Sustainable Redevelopment Feasibility Study

Pen y Cae Project

CLIENT / EMPLOYER:		
Ian Mabberley Director Grwyne Fawr CIC	**Revision**	**A**
	Prepared By	Dean Partridge
	Date:	**15.05.2019**

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Executive Summary

An assessment was undertaken to ascertain the sustainable renewable options to provide meaningful energy supply to the off-grid property at Pen y Cae.

The building, Pen y Cae (PYC), is owned by Natural Resources Wales (NRW). It could provide shelter and basic amenities which would widen the range of residents and visitors able to engage in all-weather activities in an upland environment. This would promote health and wellbeing, awareness of biodiversity and appreciation of natural environment.

The Grwyne Fawr Community Interest Company (GFCIC) is seeking to revitalise a former shepherds cottage in the valley which was used as a school outdoor education centre for 15 years.

This report constitutes part of Phase 2 of the redevelopment process and considers the feasibility of redevelopment of the building using renewable energy sources to generate power, lighting and heat and to utilise the local natural water source.

As there is no electricity or heating fuel on site, this report had to consider renewable options for electricity and heat demand requirements and this also underpins the Grwyne Fawr CIC philosophy for the building the be a self-sustaining environmentally conscious building that mitigates its impact to the local environment and uses energy that does not contribute to the greenhouse gas emissions that are accelerating climate change.

A number of scenarios have been reviewed and costed and these are listed in the Conclusions section of this report. Retrofit insulation is not achievable due to the small footprint and head height of the property.

It is clear that this building could run using PV, Solar thermal renewables whilst using a would stove to use as the heat source in the central core of the building allowing the thermal mass to absorb the heat and using heat recovery from the central core and planned shower rooms would assist in meeting demands.
The issue is that this could be too efficiency engineered and not allow for poor sunshine days, so the use of wind as a technology has also been considered with the additional generation providing contingency should it be required.

It is recommended that the Grwyne Fawr Community Interest Company reviews this report and also considers practical items such as developing a secure wood store in the existing lean-to, insulating the roof between joists where possible and potentially providing a water tank for water attenuation to allow for suitable pressure and flow rates to enable these potential technologies to operate sustainably.

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1. Introduction

The Grwyne Fawr Community Interest Company (GFCIC) was founded in April 2015 with the aim to improve the living and visiting environment of the Grwyne Fawr valley area. The area borders Monmouthshire, Powys and Herefordshire and is popular with walkers and mountain bikers along with a natural destination area for schools and community groups to visit.

The GFCIC is seeking to revitalise a former shepherds cottage in the valley which was used as a school outdoor education centre for 15 years.

The building, Pen y Cae (PYC), is owned by Natural Resources Wales (NRW). It could provide shelter and basic amenities which would widen the range of residents and visitors able to engage in all-weather activities in an upland environment. This would promote health and wellbeing, awareness of biodiversity and appreciation of natural environment.

In September 2018 the GFCIC created a working group to take these plans forward, conducting an initial consultation with local stakeholders. This revealed overwhelming support for revitalising PYC as a shelter with basic amenities for day and overnight use. Potential was also identified for PYC to be used as an educational resource promoting appreciation of the natural and social heritage of the valley and providing access to off-grid experiences.

A two-year revitalisation plan has been developed. This involves:

- Phase one: Scoping interest and need (complete)
- Phase two: Identifying community owned, realistic plans
- Phase three: Implementing plans to achieve community owned, realistic goals
- Phase four: Project launch

The working group member have extensive experience in project management, outdoor education and community engagement. Potential funding sources have been identified. Additional volunteer help has been offered for specific tasks.

25 local organisations have offered letters of support during the Phase 1 process.

This report constitutes part of Phase 2 and considers the feasibility of redevelopment of the building using renewable energy sources to generate power, lighting and heat and to utilise the local natural water source.
This is to enable future building users to have suitable mean of lodging and welfare, shower and drying room requirements to allow for overnight stays and to safely use the building as an accommodation shelter facility.
The report will review the characteristics of the building, the location and the intended use to provide suitable options to consider as a sustainable, off-grid solution to enable the building to become an established all weather basic residential shelter.

2. Background

Pen y Cae is a former shepherd's cottage and school outdoor centre in Grwyne Fawr valley, located on the forest track above the Cadwgan car park. A former user of Pen y Cae (PYC) and resident of Abergavenny together with a GFCIC member, resident of Grwyne Fawr valley brought a proposal to renovate PYC to the GFCIC (see appendix 1). The GFCIC decided that the proposal was worthy of investigation. With permission from NRW, who own the property, GFCIC members conducted a site visit (see photos below). We have now a formed a working group, including the former user and resident who brought the proposal to the meeting.

It is noted that concerns about the deteriorating state of the property had previously been reported to NRW by the GFCIC, and the interior of the building has been cleaned up by NRW contractors and secured to avoid further deterioration.
A previous site visit confirmed that the building has remained secure. A report from the GFCIC on 24th November 2018 highlighted the following aims;

• As a well utilised property, PYC would become less of a target for anti-social behaviour and more a source of outdoor learning and volunteering opportunities.

• It could become an excellent resource providing shelter and basic amenities for both residents and the wider general public enabling all weather activities in the valley.

• It would also allow those less well-off to experience the outdoors life.

• It would demonstrate the commitment of GFCIC to enhancing the quality of life of residents and visitors (as per the Aims of the Company) by:

- o Making the valley more accessible
- o Celebrating the heritage of the valley
- o Promoting an appreciation of biodiversity
- o Promoting the wellbeing of future generations by encouraging access to off-grid space and developing an appreciation of natural environments

In addition, that report states the following;
"Revitalising Pen y Cae would contribute to meeting Welsh Government and NRW policies for example Vital Nature – making connections between biodiversity and the people and places of Wales.
Moreover, Hannah Blythyn, Minister for Environment says 'I am committed to ensuring AONBs and National Parks are valued for their natural beauty by our people, communities and country – and, that our designated landscapes deliver rich ecosystems, vibrant and resilient communities and opportunities for outdoor recreation for all of the people of Wales' July 2018. We believe this project can contribute to this ambition."

3. Aims & Objectives

The aims and objectives of this report are to identify realistic goals in considering the re-development of the building.

The project aims to create a sustainable off-grid building which is both functional in use and educational in how the building is serviced.

The building is intended as a short stay facility for up to 10 visitors during spring, summer and autumn to;

- Provide shelter and a bed for the night.
- Provide toilet and shower facilities.
- Provide a space to dry clothes and footwear.
- Provide a basic kitchen facility.
- Provide a basic level of comfort lighting, heating and hot water.
- Ensure WC facilities are suitable and flush away to local septic unit is operational.
- Provide power outlets for some appliances.
- Enable appropriate ventilation of steam and natural moisture build up to avoid any condensation issues.
- Provide recycling bins and natural composting for food waste for building users.

4. The Building

Located in an exposed elevated mountain position, the building is stone structure with a slate roof, the original build date has not been ascertained however, the build time could be between the 16th and the 19th centuries.

The following images have been provided courtesy of PYC Project Plan;

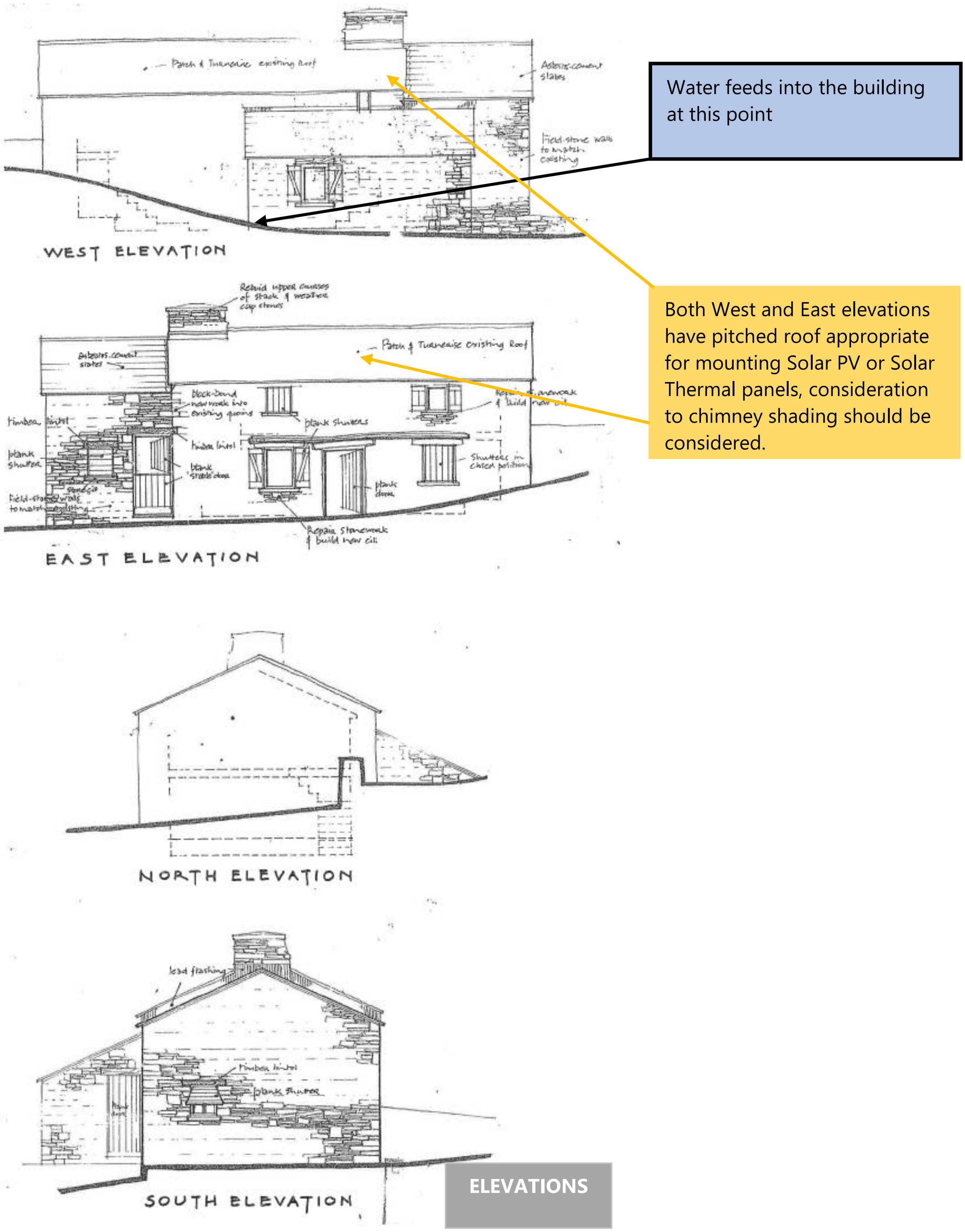
4.1 Existing known services

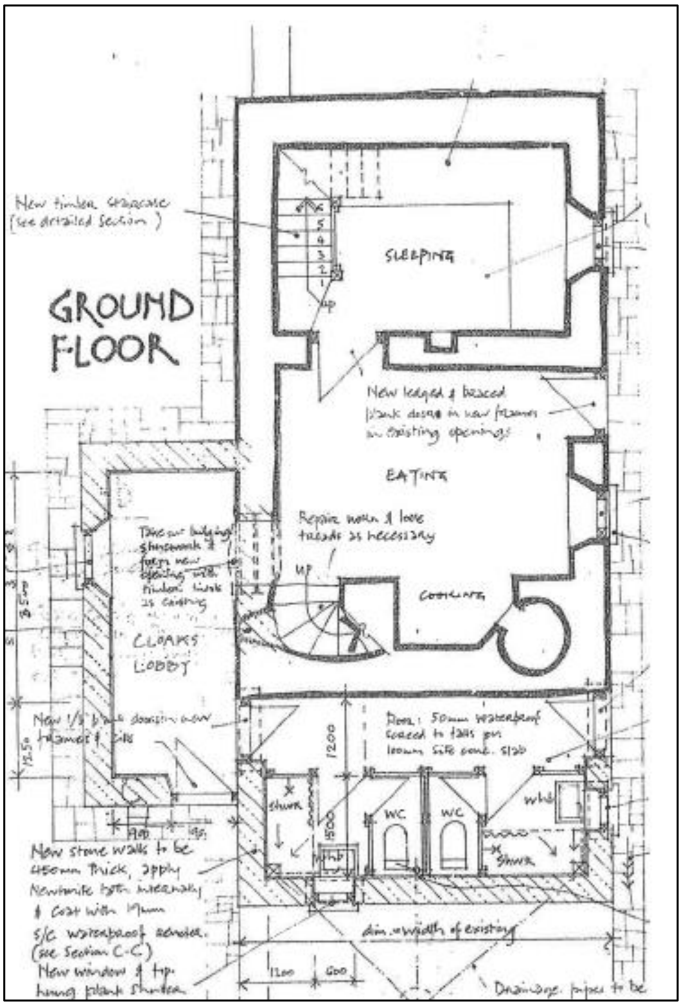
There is a potential water supply from stream and pond with the water source emanating away from the building and slightly elevated. Current connection via an existing pipe to the building has been temporarily capped.

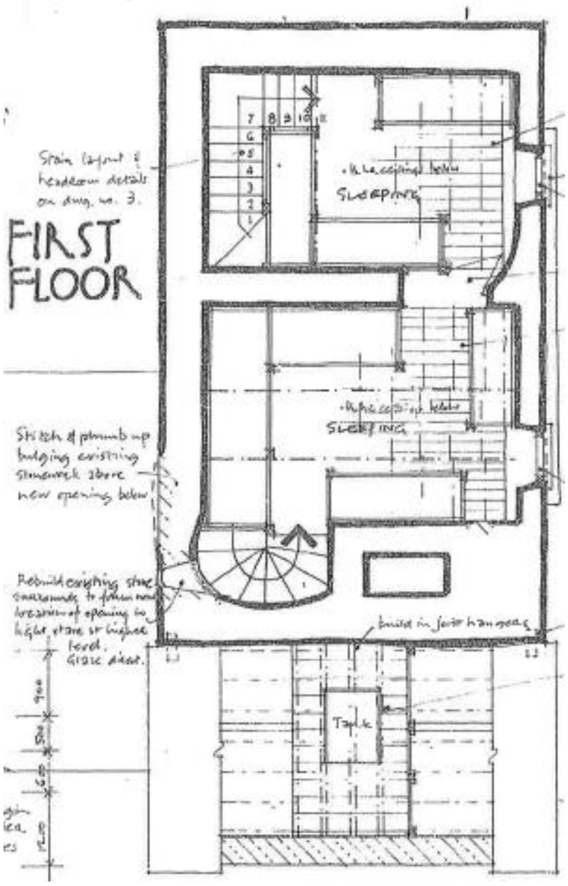
There is no grid power or gas to the building.

4.2 Sketch Plans of the Building

The following plan drawings were created by Hugh Symons (South West) Ltd for planning approval and have been kindly provided by Ian Mabberley of Pen y Cae Working Group, Grwyne Fawr Community Interest Company (CIC).



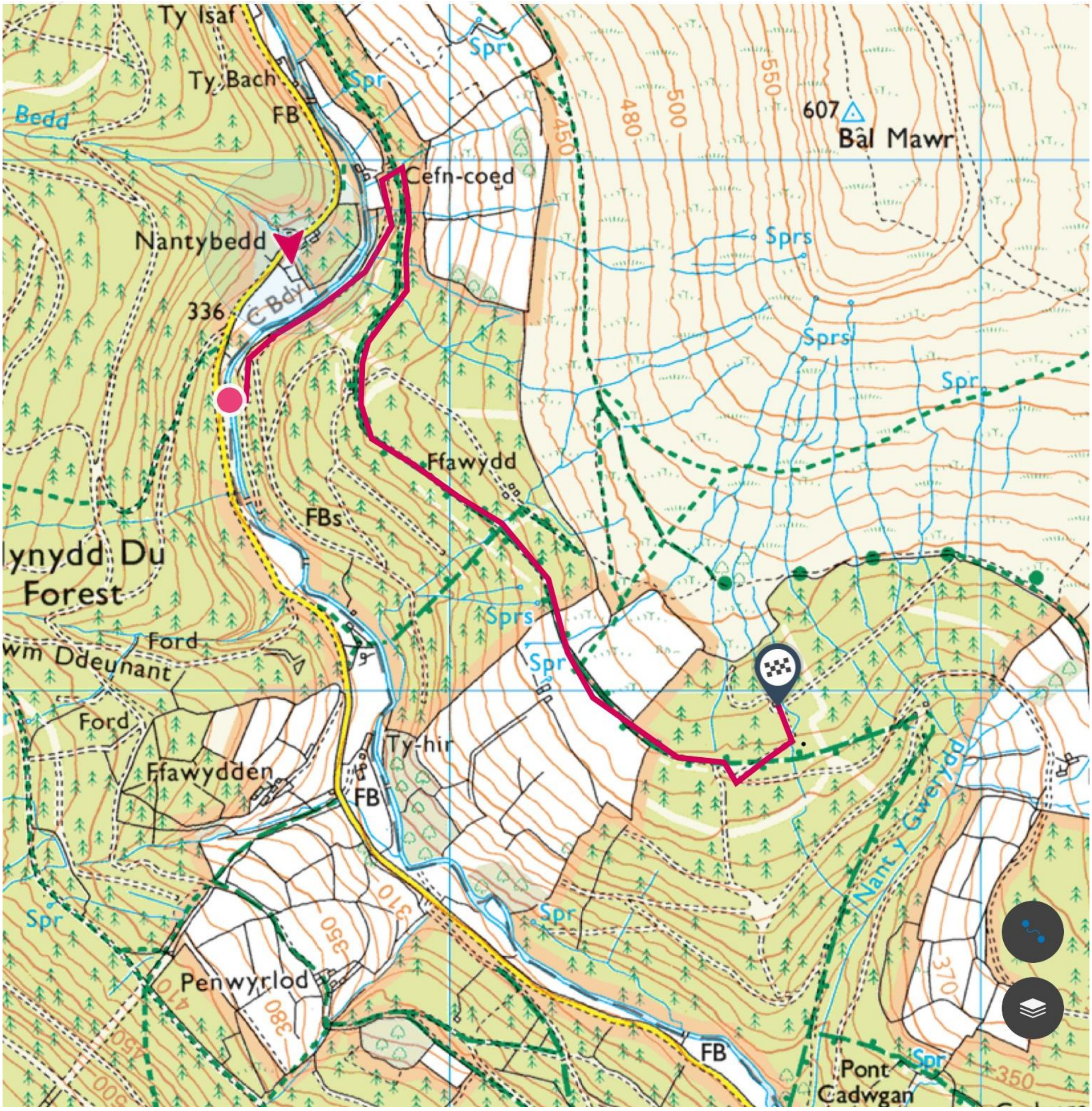

GROUND FLOOR
SLEEPING
EATING
CLOAKS LOBBY
WC
WC


FIRST FLOOR
SLEEPING
SLEEPING

PLANS

5. Site Assessment

A site survey was undertaken on Thursday 6th March 2019. Present on the survey were; Ian Mabberley GFCIC, Andrew David SEWEA, Phil Powell, Gwent Energy Ltd and Dean Partridge, Ategga Ltd.



Located in an exposed elevated mountain position, the building is stone structure with a slate roof, the original build date has not been ascertained however, the build time could be between the 16th and the 19th centuries. The walls are generally 500mm thick dry stone with the external and internal envelopes pointed (possibly lime).

5.1 Building Condition

The building is generally robust although there are signs of wear and tear to the roof and stone mortar pointing along with boarded up windows with frame and cill damage.

There is no insulation to the walls and roof space and a central chimney space is present in the building.

Floors are uninsulated and the internal head height is low with limited internal wall space.

The building is in a fairly good state of repair considering the age, location and the lack of use. There are no signs of damp penetration via roof or walls.

Floors are uninsulated and the head height and limited space may not be suitable for enabling a significant amount of insulation via new suspended ceilings or internal wall insulation.

Can we insulate?

Traditional stone buildings need to be able to absorb and release moisture to prevent decay of the building fabric. Any insulation prescribed cannot interfere with this process.

Ventilation is also necessary in traditional buildings, and a balance needs to be struck between air circulation and warmth.

Providing internal insulation throughout would improve heat retention although this would reduce internal building footprint and the client was also considering the aesthetic and natural build consistent with its form and age.

There first floor is open beam to roof and the internal floor to ceiling height will not allow for insulated internal ceilings, which would reduce the existing limited head height.

Considerations?

Option here would consider roof repairs, insulation potential between joist with lime plaster finish, repairs to verge, soffits, repair to window linings and cills and consider rake and installation of a thermally efficient phase change polymer-based material mortar.

The use of cement mortars is widely recognised as being detrimental to such buildings and structures as they can drastically alter the way in which a wall handles water and water vapour. Cement mortars tend to trap water rather than allowing the building to breathe (not necessarily a problem in modern cavity wall construction). Any trapped moisture will expand if subjected to freezing conditions, and mortars may ultimately fail, often causing damage to the surrounding masonry in the process.

Lime mortars can readily handle the transmission of water and water vapour between the inside and outside of a masonry wall, owing to the complex interconnected pore structure of masonry. The incorporation of polymer-based phase change materials (PCM) into the new mortar to help regulate the temperature inside the building. In summary, the material is quicker to heat up and slower to cool down.

5.2 Existing Services

The building has no electric or gas supply and its location would prohibit connection to these grids to the sheer cost of to connect. There is a water supply to the building that is fed via a stream on a higher elevation to the building. This water source was not assessed, and this gives us two issues to think about.

1. Is there sufficient water pressure to allow for any planned water/heating system to function?
2. Is there enough volume of water to meet future water demand for showers, washing, waste flush to septic tank and heating?

5.3 What functions are required?

From information provided and discussions on site, the building was seeking to provide adequate general and safety lighting, small power for appliances use, heating for space and hot water for showers and basins.

Review of plan drawing provided the following requirements;

Room	Electricity Requirement	Heat Requirement	Comments
Ground Sleeping	Lighting, radiant heater		
Ground Eating Room	Lighting, power socket	Wood stove potential	CM detector advised
Cloaks/Lobby Kitchen	Lighting, power sockets	Hot water to sink	
Amenities corridor	Lighting, power sockets	Radiator	
Shower/WC Room 1	Light	Water heating/radiator	Extract ventilation required
Shower/WC Room 1	Light	Water heating/radiator	Extract ventilation required
First Floor Sleeping 1	Lighting, power socket		
First Floor Sleeping 2	Lighting, power socket		Use heat from wood stove through breast
External	Light at entrance door and north side lean-to		Lean to could be used as wood store and or cycle store

Table 1: Functionality

5.4 Load Calculations

Load calculations have been made as an estimate using efficient appliances and use figures. The electricity use and heat demand tables are indicative only and to be used for guidance.

The property shall be used no more than 100 days per annum.

Electricity use may be greater or lesser than the suggested table. The heat loss calculator tool used is generally for house heat loss and boiler sizing to achieve internal comfort temperatures of 21°C. Pen y Cae will not need this level of heat demand so the heat demand tool could be used as worse-case scenario, therefore heat demand may be lesser than the suggested table.

The electricity table is below with the heat demand table on the following page.

Electricity

Appliance Type	Quantity	Usage (Hours/ day)	Power Rating (Watts)	Total Daily Watts	
Fridge	1	24	300	7200	
kettle	1	6	800	4800	
Microwave	1	4	750	3000	
Lighting	22	4	15	1320	
External Lighting	3	4	15	180	
Radiant Heater	1	4	1200	4800	
Pump power	1	6	200	1200	
heat controls	1	6	85	510	
MVHR	1	4	70	280	
Other	1	10	100	1000	
	Average Energy used per day			24290	wh
	Average Energy used per month			728.7	kWh
	Total Energy used per year (100 days)			2550.45	kWh

Table 2: Potential Electricity Demand

Applying a recognised BS7671 diversity factor of 80% (i.e.: all the lights and appliances are not on at the same time), the load could be considered at 2550.45 x 0.80 = 2040.36kWhs.

Heat Demand

Step 1	Dimensions						
	Ext. Length	Room Ht.		Ext. Width	# Floors		
	10	2		5	1		
Step 2	Calculate Total External Wall Area m2						
	Width	*# ext. walls*			*Room Height*	*# Floors*	Tot. ext wall area (m²)
	5	4	20				
	Length	*# ext. walls*		60	2	1	120.00
	10	4	40				
Step 3	Calculate Wall & Window Heat Loss						
	Total ext. wall area	*Table 1*	*Window area*	*U value*	A Window heat loss		
	120	0.17	40	3	120.00		
	Total ext. wall area	*Window area*	*Wall area*	*U value*	B Wall heat loss		
	120	50	80	1.2	96.00		
	Volume (m³)						
Step 4	Calculate Floor & Roof Heat Loss						
	Length	*Width*	*Roof Area*	*U value*	C Roof heat loss		
	10	5	50	1.6	80.00		
	Length	*Width*	*Floor Area*		D Floor heat loss		
	10	5	50	1.6	35.00		
Step 5	Totals (W)						
	A	*B*	*C*	*D*		*location*	Total fabric heat loss
	120	96	80	35	331	27	8937.00
Step 6	Calculate Ventilation Heat Loss						
	Floor area	*Room Height*	*No. of Floors*	*Volume*		*location*	Ventilation Heat Loss (W)
	50	2	1	53	0.25	27	357.75
Step 7	Calculate Boiler Output						
	E	*F*		*Water Heating*		*Extensions*	Total Demand kW
	8937.00	357.75	9294.75	4000	13294.75	0	13.29

Table 3: Potential Heat Demand

The above table considers heat demand which is 13.29kW.

This report assumed heat use of 4 hours per day which would see ‘E’ 8.937kW in Step 7 in the above table multiplied by 4 which gives us 35.748 kWhs per day.
The 4kW water heating demand is based upon using a 200litre tank of hot water and re-heating new cold water to replace the volume. This equates to the shower using 40 litres of water per shower, 10 times per day.
It may be worth considering adding 10% to the above table as a buffer? This gives us 4.4kWhs per day. Alternatively, we have not factored reduction in heat requirements during summer months.

6. Sustainable Development Options

As there is no electricity or heating fuel on site, this report has to consider renewable options for electricity and heat demand requirements, and this also underpins the Grwyne Fawr CIC philosophy for the building the be a self-sustaining environmentally conscious building that mitigates its impact to the local environment.

The electricity demand has been considered as 24.29 kWhs per day with a generation requirement of 2550.45 kWhs per annum (100 days), or 2040.36 kWhs when applying diversity.

The heat demand has been considered as 39.75 kWhs per day with a generation requirement of 3974.8 kWhs per occupation per annum (100 days). Part of the heat demand is by electrical radiant heater at 4.8 kWhs per day, therefore the kWhs per day demand for heat drops to 34.95 kWhs which now requires 3495 kWhs of heating per occupation per annum (100 days).

6.1 Technology Considerations

The following technologies have been considered to the location, demand and space factors affecting the building;

6.1.1 Solar PV

Review of the roof area enables us to consider a Solar PV installation. The west facing roof elevation, with minimal chimney shading would be a suitable choice for mounting a 3.3kWp system feeding a 20 to 30kWh battery store will allow for 2772 kWhs per annum (1 year) generation and storage.
Over 100 days, generation for that period may drop to 760kWh, with the battery storage able to store surplus, assumed as 50% when not used and safely discharge to 80% of its capacity, for a 30kWh battery store, this could realise an additional 1200kWhs, a total of 1960kWh for use in a 100-day period.

Pro's

Standard install will be able to be undertaken and controls, battery fitted in the mezzanine ceiling space above the shower rooms.
When applying diversity and considering the suggested use hours, the electric demand for the 100-day period could be 2040.36 kWhs. The PV and battery storage system could generate and provide 1960 kWhs for that period and therefore meet demand. Minimal maintenance requirements.

Con's

Using electric demand for the 100-day period is 2040.36kWhs, applying diversity, assuming items are on for the hours suggested in table 1 page 12, and radiant heater is in use, this could mean that the PV would not meet demand by 13%.
Planning consent may be required for installation of the technology.
There will be a need for controls to ensure generation does not become a hazard when there is no demand required. Tree to the west will require branches lopped to stop shading.

Estimated cost for technology, supplied and installed circa £9000 to £10000 depending on battery size.

6.1.2 Solar Thermal

The expected daily hot water use is taken largely from the requirement for showers, this could see a demand of up to 350 litres of hot water in a day. In addition, we consider the installation of 3 to 4 radiators in the showers/amenities area. A 500litre cylinder MULTI FUEL UNIVERSAL THERMAL STORE with dedicated 150 litre of solar storage is sized at 1800mm/750mm.

With reference to CE131 Energy Saving Trust Guidance where the dedicated solar volume should be the greater of the expected domestic daily hot water use, or 35 litres per meter squared of net collector area, if we consider 150 litres dedicated solar, we would need 3 to 5m^2 of collector area (150/35), this requirement could be met by to 3 flat plate collectors or up to between 30 and 50 evacuated tubes giving an equivalent net area.

The roof on the building has sufficient size to meet the collector size requirements. Due to location, orientation and roof pitch, a potential yield of 950kWh per m^2 per annum of collector may be achievable. A 5m^2 collector system could therefore generate 4750kWhs per annum or circa 1357kWhs per 100 days.

Alternatively, a smaller cylinder with additional immersion tank could be used.

Pro's

The roof area is compatible with the collector size requirement and there is suitable space to install system cylinder and controls on the mezzanine floor above the shower and amenity area.

A 5m^2 collector system could therefore generate 4750kWhs per annum or circa 1300 kWhs per 100 days. This could provide 40% of the heat demand requirement for the building.

Using a MULTI FUEL UNIVERSAL THERMAL STORE, there is potential to use technologies like PV, wind and wood heating to feed additionally into the same storage cylinder.

Con's

A 5m^2 collector system could therefore generate 4750kWhs per annum or circa 1300 kWhs per 100 days. This could provide only 40% of the heat demand requirement for the building, a suitable system must be designed in using a MULTI FUEL UNIVERSAL THERMAL STORE, as there is potential to use technologies like PV, wind and wood heating to feed additionally into the same storage cylinder. Additional water tank may be required with pump to allow for sufficient amount, pressure and flow rate of water to the building.

Maintenance is important and annual checks must be undertaken, with cost for this considered. Perhaps the most important thing for you to check for is whether there are any leaks.

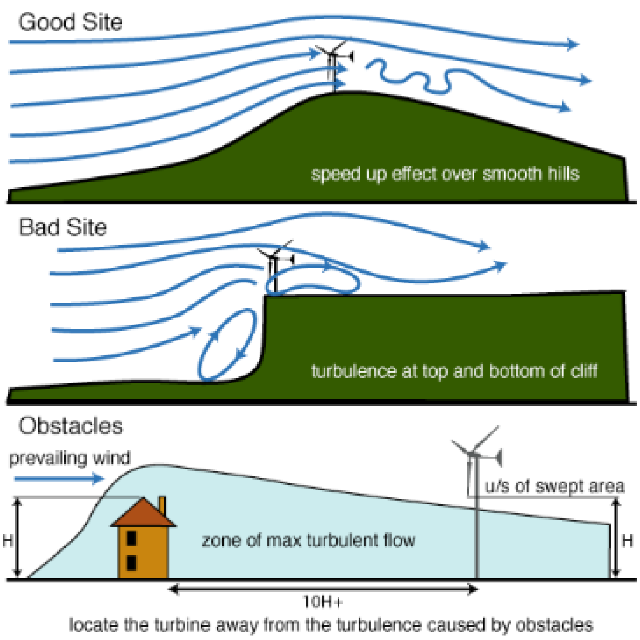
A suitable collector is required for any bow/off leaks of the glycol mixture used in the solar circuit. Leaks of glycol are not allowed to drain into the watercourse.

Estimated cost for technology, supplied and installed circa £6000 to £8500 depending on vessel and storage configuration.

6.1.3 Wind

Pen Y Cae is located near the top of a mountain overlooking the Grwyne Fawr Valley. The building is remote to other residential properties and the location suitable for a small-scale wind turbine.

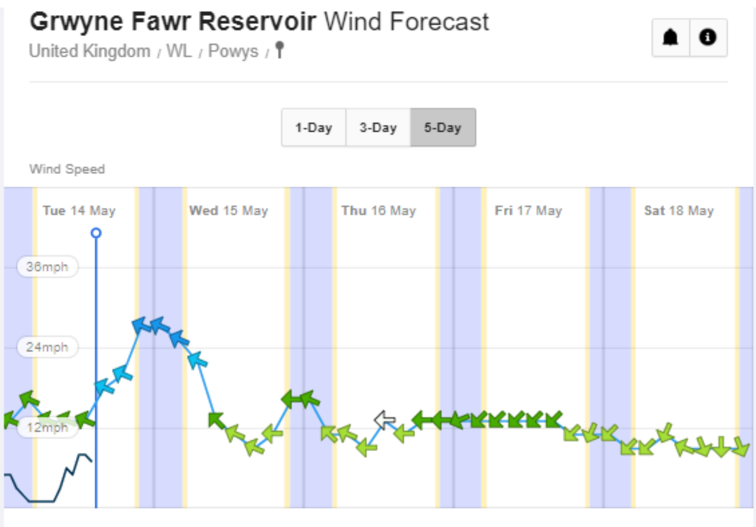
There are no turbulence factors or obstacles for siting;



Across: Image taken from http://www.greenspec.co.uk/building-design/small-wind-turbines/

A Wind turbine sited at this location could maximise the requirement for suitable wind speeds with low turbulent flow of wind to enable more efficient use. To be consistent, a wind speed of between 5 and 15 metres per second is preferable. Any less will require power to by used to start the turbine, any more may see the turbine rotor hub locking out for safety.

The NOABL databased used for calculating average UK wind speeds is not operational so the only option is referring to the wind statistics for the area, currently wind speeds 5.5 meters per second so within the acceptable band.



Consideration to a 2.5 to 3kWp turbine should be made with allowance for battery control, a solar PV charge unit and a suitable weatherproof enclosure to house the kit.

The height of the turbine would be circa 6 metres to hub and 11m to top of blade.

This could generate circa 6000 kWhs per annum.

Pro's

Location is suitable for siting of a turbine. The turbine could generate 6000kWhs per annum or 1644 kWh per 100 days. This would provide 30% of the total demand requirement for electricity and heat.

Con's

Planning permission may not be forthcoming. A suitable wind speed assessment should be carried out. Noise levels are around 55 db. within 10 metres.
Area may be in the RAF low fly zone.
Maintenance is important and annual checks must be undertaken, with cost for this considered.
System may get locked out and require manual re-set.

Estimated cost for technology, supplied and installed circa £10000 to £15000 depending on PV kit and battery configuration.

6.1.3 Mechanical Ventilation and Heat Recovery (MVHR)

Heat Recovery Ventilation is required for the building due to use of showers creating steam and the lack of insulation leading to cold internal surfaces which could create condensation. This will work by continuously extracting air from the wet rooms of the property and at the same drawing in fresh supply air from outside

The heat from the extracted stale air is recovered via a heat exchanger inside the heat recovery unit which is then reused to temper the filtered supply air for the habitable rooms such as living rooms and bedrooms

Up to 95% of the heat can be recovered. The Heat Recovery Unit runs continuously on trickle and can and is boosted when higher rates of ventilation are required e.g. bathing, cooking.

In warmer months a summer by-pass function helps ensure comfort levels are maintained in the building. When summer by-pass is activated, the building continues to be ventilated and receive fresh filtered air, however the heat recovery process is intermittently switched off (heat recovery is by-passed). This will allow the turn off of at least 1 x 2kW radiator in amenity corridor, saving 800kWhs.

Pro's

Ventilation is required from the wet rooms so including the heat recovery unit we can heat the amenity corridor kitchen area reducing impact of heat loss through the entrance door. MVHR recovers and reuses up to 95% of the waste heat within the area and can be incorporated as part of the ventilation system at minimal cost.

Con's

Consideration should be given to existing space for duct runs and to ensure the unit is sized correctly so it is not running a high rate all of the time.

Estimated cost for technology, supplied and installed circa £600 to £1600 depending if system extends to utilise heat from Wood stove

6.1.3 Wood Stove

The building has an existing fireplace, hearth and chimney. The fireplace is located in the Eating room and consideration to using this feature to allow for a wood stove with back connection to the thermal store with flue through existing chimney is a clear option. Using a vented system and MULTI FUEL UNIVERSAL THERMAL STORE, a by-product from heating the space would be provision of hot water to the store to assist the hot water demand for showers.

Due to the size of the space, a maximum 2kW to 3kW wood stove should be considered as practical due to the minimal space and being comfortable in the room with the heat produced by the wood stove. Clean combustion will consist largely of water vapour and carbon dioxide (plus nitrogen and oxygen from the combustion air). The emissions will also contain traces of carbon monoxide, particulates and volatile organic compounds. These emissions are also produced when fossil fuels like gas and oil are burned to produce energy.

Wood can be burned in a smokeless zone if the appliance (stove or boiler) has an Exemption Certificate. Companies which manufacture log stoves with Exemption Certificates include Clearview, Vermont Castings, Dovre, Dunsley Yorkshire Stoves, Morso and Jotul.

It is assumed that the wood required to facilitate use would be in the region of 2 to 3m^3 per annum. This could realise 5500kWhs of heating per annum, this then would equate to 1500 kWh per 100-day use. This would provide 38% of total heating demand.

Pro's

Wood stove would provide a suitable means of heat and utilise the thermal mass of the chimney breast to heat the core of the building. There are no residential properties within the vicinity, so air quality impact is minimal. The use of the wood stove could make the radiant electric heater use minimal and thus ensure that PV could meet the electric demand.

Using locally sourced wood has no embodied CO^2 emissions in relation to wood supplied to buildings in Wales from out or the local area or overseas.

The opportunity to source local wood, cut and season by storing in the lean too building could be an activity for visitors to take part in.

Con's

Wood storage is required, and suitably dried wood only used to increase burn efficiency and reduce ash and airborne particulates. Stove use must be managed properly, and safeguards put in place when children use the facility. The size of the wood stove is critical to reduce radiant heat flux in the vicinity. (i.e. to big a stove would become too hot in the immediate vicinity).

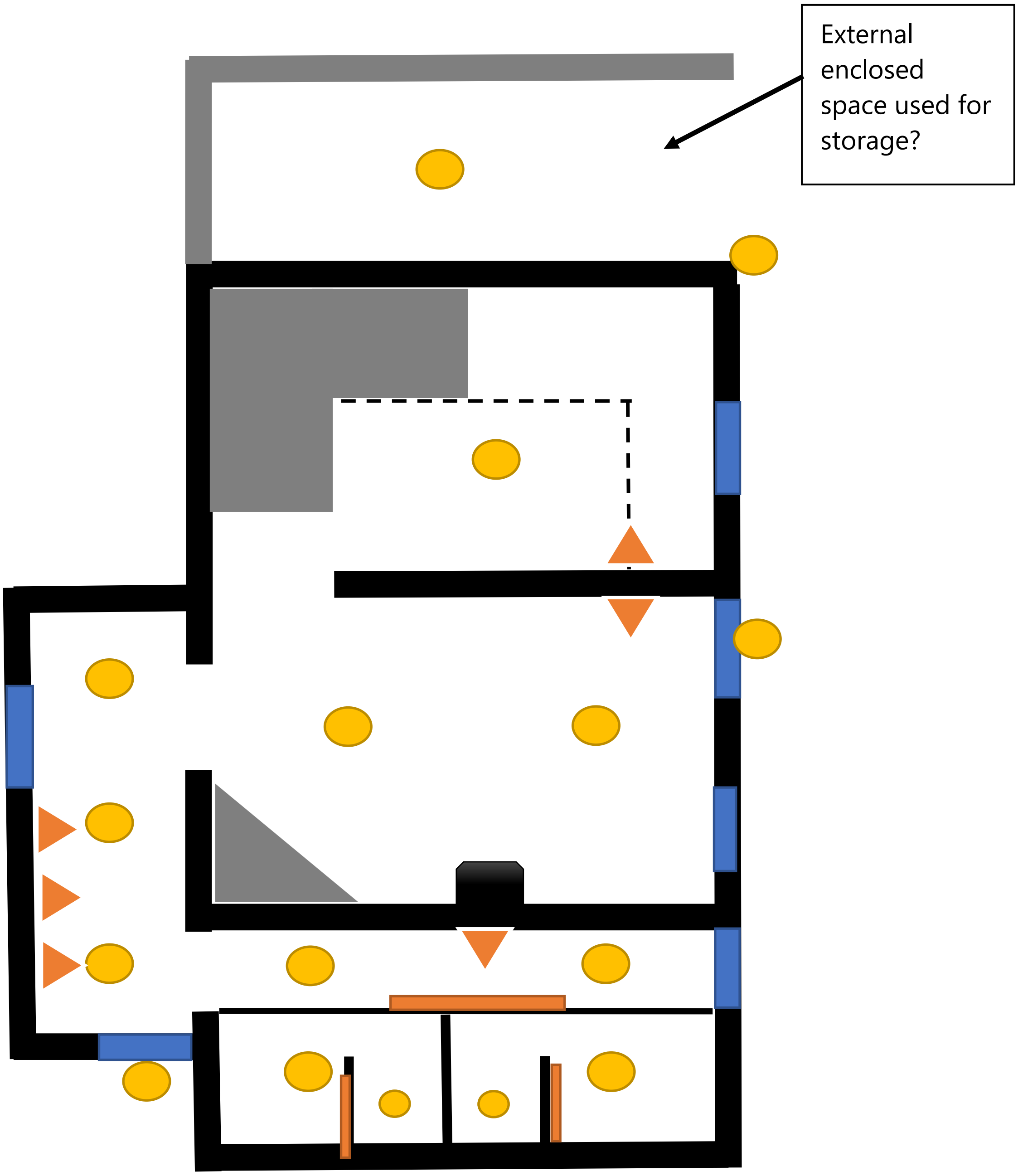
Installation of a CO_2 monitor is required.

Maintenance is important and annual checks must be undertaken, with cost for this considered.

Estimated cost for technology, supplied and installed circa £4000 to £5000 depending model and responsibility for connection configuration to thermal store.

6.2 Example Services Plan

Ground



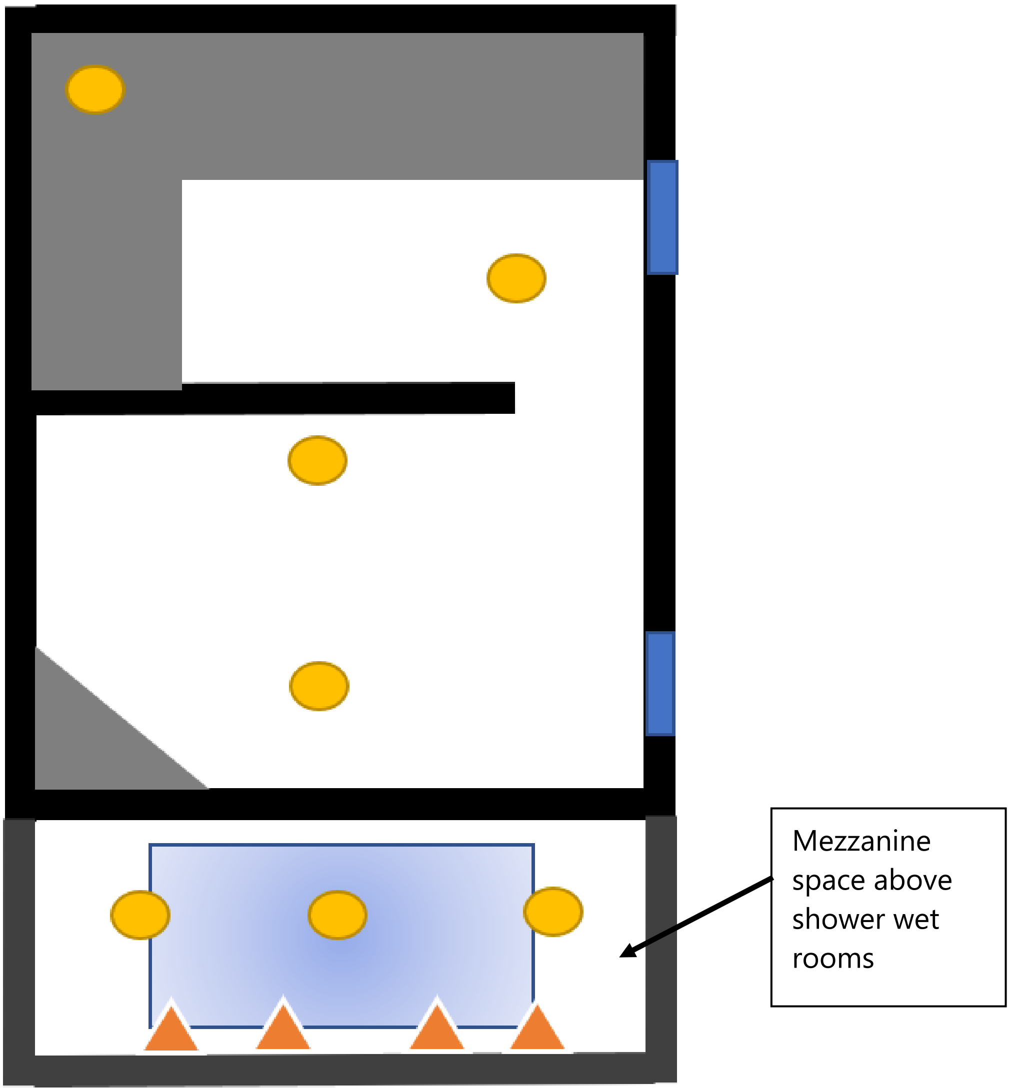
Indicative light position

Indicative socket outlets and isolation points

Wood stove

Location of thermal store, PV battery and associated controls on mezzanine

Radiator Position


Mezzanine space above shower wet rooms

7. Conclusion

The Grwyne Fawr Community Interest Company (CIC) has a vision to turn this derelict property into a functional usable space to serve the demand for walkers, mountain bikers, schools and community groups as a safe base to explore the local countryside. To provide shelter and basic amenities so that groups can stay for short periods throughout the year. As there is no electricity or heating fuel on site, this report has to consider renewable options for electricity and heat demand requirements and this also underpins the Grwyne Fawr CIC philosophy for the building the be a self-sustaining environmentally conscious building that mitigates its impact to the local environment and uses energy that does not contribute to the greenhouse gas emissions that are accelerating climate change.

Renewable options have been considered to meet an electrical and heat demands, the following table provides a summary of technologies to meet 100-day kWh demands;

Electricity demand inc radiant heater	Electricity demand without radiant heater	Heat demand	Heat demand when using electric radiant heater
2550.45 (2040 with diversity)	2046.5 (1637 with diversity)	3975	3495
Technology	Electricity generation	Heat Generation	Cost
PV Solar	1960	Up to 323 if no radiant heater	£9k to £10k
Solar Thermal	0	1357	£6k to £8.5k
Wind	1644	Any surplus to thermal store	£10k to £15k
Wood stove	0	1500	£4k to £5k
MVHR	0	800	£600 to £1600

From the table above, we can see that the most cost-effective solution is the combination of PV, Solar Thermal, MVHR and a wood stove to meet electric and heat demands for the building.
By applying diversity to electric use, we see that the PV can contribute to the thermal store along with solar thermal and wood stove. The MVHR use extracting heat from the high use shower rooms and the wood stove will enable heating to the amenity corridor and kitchen area, reduction the need for at least 1 radiator.

The concern here is the lack of suitable supply of energy via PV and Solar Thermal on bad weather, rain and overcast days.

The use of wind technology can allow for poor weather, winter use, extended use, visits and contribute to heat demand requirement in the thermal store.

Scenario A Using electric radiant heater in ground sleeping room and applying diversity

Elec demand 2040 kWhs PV only Generation 1960 kWhs -we are 80kWhs deficit
Heat demand 3495 kWhs Heat generation 3657 kWhs -we meet demand with 5% surplus

This is allowing diversity of using 80% of the load demand highlighted in table 1. Consider using more efficient lights, kettle and fridge to drop electric load for PV to meet demand.
Ideally, it would be prudent to review appliances and operational hours from table 1 to consider whether this is a suitable demand. Ideally, if we could reduce electric demand by an additional 10% this will give us a safety buffer of generation.

Scenario B Using electric radiant heater in ground sleeping room with no diversity

Elec demand 2550.45 kWhs PV only Generation 1960 kWhs -we are 590.45 kWhs (23%) deficit
Heat demand 3495 kWhs Heat generation 3657 kWhs -we meet demand with 5% surplus

If electric use is close to full load demand, then PV only will not be able to meet demand.

Scenario C Not using electric radiant heater in ground sleeping room, applying diversity

Elec demand 1637 kWhs PV only generation 1960 kWhs -we are 323 kWhs surplus
Heat demand 3975 kWhs Heat generation 3980 kWhs -we meet demand

This appears to meet current demand with generation. This is allowing diversity of using 80% of the load demand highlighted in table 1.

Scenario D Not using electric radiant heater in ground sleeping room, with no diversity

Elec demand 2046.5 kWhs PV only generation 1960 kWhs -we are 86.5 kWhs deficit
Heat demand 3495 kWhs Heat generation 3657 kWhs -meets demand

If electric use is close to full load demand, then PV only will not be able to meet demand.

Scenario E Not using electric radiant heater in ground sleeping room, applying diversity

Elec demand 1637 kWhs PV/Wind generation 3604 kWhs -we are 1967 kWhs surplus
Heat demand 3975 kWhs Heat generation 3980 kWhs -we meet demand

This appears to meet current demand with generation. Allows for additional electric use, support any poor sunshine days and allows for extra electrical drying kit for wet clothes etc.

Scenario F Not using electric radiant heater in ground sleeping room, with no diversity

Elec demand 2046.5 kWhs PV/Wind Generation 3604 kWhs -we are 1557.5 kWhs surplus
Heat demand 3975 kWhs Heat generation 3657 kWhs -meets demand using electric surplus

This also appears to meet current demand with generation. Allows for additional electric use, support any poor sunshine days and allows for extra electrical drying kit for wet clothes etc.

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