

**Breach House, Market
Bosworth**

Energy Strategy

Issue P04

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ISSUE HISTORY

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P02	09/08/2023	Updated following SB comments and internal review. Issued to client.
P03	18/09/2023	Updated following clients comments
P04	27/09/2023	Issued for Planning Application

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1.0 INTRODUCTION

Breach House aims to embody the principles of low energy use and sustainability to create a self-sustaining home. The aspirations of being a self-sustaining and the capability to run off-grid, are intrinsically linked to achieving high building fabric performance. A well-designed building envelope with high-quality insulation, airtightness, and low U-values plays a pivotal role in maximising energy efficiency and reducing overall energy demand. This efficient building fabric not only is important to ensure effective utilisation of generated electricity but also lessens the performance demands on active sustainability measures and renewable energy generation.

High building fabric performance is proposed in combination with other passive design measures, such as natural ventilation and glazing reveal depths. These passive measures compliment the planned active systems like Ground Source Heat Pumps (GSHPs), background Mechanical Ventilation with Heat Recovery (MVHR), and solar thermal domestic hot water heating. Together, these technologies minimise energy demand, making the integration of renewable generation sources as viable as possible for self-sufficiency.

The proposed energy strategy has been developed to provide the capability to operate 'off-grid', provided that high construction standards are met, and that energy use is managed positively by the occupants. However, it seems prudent to connect the house to the electricity grid in order to manage any fluctuations in energy supply and demand; and to facilitate the exporting of any surplus energy.



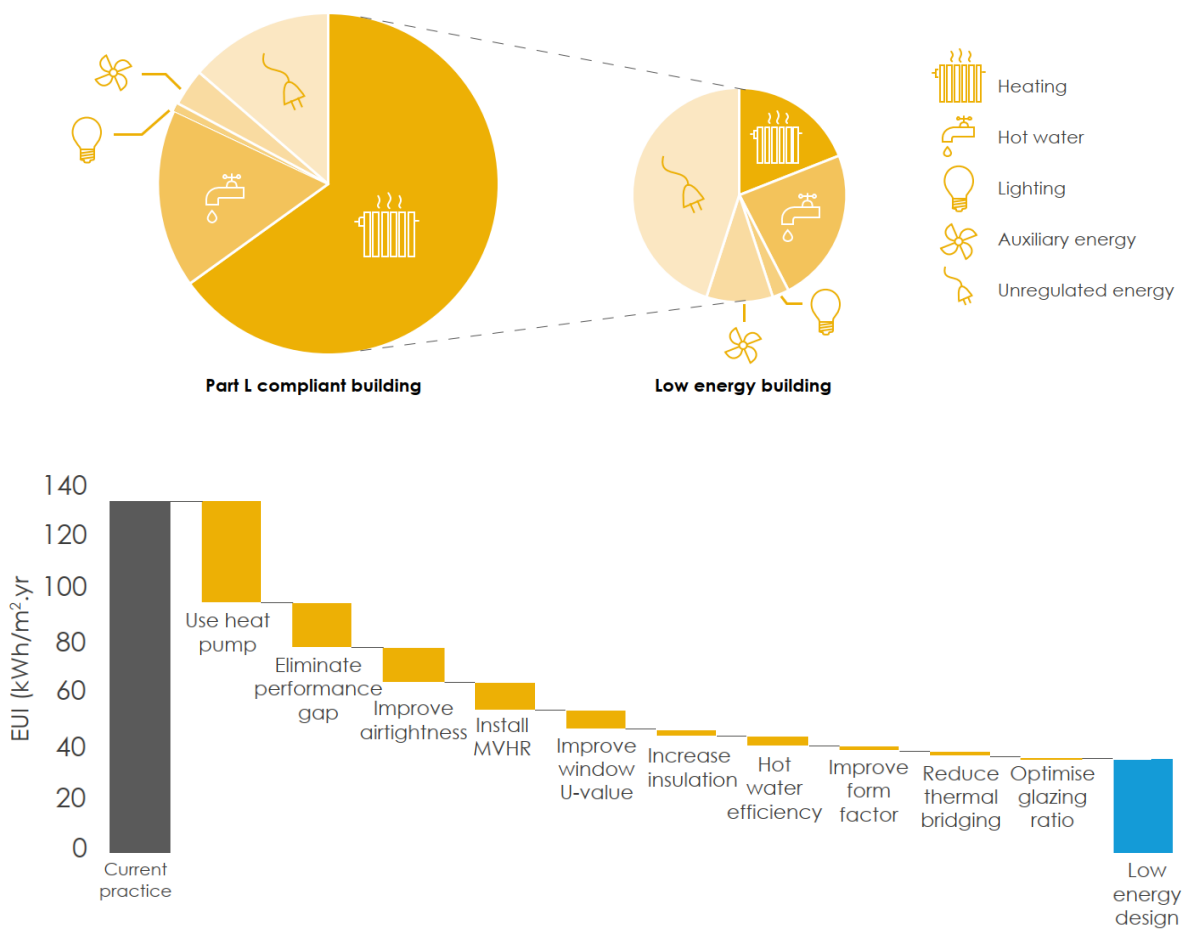
Studio Bark Renders of Breach House

2.0 ENERGY PERFORMANCE TARGETS

The energy strategy has been developed with Passivhaus design principles in mind; particularly in relation to the thermal performance of the building fabric and design choices in relation to the MEP systems.

Keeping energy demand (in-use) to a minimum will be key in realising off-grid operation in practice. The design proposals are based on constructing a building that aligns with the principles set out in LETI Climate Emergency Design Guide.

Below is a diagram showing how LETI's best-practice parameters affect the overall amount and breakdown of the energy demand in a typical domestic dwelling as well as the steps that can be taken to reach a low energy design.



LETI Climate Emergency Design Guide Figures

3.0 **PASSIVE DESIGN MEASURES**

3.1 **Fabric, thermal bridging, and Air tightness**

High building fabric performance is key for the off grid/self-sustaining aspirations of this building. An efficient building envelope, characterised by high-quality insulation, airtightness, and low U-values, plays a crucial role in maximising energy efficiency and reducing overall energy demand. An energy-efficient building fabric ensures that this electricity is utilised more effectively, as reduced energy demand translates to more surplus electricity

By reducing the buildings energy demands it reduces the performance demand of the active sustainability measures and renewable energy generation.

The following table compares Building Regulations Part L (2021 edition incorporating 2023 amendments) minimum standard for energy targets with Breach House's **fabric performance targets**.

Element or System	Part L Minimum 2023	Breach House Target
Walls	0.18 W/(m ² K)	0.13 W/(m ² K)
Floors	0.13 W/(m ² K)	0.08 W/(m ² K)
Roofs	0.11 W/(m ² K)	0.10 W/(m ² K)
Doors	1.0 W/(m ² K)	1.0 W/(m ² K)
Windows (Glazed Area <60%)	1.2 W/(m ² K)	0.8 W/(m ² K)
Roof Lights	1.7 W/(m ² K)	1.0 W/(m ² K)
Air Permeability	5 m ³ /(h m ²) at 50 Pa	<1 m ³ /(h m ²) at 50 Pa
Thermal Bridging	Default value 0.20 W/m ² K	<0.01-0.04 W/m ² K

3.2 **Natural Ventilation**

Natural ventilation is proposed as the primary means of removing heat gains in the summer, in lieu of energy intensive air conditioning.

This will be achieved by providing ample openable windows on the façade and by allowing the warm air to expel at the top of the house via the tower creating a stack/chimney effect.

3.3 **Window shading**

Large overhanging eaves and the master bedroom balcony which shade windows from high altitude summer sun and help to guard against excessive solar ingress and reduce the need for active summer cooling.

The form of the large overhanging eaves enables the low altitude winter sun to ingress, enabling the building to benefit from passive solar gains and reducing heat load. This measure will be particularly beneficial when the renewable electrical energy generation is at its lowest and the electrical demand is at its highest.

4.0 ACTIVE DESIGN MEASURES

4.1 Ground Source Heat Pump

A ground source heat pump system is proposed as the primary means of generating low temperature hot water for space heating and domestic hot water.

One of the key reasons for choosing GSHPs lies in their quiet operation and space-saving design, as the equipment will be discreetly installed internally. Unlike air source heat pumps that require fans for air circulation, GSHPs operate silently, without generating any additional noise. This will help to maintain a peaceful and comfortable outdoor environment.

4.2 Mechanical Ventilation with Heat Recovery

A mechanical ventilation system with heat recovery (MVHR) is proposed as a background ventilation and fresh air supply system.

In addition to the energy-saving benefits, this strategy will play a crucial role in maintaining a comfortable indoor environment by eliminating pollutants, allergens, and excess humidity, while effectively managing moisture levels; therefore providing good air quality for the occupants.

4.3 Solar Thermal Water Heating

A solar thermal roof panel system is proposed as the primary means of generating domestic hot water. This will reduce the electrical energy load on the GSHP and provide more energy independence.

4.4 Hydraulic Ram Pumps

A hydraulic ram pump system is proposed to feed the building with fresh water for domestic use from onsite water sources. Ram pumps do not require electricity to operate so the used of the pump will reduce the electrical energy load of the building.

5.0 RENEWABLE ENERGY GENERATION

5.1 Photovoltaics

The majority of the electricity generated on site will be from the proposed Photovoltaic (PV) array.

The PV array will be paired with battery storage, allowing the self-sustaining house to store excess electricity generated during sunny periods. This stored energy can then be utilised during cloudy days or at night, ensuring a continuous and reliable power supply, further enhancing the sustainability and self-sufficiency of the house.

5.2 Micro Hydro Generation

A micro-hydro generation system is proposed as a secondary renewable energy generation source. The combination of an onsite fresh water supply and varying height across the site makes small hydroelectric energy generation a viable option for the location.

5.3 Wind Turbine

While wind turbines offer several benefits for a self-sustaining house, such as environmentally clean energy production and offsetting energy demand in particularly in windy periods, which typically occur in winter where solar generation is reduced. There are significant drawbacks to consider. Wind turbines heavily rely on wind speed and consistency, which can result in inconsistent energy generation. According to nearby weather station data Market Bosworth has a moderately low average wind speed. Moreover, the capacity of a building mounted installation will be reduced by the various obstructions creating turbulence and vortex shedding, impacting efficiency, and potentially decreasing the turbine's lifespan due to wind shear. Consequently, we have decided not to include wind turbines in this self-sustaining design scheme.

6.0 OVERVIEW

6.1 Design summary

With the combination of passive & active design measures and renewable energy generation, Breach House has the potential to be a self-sustaining home. The table below is a design strategy overview showing different key design attributes of the proposed strategy.

Design element	Strategy
Energy Performance targets	LETI: 35 kWh/sqm/yr EUI
Fabric First Design	An energy-efficient building fabric reduces the buildings total energy demand. Better U-values and envelope airtightness than building regulations minimum requirements. Attention to minimizing heat loss through thermal bridging and careful detailing of the building's junctions.
High Construction Standards	Adhering to high building standards will help reduce the energy demand of buildings. Attention to workmanship, quality control and monitoring of the construction process.
Power Generation	Photovoltaics and hydro-power.
Domestic Cold Water	Use of hydraulic ram pumps to pump water from onsite water sources to an elevated water storage tank.
Domestic Hot Water	Primarily generated by solar thermal panels. Secondarily generated by GSHP or electric immersion element.
Space Heating	Primarily generated from the GSHP that is powered by renewables electricity. Secondarily generated by wood burners mid-winter.
Ventilation (air quality)	Fresh air supply and extract via heat recovery ventilation system (MVHR).
Summer comfort	Removal of heat gains via natural ventilation rather than air conditioning.
Connection to electricity grid	The house can support the grid when surplus electricity is available. The grid can support the house during unusual periods.

6.2 Key Design Metrics

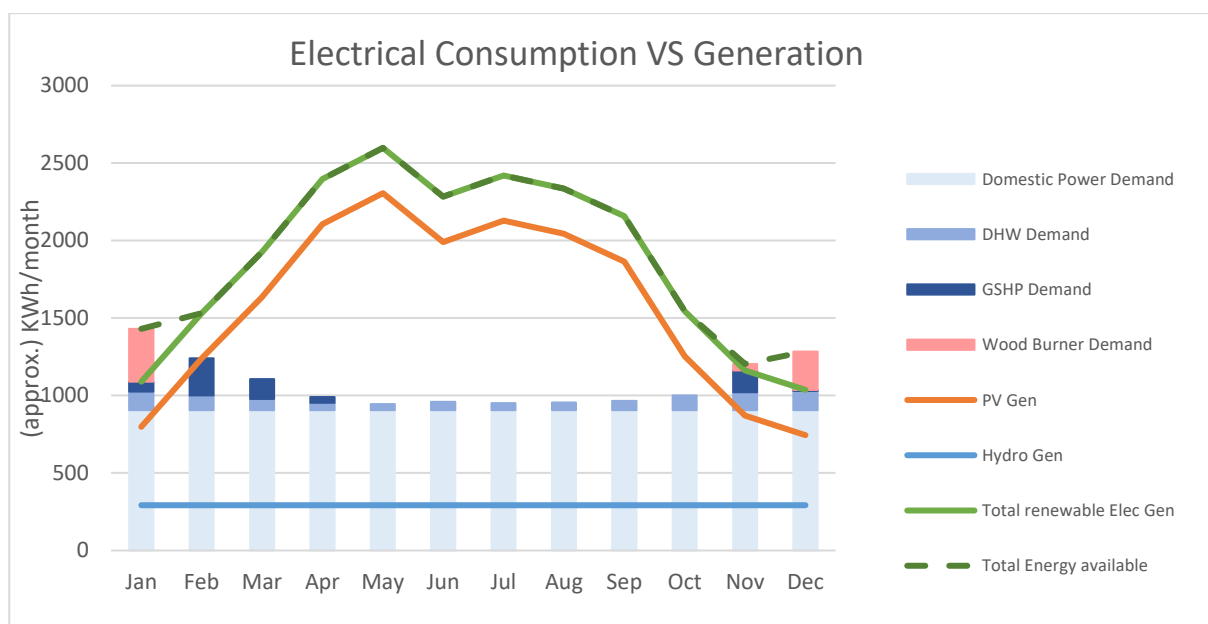
Below is a table of key design metrics that were used in the design assessment.

Design Metric	Value	Notes
Gross Internal Area	430 m ²	
Energy Use Intensity (EUI)	kWh/m ² /yr	See section 6.1 table
Peak Heat Loss	8.0 kW	External Air Temperature -4 °C Internal Air Temperature 20 °C
Building Fabrics & Air Tightness		See section 3.1 table for fabric performance targets
Occupants	5 People	Assumed occupancy based on bedroom quantity
Potable Water	75 L/person/day	RIBA 2030 Climate challenge report
Domestic hot water use	47.5 L/person/day	Conservative estimate based on BRE and RIBA 2030 Climate Challenge report information
Solar Thermal Area	8.5 m ²	≥ 35% efficiency
PV panel area / Peak capacity	114 m ² / 16.2 kWp	19% Panel Efficiency, 75% Performance Ratio
PV annual yield	18900 kWh	
Micro Hydro Generation	400 W	Estimate provided by water engineering/storage consultant
Micro Hydro annual yield	3500 kWh	
Ground Source Heat Pump SCOP	3.5-4.5	Subject to ground conditions tbc by survey
MVHR	90% heat recovery efficiency	

6.3 Supply vs Demand

The graph below presents an approximate profile of the available electrical generation vs consumption across a typical year in kWh. This graph is produced with the key design metrics shown above, along with area specific data such as weather and solar irradiation.

During winter months when electrical demand is at its highest, it is proposed that the renewable electricity production is prioritised for domestic power and hot water as a priority. Then any remaining renewable electrical energy can be used for space heating. If the space heating demands cannot be met via renewable electricity alone, wood burners can make up the remaining heating load.



6.4 Connection to the grid

Breach house appears capable of being fully off-grid if the occupants proactively manage energy consumption and the building is built to high building standards. However, a connection to the grid at a future point in time would offer benefits.

A connection to the electricity grid will eliminate the risk of the house running out of power during unfavourable periods (e.g., periods of atypical consumption demands or unusual weather).

A grid connection will benefit the local electricity network and allow for any surplus energy to be exported. This will reduce the need to install unnecessarily high amounts of battery storage on site.

Establishing a grid connection will also pave the way for future green energy initiatives. This will allow the house to tap into the grids renewable energy sources during periods of low on-site renewable generation, reducing the reliance on non-renewable methods like wood burning for heating.