Youlditch Farm House: Energy Efficiency Measures

Introduction

Youlditch dates from circa 1650 and is listed as an example of the Devon Longhouses of the period. We bought in November 2003 and moved in full time in May 2006.

Youlditch was a farm until 1970 with no power or telephone. Water was drawn from a nearby well. The last farmers had no powered equipment or transport, only a pony and trap. Several owners since 1970 have made significant changes, including electrical power, pumped water, telephone, and conversion of the shippon (barn) into living accommodation. However, the building remained very damp, draughty and dark and many of the changes were done to a low standard.

The most severe problem was damp which caused mould to grow in all ground floor and some first floor rooms. After prolonged periods of intensive rain the ground water table would rise and flow under pressure up between the parlour floor flagstones.

Exposed 1,000ft up on the west escarpment of Dartmoor, draughts entered the building both through the roof eaves and around the external doors and some windows. This made heating the shippon end of the building virtually impossible.

Working with architect Sue Spackman and builder Nick Fell (both of Tavistock) the house was transformed between 2004 and 2008. The objective was to bring the property up to 21st Century standards of comfort and convenience whilst retaining the character of the original building. The house is about 220m^2 indoor net area (ground floor 148m^2 and first floor 72m^2).

All works required Dartmoor National Park Authority (DNPA) planning permissions and listed building consents, and West Devon building regulations approvals.

The following sections only cover the works relating to energy efficiency:

- resolving damp
- insulation to minimise heat load
- resolving draughts
- efficient heating
- efficient domestic hot water

Resolving damp

In the first two years we followed conservation advice to strip a thin cracked cement render from the external face of the house walls and re-point with lime mortar. We then stripped the plaster from internal walls in some rooms, re-pointed with lime mortar, re-plastered with lime plaster, and painted with a lime wash. The advice was based on the principle that the walls would 'breath' (absorb and give up moisture) and eventually reach an acceptable equilibrium that would not support mould.

While the external walls were aesthetically much improved, the mould returned and became worse inside. Indeed the internal humidity was such that books and clothing became mouldy. It was clear that the walls had 'wet feet' and the moisture was also penetrating from the outside. We then understood that a more radical approach would be required as part of the major renovation works.

The primary solution was to excavate about 600mm below the ground floor levels and lay field drains (perforated plastic pipes) in gravel sloping with the hill to discharge to the field below the west end of the house. The gravel was covered with a waterproof membrane and 100mm concrete slab.

The rubble stone walls are founded directly on the underlying wet soft rocks (shillet) and have no form of damp proof course. Therefore water rises in these walls through capillarity. The external walls are also saturated in rainy periods (particularly the western face) and moisture soaks into the walls through the lime mortar. Parts of the east end of the house are 'buried' into the slope with inside floor levels as much as 800mm below the outside ground level.

Therefore the inside face of the walls were 'sealed' in affected areas using two very different types of tanking:

- all the kitchen walls and floor, and the west wall of the building - cementitious slurry sealing
- in the parlour - stiff plastic sheeting with studs that leave an air gap against the wall for moisture to drain preventing a build up of pore pressure

Insulation to minimise heat load

The structural works involved re-slating the roofs with reclaimed Delabole slates. This allowed over-the-rafters insulation at the shippon end of the building using a multilayered fabric (Actis Triso-Super 9) which is only 25mm thick but is thermally the equivalent of 200mm of mineral wool. The effective U Value is ~ 0.15 to 0.20 W/m^{2}k (Watts per square meter per degree centigrade)

Another part of the roof was raised over the cross passage to create space for a bathroom. To minimise the roof height change 100mm thick rigid thermal insulation board was fitted between the rafters. The effective U Value is ~ 0.25 W/m^{2}k

In the eastern part of the house conventional soft fibre insulation was fitted both between and over the ceiling joists on the loft floor, with a total thickness of 250mm giving an effective U Value of ~ 0.25 W/m^{2}k

All new windows and the screen walls to the porches are double glazed to achieve a U value of ~1.7 W/m^{2}k

Throughout the ground floor (except the kitchen) to be under floor heated, we fitted rigid insulation board of between 65 and 100mm achieving floor U Values ~ 0.15 - 0.20 W/m^{2}k.

The following table summarises the impacts of insulation:

Element	Typical % losses	2007 Regs U Values	Achieved 2008	Notes
Roof	30	0.25	0.15 - 0.25	Future regs will require 0.15
Walls	25	0.35	1. 5 - 2	Insulation incompatible with listed building character
Ventilation	20	-	-	See 'resolving draughts'
Windows / doors	13	2.2	1.7	Some single glazed windows U values 5.5
Floors	7	0.25	0.15 - 0.2	Maximum achievable in each situation
Thermal Bridges	5	-	-	Limited measures only

Resolving Draughts

As shown above even typical ventilation represents about 20% of heat losses. The draughty conditions of Youlditch were extreme. The worst draughts were through the roof eaves in the shippon and this was fully resolved with the use of the multilayered fabric insulation which effectively sealed the roof against wind. Another source of draughts were the poorly built farmhouse porches and ill fitting doors which were replaced by the new screen wall porches with effective door seals. The chimneys were a third source of draughts and these were lined and close fitted to the new wood burning stoves with proper door seals.

Efficient Heating

The rubble stone walls are from 350 to 1,000 mm thick which when damp are difficult to warm up. However, with the damp issues resolved, the thermal inertia of thick walls become an asset. Once the fabric of the building is brought up to a comfortable minimum temperature these walls are slow to give up their heat.

Having installed drainage below the house we were able to install under floor heating throughout the ground floor (except kitchen which has an Aga). Under floor heating efficiency is partly from using water at about 30ºC compared to 65ºC for conventional radiators. Also the heat is evenly distributed throughout the room and warms the internal fabric, including the thick walls with high thermal inertia. The result is a stable comfortable environment. Thermostats control the temperature in each room (we generally set the Bathroom at 20ºC, the Living Rooms at 18ºC and the Bedroom at 17ºC).

The upstairs rooms have radiators controlled by thermostats. Generally we do not heat the upstairs (which are guest bedrooms and guest bathrooms) and they 'borrow' heat from the ground floor and remain at temperatures above 10ºC.

Resolving the draughts, insulating to minimise heat losses, and using under floor heating reduced the required design heat load of the building from about 38kW to about 18kW (say 50% reduction).

The existing 25kW oil boiler was probably circa 1975-80, inefficient (probably 60 to 70%) and unable to provide sufficient heat during cold spells (ie below about 5ºC). The new boiler is a

modern oil condensing boiler with an efficiently of about 93% (reducing fuel use per kW by 20 to 30%).

The new boiler is an 18 to 25 kW Worcester Bosch Greenstar Camray Utility.

Efficient Domestic Hot water

We installed a 'Grant Sahara' in-roof solar panel system for domestic hot water heating. There are two panels total 4.64m^2 with an effective capacity of 3.4kW. This is fed to a 250 litre domestic hot water cylinder. The oil boiler will heat the water only when the solar panels have not sufficiently raised the cylinder temperature. Heating controls allow the boiler hot water function to be turned off to prevent unnecessary heating (ie before the sun is up) or set to cut-in for limited period to suit times when hot water is required. The solar heating probably satisfies about 60 to 70% of annual hot water demand.

Summary

All of the above measures taken together have resolved the damp and draughty conditions, created a comfortable internal environment and achieved substantial energy use savings.

- Heat load saving ~ 50%
- New boiler and heating system efficiency saving of 20 to 30%
- The energy use for heating is therefore reduced by about 75%

Actual fuel use is about 50% less due to heating rooms that could not be heated before, and the Aga use which has not changed.

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