

## Maes Yr Onn



### A partnership project providing an innovative "off grid" solution

#### Overview

SSE, Caerphilly County Borough Council and Building Research Establishment (BRE), have helped to develop an entirely sustainable farmhouse in Wales, which has been hailed as an exemplar of sustainable building excellence.

The project has supported the Davies family of Maes Yr Onn Farm. For over 30 years the family has farmed award winning South Wales mountain sheep that thrive in the hillside pastures surrounding Manmoel in South Wales.

Mr Davies, previously travelled a 7 mile journey to the farm over poor mountain roads on average twice each day to feed, tend to his stock and to carry out farm maintenance. During the winter months, the farm can be inaccessible due to snow and ice, which raises concerns relating to the welfare of the stock.

Planning permission was granted in May 2011 for a detached two storey dwelling, based on a traditional Welsh longhouse design but updated to provide a comfortable family home. The development will enable further expansion of the business and better management of the stock.

A significant challenge for the development was that it is entirely 'off grid' for electricity, gas and water. The project therefore provided an excellent opportunity to put to the test a combination of renewable energy technologies and gain valuable insight into the impact of living and running a small business sustainably. The farm's electricity, heat and water generation and consumption is metered and will be monitored for the next 3 years under the Exemplar Programme run by Constructing Excellence Wales. The project will be used to demonstrate the benefits of sustainable living without losing any quality of life.



## • Building design and fabric performance

### Project aims

The main aim of the project was to provide a renewable energy generation and water resource solution in an off grid setting. This presented a challenge to designers in balancing the various technologies whilst also ensuring compliance with all appropriate regulations, including Planning, Building Regulations and the Code for Sustainable Homes Level 3.

### Partnership working

The project has involved an effective working partnership between the key stakeholders; the Davies family, Caerphilly County Borough Council, the Building Research Establishment (BRE), and SSE, who provided funding, expertise in project management and design and installation services of the technologies.

**Councillor Ken James, Cabinet Member for Regeneration, Planning and Sustainable Development, said:**

"The project at Maes Yr Onn Farm presented the council with the opportunity to truly embrace renewable and sustainable technologies, and working alongside our partners for the past year we have seen the building works progress and the farmhouse take shape. As the works near completion, we can look forward to seeing the green technology that makes this project unique in action."

### Feasibility study

BRE were commissioned to carry out a feasibility study of the building, taking in to account occupation, usage and power requirements. A major requirement for the property was to minimise heat loss from every part of the building fabric. The envelope of the building has been designed as a super-insulated home to achieve low U-Values demonstrating minimal heat loss.

Building Element	Expected U-value (W/m <sup>2</sup> .K)		
	Traditional building	New build	Maes Yr Onn
Ceiling	0.4	0.2	0.15
Walls	0.4	0.2	0.15
Floor	0.4	0.2	0.15
Windows	3	2	1.4



• solar PV on roof



• wood cladding over thermal insulation



• battery bank and solar inverter

## • Electrical power, heating and water

### Solar photovoltaic generation

Twenty-one solar PV panels mounted on a unistrut frame are installed on the south facing roof pitch, in an array of 3 rows high by 7 rows long. These are split into 3 circuits connected in parallel to the charge controller via an inverter. The capacity of the 21 Panels x 185W / 1000 = 3.9kW. The panels provide general power throughout the day and any surplus charges the batteries for hours of darkness. The battery bank stores 42Kwh and if this dips below 40% a 10Kw back-up diesel generator takes over to provide the necessary power.

### Water supply

As Maes Yr Onn is an off grid residence set in a remote location, getting water to the property is not possible with conventional pipe work. To overcome this, rainwater harvesting technology for domestic use has been installed which includes potable water for drinking.

Rainwater is collected from the roof of the house and stored in a 5500 litre tank located in the basement plant room. Water is filtered for particles to 5 microns and treated with UV light to sterilize bacteria, and then pumped around the house to feed the two bathrooms, the kitchen sink and the utility area.

### Heating and hot water system

Heating and hot water to the house is provided by a 20kW biomass boiler to meet the Davies family requirements. Due to the rural location of the property the boiler is fed from the family's own woodland, creating a self sufficient supply of fuel. Logs are cut into 600mm lengths and then quartered to provide maximum surface area for burning and thus maximising the efficiency of the boiler.

The wood gasification boiler chosen for the scheme uses the process of gasification to convert wood into wood gas which is then burnt cleanly and efficiently. The wood gas is precisely mixed with air utilising the in-built lambda control so the superheated mix results in complete combustion which leaves little or no ash. The heat is then transferred to two separate heat stores and drawn on by the family when required.



• rainwater storage



• smart meter collection points



• innovative skirting board heating

### Technologies considered

SSE's Contracting division who provide mechanical and electrical contracting services, installed all the power, heating and water supply technologies which included:

- solar PV
- battery bank
- rainwater harvesting
- biomass boiler
- thermal storage
- skirting heating

Preliminary assessment of wind technology was also considered as an option for the future. CHP and heat pumps were also considered but deemed not practical. Specialist software tools including SAP, Design Builder, PV-sol and Code for Sustainable Homes Water Calculator were used to specify the size of the systems.



• biomass boiler and thermal store in plant room

### Electrical power

Electricity to the house is provided by a battery-based system with the generation supplied by solar PV, backed up by a diesel generator which will only be used as a top-up facility.

An important factor in specifying the electrical power sources was a realistic load assessment required to run a home and a business. The detailed BRE feasibility study examined likely power demands including large and small appliances such as washing machine, kettle, vacuum cleaner, computer printer, and also building services such as security systems.

An innovative skirting radiator system was installed which provides an even heat to the perimeter of each room. Easy to fit and replacing conventional skirting boards, heat is controlled in 7 zones (on a room by room basis) and gives up to 700btu's (British thermal units) 210W per meter length.

### Regulatory framework

Ensuring compliance with all appropriate regulations, including Planning, Building Regulations and the Code for Sustainable Homes Level 3, the Standard Assessment Procedure (SAP) examines environmental performance at the design stage and upon completion. The assessment will therefore be repeated post commissioning when the building is fully completed to show what has actually been achieved against the design. The SAP assessment results from the design phase at Maes Yr Onn were as follows:

Energy consumption	Energy Consumption	
	Space heating (kWh/yr)	7334
	Water heating (kWh/yr)	1819
	Fabric energy efficiency (kWh/m <sup>2</sup> )	66.9
Energy efficiency rating / band		95/A

CO <sub>2</sub> emissions	CO <sub>2</sub> emissions	
	Space heating (kg/yr)	59
	Water heating (kg/yr)	14
	Pumps and fans (kg/yr)	106
	Lighting (kg/yr)	231
	PV (kg/yr)	-1252
	Total CO <sub>2</sub> emissions (kg/m <sup>2</sup> /yr)	-7.82
Environmental impact rating		107/A

## The reality of living 'off grid'

A significant part of learning lessons from the research at Maes Yr Onn farm, will be the way in which the Davies family can adapt to living with a different utility infrastructure. To maximise electrical power usage some appliances will need to be run during the day where possible to take advantage of the photovoltaic generation, instead of taking power from the battery bank. The family will need to reduce their overall consumption by around 50% from their previous grid connected house.

The summer months may present challenges, if there are long hot dry spells, using water efficiently will be important. New maintenance regimes for weekly checking of the UV filtration system will have to be established and preparing and storing the wood in optimum conditions will also be required to get the best performance from the boiler.

A comprehensive metering strategy has been devised to monitor energy usage, how much power generated by the solar PV panels and how much is used to charge the batteries. This will provide valuable feedback for the lifestyle adjustments that the Davies family will have to go through. SSE have provided the family with a computer tablet to view their real time energy usage via an online web portal. This will assist them with managing their energy use effectively.

The ongoing monitoring and feedback from the project will provide valuable information and it is hoped will demonstrate a benchmark for off grid living. The information will be shared between SSE, Caerphilly County Borough Council, BRE, Construction Excellence Wales, and the Davies family.

**Jo Horrigan, National Development Director SSE, said:**

"We are very excited that we are able to monitor the benefits of this exemplar project in order to understand the true challenges of off grid living and to replicate the lessons learnt."

**Andy Sutton, Associate Director BRE said**

"Arthur and Sue's house gave a great opportunity to develop a modern reinterpretation of Welsh rural living drawing on the traditional building forms and materials".

**Mr Davies, owner of Maes Yr Onn Farm said:**

"Rebuilding the farmhouse so that we can live and run a business sustainably has been an amazing journey and the project partners have all helped enormously to turn this dream into reality."



• Mr Davies using the monitoring tablet



• Traditional stone craft on cladding



• Mr Davies and the SSE team

## Project Partners

- Client: Arthur Davies, Maes Yr Onn
- Sponsor: Caerphilly County Borough Council
- Building design: Building Research Establishment
- Renewable energy finance: SSE
- M&E contracting: SSE Contracting

