Sustainability Statement

Variety Barn
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Nihad Mir Abbas
Nabbas@mesh-energy.com

0844 500 3383
www.mesh-energy.com



mesh.
the smart renewable energy consultancy

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Revision Log

Section	Revision	Issue	Date
	For review and comment	Draft	30/10/2023
	Revision 1	1	31/10/2023
	Revision 2	2	31/10/2023
Conclusion, Policies	Updated to local policies	B	03/11/2023

1 Executive Summary

Mesh Energy have been appointed to produce a Sustainability Statement as part of the Planning Application for the proposed Variety Barn development.

This report outlines the sustainable features to be incorporated into the design of the building to improve its overall environmental performance through both good building design and the implementation of renewable technologies. The study is carried out by performing a comparison between the house under notional conditions and proposed design conditions to understand the balance of factors to achieve better sustainability targets. This should initially be achieved using a 'fabric first' approach, whereby household carbon emissions are cut via a more efficient use of energy by the dwelling in question. Local council policies usually encourage that at least part of this reduction is achieved by using low and zero carbon technologies.

This report concludes that energy efficiency measures in conjunction with a suitably sized Air Source Heat Pump (ASHP) or Ground Source Heat Pump (GSHP) is the most desirable energy strategy option for the development, and offers a significant reduction in CO_2 emissions, along with the provision of energy from renewables and low carbon technologies. This would far exceed the aspirations set out in the Wiltshire Core Strategy.

The proposed SAP calculations demonstrate a remarkable 83% improvement in primary energy rate and a corresponding 33% increase in dwelling energy efficiency impact when compared to the Notional SAP calculations. The higher energy efficiency rating in the proposed calculations is achieved through the incorporation of renewable technologies and better building fabric, that reduce energy consumption and lower environmental impact, showcasing a more sustainable and environmentally friendly approach.

Energy & carbon calculations have been carried out using SAP 10 methodologies, while the new Building regulations have raised the bar on the minimum performance of buildings, the results summarised in the table below demonstrate that the proposed design is a substantial improvement both on the existing dwelling and the minimum standards for new buildings. The figures below demonstrate:

- A DER improvement of 80% beyond the Notional building SAP Calculations.

This strategy is considered a good fit for the development as this helps to decarbonise the domestic sector, along with reducing local emissions from combustion fuels.

	Notional Building 2021 kgCO2/m2	Proposed Design kgCO2/m2
Target Emission Rate (TER)	8.11	7.7
Dwelling Emission Rate (DER)	6.07	1.21

2 Introduction

2.1 Overview

Mesh Energy have been appointed to produce a Sustainability Statement as part of the Planning Application for the proposed Variety Barn development.

This report outlines the sustainable features to be incorporated into the design of the building to improve the overall environmental performance through both good building design and the implementation of renewable technologies.

2.2 Overview

Mesh Energy are working closely with Bell Architects on Variety Barn, where they are planning to build a new and bespoke family home, 'Variety Barn'. The project is in Tilsbury.



Figure 1: The dynamic thermal model of the proposed design

The energy strategy includes an Air-source heat pump for warmth and domestic hot water.

The proposed solar PV array will meet the expected loads of the property, providing a balance between covering winter lows in energy generation and minimising wasted excess to the grid.

The installation on a mechanical ventilation and heat recovery system will reduce the annual consumption of the home by 20%. EV charging is anticipated to reduce typical travel carbon emissions by 1.6 tonnes per year.

3 Relevant Planning Policy

3.1 National Policy (NPPF)

The National Planning Policy Framework (NPPF) was published on 27 March 2012 with updates in July 2021 and more recently, September 2023. This document sets the overarching policies for development in England and states that:

'So that sustainable development is pursued in a positive way, at the heart of the Framework is a presumption in favour of sustainable development.' (NPPF, 2021).

Paragraph 11 states: '… promote a sustainable pattern of development that seeks to: meet the development needs of their area; align growth and infrastructure; improve the environment; mitigate climate change (including by making effective use of land in urban areas) and adapt to its effects'.

The NPPF also references the 17 UN Sustainable Development Goals, which is reiterated in turn through the RIBA Sustainable Outcomes guidance.

3.1.1 CP1 Sustainable Development

Variety Barn delivers the vision and objectives, and principles in the district and thereby delivers sustainable development. This includes maximising passive solar heating, lighting, natural ventilation, and energy. This requires that dwellings consider orientation and solar gains in addressing energy and carbon concerns.

3.1.2 CP12 Climate Change

Variety Barn mitigates and adapts to climate change in a variety of ways:

- Adopting higher water efficiency standards to contribute to alleviating water stress across the district.
- Integrating renewable technologies throughout the house.
- Utilising materials that have lower carbon impact.

3.1.3 DM33 Managing Carbon Emissions

In accordance with Policy DM33.1(g), the house will incorporate renewable technologies.

3.1.4 Wiltshire Core Strategy

The Wiltshire Core Strategy aims to create stronger, more resilient communities by promoting sustainable development. In terms of construction of new houses, the strategy emphasizes the need for an appropriate balance of jobs, services, facilities, and homes to avoid out-commuting and address the imbalance in local jobs and infrastructure.

In terms of domestic insulation, renewables, and energy efficiency, the strategy aims to reduce Wiltshire's carbon footprint through the appropriate location of development and the use of renewable energy and sustainable construction methods. The strategy encourages the design of new buildings that minimise energy demands and considering carbon savings from existing buildings. Overall, the strategy seeks to achieve sustainable development and conserve natural resources while providing everyone with access to decent and affordable homes as established by the CP41 Sustainable Construction and Low-Carbon energy. (p. 11p. 27p. 242p. 243).

4 Energy Statement

4.1 Analysis and Methodology

The report will aim to demonstrate the most feasible strategy for achieving CO2 emissions and energy consumption reductions.

The policy requires that developments reduce energy demand and implement energy-efficiency measures in-line with the Energy Hierarchy, and that developments provide some of their energy demand from renewable or low carbon technologies.

The first stage of addressing the Energy Hierarchy is to establish the baseline energy demand and carbon emissions.

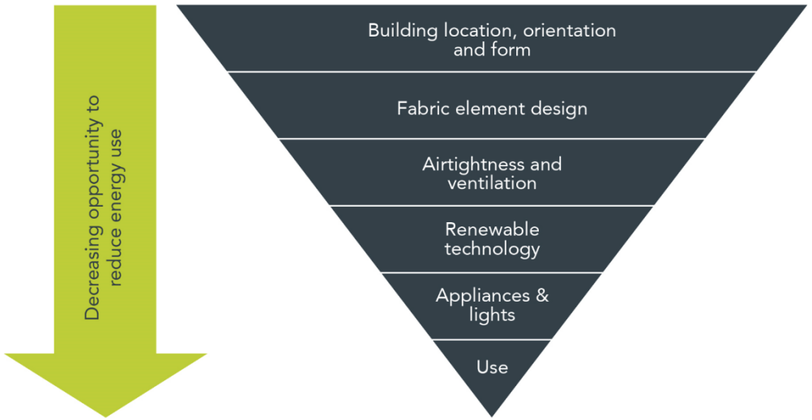


Figure 2: The Energy Hierarchy

Step 1: Reduce elemental building fabric heat loss
Step 2: Reduce unnecessary ventilation and air heat losses
Step 3: Harvest energy more efficiently to heat home and produce hot water
Step 4: Incorporate micro-generation to generate electricity and power efficient technology
Step 5: Store surplus locally generated electricity to reduce imported electricity from the grid

This strategy is based on upon planning-stage SAP calculations undertaken on a drawing of the newly proposed dwelling, to provide a reasonable estimation for energy demand and carbon emissions at this stage.

It should be noted that these calculations are to inform the Planning Application only and should not be used for Building Control purposes. A baseline calculation of CO_2 emissions using the Target Emissions Rate for the new dwellings has been conducted and forms the basis of the energy and carbon savings detailed in this report.

4.2 Establishing the Baseline CO_2 Emissions

As discussed above, this report establishes a baseline assessment of the energy demands and associated CO_2 emissions for the proposed development.

A planning stage SAP calculation of the proposed development has been used for the energy assessment.

The SAP calculations have been carried out considering ASHP as the heating element and have cleared compliance with the proposed design, the dwelling could also have GSHP which would result in lower CO_2 emissions.

4.3 Baseline CO_2 Emissions Methodology

To establish the baseline carbon emissions and energy demand for the development, the Target Emissions Rate as calculated in SAP has been used to model a ‘base case scenario’ for each element. The notional building fabric from Part L have been used as a performance standard, which in this case has assumed an ASHP heating system, while no active cooling is assumed.

4.4 Fabric First

To ensure that the sustainable aspirations of the development are met, the design team have improved beyond that of the Notional Building. This will also ensure compliance with Part L of the Building Regulations.

5 Sustainable Design

5.1 Minimising Carbon Emissions

5.1.1 The Notional House Vs Proposed House

The proposed house at Variety barn, was a stone barn which is being replaced with a 4-bedroom home. The design suggests reusing all the stone from the barn in the replacement dwelling, as well as using materials with lower carbon impacts.

The notional building has poor environmental performance, in comparison to the improved Building materials in the proposed house. This can be seen from the EPC of the proposed vs notional (below).

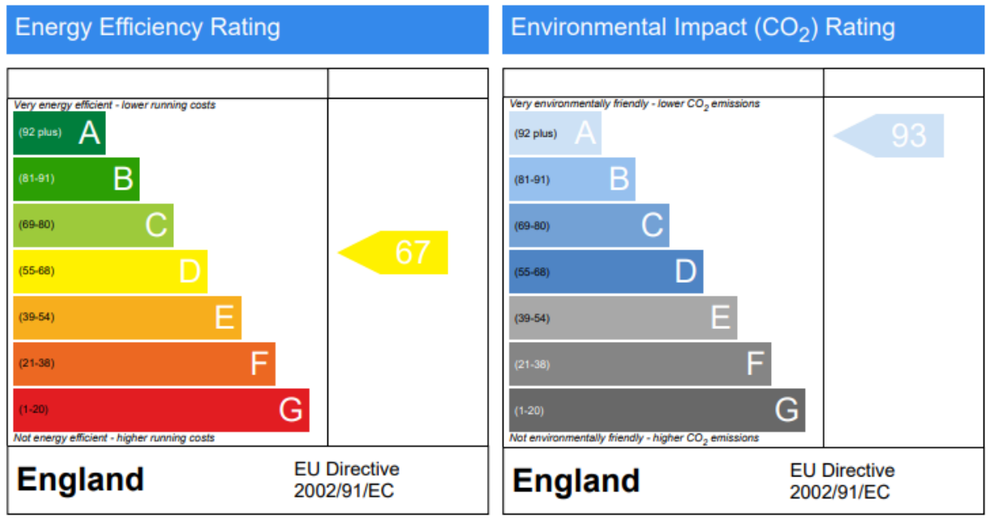


Figure 3 Notional Building Design

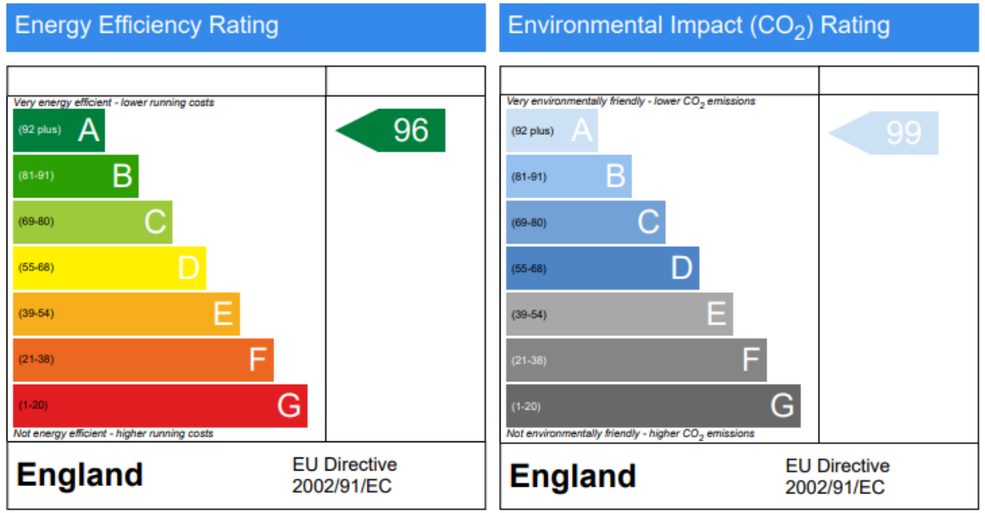


Figure 4 Proposed Building Design

The notional building design has the notional building regulations for the fabric criteria, meanwhile in the proposed design we go beyond the notional values while incorporating renewable technologies to reach an energy rating of 96(A). This rating is achieved considering the heating system to be ASHP, in the case of considering GSHP the rating would be 95(A). In, both cases having performance far superior to just Notional Values.

On the balance of the reasons listed above it is conclusive that the existing house cannot be adapted to adequately reduce its energy consumption.

The SAP calculation was undertaken for the house in 2 scenarios, One with the notional building regulations and two with our proposed U values.

On the basis that a new building is required, it is conclusive that the replacement dwelling should adopt passive environmental strategies, a “fabric first” approach and sustainable heating, cooling, and ventilation technologies wherever possible.”

5.1.2 Building Fabric Performance

A ‘fabric first’ approach to building design involves maximising the performance of the components and materials that make up the building fabric itself, before considering the use of mechanical or electrical building services systems. This can help reduce capital and operational costs, improve energy efficiency, and reduce CO_2 emissions through methods such as:

- Maximising airtightness.
- Using super-high insulation.
- Optimising solar gain through the provision of openings and shading.
- Optimising natural ventilation.
- Using the thermal mass of the building fabric.
- Using energy from occupants, electronic devices, cookers and so on.

Construction Element	Notional Building Regulations Fabric Parameters, (W/m^2K)	Proposed fabric performance (W/m^2K)
Ground floor	0.18	0.13
External walls	0.26	0.12
Roof	0.16	0.14
Windows	1.60	1.3
External doors	1.60	1.50
Infiltration Rate	$5m^3/h.m^2$@50Pa	$4m^3/h.m^2$@50Pa

Table 1 Proposed fabric performance

5.2 Low Carbon and Energy Technology Feasibility Summary

Technology	Energy Generation	Physical, Spatial & Land Use Impact	Noise Impact	Suitability of technology	Feasible
Wind Turbine	Electric	Are wind speeds at least 6 m/s for stand-alone or at least 3.5m/s for small scale? Is the area free from obstructions that could cause local wind turbulence?	Wind turbines generate noise that can be heard up to a few hundred metres away. However, this level is normal only marginal greater than the actual wind noise itself.	Average windspeed at site is 3.68m/s which is slightly above the requirements for small scale. A wind turbine would not be acceptable for visual amenity.	✗
Solar photovoltaics	Electric	Will the buildings have an east to west (through south) facing roof or flat roof? Are roofs free from overshadowing for most of the day from	None	The ground mounted installation of solar PV meets the requirement in energy production	✓

Technology	Energy Generation	Physical, Spatial & Land Use Impact	Noise Impact	Suitability of technology	Feasible
		buildings or other structures?			
Solar thermal	Hot Water	Will the buildings have a year-round demand for hot water? Will the buildings have an open aspect southeast to southwest facing roof of at least 4m^2? Is space available for hot water cylinder near the panels? Is the building in a conservation area?	None	Solar hot water works best when the panels can be located close to the water storage therefore run distance to lower flats makes it impractical.	✗
Biomass	Heat and hot Water	Is there a local supply and space for storage of biomass fuel or can one be set up? Is a room heater or boiler required?	Normal noises associated with boiler plant. Potential additional noise generation associates with the fuel deliveries.	The biomass is feasible but not recommended as heat pumps work better coupled with Solar PV.	✓
Air-source heat pump	Heat and hot Water	Is there space for siting the heat pump, including the desired room for air movement?	Minimal external noise	Concerns about visual amenity.	✓
Ground-source heat pump	Heat and hot Water	Will there be room for a horizontal buried pipe? Is the ground suitable for vertical pipe system?	No external noise	There is sufficient space for the GSHP vertical pipe infrastructure, but insufficient space for horizontal.	✓
Water-source heat pump	Heat and hot Water	Is there room to protect an energy blade in a nearby watercourse?	No external noise	There isn't a water source for the system.	✗
Combined heat and power	Heat and hot Water	CHP works well with a large demand (large plots) to create more electricity generation, as the boiler itself is not that efficient with small demand requirements.	Normal noises associated with boiler plant	The size of the dwelling within this development makes the installation of CHP plant inefficient.	✗

5.3 Mechanical Ventilation and Heat Recovery (MVHR)

5.3.1 Technology Introduction

An MVHR unit operates by utilising a network of concealed ducting to recover heat produced within a property from lighting, cooking, general electrical appliances, heating systems and occupants. This recovered heat is then used to warm up incoming cooler fresh air.

5.3.2 The benefits of MVHR

The installation of an MVHR system will reduce the annual consumption of the home by 20%, while maintaining good indoor air quality during the heating season.

5.4 Underfloor heating

5.4.1 Technology Introduction

Low central heating flow temperatures allow heating systems to operate more efficiently. This is particularly true when installing heat pump technology, which works best with flow temperatures of between 35-45°C. Heat loss calculations have confirmed that the most appropriate flow temperature for the central heating system at this property is 40ºC.

5.5 Air Source Heat Pumps

5.5.1 Technology Introduction

Air source heating uses electricity to convert energy gathered from the air into low temperature water for heating and domestic hot water use. The energy is collected externally via a fan unit which can be either be adjacent to the property using a "monobloc" unit or up to 50m away using a "split" unit design. Depending on the availability of outside space and the location of individual properties' social areas split units can reduce noise and visual concerns. The operation of the fan within ASHPs, can be considered as a nuisance noise, but if they are not immediately adjacent to living spaces, they are unlikely to pose a nuisance.

Internally a monobloc heat pump requires no additional equipment, except for a manifold connecting it to your central heating circuits and a domestic hot water (DHW) cylinder as the external fan unit houses the refrigeration circuit which converts the heat to a useable form.

When installing a split system, an additional unit, approximately the size of a conventional gas boiler, is installed internally and it is this unit which houses the compressor and condenser.

In special cases it may also be desirable to site a monobloc heat pump some distance from a property, for example if both external and internal plant positions were constrained. In this case highly insulated buried pipework would connect the external unit to the heating circuit within the property. This would add approximately £100/m to the cost of installation.

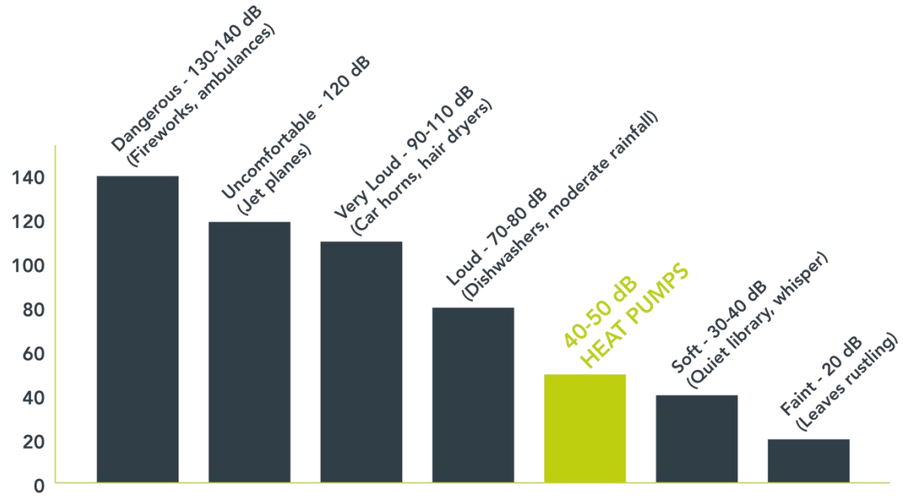


Figure 5: ASHP decibels compared

Advantages
- Significant carbon savings
- Reduced running costs.
- Ideal to use with underfloor heating.

Disadvantages
- External unit required.
- Low level noise during operation



Figure 6: Left to right typical air source plant room installation, typical outdoor small fan unit, example cover for aesthetic purpose.

5.6 Ground Source Heat Pumps (GSHPs)

5.6.1 Technology Introduction

Ground source heating uses electricity to convert energy gathered from the ground into low temperature water for domestic heating and hot water use. The energy is collected externally via horizontal loops buried beneath the ground or alternatively by vertical boreholes (to a depth of 100m) if space is restricted. The size of the collector array required is influenced by the size of the heat pump, the expected full load equivalent run hours of the heat pump and the ground conditions.

Internally the heat pump unit which converts the low-grade energy from the outdoor loops to higher temperature heating water is often located within a plant room or utility room. The further addition of a buffer cylinder (nominally 400-500ltr) is also required to regulate heating water distribution and maximise system efficiency and running costs.



Figure 7: Typical plant room installation and typical “bulk excavation” ground collector field

- a minimum of 600mm clearance to the front of the GSHP
- a minimum of 300mm clearance to the rear and side of the GSHP

- a minimum of 150mm clearance around the plant room cylinders.

Advantages
- Significant carbon savings
- Reduced running costs.

Disadvantages
- Large area of land required for loops or bore holes.
- Expensive capital cost
- Site specific study required to ascertain if soil conditions are favourable.

5.7 Solar Photovoltaics (PV)

5.7.1 Technology Introduction

Solar photovoltaic panels are employed to reduce the amount of energy used by the household from the main electricity network and in turn reduce the overall electricity bill for the home. Photovoltaic systems have minimal internal components to consider and can easily be integrated into the home electricity supply.

5.7.2 Installation Considerations

The most suitable location for a solar PV is on the roof. The limiting factor on solar PV at this site is the availability of suitable roof space and visual amenity. The roof will allow up to 32 panels of 370kW, which equates to 11.84kWp of installed capacity.

Provided inputs:	
Location [Lat/Lon]:	51.627,-0.044
Horizon:	Calculated
Database used:	PVGIS-SARAH2
PV technology:	Crystalline silicon
PV installed [kWp]:	11.84
System loss [%]:	14

Simulation outputs:	
Slope angle [°]:	40 (opt)
Azimuth angle [°]:	-6 (opt)
Yearly PV energy production [kWh]:	12129.03
Yearly in-plane irradiation [kWh/m^2]:	1264.41
Year-to-year variability [kWh]:	471.40
Changes in output due to:	
Angle of incidence [%]:	-3.03
Spectral effects [%]:	1.93
Temperature and low irradiance [%]:	-4.69
Total loss [%]:	-18.98

Figure 8: Solar PV array installation criteria

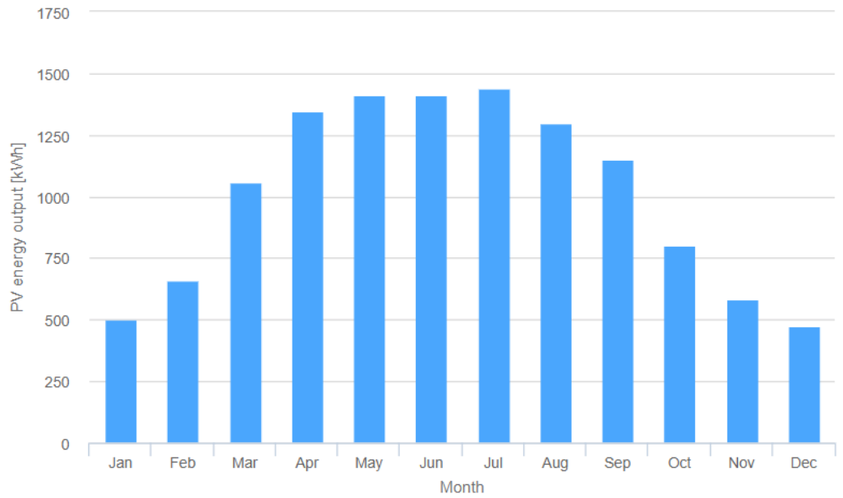


Figure 9 Monthly solar generation at site

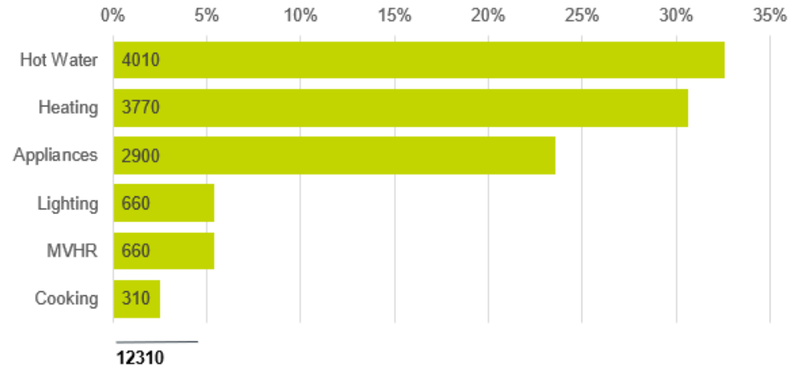


Figure 10: Likely electricity consumption by area

Figure 6 demonstrates the monthly daily average of energy generated and consumed onsite, based on the desired array size for this property - 11.84kWp. With the current size of the PV system, there is excess electricity that can be supplied to the grid or stored in the battery for nighttime usage.

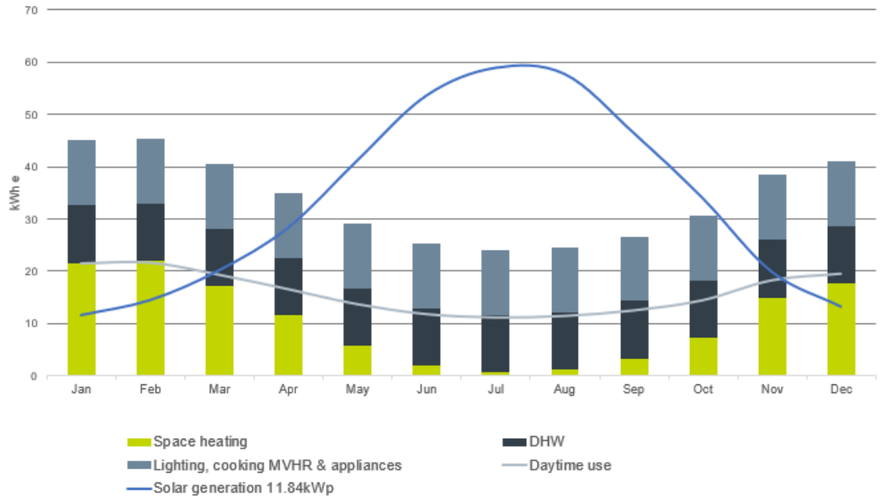


Figure 11: Average daily electricity production and usage by month

5.7.3 Carbon Savings

The proposed strategy shows a 30% improvement on current Building Regulations using SAP and an EPC rating of 96 (A), again, significant improvement upon the notional and even the optimistic 'potential' score.

The dwelling has an estimated carbon emission of 0.2 per year in comparison to 1.5 for notional building regs.

5.8 Minimising Pollution

- The ASHP has been specified to meet the domestic hot water load and heating requirements, which is a green technology with its performance.
- The proposed green roof can help catch dust and smog particulars, improving localised air quality.
- Light: Light emitting diode (LED) technology and low energy fluorescent fittings will also be incorporated throughout the dwelling.
- All external lighting will be specified with low energy fittings and dusk to dawn sensors and / or timers to reduce energy use.

6 Cooling and Overheating

During the design stage of this project the overheating and cooling have been reviewed. Summer overheating is one of the standard parameters checked as part of Part L compliance.

6.1 The Cooling Hierarchy

The project will follow and implement a strategy based upon the following cooling hierarchy.

6.1.1 Reducing the amount of heat entering the building in summer

External brise shading, to avoid summer overheating, has been implemented.

6.1.2 Using thermal mass and high ceilings to manage heat within the building.

Where practical and possible exposed thermal mass will been used to reduce the likelihood of overheating

6.1.3 Passive cooling

Where practical and possible openable windows and dual aspects have been used.

6.1.4 Mechanical ventilation

Mechanical ventilation will include a summer by-pass on any heat recovery system installed.

6.1.5 Mechanical cooling

As a final option, the design can incorporate mechanical cooling. This system utilizes a coil unit placed in the designated rooms for cooling, connected to the ASHP, capable of operating in reverse to cool these specific areas.

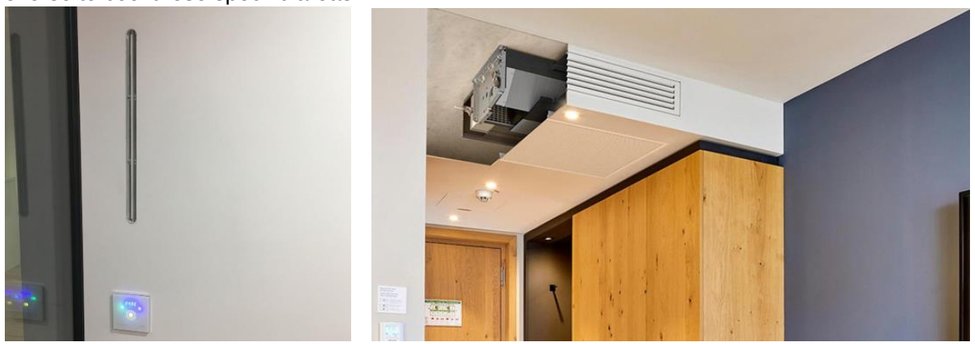


Figure 13: Example of cooling wall vent and thermostat (right) and ceiling fan coil

7 Potable Water Usage

7.1 Efficicent Use of Resources

To achieve a low environmental impact, water systems will be designed, used and managed efficiently, saving water and reducing associated energy and CO_2 emissions.

The potable water use is calculated according to Building Regulations Part G Appendix A ‘Water efficiency calculator for new dwellings’.

7.2 Part G result

In specifying the following fixture and fitting flow rates potable water usage is will be 124.2 l/p/d.

Space	Design
Kitchen sink taps (litres/min)	7
Dishwasher (litres/place setting)	0.9
Washing machine (litres/kg dry load)	6.4
Waste disposal (litres/use)	1.18
Bathroom sink (litres/min)	5
Shower only (litres/min)	11
Bath only	225
Bathroom dual flush WC (4/2.6 litres)	3.0
Water consumption (litres/person/day)	124.22

8 Summary

Mesh Energy have been appointed to produce a Sustainability Statement as part of the Planning Application for the proposed Variety Barn development.

This report outlines the sustainable features to be incorporated into the design of the building to improve its overall environmental performance through both good building design and the implementation of renewable technologies. The study is carried out by performing a comparison between the house under notional conditions and proposed design conditions to understand the balance of factors to achieve better sustainability targets. This should initially be achieved using a ‘fabric first’ approach, whereby household carbon emissions are cut via a more efficient use of energy by the dwelling in question. Local council policies usually encourage that at least part of this reduction is achieved by using low and zero carbon technologies.

Technology Considerations-

- The ASHP has been considered for proposed design and subsequent SAP calculations, to reach a rating of 96(A).
- There is a provision for utilisation of GSHP with the SAP calculations reducing to only 95(A).
- The design has ground mounted PV panels at a 11.84kWp capacity.
- The design has a provision to have a mechanical cooling system when the ASHP is run in reverse.

Design Improvements-

- Proposed SAP has 83% improvement in primary energy rating over Notional SAP.
- The proposed SAP has 33% increase in dwelling energy efficiency over Notional SAP.
- A DER improvement of 80% beyond the Notional building SAP Calculations.

The proposed plan for Variety Barn harmonizes well with important national and local policies, specifically the National Planning Policy Framework (NPPF) and the Wiltshire Core Strategy. Reflecting the NPPF's emphasis on sustainable development, the dwelling integrates very good insulation, recycled stone walls, a heat pump, PVs, and MVHR systems. These components directly aid in lessening climate change effects, enhancing energy efficiency, and backing a sustainable development approach. Additionally, the design echoes the Wiltshire Core Strategy's ambition to forge robust communities through sustainable development. By incorporating renewable technologies and highlighting energy efficiency, the design supports the strategy's objective of lessening the area's carbon footprint while providing quality, reasonably priced homes. The proposed dwelling not only meets local development needs but also adheres to the fundamental principles of these policies by embracing eco-friendly methods and renewable energy solutions.

This strategy is considered a good fit for the development as this helps to decarbonise the domestic sector, along with reducing local emissions from combustion fuels.

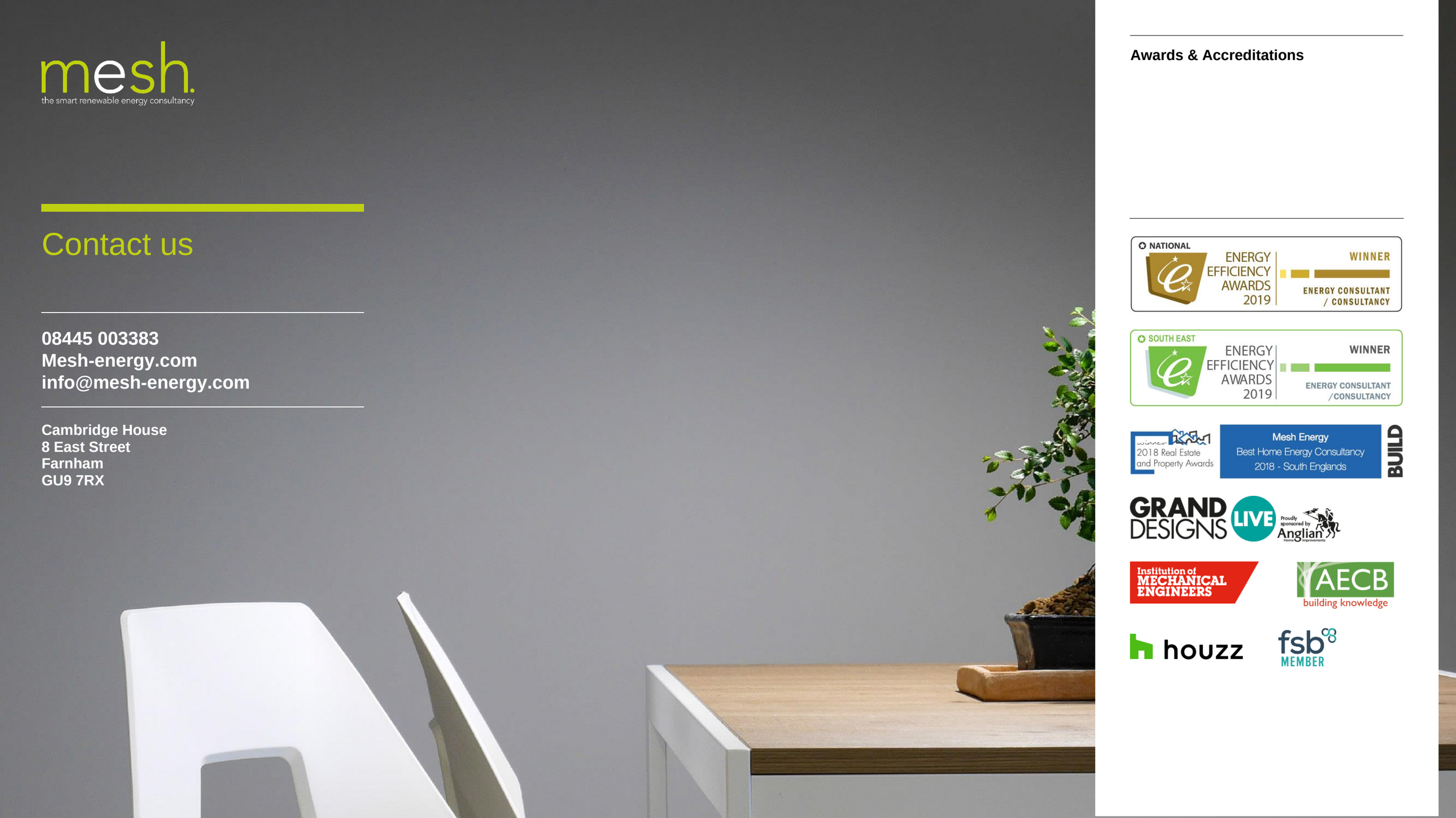
Technology	Energy Generation	Feasible
Wind Turbine	Electric	✗
Solar photovoltaics	Electric	✓
Solar thermal	Hot Water	✗
Biomass	Heat and hot Water	✓
Air-source heat pump	Heat and hot Water	✓
Ground-source heat pump	Heat and hot Water	✓
Water-source heat pump	Heat and hot Water	✗
Combined heat and power	Heat and hot Water	✗

mesh.
the smart renewable energy consultancy

Contact us

08445 003383
Mesh-energy.com
info@mesh-energy.com

Cambridge House
8 East Street
Farnham
GU9 7RX



Awards & Accreditations

NATIONAL ENERGY EFFICIENCY AWARDS 2019 — WINNER — ENERGY CONSULTANT / CONSULTANCY

SOUTH EAST ENERGY EFFICIENCY AWARDS 2019 — WINNER — ENERGY CONSULTANT /CONSULTANCY

2018 Real Estate and Property Awards — Mesh Energy — Best Home Energy Consultancy 2018 - South Englands — BUILD

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