

Biomass Boiler Case Study Wills Barn, Mendip

This case study provides details of a domestic scale biomass boiler in a low energy building used for educational visits, training and conferences. Wills Barn, which is owned by Yeo Valley Organic, is a 250 year old limestone building that was renovated between 2006 and 2008. It is not connected to the national grid or serviced with mains gas. Instead the building is energy self sufficient, with all the heating provided by the biomass boiler and the electricity produced by a 2 kilowatt (kW) solar photovoltaic array. Surplus power is stored in a set of batteries. In addition, toilets are flushed using rainwater captured from the roof gutters and stored in a tank.



*Wills Barn is situated in the Mendip Hills above Chew Valley Lake.
The photovoltaic array is on the left of the building facing due south.*

Heating requirements

The building consists of three rooms on the ground floor and a large open plan teaching area on the upper floor. As the building was previously derelict there was no historic data available on heating fuel use and costs. The boiler size and annual heating use was estimated from the volume of the building, the insulation levels and the predicted number of occupants.

Boiler choice

The chosen system is a 22 kW Idro Extraflame Italian wood pellet stove with back boiler installed by Devon based Wood Energy Ltd. Yeo Valley initially considered a log boiler but decided on the pellet stove because they didn't want an industrial looking boiler and also wanted the added functionality that these systems provide. Pellet stoves are much more user friendly and require less maintenance than traditional log stoves or log boilers. They approach the convenience that consumers expect from their heating system with features such as a pre-set timer which lights the boiler automatically. Yeo Valley got two other quotes prior to deciding on this system.



*Yeo Valley's Director of
Communications Graham
Keating with the Wills Barn
pellet stove.*

Heating system

The building has significant amounts of insulation in the walls, roof area and under the floors. As a result the heating required is quite moderate. During winter the boiler is operated for two hours in the morning. The boost to the ambient temperature that this provides is sufficient to keep the building warm all day. If the building is used for evening events the boiler is set to come on again at 4pm.

Following ignition the stove takes around 15 minutes to start heating the radiators. It services three double radiators upstairs and three double radiators downstairs. Once the water reaches 72°C the boiler stops burning fuel and only starts again when the thermostat instructs it that the temperature has fallen below 60°C. This is exactly the same as a gas or oil system. The stove has five temperature settings but this system is usually set on three. The front of the stove can get quite hot so there is a fireguard that can be attached as a safety feature.

Fuel Supply and Storage

The system uses wood pellets produced from compressed sawdust. This type of fuel is very dense and has a higher calorific value than wood chips or even seasoned logs; as a consequence, pellets are much more expensive. Pellets can also be produced from other sources such as crops grown specifically for energy production such as willow, oilseed rape and even bracken. The latter are slightly inferior in quality than those produced from sawdust and are moderately cheaper. Yeo Valley have not tested alternative pellets in the Wills Barn stove but are investigating the potential of using the energy grass miscanthus in other boilers on their estate.

The wood pellets are delivered as a one tonne consignment made up of individual 15kg bags. As the building has not been in use for a full year or used at full capacity there is currently no information on the annual consumption of wood pellets. During winter it has used an average of 10kg of pellets per day. This would be equivalent to about 1.5 tonnes for the winter season.

Yeo Valley paid £185 (ex VAT) for one tonne of pellets in the summer of 2008 but prices have since gone up. Current prices (as of March 2009) range between £220-290 per tonne depending on the supplier used. These prices include delivery but not VAT.

A typical UK house using 20,000 kilowatt hours (kWh) of heating might require 3.5 tonnes of pellets per year. This is based on the replacement of an aging fossil fuelled boiler working at an efficiency of 70% with a 90% efficient pellet boiler. A well insulated house would require perhaps half this amount.



The stove front can get hot so there is a fire guard that can be used as a safety feature.



Wood pellets. The ones on the left are made of compressed sawdust whilst the ones on the right are oilseed rape meal.

(Picture courtesy of Dorset County Council)

Fuel	Amount required	Unit price (inc VAT)*	Annual fuel costs
Pellets	3.5 tonnes	£255	£892.50
Mains gas	20,000 kWh	3.7p/kWh	£740.00
Heating oil	1900 litres	50p/litre	£950.00

* Correct as of March 2009

The table above suggests that pellets are likely to be cheaper than oil but more expensive than mains gas. Many dwellings in Mendip AONB are heated with oil so pellets may allow residents to reduce their fuel bills. You can size your own boiler and calculate your fuel use by following the link in the more information section below.

Operation and Maintenance

The most significant activity is the daily addition of the bagged fuel to the boiler's integral hopper. The boiler has a self-cleaning mode which activates for a few seconds during every hour of operation. Additional routine maintenance is undertaken by Yeo Valley staff. This is not particularly onerous and simply involves vacuuming the boiler once a week to remove any dust. The boiler is very efficient so the ash pan only needs emptying once a month. Every six weeks the boiler tubes are cleaned using pipe cleaners that are supplied with the boiler.



Adding wood pellets to the integral hopper. This needs to be done 1-2 times per day.



The stove needs vacuuming out to remove dust every week and de-ashing every month.

Capital and Operational Cost

The overall capital costs of the installation including plumbing and the flue was £7,500. A grant of £1,000 was obtained from Mendip AONB through the Co-ordinated Woodfuel Initiative. Unfortunately this funding stream is no longer available. However, other grants are available from the following sources:

- Low Carbon Building Programme (ends June 2010) www.lowcarbonbuildings.org.uk
- Bioenergy Capital Grant Scheme Round 5 ends April 2009 but further rounds are expected www.bioenergycapitalgrants.org.uk

Carbon savings

As there was no previous heating at Wills Barn the pellet system has not led to any direct reduction in emissions of the greenhouse gas carbon dioxide (CO₂). However, had the pellet stove not been installed the most likely alternative heating system would have been oil. The use of 1.5 tonnes of pellets is equivalent to around 700 litres of oil. Such an installation would have resulted in 1.8 tonnes of CO₂ being emitted.

Burning wood pellets is not quite carbon neutral because of the fossil fuels used in their harvesting, processing and

transport. Also, the boilers fan uses 70 watts of power, the same amount as an old incandescent light bulb or three energy saving compact fluorescent lamps (CFLs). Nevertheless, these emissions are a tiny fraction of the emissions from an oil boiler.

Key Lessons Learnt

Initially there were a few minor teething problems with the system; some of the fuel loads were not burning properly and this was causing the stove to go out (flame failure) and there were noticeable glassy deposits known as clinker in the ash. In addition, some smoke was being produced from the flue which doesn't happen when the stove is burning pellets efficiently.

These issues were soon cleared up but a bigger problem was that the instruction book was a poor translation from Italian and not user friendly. Yeo Valley staff have now become familiar with the system and have written their own simple instruction booklet for people using Wills Barn on evenings and weekends.



As long as the boiler is functioning properly no smoke is produced from the flue.

Graham Keating of Yeo Valley said that he is considering installing a pellet stove at his own home. His only concern would be the need for a secondary back up. "If you rely just on the pellet stove without a back up and go away on holiday during the winter time you would need a friend or family member to come in and fill the hopper every few days." He added that the boiler fans are a little noisy so it would be ideally placed in the kitchen but would be less well suited to a living room.

Summary information

Boiler type	22 kW wood pellet boiler
Installer	Wood Energy
Capital cost	£7,500
Amount of wood fuel used	Approx 1.5 tonnes/year
Grant	£1,000

Contacts and more information

<p>Mendip AONB Tel: 01761 462338 Website: www.mendiphillsaonb.org.uk</p>	<p>Wood Energy Tel: 0845 070 7338 Website: www.woodenergyltd.co.uk</p>
<p>Centre for Sustainable Energy Tel: 0117 934 1400 Website: www.cse.org.uk</p>	<p>Wills Barn Tel: 01761 462798 Website: www.willsbarn.co.uk</p>
<p>Sizing your own boiler Download a report showing how you can size your boiler and woodfuel needs for your own home. www.cse.org.uk/woodfuel</p>	<p>Forestry Commission (Biomass Energy Centre) Overall advice, guidance and information and enquiry centre www.biomassenergycentre.org.uk</p>