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Case Study 15

Centre for Alternative Technology and Wales Institute for Sustainable Education (CAT WISE)

Client:
Centre for Alternative Technology

Architect:
Patrick Borer and David Lea Architects

Location:
Machynlleth, Wales

Building Types:
Education
Residential
Public

Project Description

The Wales Institute for Sustainable Education (WISE) is a state of the art educational facility which opened in 2010. It forms part of the Centre for Alternative Technology (CAT) which is Europe's leading eco–centre. CAT started in 1973 on the site of a former slate quarry, and was originally an eco–community and research centre for new sustainable technologies.

The WISE building houses the post–graduate department of CAT and includes a 180 seat lecture theatre, 24 en–suite twin bedrooms, seminar rooms, workshops, a research laboratory, in addition to a restaurant and bar.

Key Drivers

The key driver behind the WISE development was to provide an opportunity for people to learn about green architecture, renewable energy and environmental technologies.

In line with the general approach at CAT, a primary objective for WISE was to create a very low energy, low impact building which utilised building materials with low embodied carbon and passive design features as far as possible (refer to chapter 2 of the practice guidance for information on the energy hierarchy).

Another key aim for the WISE building was to maximise the use of sustainable building materials and minimise the use of high embodied energy materials such as cement wherever possible.

Through implementing passive solar gain design, energy efficiency and renewable energy solutions, the WISE building achieved a building emission rate (TER) of approximately 19 kg CO_2/m^2.annum compared to a target emission rate (TER) of 75.4 kgCO_2/m^2.annum. However, a proportion of this saving was down heat being produced by biomass, which has a low emission rate, and due to problems with the CHP plant this has not been realized in practice, highlighting the importance of looking at overall energy consumption figures as well as emission rates. Consumption figures for heat (DHW & space heating), were 118MWh in 2011, around 60kWh / m^2 / annum.

The WISE building is largely naturally ventilated and maximises the use of daylighting. Mechanical ventilation with heat recovery (MVHR) is provided in the lecture theatre, bedrooms and WC's. Renewable and low carbon technologies utilised specifically for the WISE building include:

- 70 m^2 evacuated tube solar thermal collectors;

LZC Technologies

- Solar thermal collectors
- PV array
- Biomass CHP

- 6.4 kW (60 m^2) monocrystalline photovoltaic (PV) array; and
- Space heating provided by the CAT district heating system, distributed around the WISE building via underfloor heating.

A unique characteristic of the WISE building is it's extensive use of low embodied building materials. These include:

- Rammed earth for the lecture theatre curved wall;
- FSC certified timber frame;
- Clay piping – PVC avoided wherever possible;
- Solid hemp and lime external walls, cast around the frame;
- Lime render; and
- Limecrete in lieu of cement.

Procurement of WISE

The WISE site was purchased by CAT in 2004, (previously leased), with detailed design being undertaken between 2004 and 2006. The new building was completed in 2010.

Sourcing of building materials was undertaken on a local basis wherever possible. The slate fill used for the building foundations was sourced from within the CAT site, while the rammed earth for the lecture theatre wall was sourced from Llynclys Quarry in Shropshire (approximately 45 miles from the site). The timber frame for the WISE building was, however, sourced from Denmark due to the size and complexity of the structure.

Scheme costs and finance

The total cost of the WISE building was in the region of £5.2 million. Of this, the solar photovoltaic panels were £30,000 (excluding roof structure), while the solar thermal collectors were donated to CAT by NG Bailey Ltd.

Technology selection process

A primary objective for WISE was to reduce the energy demand of the building through passive solar gain and energy efficiency. The building is very well insulated and has low levels of air leakage, approximately half of the level required by the standards under Building Regulations when designed (Part L, Conservation of Fuel and Power 2006). High performance glazing is used to optimise daylighting and minimise unwanted solar gain.

Installation of second community wind turbine in 2003
Reproduced: Need approval from CAT, media@cat.or.guk

Monitoring and operation

Extensive monitoring of the WISE building has been undertaken since occupation of the building in 2010. Comparison of monitored energy consumption of the WISE building was made against modelled predictions undertaken during the design stage of the project.

On an annual basis, the heat energy consumption of the building has been found to be around 41% lower than design predictions. In a similar way, electrictiy consumption is around 50% of the predicted level, at around 54 MWh per annum.

The CHP unit has subsequently been used relatively infrequently thus far for the WISE building.

For example it was utilised for less than 10 days during 2010. This is due to performance problems of the prototype unit (both manufacturing and design issues), coupled with difficulty in matching the output to CAT's heat requirements, due in part to the unit producing a much higher heat to electricity ratio than the design specification.

The new WISE development at CAT
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Key features

There are a number of site wide sustainable features at CAT, including:

- Rapid growth of CAT at the time of development of the WISE project meant that the energy demand of the CAT site was increasing as new buildings were developed. Consequently, there was a strong incentive to develop an energy solution which could meet the demands of the entire site. Due to the range of uses at the CAT site (offices, accommodation, workshops and educational facilities).
- CAT's renewable energy systems are widely distributed across the site; heat producing units are connected via a district heating scheme, and electrical generators are connected to a microgrid.
- A micro grid is a collection of energy generating technologies grouped together in a specific area with a small-scale power supply network. A micro grid system can be suitable for communities, industrial and trading estates, and academic or public institutions, and are normally connected at a single point to the national grid. CAT's generators include two small hydro turbines with a total output of 7.5kW, 20kW of PV's, including the new WISE roof, a 600kW Proven wind turbine, and the biomass CHP unit, although the latter is rarely used. Generated energy is used on site, and topped up by imports from the national grid when demand is greater than supply. When excess energy is produce, it is exported to the national grid. Currently, these generators provide around half of CAT's electricity.
- Heating units include two solar arrays, 70m^2 on WISE, which provides pre-heat for that building and the site restaurant, and 112m^2 that feeds directly into the district system, a 20kW pellet boiler, the CHP, and a gas back up. A 50kW woodchip boiler is currently being replaced.
- A reed bed system that is used to treat wastewater generated on the CAT site.

CAT use biomass as the feedstock for boilers due to the presence of a local and reliable supply of woodchip with carbon emissions associated with burning the fuel offset due to sequestration during growth of the biomass. It should be noted that biomass resources must be very carefully managed if this if to achieved (refer to practice guidance chapter 5.5).

An insulated pipework system was installed in order to provide district heating to the offices and dwellings around the CAT site. For the WISE building which has an annual heating demand of around 120 MWh, a 200 kW plate heat exchanger transfers heat from the sites district heating system to provide space heating for WISE, via an underfloor heating system.

Biomass CHP unit installed at CAT
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Pre–heating of domestic hot water for the building is achieved using a 70 m^2 array of evacuated tube solar panels which provides around 66% of the yearly hot water demand. The existing district heating system then provides top–up heat as required.

A 6 kW, 60 m^2 monocrystalline PV array is mounted on the roof of the WISE entrance courtyard. An innovative feature of the array is that the pv cells are set in glass panels to allow daylight to penetrate into the courtyard. In order to prevent overheating of these panels, an air gap has been left between the two roof planes to allow air flow and cooling. The new PV array is mounted adjacent to an older building integrated PV (BIPV) 13.5 kW array, which was installed in 1997 on the roof of the main CAT office.

Lessons learnt

Technological supply issues:

- Employing a main contractor not used to working with Cat's sustainability standards did cause some problems. Considerable work was done with the contractor during the design phase to assist them, and additional specification clauses were added to the contact. However, the archticts and Cat project team had to work closely with the contractor during the build to ensure acceptable sourcing of materials. Timber proved especially tricky; the FSC requirement solved many issues, but sometimes led to excessive travel distances (for example from Siberia), which CAT were keen to avoid.

  Having flexible and innovative consultants, particularly the structural engineers, was an important factor in being able to specify the materials CAT wished to use, in particular the rammed earth walls.

Occupant involvement:

- CAT used a planning for real process during the initial design stages, and maintained a high level of of building user involvement as designs progressed.

  There was also a more detailed handover phase than is always the case, which can be very beneficial in maximisising the benefits of building management systems and energy saving design. Keeping the project management in house helped to ensure the transfer of information to the building users.

Financial lessons:

- Grant funding, particularly from statutory bodies, brings it's own challenges to the financial management of a project, and it is important that funder's objectives, and their reporting requirements are built into management systems as early in the project as possible. When this did not happen successfully, there were big implications for the time taken on financial administration.

CAT used a PPC 2000 partnering contract for WISE, with mixed success. The general principal of early contactor involvement is felt by those involved to be a good one, and CAT would use this contract again, but difficulties over price certainty, and the level of detail available to the contractor at certain design stages highlighted the importance of all parties fully understanding the partnering process and it's differences to the more common tendering approach.

Awards and Achievements

- Nominated for the European Union's Mies Van der Rohe Award fro Contemporary Architecture;
- Listed as the Favorite Completed Building of 2010 by the Architects Journal;
- Finalist for ACE Engineering Excellence Awards 2011;
- Daily Telegraph's Building of the Year 2010; and
- 4th in the Guardians Top 10 Buildings of 2010.

- RIBA Award 2011
  IStructE David Alsop Sustainability Award 2011
  Shortlisted: Wood Awards 2011
  LABC 2011 South Wales Sustainability Award
  National Eisteddfod 2011, Highly Commended.

References and Acknowledgements

Timothy Soar (Photography).
For approval for use of images need to contact CAT media office on media@cat.org.uk/ 01654 705953

Danny Harris, CAT –
(Approval cannot be obtained from Danny until January as he is currently very busy.)

Further information

Centre for Alternative Technology
www.cat.org.uk

Internal view of glass mounted PV array with daylight penetration
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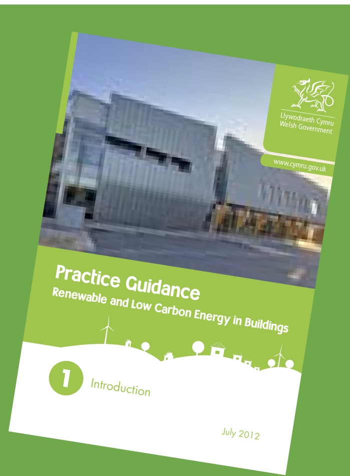
These case studies are presented to show examples of how buildings can be designed and built to be low carbon and incorporate renewable and low carbon technologies.
This case study is part of a series of case studies supporting a separate practice guidance document on low carbon buildings.
For further information see www.wales.gov.uk/planning



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