supplier will not accept any claims whatsoever for loss or inconvenience due to not obtaining statutory consents if it is not included in this agreement. By signing the order the Customer is accepting responsibility for ensuring that as owner of the property he has the consequent rights to make alterations to the property.

5.4. Where the Customer is not the legal owner of the building it is the Customer’s sole responsibility to ensure that consent has been obtained from the legal owner for the Supplier to install its Products.

5.5. Where the Customer has instructed the Supplier as part of an order to apply for permission from the district network operator to connect the system encompassing the Products to the electrical grid, the Supplier will not be responsible for any delays or errors, or losses resulting from them.

6. CANCELLATIONS AND RESCHEDULING

6.1. Subject to section 12, any request by the Customer for cancellation of any order or for the rescheduling of the installation date will only be considered by the Supplier if made at least 7 working days before any order for Products is made or installation date. Any such request shall be subject to acceptance by the Supplier at the Supplier’s sole discretion.

6.2. The Customer hereby agrees to indemnify the Supplier against all its direct and indirect costs, damages, charges and expenses incurred in connection with the order and its cancellation or rescheduling.

6.3. The Supplier reserves the right to refuse to work for customers or clients that are abusive or aggressive in any way towards its staff members or representatives, or where such work would lead to a breach of the Supplier’s undertakings to other bodies.

7. PRICING

7.1. Proposals, catalogues, price lists and other advertising literature or material as used by the Supplier are intended only as an indication as to the price and range of goods offered and no prices, descriptions or other particulars contained therein shall be binding on the Supplier.

7.2. All prices are given by the Supplier at the time of the order are on an ex-works basis.

7.3. All quoted or listed prices are based on the cost to the Supplier of supplying the Products to the Customer. If before delivery of the Products there occurs any increase in any way of such costs in respect of Products that have not yet been delivered, the price payable may be subject to amendment without notice at the Supplier’s discretion.

7.4. All prices are exclusive of Value Added Tax and any similar taxes. All such taxes are payable by the Customer and will be supplied in accordance with UK legislation in force at the tax point date.

8. PAYMENT TERMS

8.1. Invoices will be raised by the Supplier upon the placing of an order by the Customer (deposit), upon delivery of the renewable equipment either to the Supplier’s address or to the Customer’s site (interim payment), and upon completion of the installation (balance).

8.2. Unless otherwise agreed, the deposit will be 40% of the total price of the contract including VAT, the interim payment will be 35% of the total price of the contract including VAT, and the balance will be 25% of the total price of the contract including VAT. This may only be varied in writing by a director of the Supplier.

8.3. Unless otherwise specifically requested and agreed all invoices will be payable by the Customer within 7 days from the date of the invoice.

8.4. Payments which are not received by the due date will be considered overdue and remain payable by the Customer together with interest for late payment from the date payable at the rate of 4% per annum above the base rate for the time being. Such interest shall accrue on a daily basis and be payable on demand after as well as before judgement.

8.5. Title to all goods supplied and installed shall pass to the Customer when all prices, taxes and charges due in respect of the total price of the contract have been paid in full.

9. SPECIFICATION OF PRODUCTS

9.1. The Supplier will exercise reasonable endeavours to ensure that the Products supplied to the Customer are identical to the Products specified in any proposal or associated emails or other communications. For the avoidance of doubt, the unpredictability of the supply of Products by wholesalers and manufacturers mean that it would be impossible to exercise any higher standard of endeavour.

9.2. The Supplier will not be liable in respect of any loss or damage caused by or resulting from any variation for whatsoever reason in the manufacturer's specifications or technical data and will not be responsible for any loss or damage resulting from curtailment or cessation of supply following such variation. The Supplier will use its reasonable endeavours to advise the Customer of any such impending variation as soon as it receives any such notice thereof from the manufacturer.

9.3. Unless otherwise agreed, the Products are supplied in accordance with the manufacturer's standard specifications as these may be improved, substituted or modified. The Supplier reserves the right to increase its quoted or listed price or to charge accordingly in respect of any orders accepted for Products of non-standard specifications and in no circumstances will it consider cancellation of such orders or the return of such orders.

10. WARRANTY ON GOODS & SERVICES

10.1. The Supplier warrants that it has good title to or license to supply all Products to the Customer, and that the products are new unless otherwise stated.

10.2. The Supplier provides a warranty on its workmanship for a period from the date of completion, that period being 24 months for the installation of complete systems, but reducing to 3 months in the case of upgrades to existing systems, operations and maintenance inspections, repair and service work, and the replacement of equipment to existing systems, PROVIDED THAT no unauthorised modifications or interference to the Product or to the system of which the Product forms part have taken place.

10.3. If any of the equipment installed in the system should prove defective under normal operation or service, such Products will be repaired or replaced in accordance with any warranty cover or terms as provided by the manufacturer of the Products. The Supplier will not be liable for the cost of labour and other expenses incurred in repairing or replacing defective equipment where these are not included in the manufacturer's warranty cover. The cost of labour should be agreed with the Supplier before.

10.4. For full terms and conditions of our workmanship warranty, please see our workmanship warranty document, normally issued upon completion of and payment for the works.

10.5. If the Products are rejected by the Customer as not being in accordance with the Customer's order, the Supplier will only accept the return of such Products provided that it receives written notification thereof giving detailed reasons for rejection. The Supplier will not consider any claim for compensation, indemnity or refund until liability, if any, has been established or agreed with the manufacturer and where applicable the insurance Supplier. Under no circumstances shall the invoiced Products be deducted or set off by the Customer until the Supplier has passed a corresponding credit note.

10.6. Solarsense are not liable for the cost of hiring and erecting access equipment (including but not limited to scaffolding, tower, cherry pickers and any other means of mechanical access at heights) in order to gain safe access to roofs to investigate and rectify defective components such as optimisers, modules, micro-inverters, sensors, valves, tubes and any other component situated on-roof, and this remains the responsibility of the customer to enable safe access for our workers, whether covered by manufacturers' warranties or otherwise.

11. INDEMNITIES AND LIMITS OF LIABILITY

11.1. The Supplier will indemnify the Customer for direct physical injury or death caused solely by defects in any of the Products or caused solely by the negligence of its assigned employees acting within the course of their employment and the scope of their authority. The total liability of Solarsense UK Ltd under this sub clause shall be limited to £2 million for any one event or series of connected events.

11.2. The Supplier will indemnify the Customer for direct damage to property caused solely by defects in any of the Products or caused solely by the negligence of its assigned employees acting within the course of their employment and the scope of their authority. The total liability of Solarsense UK Ltd under this sub clause shall be limited to £2 million for any one event or series of connected events.

11.3. Except as stated in clauses 11.1 and 11.2 above, the Supplier disclaims and excludes all liability to the Customer in connections with these terms and conditions including the Customer's use of the Products and in no event shall the Supplier be liable to the Customer for special, indirect or consequential damage including but not limited to loss of profits arising from loss of data or in connection with the use of the Products. All terms of any nature, express or implied, statutory or otherwise, as to correspondence with any particular description or sample, fitness for purpose or merchantability, are hereby excluded.

11.4. The Customer shall indemnify and defend the Supplier and its employees in respect of any claims by third parties which are occasioned by or arise from any Supplier performance or non-performance pursuant to the instructions of the Customer or its authorised representative.

11.5. The Supplier will in no circumstances be liable for any losses in generation howsoever caused incurred by the Customer or any subsequent owner to whom the Customer may transfer ownership of the Products which results from the failure of the Products in any way.

12. TERMINATION FOR CAUSE

12.1. This agreement may be terminated forthwith by notice in writing:

- 12.1.1. By the Supplier if the Customer fails to pay any sums due hereunder by the due date notwithstanding the provisions for late payment as in clause 7.1.
- 12.1.2. If either party fails to perform any of its obligations under this Agreement and such failure continues for a period of 14 days after written notice thereof, by the other party.
- 12.1.3. If either party is involved in any legal proceedings concerning its solvency, or ceases trading, or commits an act of bankruptcy or is adjudicated bankrupt or enters liquidation, whether compulsory or voluntary, other than for the purposes of an amalgamation or a reconstruction, or makes an arrangement with creditors or petitions for an administration order or has a Receiver or Manager appointed over all or any part of its assets or generally becomes unable to pay its debts within the meaning of Section 123 of the Insolvency Act 1986, then without prejudice to any other rights or remedies available to it, the other party shall have the right to terminate this Agreement forthwith.

12.2. Any termination of this Agreement pursuant to this clause shall be without prejudice to any other rights or remedies a party may be entitled to hereunder or at law, and shall not affect any accrued rights or liabilities of either party.

13. CONTRACT

13.1. The headings in this Agreement are for ease of reference only and shall not affect its interpretation or construction.

13.2. No forbearance, delay, indulgence by either party in enforcing its respective rights shall prejudice or restrict the rights of that party and no waiver of any such rights or of any breach of any contractual terms shall be deemed to be a waiver of any other right or any later breach.

13.3. The Customer agrees not to assign any of its rights herein without the prior written consent of the Supplier.

13.4. In the event of any of these terms and conditions or any part of them being judged illegal or unenforceable for any reason, the continuation in full force and effect of the remainder of them shall not be prejudiced.

13.5. Neither party shall be liable to the other for any delay in failure to perform its obligations hereunder (other than a payment of money) where such delay or failure results from force majeure, act of God, fire, explosion, accident, industrial dispute or any cause beyond its reasonable control.

13.6. Any documents or notices given hereunder by either party to the other must be in writing and may be delivered personally or by recorded delivery or registered post and in the case of post will be deemed to have been given 2 working days after the date of posting. Documents or notices shall be delivered or sent to the addresses of the parties on the first page of this Agreement or to any other address notified in the normal course of trading in writing by either party to the other for the purpose of receiving documents or notices after the date of this Agreement.

13.7. These terms and conditions shall be governed and construed in accordance with the law of England and Wales.

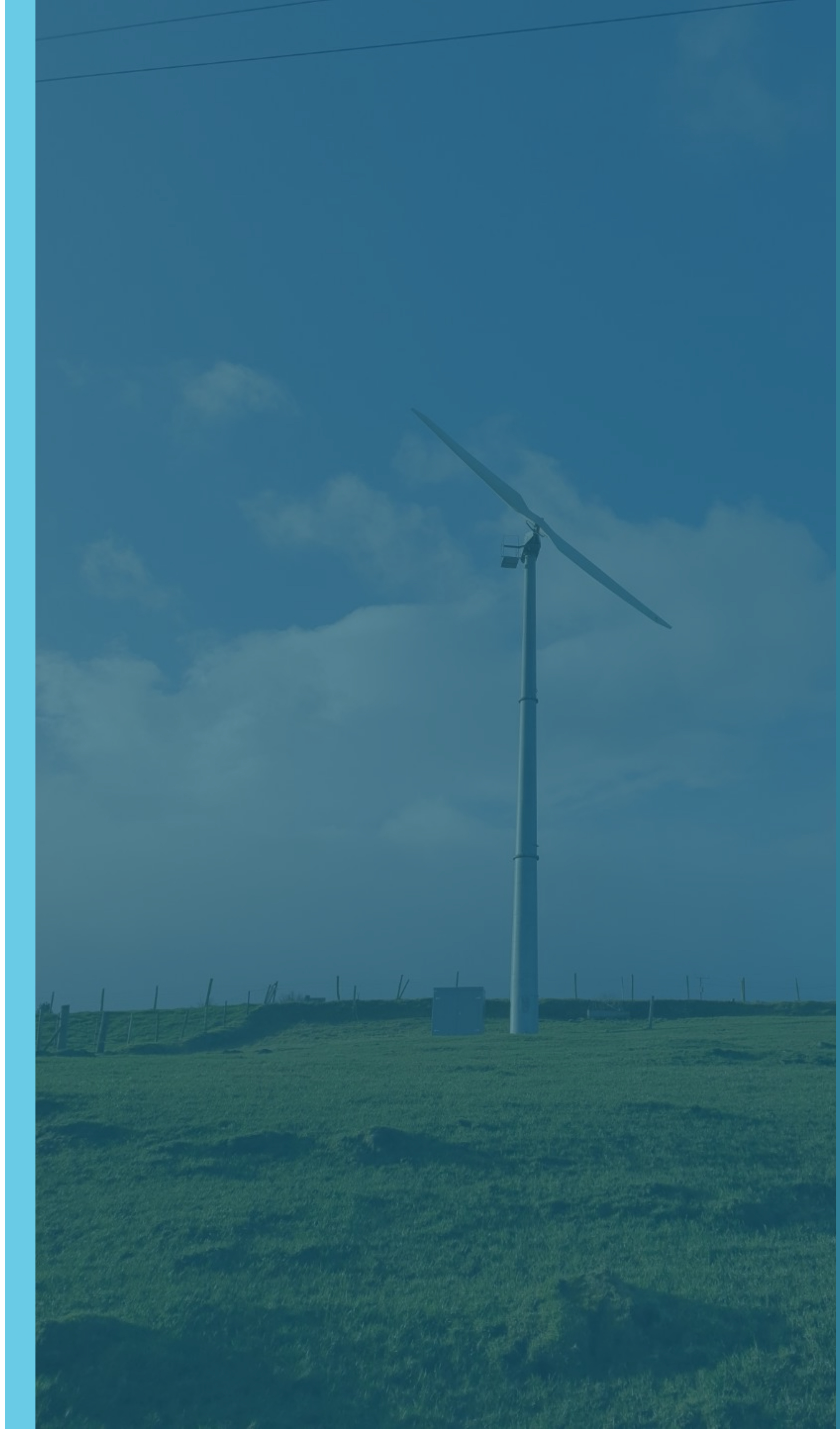
E-5 & G-11 TECHNICAL & COMMERCIAL PROPOSAL

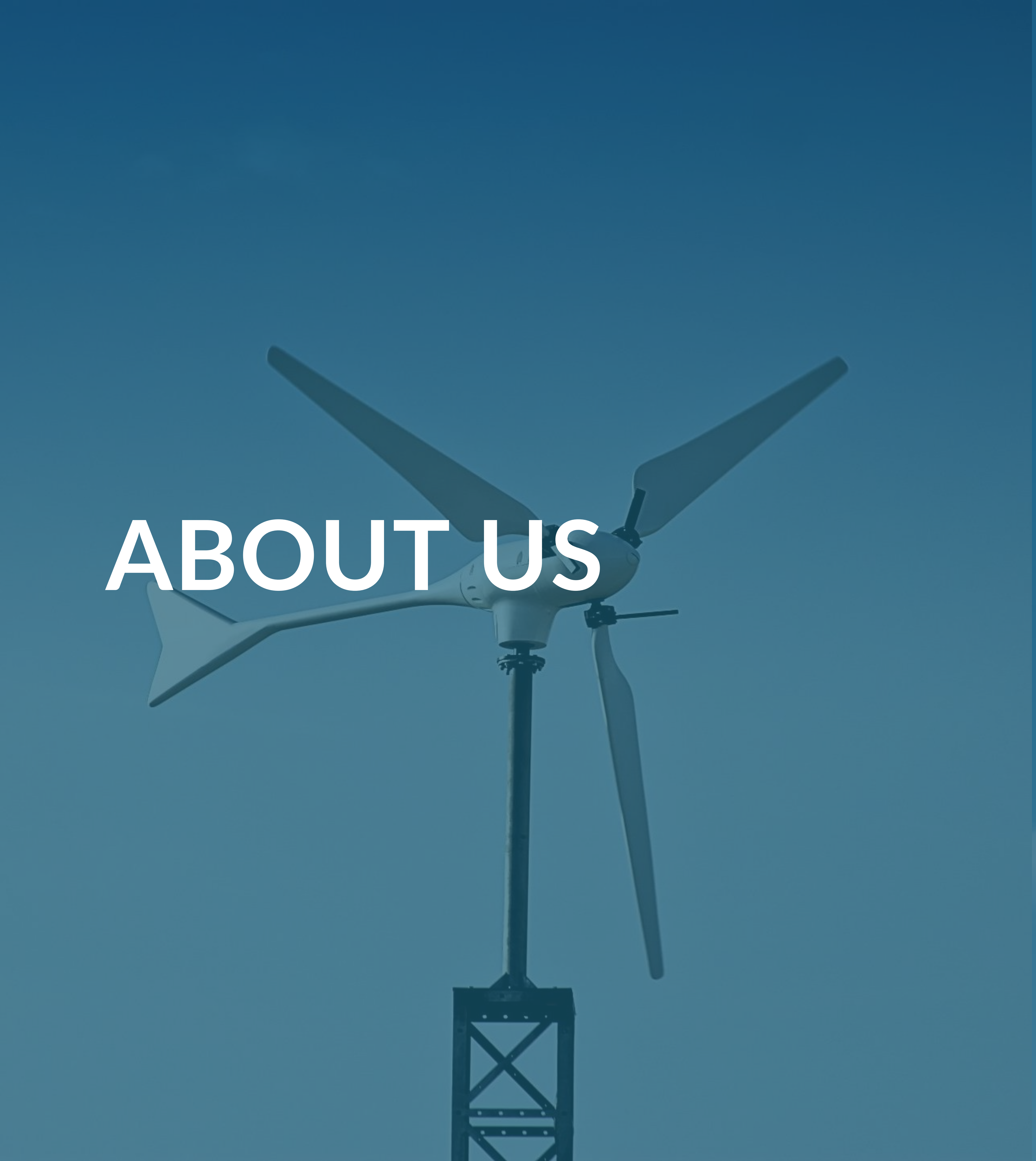
Brendan Ashby

4 October 2024

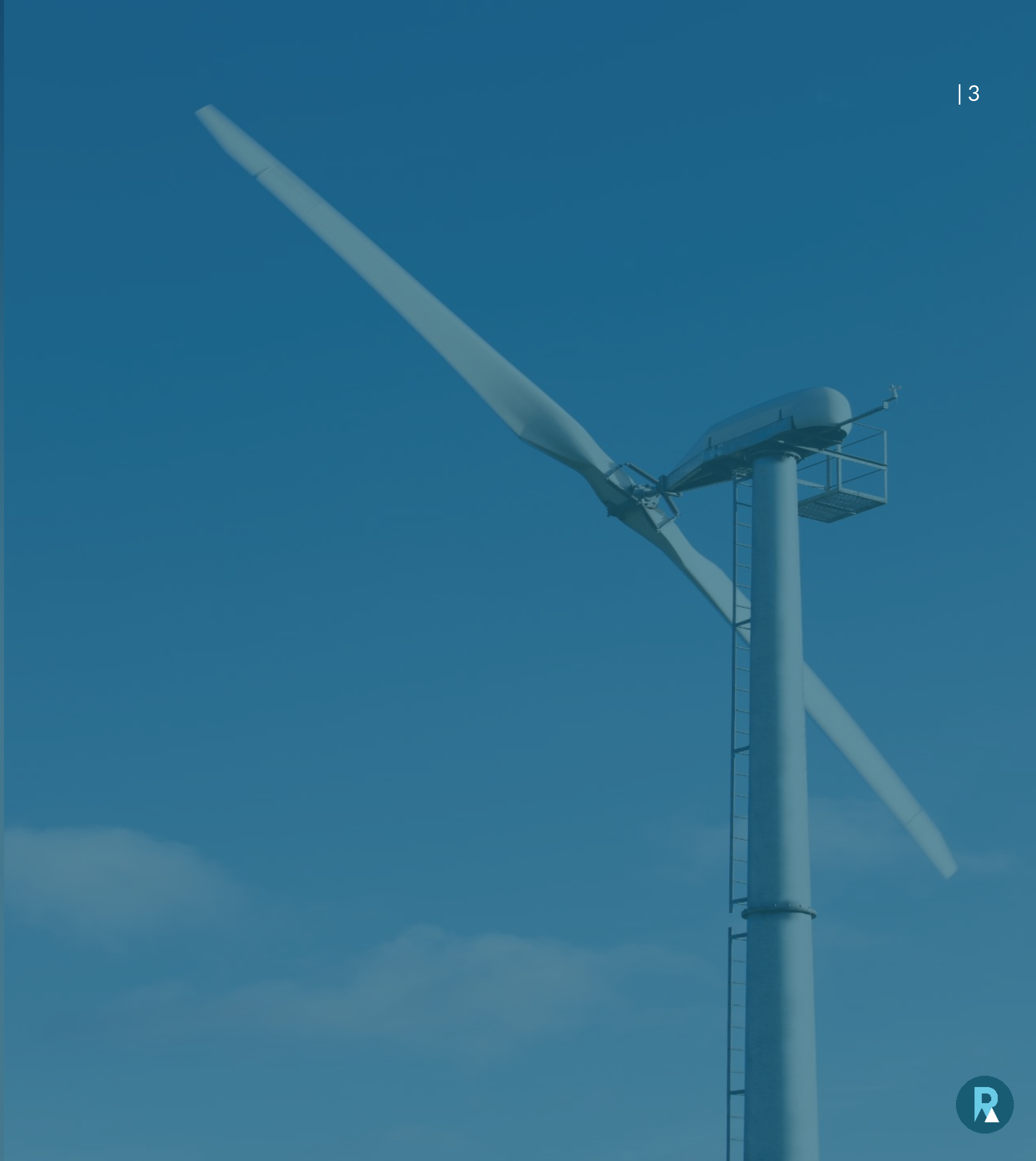
Ryse Energy

CONTENTS





ABOUT US



MADE IN THE UK

HOMEGROWN IN THE UK

With over 180,000 installations across all seven continents, Ryse Energy is the global leader in decentralized renewable energy and wind energy technologies.

OVER 2,000 UK INSTALLS

We build high performance and technologically advanced wind turbines in the UK, and have over 2,000 UK installations, assisting the UK to be a net-zero society by 2050.

EXPORTING INTERNATIONALLY

We export our renewable energy technologies across the world, accelerating UK's shift towards a climate-resilient economy and building its position as a global leader in sustainability and climate action.

INVESTING IN-COUNTRY

As a high growth UK renewable energy technology company, we are continually investing in our business, in research and development, in our innovations and in our people, to tackling climate change and tackling energy poverty in developing countries.

MEMBERSHIPS & ACCREDITATIONS

As a global leader in renewable energy, Ryse Energy works with the largest renewable energy bodies and provides the highest standards or quality, reliability and transparency.

International Renewable Energy Agency (IRENA)

The IRENA Coalition for Action is a key international network to discuss industry trends, determine actions, share knowledge and exchange best practices with the vision to drive the global energy transition in line with the United Nations Sustainable Development Goal on energy.

Renewable Energy Consumer Code

Sets out high consumer protection standards for businesses who are selling or leasing renewable energy generation systems to domestic consumers.

Alliance for Rural Electrification

The international business association that promotes a sustainable decentralized renewable energy industry for the 21st century.

Electrical Contractors Association

The UK's leading trade association representing and supporting the interests of electrotechnical and building engineering services contractors.

Microgeneration Certification Scheme

Ryse Energy is an MCS approved installer.

RYSE ENERGY OPTIONS

RYSE ENERGY OPTIONS

Ryse Energy offers two options for this project

OPTION N°1

E-5 (4 kW)

- **4 kWp Horizontal Axis Wind Turbine**
- **Main Dimensions:**
  - **Swept Area**: 14.5 m^2
  - **Diameter**: 4.3 m
  - **Turbine Tower**: 15 m (can be customized)
- **Operating Wind Speed:**
  - **Cut-in Wind Speed**: 2 m/s
  - **Cut-off Wind Speed**: 60 m/s
  - **Rated Wind Speed**: 11 m/s
- **Efficiency** = 77%* = C_p = 0.459

OPTION N°2

G-11 (11 kW)

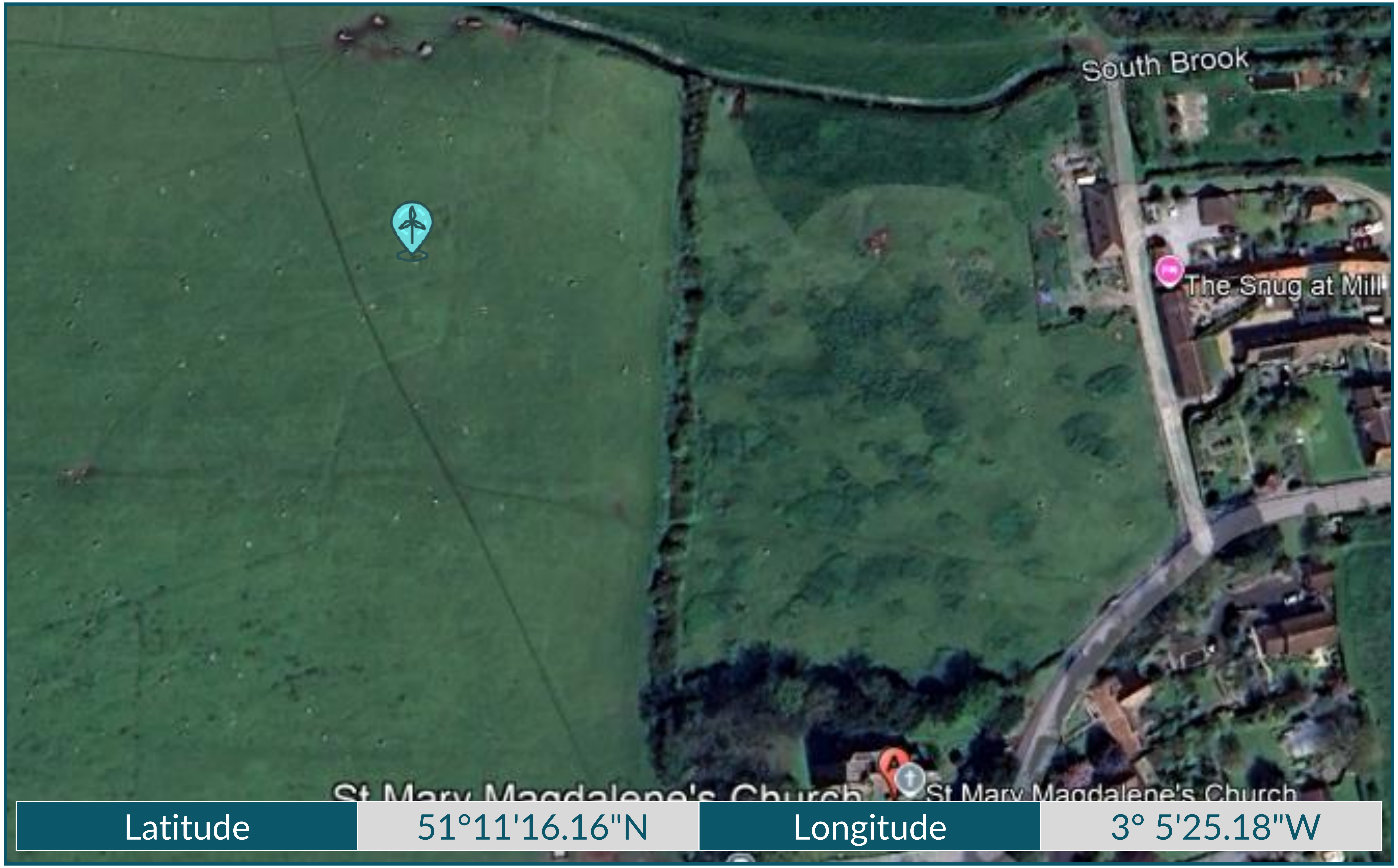
- **11 kWp Horizontal Axis Wind Turbine**
- **Main Dimensions:**
  - **Swept Area**: 133 m^2
  - **Diameter**: 13 m
  - **Turbine Tower**: 18 m (can be customized)
- **Operating Wind Speed:**
  - **Cut-in Wind Speed**: 3 m/s
  - **Cut-off Wind Speed**: 25 m/s
  - **Rated Wind Speed**: 11 m/s
- **Efficiency** = 44%* = C_p = 0.26

**Note: Maximum efficiency point for our wind turbines using the Betz's Limit as reference.*

SITE ASSESSMENT

G-11 & E-5 PROPOSED WIND TURBINE LOCATION

Location of the wind turbine technology at St. Mary Magdalen church, Stockland Bristol, TA5 2PZ



Latitude	51°11'16.16"N	Longitude	3° 5'25.18"W

This assessment has been conducted based on the information available and figures should not be taken as exact. For more accurate information, a site survey will be required.

CALCULATION – ESTIMATED ENERGY CAPTURE

The energy Resource Assessment has been made following the UK restriction by using the MCS Calculation

These calculations have been undertaken by following the guidelines in the UK Business Enterprise and Regulatory Reform (BERR) standard for small wind turbines (formally the Department of Trade and Industry (DTI)). The latest copy may be downloaded from: https://mcscertified.com.

This energy performance estimate is based upon a standardised method using publicly available information and assumes a Rayleigh wind speed distribution. It is given as guidance only and should not be considered to be a guarantee. The energy performance of wind turbine systems is impossible to predict with a high degree of certainty due to the variability in the wind from location to location and from year to year.

For a greater level of certainty, it is recommended that on-site wind speed monitoring is undertaken ideally for at least a year. Note: it may be useful to monitor for shorter periods, especially if the acquired data is then correlated with other sources in order to estimate an annual mean wind speed. A site and hub height specific Met Office Virtual Met Mast dataset could be produced for this site upon request

Wind speed varies with time, from nothing on calm days to occasional violent gusts. If the wind speed at a site is recorded over a year, it will be seen to vary about a mean wind speed value. This is the annual mean wind speed (AMWS) and is an indication of how much wind energy is available. In the UK, AMWS could be as low as 4 m/s (9.0 mph) for an inland site to around 8 m/s (18 mph) or higher on the most exposed sites.

The database of wind speeds used by Ryse Energy was developed by the DTI and is called the UK NOABL Windspeed Database. It does, however, have some limitations, and the average wind speed and energy estimates produced from it, are subject to a number of potential inaccuracies:

1. It is based upon a 1 km square grid and depending upon the topology of the area in which the site is located, there can be significant differences between local areas within the 1 km grid.
2. Sites on the top of hills, especially with southwest-facing slopes, could be expected to have a significantly higher AMWS than other sites.
3. The NOABL database does not take account of the impact of "sea breezes", and therefore may significantly under-estimate the AMWS in coastal regions.
4. The NOABL database records are for a height of 10 m, but Ryse has adjusted the expected energy generation to apply to the tower height(s), as a low tower, e.g., 9 m, may be expected to produce less energy than a high tower, e.g., 18 m, but the actual differences, however, are highly dependent upon the local conditions.

1. *This assessment has been conducted based on the information available and figures should not be taken as exact. For more accurate information, a site survey will be required.*
2. *Ryse Energy, therefore, cannot accept responsibility for the AMWS and resultant annual energy generation estimates as they are subject to many factors beyond Ryse Energy's control. Any provided estimates should only be used as a general guide to what you might expect at this site.*

ESTIMATED ANNUAL ELECTRICITY GENERATION

The energy Resource Assessment has been made following the UK restriction by using the MCS Calculation

The estimated annual mean wind speed (AMWS) for this location is 5.1 m/s, being for the 1 km square containing this address. This has been generated from the NOABL database for a height of 10 m and may not be accurate in all cases.

In order to better estimate the likely AMWS and from that, the estimated annual energy from the proposed wind turbine(s), we need to apply a number of correction factors.

Please ensure that these assumptions are correct for the proposed turbine location:

Tower Height

15 m Tilt-Up (E-5), 18 m Lattice (G-11)

Location Description

Category 2: Gently undulating countryside with low crops, hedges and few trees.

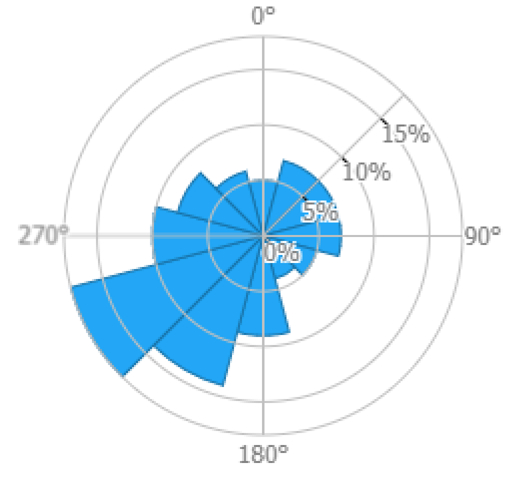
Identification of nearest significant obstruction; e.g., house or trees in the upwind and downwind zones adjacent to the turbine:

Distance:	N/A m Upwind	N/A m Downwind
Height:	N/A m	N/A m

Based upon the tower height, above location type and nearest obstruction information, the adjusted wind speeds and estimated annual energy outputs are shown below:

Option	Wind Turbine Model	Tower Height (m)	Correction Factor	Corrected Wind Speed (m/s)	Estimated Annual Energy Production (kWh/year)
1	E-5	15	1.08	5.5	8,450
2	G-11	18	1.11	5.7	34,822

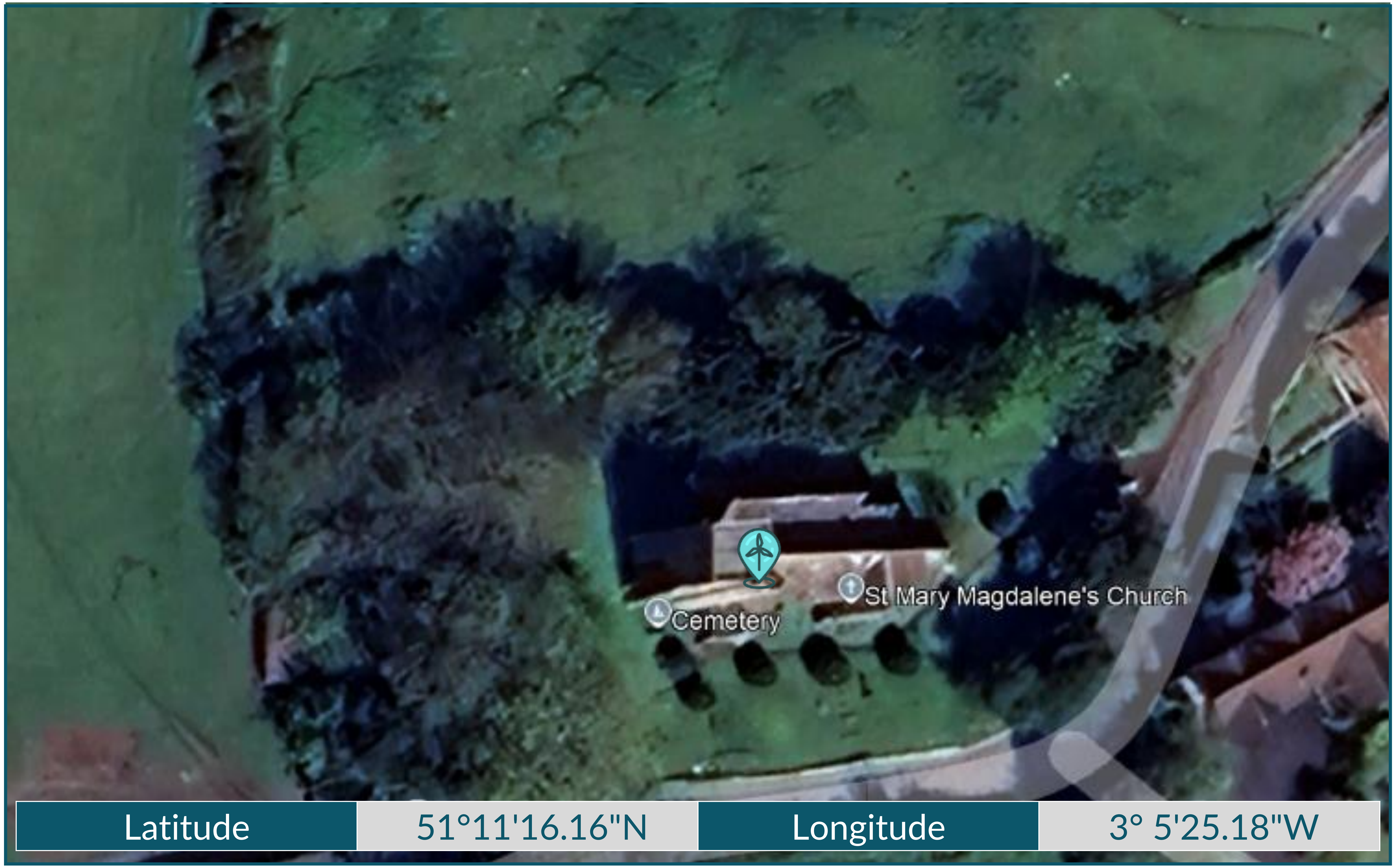
Wind Rose



Ryse Energy, therefore, cannot accept responsibility for the AMWS and resultant annual energy generation estimates as they are subject to many factors beyond Ryse Energy's control. Any provided estimates should only be used as a general guide to what you might expect at this site.

E-5 PROPOSED WIND TURBINE LOCATION

Location of the wind turbine technology at St. Mary Magdalen church, Stockland Bristol, TA5 2PZ



Latitude	51°11'16.16"N	Longitude	3° 5'25.18"W

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CALCULATION – ESTIMATED ENERGY CAPTURE

The energy Resource Assessment has been made following the UK restriction by using the MCS Calculation

These calculations have been undertaken by following the guidelines in the UK Business Enterprise and Regulatory Reform (BERR) standard for small wind turbines (formally the Department of Trade and Industry (DTI)). The latest copy may be downloaded from: https://mcscertified.com.

This energy performance estimate is based upon a standardised method using publicly available information and assumes a Rayleigh wind speed distribution. It is given as guidance only and should not be considered to be a guarantee. The energy performance of wind turbine systems is impossible to predict with a high degree of certainty due to the variability in the wind from location to location and from year to year.

For a greater level of certainty, it is recommended that on-site wind speed monitoring is undertaken ideally for at least a year. Note: it may be useful to monitor for shorter periods, especially if the acquired data is then correlated with other sources in order to estimate an annual mean wind speed. A site and hub height specific Met Office Virtual Met Mast dataset could be produced for this site upon request

Wind speed varies with time, from nothing on calm days to occasional violent gusts. If the wind speed at a site is recorded over a year, it will be seen to vary about a mean wind speed value. This is the annual mean wind speed (AMWS) and is an indication of how much wind energy is available. In the UK, AMWS could be as low as 4 m/s (9.0 mph) for an inland site to around 8 m/s (18 mph) or higher on the most exposed sites.

The database of wind speeds used by Ryse Energy was developed by the DTI and is called the UK NOABL Windspeed Database. It does, however, have some limitations, and the average wind speed and energy estimates produced from it, are subject to a number of potential inaccuracies:

1. It is based upon a 1 km square grid and depending upon the topology of the area in which the site is located, there can be significant differences between local areas within the 1 km grid.
2. Sites on the top of hills, especially with southwest-facing slopes, could be expected to have a significantly higher AMWS than other sites.
3. The NOABL database does not take account of the impact of "sea breezes", and therefore may significantly under-estimate the AMWS in coastal regions.
4. The NOABL database records are for a height of 10 m, but Ryse has adjusted the expected energy generation to apply to the tower height(s), as a low tower, e.g., 9 m, may be expected to produce less energy than a high tower, e.g., 18 m, but the actual differences, however, are highly dependent upon the local conditions.

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1. *This assessment has been conducted based on the information available and figures should not be taken as exact. For more accurate information, a site survey will be required.*
2. *Ryse Energy, therefore, cannot accept responsibility for the AMWS and resultant annual energy generation estimates as they are subject to many factors beyond Ryse Energy's control. Any provided estimates should only be used as a general guide to what you might expect at this site.*

ESTIMATED ANNUAL ELECTRICITY GENERATION (CHURCH MOUNTED)

The energy Resource Assessment has been made following the UK restriction by using the MCS Calculation

The estimated annual mean wind speed (AMWS) for this location is 5.1 m/s, being for the 1 km square containing this address. This has been generated from the NOABL database for a height of 10 m and may not be accurate in all cases.

In order to better estimate the likely AMWS and from that, the estimated annual energy from the proposed wind turbine(s), we need to apply a number of correction factors.

Please ensure that these assumptions are correct for the proposed turbine location:

Church Mounted: Assumed height of 24m

Location Description

Category 3: Farmland with high boundary hedges, occasional small farm structures, houses and trees etc.

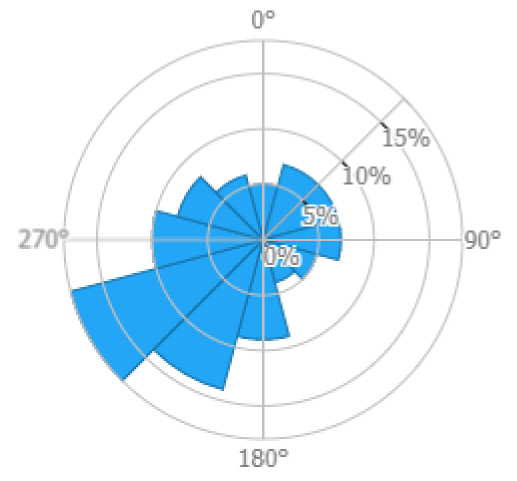
Identification of nearest significant obstruction; e.g., house or trees in the upwind and downwind zones adjacent to the turbine:

Distance:	25m Upwind	25 m Downwind
Height:	10m	10m

Based upon the tower height, above location type and nearest obstruction information, the adjusted wind speeds and estimated annual energy outputs are shown below:

Wind Turbine Model	Tower Height (m)	Correction Factor	Corrected Wind Speed (m/s)	Estimated Annual Energy Production (kWh/year)
E-5	24	0.96	4.9	6,600

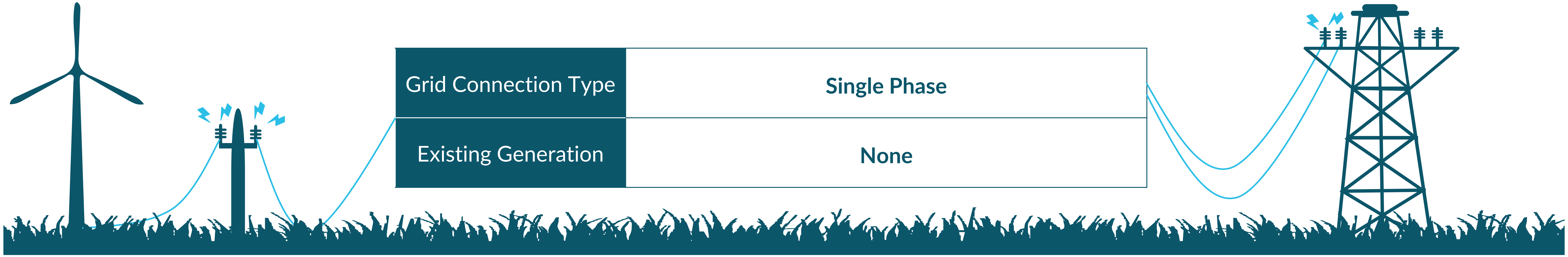
Wind Rose



Ryse Energy, therefore, cannot accept responsibility for the AMWS and resultant annual energy generation estimates as they are subject to many factors beyond Ryse Energy's control. Any provided estimates should only be used as a general guide to what you might expect at this site.

GRID CONNECTION: 1.PH

Requirements for connection to the UK Grid



Grid Connection Type	**Single Phase**
Existing Generation	**None**

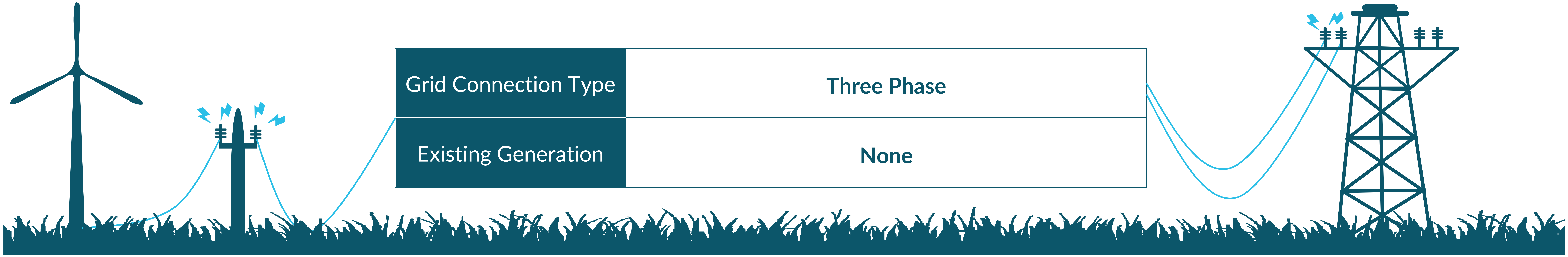
Wind turbine systems rated up to 3.68 kW on single-phase (up to and including 16 A per phase) can be connected under Engineering Recommendation G98 with only post-notification being required by the UK District Network Operator (DNO). An application will need to be made to the DNO to determine the costs associated with connecting either the E-5 or the G-11 wind turbine to the grid.

An application will need to be made to the DNO to confirm whether an E-5 can be connected to the grid with a Declared Net Capacity (DNC) of 5 kW without any supply upgrade works. However, the turbine can be connected to the grid with a reduced DNC of 3.68 kW without submitting an application to the DNO.

Your MPAN (Meter Point Administration Number) is needed for a DNO application. This is used along with details of the proposed installation to obtain permission to connect the wind turbine to the grid. The MPAN is your unique meter point reference within the electricity system and is typically printed on your electricity bill.

GRID CONNECTION: 3.PH

Requirements for connection to the UK Grid



Grid Connection Type	**Three Phase**
Existing Generation	**None**

Wind turbine systems rated up to 11.04 kW on three-phase (up to and including 16 A per phase) can be connected under Engineering Recommendation G98 with only post-notification being required by the UK District Network Operator (DNO).

An application will not be required for connection of the proposed wind turbine.

Your MPAN (Meter Point Administration Number) is needed for DNO post-notification. This is used along with details of the proposed installation to notify the DNO of connection of the wind turbine to the grid. The MPAN is your unique meter point reference within the electricity system and is typically printed on your electricity bill.

PLANNING PERMISSION

A basic assessment of potential planning

Planning permission will need to be obtained from your local planning authority for the wind turbine installation. Ryse Energy has extensive experience in preparing and submitting wind turbine planning applications and is able to assist you during this process.

Having conducted a basic planning assessment of your site, the follow may need to be addressed as part of a planning submission:

Visual Impact & Noise – An assessment may be required to determine the impact of the turbine upon local receptors.

Heritage – Due to a number of listed buildings within the vicinity of the turbine, heritage and archaeological assessments may be required.

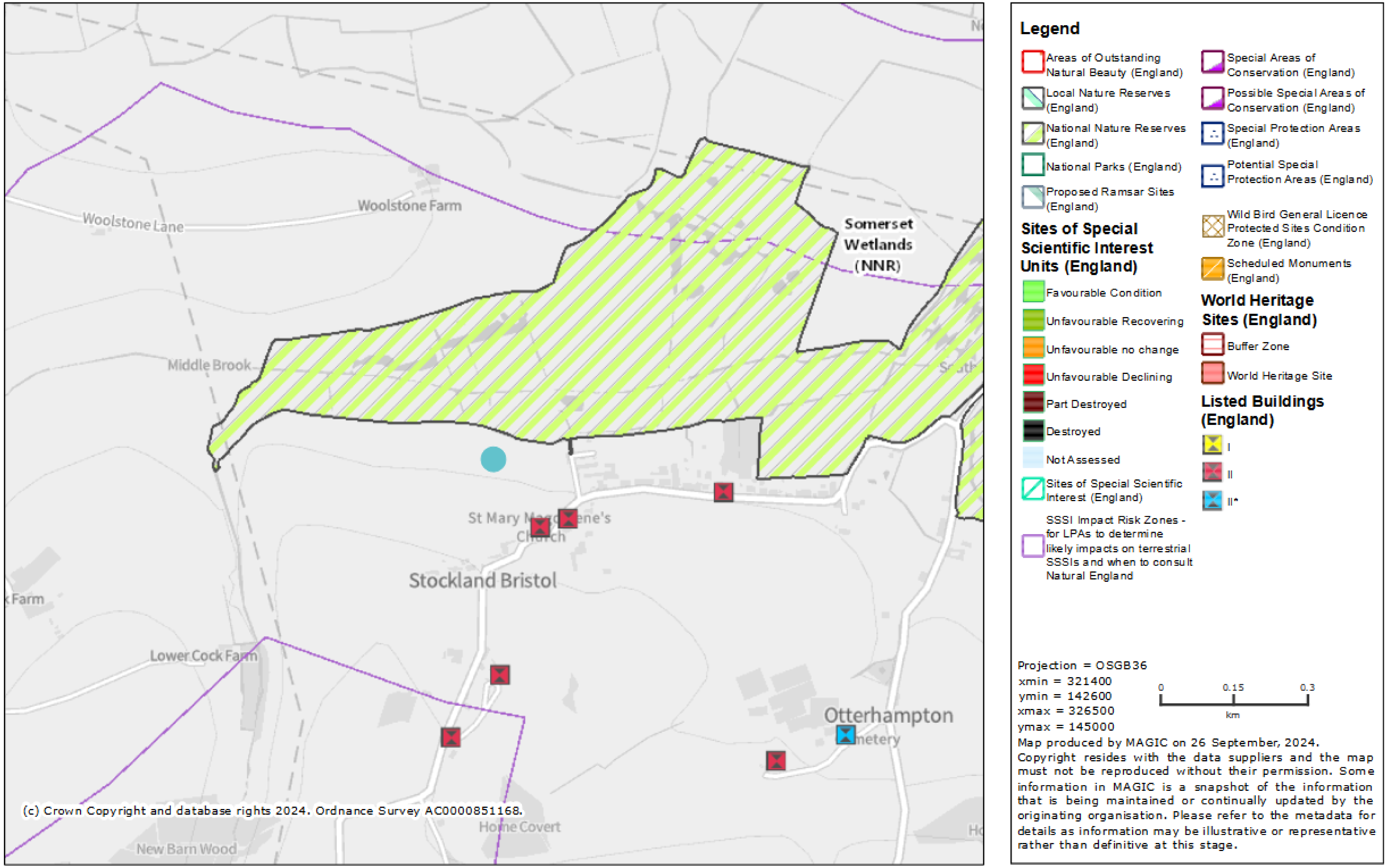
Risk Zone – The site is located in the vicinity of SSSI impact risk areas and must be considered in the planning permission.

National Nature Reserves – The site is located in the vicinity of National Nature Reserves and must be considered in the planning permission.

It is recommended that you check with your local planning authority for any local restrictions or requirements.

DESK BASED PLANNING ASSESSMENT

The below map is taken from Magic.gov.uk and shows possible planning concerns at your site.



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Projection = OSGB36
xmin = 321400
ymin = 142600
xmax = 326500
ymax = 145000
Map produced by MAGIC on 26 September, 2024.
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COMMERCIALS

COMMERCIALS: E-5, 1.PH (1/6)

Commercial offer for Ryse Energy Renewable Solution

OPTION 1: E-5 SUPPLY & INSTALLATION – INITIAL COSTING ESTIMATE

DESCRIPTION	QTY.	TOTAL PRICE (GBP)
E-5 Wind Turbine, Single Phase, 4 kW, 15m Tilt-Up Tower, including foundation and installation	1	Included
	Sub -Total Project Cost*	**£ 37,500**
	VAT 20%	**£ 7,500**
	Total Project Cost	**£ 45,000**

*Cost are based on an average installed cost. A full site survey would be required for a firm quotation.

The above is an estimated supply and installation cost and is subject to full site survey. All pricing is subject to VAT.

The price above doesn't cover planning applications, DNO applications, or any grid upgrades.

COMMERCIALS: E-5, 3.PH (2/6)

Commercial offer for Ryse Energy Renewable Solution

OPTION 1: E-5 SUPPLY & INSTALLATION – INITIAL COSTING ESTIMATE

DESCRIPTION	QTY.	TOTAL PRICE (GBP)
E-5 Wind Turbine, Three Phase, 4 kW, 15m Tilt-Up Tower, including foundation and installation	1	Included
	Sub -Total Project Cost*	**£ 37,500**
	VAT 20%	**£ 7,500**
	Total Project Cost	**£ 45,000**

*Cost are based on an average installed cost. A full site survey would be required for a firm quotation.

The above is an estimated supply and installation cost and is subject to full site survey. All pricing is subject to VAT.

The price above doesn't cover planning applications, DNO applications, or any grid upgrades.

COMMERCIALS: G-11, 1.PH (3/6)

Commercial offer for Ryse Energy Renewable Solution

OPTION 2: G-11 SUPPLY & INSTALLATION – INITIAL COSTING ESTIMATE

DESCRIPTION	QTY.	TOTAL PRICE (GBP)
G-11 Wind Turbine, Single Phase, 11 kW, 18m Lattice Tower, including foundation and installation	1	Included
	Sub-Total Project Cost*	**£ 82,500**
	VAT 20%	**£ 16,500**
	Total Project Cost	**£ 99,000**

*Cost are based on an average installed cost. A full site survey would be required for a firm quotation.

The above is an estimated supply and installation cost and is subject to full site survey. All pricing is subject to VAT.

The price above doesn't cover planning applications, DNO applications, or any grid upgrades.

COMMERCIALS: G-11, 3.PH (4/6)

Commercial offer for Ryse Energy Renewable Solution

OPTION 2: G-11 SUPPLY & INSTALLATION – INITIAL COSTING ESTIMATE

DESCRIPTION	QTY.	TOTAL PRICE (GBP)
G-11 Wind Turbine, Three Phase, 11 kW, 18m Lattice Tower, including foundation and installation	1	Included
	Sub-Total Project Cost*	**£ 77,500**
	VAT 20%	**£ 15,500**
	Total Project Cost	**£ 93,000**

*Cost are based on an average installed cost. A full site survey would be required for a firm quotation.

The above is an estimated supply and installation cost and is subject to full site survey. All pricing is subject to VAT.

The price above doesn't cover planning applications, DNO applications, or any grid upgrades.

COMMERCIALS (5/6)

Commercial offer for Ryse Energy Renewable Solution

INCLUSIONS AND EXCLUSIONS

INCLUSIONS
Supply of hardware
Delivery to site
Installation and commissioning of turbines to specification
Electrical Connection to pre-agreed connection point
Electrical Sign off and certification

EXCLUSIONS
DNO application and associated costs
Planning application and associated costs
Ongoing maintenance costs
Environmental, soil survey and/or other geotechnical surveys should they be required
Any other permits

It is the responsibility of the client to ensure all planning permits are obtained prior to installation works commencement.

COMMERCIALS (6/6)

Full Terms & Conditions of the Ryse Energy Commercial Offer

WARRANTY

Ryse Energy equipment is provided with a warranty of 24 months from commissioning for all items excluding any packing, freight, insurance and all labor, which shall be charged at our normal commercial rates. Fair wear and tear will not be considered reasonable cause for free replacement of parts or components. Any damage resulting from misuse, incorrect operation or inadequate maintenance, in accordance with the guidelines set out in the operation and maintenance manuals, will not be covered under this warranty.

Ryse Energy reserves the right under this warranty to receive and recondition at a Ryse Energy or partner factory in a suitable and proper manner, such equipment as affected by this warranty. All costs involved in the transportation of the equipment to and from the factory, including packing, freight, insurance, customs clearance etc. shall be excluded from the scope of this warranty.

Alistair Munro

Chief Executive

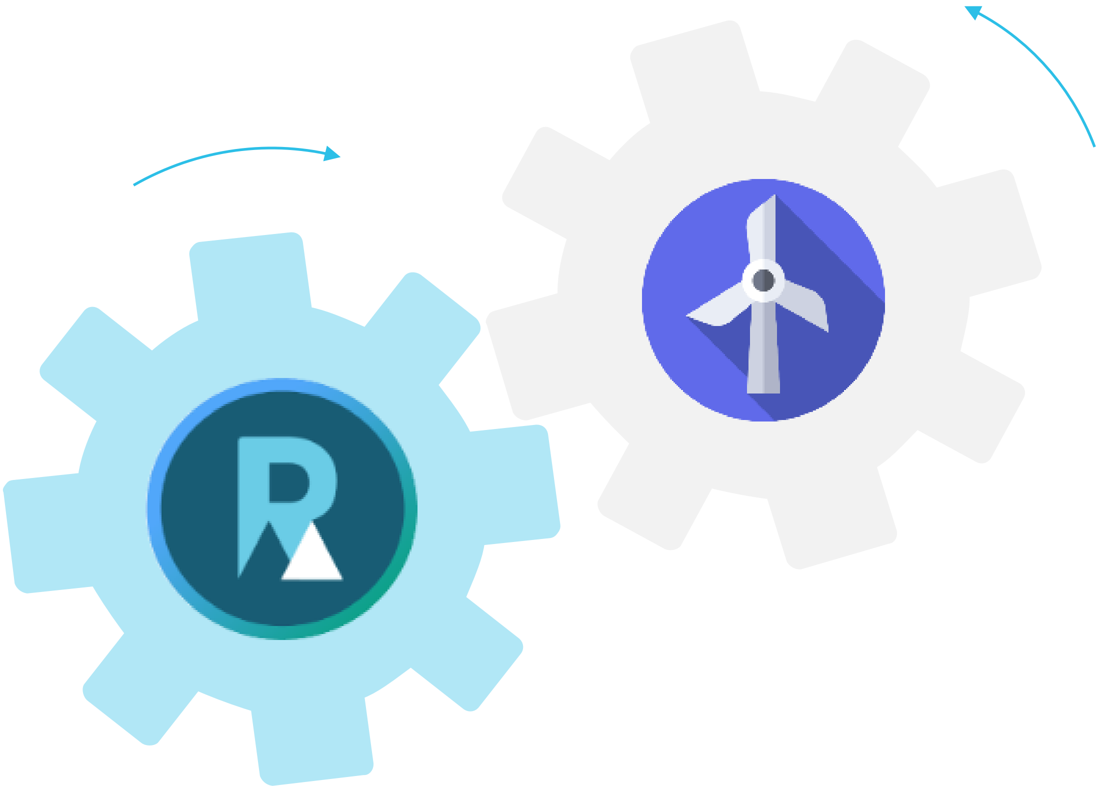
SERVICE & MAINTENANCE

SERVICE CONTRACTS

Ryse Energy can offer maintenance contracts to all wind customers

Ryse Energy carry out annual maintenance to ensure optimal operation of the renewable installation. We offer a range of service package options to suit our clients needs.

Electrical devices, wind turbine, tower, and the solar panels will be checked by experts from Ryse Energy to ensure an efficient operation of the system as well as prevent/anticipate any future fails

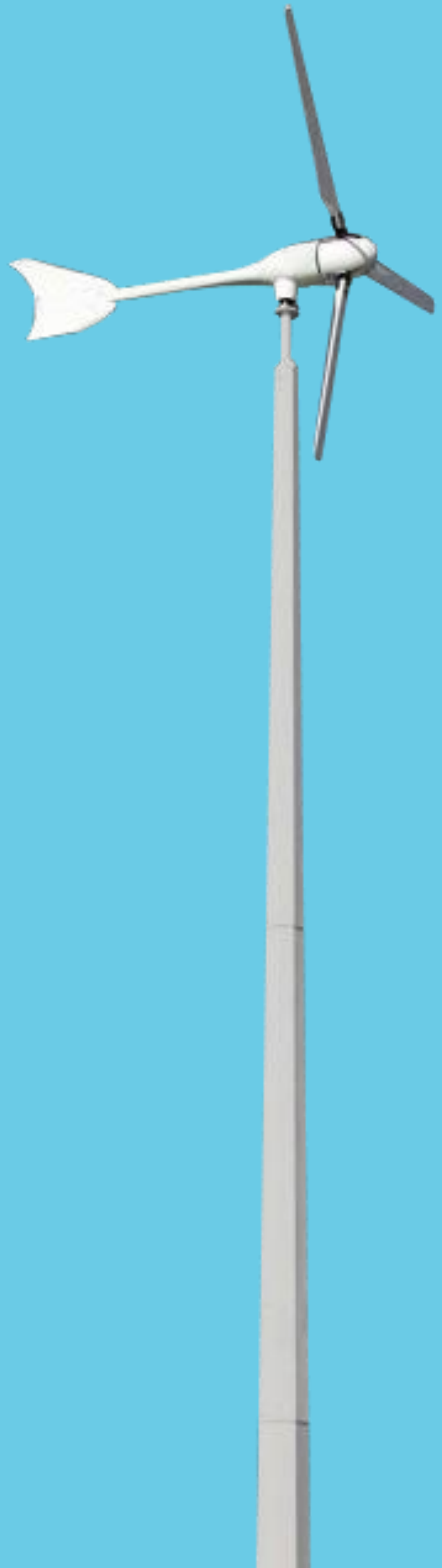


Service Packages start from £495/service*

Maintenance visit sites can be carried out once a year if the average wind speed is lower than 6 m/s.

**Excluding travel, Spare parts, and VAT.*

DATA SHEETS



E-RANGE

Advanced and innovative small wind turbines, using big wind technology

Our E-Range includes 3-blade horizontal axis turbines of 3-60 kW use big wind technology to provide a superior, more efficient performance against competitors.

The turbines are designed to IEC 61400-2 Class I specifications, in order to safely operate in high wind speed environments with the potential for extreme gusts.

AI Storm Detection algorithms and safety lock mechanisms protect the turbine in extreme weather conditions, whilst intelligent Ryse Energy software manages up to 700 variables to optimize and improve performance.

In total, several thousand of these turbines have been deployed throughout the world, in a range of applications and environments.

The E-Range's Class I design specifications, combined with a low start-up wind speed of 2 m/s, allows these turbines to be able to efficiently generate power over a wide range of site conditions.

E-5 HAWT (1/2)

5kW Small Wind Turbine for On-Grid & Off-Grid Applications

The E-5 is capable of off-setting greenhouse gas emissions from 38,902 miles driven by a passenger vehicle each year

Swept Area: 14.5 m^2
Diameter: 4.3 m
Radius: 2.15 m

250 RPM

200 KG

48 V DC **GRID**

CLASS I
—
PASSIVE REGULATION

ANNUAL MEAN WIND SPEED (M/S)	ESTIMATED ANNUAL OUTPUT (KWH)
2	290
3	1,900
4	3,900
5	6,900
6	10,900
7	14,300
8	17,700
9	20,000
10	22,500

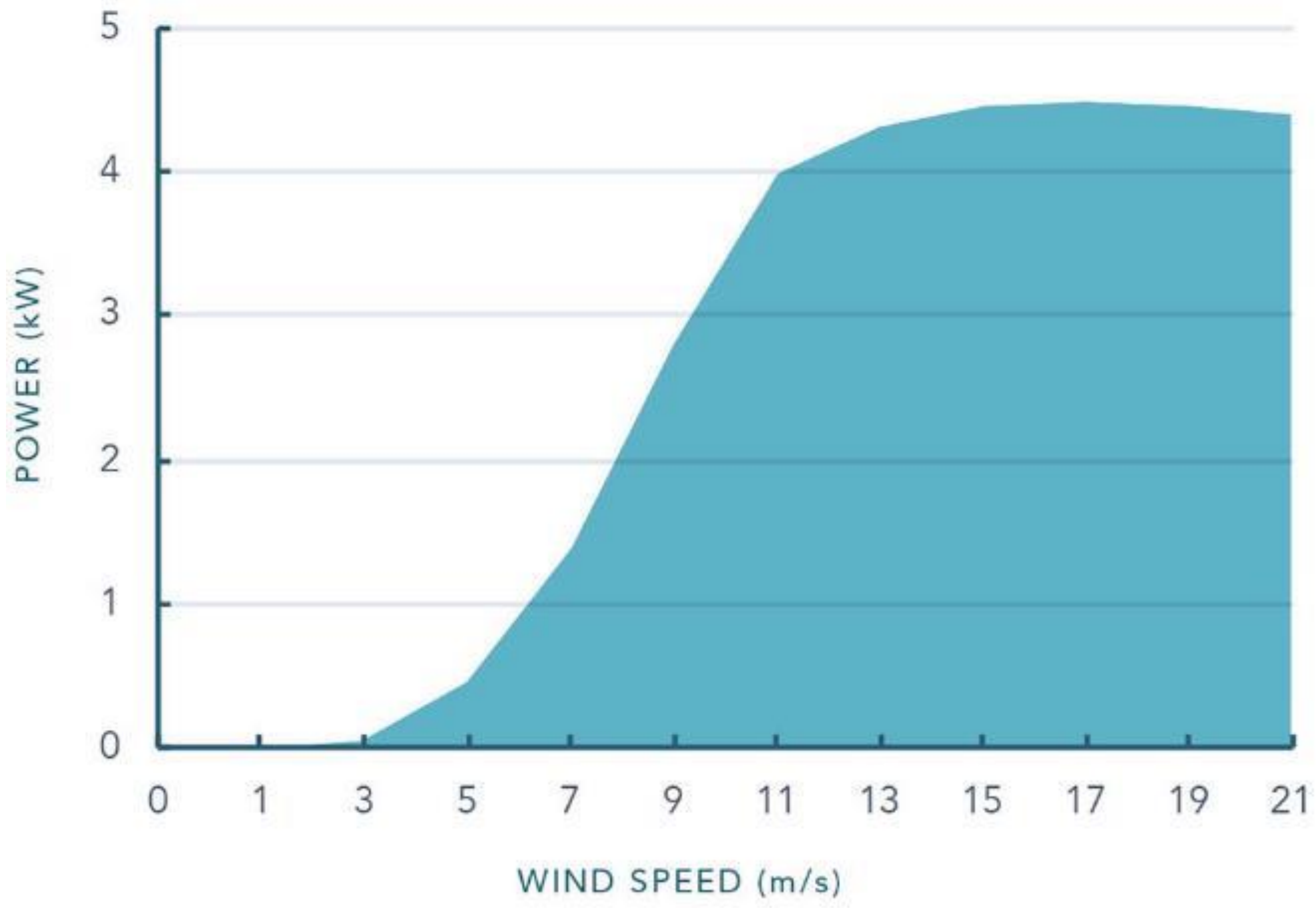
APPLICATIONS

- Telecoms
- Pipeline/Security Monitoring
- Oil & Gas
- Off-Grid
- Micro-Grid
- Residential
- Cold Weather Environments

FEATURES

- Active Blade Pitch Control
- Advanced safety mechanisms
- Remote Control
- Storm detection
- Anti-Corrosive Blades

POWER CURVE



E-5 HAWT (2/2)

Technical data for the E-5 Wind Turbine

TECHNICAL DATA

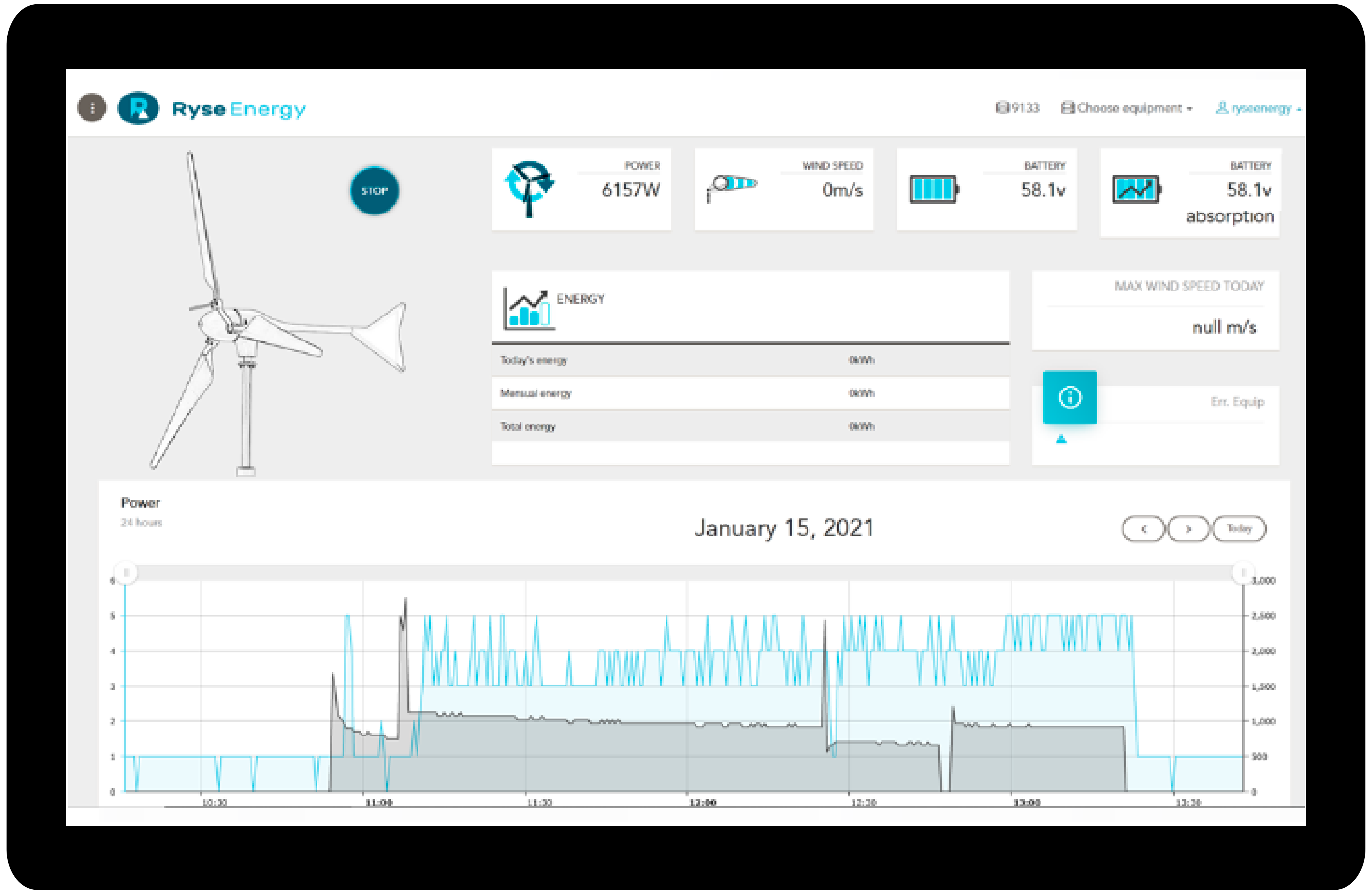
Generator Type	Permanent Magnet
Maximum Power	5.5 kW
Rated Power	4 kW
Configuration	Horizontal Axis
No. of Blades	3
Blade Material	Glass fibre with polyurethane core
Rotor Diameter	4.3 m
Swept Area	14.5 m^2
Nominal Rotor Speed	250 rpm
Pitch/Yaw	Upwind passive pitch with steering rudder
Cut-In Wind Speed	2 m/s
Rated Wind Speed	11 m/s
Cut-Out Wind Speed	60 m/s
Survival Wind Speed	70 m/s
Rotor & Nacelle Weight	200 kg
Tower Types	Lattice, Monopole, Tilt-Up
Tower Heights	L/M/T: 6 - 27 m
Temperature Range	-20° to 50°C
Lifetime & Servicing	20 years design life
IEC Turbine Design Class	Class I

REMOTE MONITORING SYSTEM: E-5

All our E-Range wind turbines can be remotely monitored

SYSTEM MONITORING

All installations will come with a remote monitoring system with a global access reach. Ryse Energy can remotely support with O&M activities in the event that a potential issue which has been automatically flagged or at the request of the client. Monthly reports, live system data, covering hundreds of parameters are available and controllable so that performance can be accurately tracked and reviewed.



POWER 6157W

WIND SPEED 0m/s

BATTERY 58.1v

BATTERY 58.1v absorption

MAX WIND SPEED TODAY null m/s

Err. Equip

Today's energy	0kWh
Manual energy	0kWh
Total energy	0kWh

January 15, 2021

List of Parameters Monitored

- Historical Data
- Energy Demand
- Renewable Energy Production
- Battery State
- Wind Speed

G-RANGE

Efficient wind energy for moderate wind speeds

Our G-Range turbines are best in class for moderate wind speed sites.

They have a simple but effective 2-blade horizontal axis design and have been shown to be reliable in a range of environments with more than 2,000 installations worldwide totaling a combined operational history of more than 2000 years.

The G – 11 turbine is an outstanding performer for its generator rated power, owing to its large blade and significant swept area, thus helping reduce energy costs and carbon footprint.

The blade diameter and swept area are a better measure of a wind turbine’s capability, rather than its generator rating because it is the swept area of the blade that captures the wind’s energy.

Another key feature is one shared with larger scale turbines in that it has a slow rotational speed which remains constant regardless of the wind speed, thus reducing noise impact (even in high winds). Additionally, the G – 11 turbine incorporates many of the active control, sensor and safety features found in larger utility-scale turbines making it a very reliable and safe machine.

G-11 HAWT (1/2)

11 kW Small Wind Turbine for On-Grid & Off-Grid Applications

The G-11 is capable of displacing greenhouse gas emissions from 15,000 litres of fuel each year

Swept Area: 133 m^2
Diameter: 13 m
Radius: 6.5 m

56 RPM

48 V DC GRID

CLASS III
—
PASSIVE REGULATION

900 KG

ANNUAL MEAN WIND SPEED (M/S)	ESTIMATED ANNUAL OUTPUT (KWH)
4.0	16,220
4.5	21,861
5	27,502
5.5	32,731
6	37,959
6.5	42,243
7	46,527
7.5	49,655

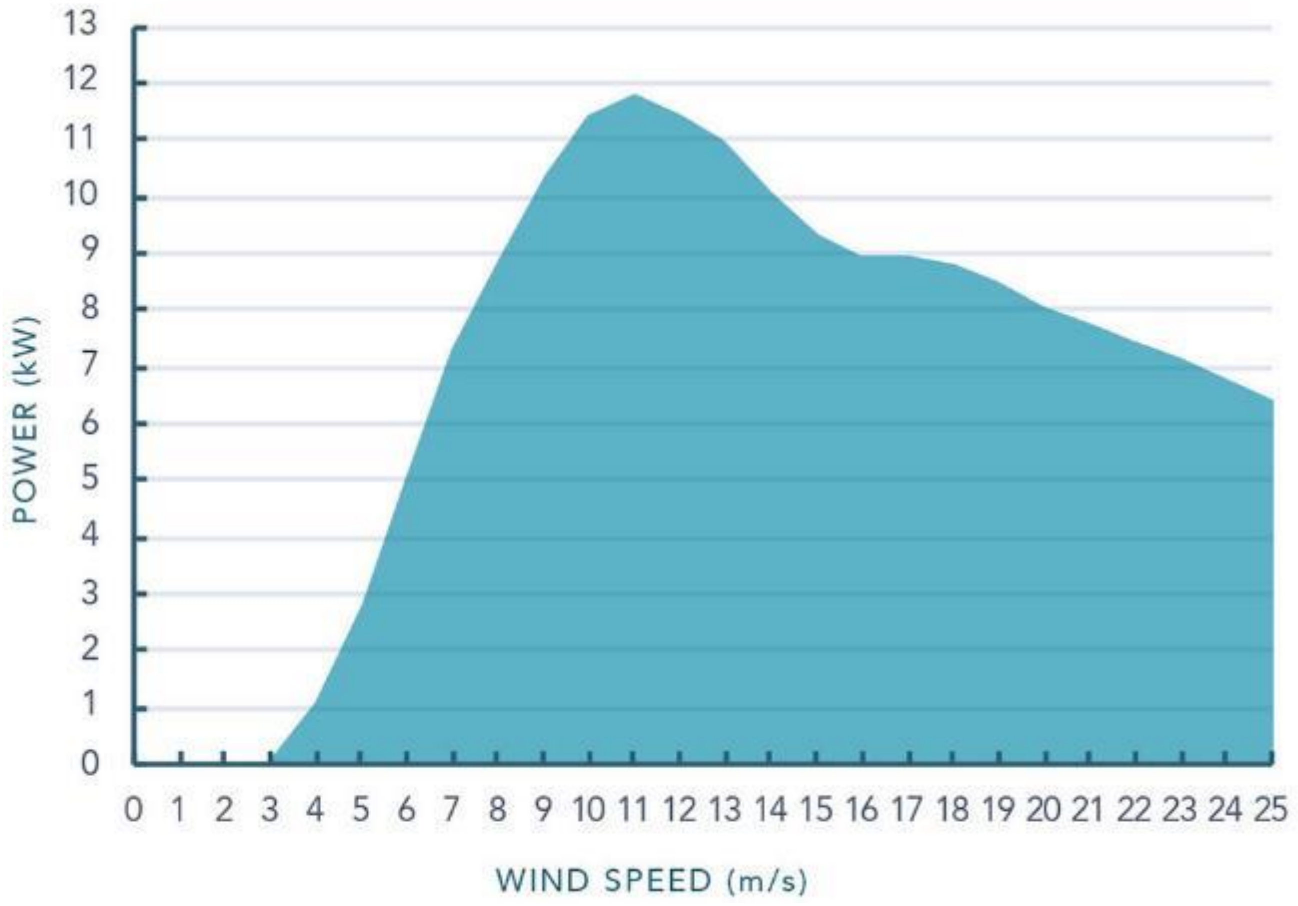
APPLICATIONS

- Industrial & Commercial
- Agricultural
- Off-Grid
- Micro-Grid
- Remote & Island Communities
- Residential

FEATURES

- Active Blade Pitch Control
- Advanced safety mechanisms
- Remote Control
- Storm detection
- Anti-Corrosive Blades

POWER CURVE



G-11 HAWT (2/2)

Technical data for the G-11 Wind Turbine

TECHNICAL DATA

Generator Type	Induction
Maximum Power	13 kW
Rated Power	11 kW
Configuration	Horizontal Axis
No. of Blades	2
Blade Material	Glass fibre
Rotor Diameter	13 m
Swept Area	133 m^2
Nominal Rotor Speed	56 rpm
Pitch/Yaw	Downwind fixed pitch with passive yaw
Cut-In Wind Speed	3 m/s
Rated Wind Speed	11 m/s
Cut-Out Wind Speed	25 m/s
Survival Wind Speed	52.5 m/s
Rotor & Nacelle Weight	900 kg
Tower Types	Lattice, Monopole, Tilt-Up
Tower Heights	L: 15-36 m M/T: 18 - 27 m
Temperature Range	-20° to 50°C
Lifetime & Servicing	20 years design life
IEC Turbine Design Class	IEC 61400-2 Class III

REMOTE MONITORING SYSTEM: G-11

Our G-11 wind turbine can be remotely monitored

SYSTEM MONITORING

Ryse Energy offers an online remote monitoring system for G-11 wind turbines which can be monitored via mobile phone or desktop.

This feature gives you a way to keep up to data of your wind turbine, where it provides you to monitor the instantaneous power, and wind speed, as well as view the energy produced per day, month, and year.

Further to these features, this type of interactive monitoring system allows you to check on the current status of the wind turbine and receive email alerts when the turbine goes offline for any reason in addition to the control of the turbine with remote stop, start and restart functions.

SCADA DATA ANALYSIS

Total generation, average wind speed, performance loss, downtime loss, power curve plot and time series plot

24/7 ACCESS

Wind speed, current power, generation RPM plus active stat codes

REAL-TIME FLEET MONITORING

Wind speed, current power, generation RPM plus active stat codes

EVENT LOG & ANALYSIS

Service techs can remotely view your turbine history to analyze errors, reducing the need for call outs

CASE STUDIES

RYSE ENERGY EQUIPS FENG-SHUI HOME WITH RENEWABLE ENERGY

Ryse Energy carried out a hybrid installation comprising of wind and solar energy

When installing this hybrid system, Ryse Energy had to take into account of important concepts so as to not disrupt the Chi of the house such as the orientation of the land so that it would benefit its owners, the height of the cables of the electrical installation so that the electromagnetic fields caused by the circulation of current did not affect the inhabitants and all kinds of details.

For Ryse Energy it was a pleasure to be selected to provide this house with clean energy, since the design, energy and efficiency requirement had to be of the highest quality for both performance and integration with the Chi of the house.

Sector	Residential
Location	Spain
Type	Off-Grid
Installation	E-5 Turbine, Solar PV & Battery Storage
Total Power	7 kWp

BUILT-UP ENVIRONMENT

PROVIDING SUSTAINABLE ENERGY FOR RESIDENTIAL

Ryse Energy installed an E-5 wind turbine for 5 single family houses for their day to day consumption.

It is estimated that the total energy expenditure consumed by the complex through night lighting, as well as the daytime expenditure on irrigation motors, treatment plants, etc. are covered by the generation of the E-5 Wind Turbine by more than 95% .

The installation is located in an area of high salinity and humidity, so the wind turbine and the tower have been covered with a highly insulating corrosive epoxy paint.

The 18-meter tower made of fiberglass, becomes an ideal complement to a place where there is high salinity.

Sector	Built-Up Environment
Location	Spain
Type	On-Grid
Installation	E-5 Turbine
Total Power	4 kW

AGRICULTURAL

PROVIDING WIND ENERGY TO A LIVESTOCK FARM

Ryse Energy installs a G-11 wind turbine to reduce the carbon footprint and energy costs of livestock farm

New Craig Farm is a livestock and arable farm located in Perthshire, Scotland.

The owners Debbie and Neil McGowan, wanted to lower their carbon footprint and reduce their energy costs. Being able to take control over a variable cost such as rising electricity bills was also a big motivation for the pair to install G-11 wind turbine.

“Since it was installed, our turbine has produced an average of 21,170 kWh per year, providing substantial feed-in tariff payments. About 73% of this energy is used on the farm and the rest is sold to the national grid. Our electricity bills have reduced by nearly a third and the extra income has helped us enormously in making farm improvements”.

Sector	Agricultural
Location	Scotland, UK
Type	On-Grid
Installation	G-11 Turbine
Total Power	11 kW

EDUCATION

SUSTAINABLE WILDERNESS CENTER IN ALASKA

Ryse energy has provided the largest residential wind turbine ever built in the peninsula of Kenai for the Ageya Wilderness Center

The Ageya Wilderness Center is an adventure-based educational facility based near the city of Homer, which was designed by the Alaskan Permaculture Guild recommending the use of renewable energy systems. Its project director, Kevin Dee, chose the Ryse Energy G-11 HAWT with a 30 m tower to power the center and supporting their ambitious Sustainability Program.

The Ageya Sustainability Team was very happy with the early results delivered by the G-11 with over 1,000 kWh of production in only the first couple of weeks.

Sector	Education
Location	Alaska
Type	Off-Grid
Installation	G-11 Turbine
Total Power	11 kW

THANK YOU

andrew@ryse.energy

Ryse Energy