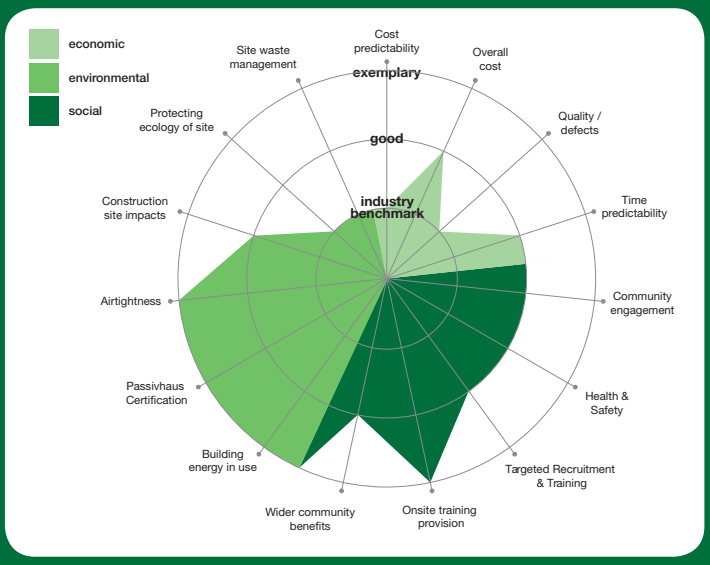
United Welsh Passivhaus

Two detached dwellings were developed by United Welsh Housing Association on a site in Ebbw Vale as part of a Passivhaus Design Competition for Wales. The project aimed to demonstrate how designing and building to the Passivhaus standard can help meet tough modern energy requirements and keep carbon emissions to a minimum. It was hoped that the lessons learned will help ensure the success of larger-scale social housing developments in the future.

The three-bedroom Larch house was designed to achieve Passivhaus Certification and the Code for Sustainable Homes level 6 energy requirements, while the two-bedroom Lime house took a lower-cost approach to achieving Passivhaus Certification and Code level 5. The homes were not occupied straight away, but will ultimately be occupied by United Welsh tenants and monitored to verify their in-use energy consumption.

The project has already initiated the development of a skilled and experienced local supply chain able to work on other Passivhaus projects.



project details

client:	United Welsh Housing Association
architect:	Bere Architects
contractor:	Pendragon Design & Build
value:	Larch house 3-bed £176,959
	Lime house 2-bed £111,492
project size:	Larch house 3-bed 99m2
	Lime house 2-bed 76m2
contract method:	JCT Design & Build 2005

what is an exemplar project?

An Exemplar is defined as 'something worthy of being copied'. The purpose of the Exemplar programme is to identify what actions have taken place at key stages of a project that have led to a successful outcome, so that this learning can be adopted on other projects. The Exemplar programme has been developed to help identify the reasons why certain projects are successful in a standardised, quantifiable way, and to share with the industry what enabled these successes. An Exemplar considers all aspects of sustainability, including economic, social and environmental factors. Projects must demonstrate that they have been innovative in one or more of these aspects in a way that exceeds normal industry practices, while achieving at least minimum standards in all other areas of the project. This is to demonstrate that the scheme is well rounded and has not sacrificed one aspect to be successful in another, while also incorporating best practice measures that can advance the state of the industry. An Exemplar project therefore reflects the ideal industry goal of achieving a scheme's primary aims in a sustainable way, at acceptable costs.

what made the project successful

- Taking a 'fabric first' approach to the design of the dwellings helped achieve the energy efficiency requirements of the Code for Sustainable Homes and Passivhaus Certification
- Learning from the development of the first plot (the Larch house) led to a different design approach on the Lime house, improving delivery and maintenance issues and identifying cost savings
- The lessons learned, along with the upskilling of the local supply chain, will enable similar projects using local products and trades to be delivered in the future

notable achievements

- Several opportunities to reduce build costs have been identified, making the Passivhaus concept more accessible for wider-scale social housing developments in the future
- Passivhaus Certification was achieved, with extremely low energy demand and airtightness of 0.19ac/h (Larch house) and 0.47ac/h (Lime house), which should significantly reduce residents' energy bills
- The dwellings met the Code for Sustainable Homes level 6 (Larch house) and 5 (Lime house) respectively, with the use of additional solar PV panels funded via the Feed-in Tariff
- Local supply chains were developed to deliver systems and components locally that were capable of meeting the Passivhaus requirements
- The project provides a visual demonstration to the public and the construction industry of what it will take to meet tough new building standards in future

economic considerations

Several opportunities to reduce build costs have been identified, making the Passivhaus concept more accessible for wider-scale social housing developments in the future

The Welsh Assembly Government's current acceptable cost guidelines for a Code level 3 and 4 house are £1250/m2 and £1350/m2 respectively (there are no guidelines for higher Code levels at present). Although the costs for the Larch and Lime houses were higher than this, the project has demonstrated ways to reduce costs on future schemes to keep them within guideline levels. In addition, CO2 emissions and household energy bills will be further reduced in these dwellings relative to Code 4 requirements, helping to reduce the risk of fuel poverty among tenants. Lessons learned on the Larch project were applied to the Lime house, bringing the cost for a single detached dwelling down to approximately £1467/m2. Economies of scale, allied with a more experienced supply chain, should help reduce costs on future wider-scale developments. A terrace design should also prove to be more cost effective.

The pilot project was design-led, leading to decisions that did not necessarily prioritise cost and maintenance considerations. For example, the external timber cladding used on the Larch house will require costly scaffolding for future maintenance; a more practical rendered solution was trialled on the Lime house. Again, the decorative slate feature wall on the Larch house will in future be substituted for a lower-cost finish. The Association would normally expect its maintenance department to have input into such decisions.

Another issue is the prevalence of rain and cloudy weather in Ebbw Vale, which made it harder for this particular Passivhaus scheme to achieve the required energy performance targets. Homes in other locations may not require the same insulation thickness, which would help reduce cost.

The Lime house saved upfront costs by aiming for Code level 5 rather than 6, meaning a smaller PV array was acceptable. This cost, however, can be discounted since it will be recouped via the Feed-in Tariff.

social considerations

Local supply chains were developed to deliver systems and components locally that were capable of meeting the Passivhaus requirements

At the time of the Design Competition there was a dearth of local skills able to design to the Passivhaus standard. Those who did become involved had to be willing to think differently and open up to new ideas. However, readiness to engage and learn how to deliver the standard has paid dividends for several local suppliers. For example, local firm Holbrook Timber Frame developed a closed panel timber frame system to achieve the necessary performance standards. It has started to apply the Passivhaus concept to improve its typical frame offering, and has since won additional work in England and Wales to deliver high energy performing Passivhaus timber frame systems.

A German Passivhaus window supplier was used for the Larch house as there were no suitable products on the UK market at the time. However, a local company tooled up to provide a similar product, having learned from the installation of the German system, and its windows were used on the Lime house.

A pool of suitably skilled local suppliers has now been established which could be used on similar projects.

The project provides a visual demonstration to the public and the construction industry of what it could take to meet tough new building standards in future

The Larch house was opened up to the public at the Wales National Eisteddfod as a show home demonstrating how new, modern energy standards could be achieved. The Lime house was also opened to the public before it was occupied, allowing both dwellings to be visited by interested parties to see first hand how they were designed and built and to learn from the lessons of this pilot scheme.

environmental considerations

Passivhaus Certification was achieved, with extremely low energy demand and airtightness of 0.19ac/h (Larch house) and 0.47ac/h (Lime house), which should significantly reduce residents' energy bills

The Passivhaus standard requires energy use of less than 15kWh/m²/yr in heating, or an overall peak power demand of less than 10W/m2. The Larch house achieved 13kWh/m2/yr heat demand, while the Lime house was designed to meet the 10W/m2 peak power demand. Air infiltration of 0.19 air changes/hour was measured for the Larch house and an initial measurement of 0.47 air changes/hour was achieved for the Lime House, comfortably within the Passivhaus compliance limit of 0.6 air changes/hour.

The Passivhaus standard sets tougher requirements than are generally demanded in a UK house. To meet these, the demonstration houses were highly insulated (all U values below 0.1 W/m2K) and designed to eliminate thermal bridging. A good level of airtightness was achieved through use of membranes and well-installed, high-quality windows, sealed to prevent heat loss around the frame (U value of ≤0.8 W/m2K). While the Larch house had large, south-facing windows to maximise solar gain, it was ultimately decided that the smaller (and subsequently cheaper) windows of the Lime house were more effective at reducing heat loss and better suited to cold, overcast weather conditions. Services were centralised and brought into the building through the floor slab to minimise disruption to the airtight layer, and significant attention was given to detailing around junctions and service penetrations.

To ensure that the built result fully met the design aspirations, attention to detail and workmanship on site was imperative. Activity on the site was closely monitored by the designers, who were also on hand to address any queries. It is anticipated that quality control on a larger-scale project would be monitored by a clerk of works.

The dwellings met the Code for Sustainable Homes level 6 (Larch house) and 5 (Lime house) respectively, with the use of additional solar PV panels funded via the Feed-in Tariff

The 'fabric first' approach to the design, to exclude draughts and ensure airtightness, for example, helped reduce demand for energy upfront. For domestic heating, a mechanical ventilation with heat recovery system was used, supplemented with solar hot water. Heat recovery ventilation is the best way to deliver fresh air in winter, avoiding the need to open windows and waste heat in the cold winter months. Heat recovery from within the building via the ventilation system ensures that valuable heat is not lost and is retained within the highly insulated structure. These measures ensured that CO2 emissions from the pilot homes have been reduced to a level exceeding the requirements of the 2006 Building Regulations Part L, by 55% (Larch) and 54% (Lime) respectively.

Solar PV panels were used to meet the additional energy need, enabling Code level 5 and 6 targets to be met (requiring 100% and 140% improvement on the building regulations respectively). PV costs will be paid back via the Feed-in Tariff scheme. It should be noted, however, that some properties, such as flats or terraced homes, may be unable to accommodate such large PV arrays, requiring community-scale schemes or other solutions to be developed.

The local supply chain has evolved and learned a great deal as a result of this pilot scheme and will be better equipped to design and deliver the Passivhaus standard in the future. This very low energy design method will reduce the baseline energy demand in housing and, ultimately, help to deliver Code for Sustainable Homes energy credits in the most efficient way. High energy efficiency will in turn protect residents from the risk of fuel poverty by reducing energy bills.