Strategies for a low carbon urban built environment

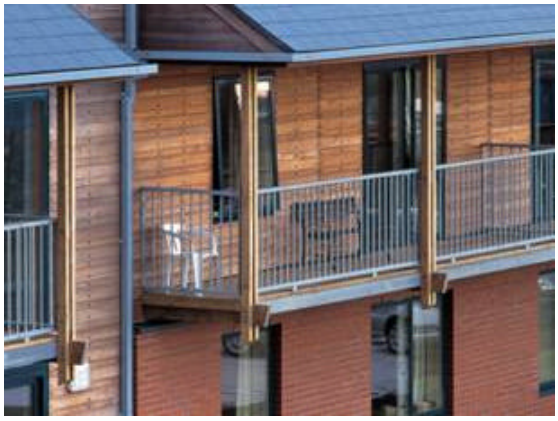
This document serves as a template or guide for the description of cases for Working Group 1 of COST Action C23. Cases will normally be designs and/or constructed buildings, but may also include software tools, educational programmes, or anything that can be argued is relevant to reducing carbon emissions in buildings. The focus of WG1 is on buildings rather than on infrastructure.

The document has been set up as a *form*, with named fields for collecting specific information. It is only possible, therefore, to enter content (text and images) in predefined areas. If you have difficulties with this please let me know. Chris (c.tweed@qub.ac.uk)

Case study title: **PLAS Y MOR PORTH TYWYN LLANELLI**

Author: Phil Jones and Jo Patterson

Reference:



The headings below should be relevant to most of the cases identified as relevant to this WG, but in some cases there may not be enough available information to provide a complete account. I have included some notes to try to clarify what I think could be described under each heading. These are not intended to be exhaustive, so if you think of something you consider important to document a case please include it. Please provide as much information as you can.

1. Context

This section should explain the context in which the case has been developed. If the case presented is a building this section should describe the procurement process, site selection and the socio-economic climate in which he case has grown. If there is anything unusual or interesting about the historical background to the case, this could also be described here, as well as any general aims or objectives.

Grwp Gwalia, is a leading provider of social housing in south and mid Wales, managing over 5,500 high quality, affordable homes and meeting the needs of a broad and diverse range of people in the community. The grwp is well known in Wales as a pioneer in environmental

architecture. Some of their earliest schemes in the 1990s made use of passive and active solar technologies, giving tenants the benefits of fuel bill savings and thermally efficient, comfortable homes. Gwalia continues to place high emphasis on green construction and emerging clean technologies. This has resulted in Gwalia winning many prestigious awards for leading the way in greener architecture and low energy buildings. Gwalia, also renowned for its use of sustainable materials in its buildings, particularly timber, constructed the first 5 and 6-storey timber frame building in Wales, at Aberystwyth and Swansea Universities.

2. Building

The building should be described under two sub-headings: physical features and management.

2.1. Physical features

This section should provide enough detail to allow someone unfamiliar with the case to understand how it sits within its site, how it has been constructed and what (if any) energy systems are in use. Of course, any novel aspects of the design, such as passive cooling or heating, should be described in detail, including how they are expected to operate under occupation. The description can (and should, where possible) include images as well as text.

Plas y Môr is a ground breaking project in the social housing sector in south Wales, UK. Completed in 2003, it providing independent living for older people, in an environment of mutual support. The development consists of 20 apartments for frail elderly people with 18 apartments for fit elderly people with other facilities including assisted bathrooms, communal lounges, a day centre, staff room, guest rooms, laundry, chiropodist, hairdresser, kiosk and offices.

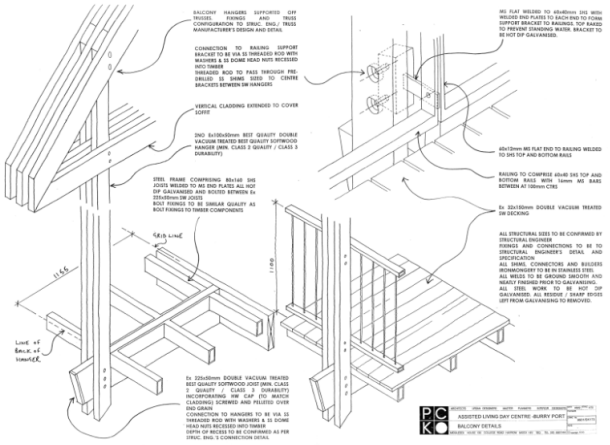
Design concept

- Privacy with accessibility to the wider community.
- Enclosed central garden and ‘day-centre’ as the focal points of community life.
- Two ‘wings’ connected by glazed garden combining the reception area and the ‘day-centre’
- ‘Transparent’ glazed garden bridging the divide to the wider community.
- Light and airy.
- Independent living for older people, in an environment of mutual support - Providing:-
- 20 apartments for frail elderly.
- 18 apartments for fit elderly.
- Assisted Bathrooms.
- Communal lounges.
- Day Centre with toilets, kitchens and store.
- Staff Room, Guest Rooms, Laundry.
- Chiropodist, Hairdresser, Kiosk, Offices.

The building contains the environmental features:

- 200mm timber-frame construction insulated with 200mm cellulose recycled newspaper.
- Certified ‘sustainably grown, untreated Laurohardwood, external cladding.
- Passive solar gains from glass garden and top glazing above the central corridors.
- Warm air from glass garden extracted by thermostatically controlled fans and ducted into communal areas or exhausted as required.

- Low-energy light fittings throughout.
- District heating by central 'biomass' boilers.
- 30 sq.m. of solar hot water panels for preheat of domestic hot water.
- Integration of solar hot water into the biomass powered, district heating system.
- Energy management systems.
- Optimisation of natural light to corridors by 'top-glazing' & the use of 'light-tubes'
- 'Sensory awareness' measures.
- Timber composite windows from 'sustainably-managed' woodlands.
- Organic paint systems and jute based floor coverings.
- Hydraulic lime mortar to external brick walls.
- Water conservation measurers.



The building incorporates both passive and active solar features, and a biomass wood pellet boiler. The solar thermal system is a 30 square metre solar array that provides a pre-heating facility to the boiler, which provides space heating and hot water system for the flats and the communal lounge areas, as well as bathrooms, kitchen, laundry and hairdressers.

The biomass pellet system comprises 2 No 95 kW Danish Passat wood pellet boilers serving the main building Low Pressure Hot Water heating system and the 3 No hot water services cylinders [2].

The pellet fuel for the Biomass boiler is stored in 2 No external silos of 8.5 tonnes capacity each, automatically feeding the boilers via a motorised auger/conveyor system. The boilers are designed to automatically adjust their operating condition to match the output required at any given time.

During summer months, the boilers are turned off, with hot water provided solely by the solar water heating system. If the solar system cannot cope with the hot water demand, electric immersion heaters installed in the calorifiers provide for a maximum of 5% demand. There is no back up to the biomass heating system as the initial idea of providing natural gas proved to be not economically viable.

Since handover of the scheme in October 2003, problems in operation of the system have varied from complete breakdown to fluctuation in temperature, the latter as a result of poor fuel burn and increased level of clinker/ash. Upon investigation, it was established that the main problem was a result of too high a moisture content in the wood pellets.

Since March 2005, twice-weekly visits have been made to remove ash and clinker. This was originally planned as a weekly operation and therefore incurs additional maintenance expenditure but has resulted in efficient running of the system.

Meetings with the fuel supplier have established several new boiler maintenance procedures, as well as new standards of fuel, delivery frequencies and boiler parts provision. The EU standard for pellet moisture content is set at 10% and the supplier has recently installed a dryer to maintain consistently accurate pellets in terms of moisture content. Additional safeguards have been provided by restricting the wood supply to pure, uncontaminated sources. Fuel quality issues are now resolved resulting in a more even burn, less fluctuation in boiler temperature and therefore more efficient boiler operation.

In terms of maintenance, since January 2007, Plas y Môr has employed a part-time, non technical, site-based boiler maintenance person, to oversee the pellet delivery, boiler operation and ash emptying duties. The employee also undertakes general janitorial duties at the scheme. This has provided more security of operation in terms of the biomass plant and heating system operation [3].

The problems experienced with the boilers have raised the issue of providing a back-up heating system. However, at £50,000 this is an expensive option and would be fossil-fuelled by Low Petroleum Gas. Due to problems with sitting fuel tanks so close to the adjoining railway line, the provision of a mobile heating backup system, brought to site when needed, has been adopted as a more feasible option.

2.2. Management

There is always the temptation to focus exclusively on the technical aspects of low carbon design at the expense of human factors, but as technical understanding improves the scope for major reductions in carbon emissions transfers to improved human understanding and operation. How is the building (or case) managed? Are there any novel methods of ensuring the case makes a significant contribution to reducing carbon emissions?

The Day Centre is open to residents and the public and provides a focal point for older people in the local community.

3. Performance criteria

This section should identify the criteria that will apply to the case to determine if the case has been successful. For example, this section might describe (briefly) the legislative requirements for a house that were in operation at the time the case was constructed. This section will set the initial objectives for the case.

4. Decision making

If possible, it would be interesting to know something about the processes that led to the final design of the case. What is the history of the project? Who was involved? What were their roles? Who made which decisions and why? It is often possible to identify key decisions that were made in a project that altered its future development significantly. If there are any such decisions in the selected case, record them here.

It was developed as a partnership project between Gwalia Housing Group, Carmarthenshire County Council and the Welsh Assembly Government. All three partners provided a share of the funding. Gwalia provided the project management and development expertise.

5. Cost analysis

It would be helpful to have an indication of costs. This can be a fairly simple calculation of both capital and operating costs, if possible showing the difference between conventional and low-carbon provision.

The development ensured that the 'green' technologies were properly integrated into the building, and not treated as 'bolt on' additions. This made them affordable and ensured no conflict between different strands of the design strategy.

The cost of the scheme at £720/m2 was relatively low for buildings of this type.

The original 3 year contract for pellets for the biomass boiler was £105 per tonne. Costs have now risen to £145 per tonne for a further three-year contract. Other options include an 'oil-tracker' price per tonne set at 20% below the cost of heating oil, or a 5-year fixed-price contract at £155 per tonne.

6. Carbon analysis

Clearly, for a case to have relevance to C23 it will be necessary to show to what extent the case has met, failed to meet, or exceeded the performance criteria specified in 3 above. This is particularly important for those criteria that relate to carbon emissions. However, it is not necessary for a case to demonstrate 'best practice,' since we are interested in learning from mistakes and

minor failures as well as exemplars. If analyses of carbon emissions are available, this is where they could be included.

The predicted energy collected by the solar collectors was estimated to be 21,450 KWh per annum which could be described as 'free' energy. Biomass systems are the only renewable systems that require fuel to be paid for, and this study examines the costs of the two boilers over the three to four year operation.

Energy Performance: methods employed for this investigation :

The following sets of data were available in compiling this report:

1. Amounts of wood pellets delivered in tonnes [4], [5]
2. Payments made for those deliveries [6]
3. Electricity payments for the common areas and facilities [7]

The first set of data provides the biomass energy consumption in kilowatt hours per annum, to be compared with other schemes. From the second set of data we can calculate energy costs per square metre. The final data gives the costs to the landlord of supplying electricity to the staff areas and other facilities at the scheme.

Figures for amount of wood pellets delivered to Plas y Môr for the four heating seasons from 2003 to 2007 are illustrated in Table 1, with the final column showing the total figure of tonnes delivered. Variations in delivery amounts over time reflect the fact that silos are filled alternatively according to which is full and which can accommodate a pellet load.

To work out the energy consumption based on the biomass figures, assuming a Low Heat Value:

One metric tonne of wood fuel yields 18GJ or 5 MWh of energy (equivalent to 5000 KWh).

We can then work out the amount of biomass energy used: using the financial year figures for four years since 2003*:

404.76 tonnes/4 = 101.19 tonnes x 5MWh = ***505.95 MWh per annum***

* First and last years are incomplete and represent part year values.

This figure covers all the heating and hot water requirement for the building, including the individual flats and the communal areas and facilities provided at the scheme.

Cost wise, biomass deliveries (without maintenance costs) came to a total of £48,150 over four years, giving an annual average of £12,037. With a total area of 3,500 square metres, this yields a figure of **£3.44 per square metre for heating and hot water** provision at Plas y Môr.

In comparison, predicted UK household energy use is 25MWh per annum. Multiply by the number of flats at the scheme, gives a value of **950 MWh** per annum. Plas Y Mor uses **505.95 MWh** per annum including communal facilities**.** It can therefore be seen as being very energy efficient.

Electricity costs are individually metered to every flat and are administered by different energy providers, according to tenant choice. This is confidential information not provided to the landlord, but tenants are being approached to see if they are willing to provide this information

in the future. We do however have The cost per annum of the total electricity consumed is available to Grwp Gwalia. From this figure we have calculated that the average weekly bill for tenants inclusive of all energy costs is **£5.45** including heating, lighting, cooking, hot water and appliances.

In overall terms the building has performed as well as predicted and at **505.95**MWh per annum for domestic hot water and central heating it is considerably below the national average.

This level of savings in terms of energy has been made, by the inclusion of high levels of insulation, correct orientation, a compact plan, natural and passive ventilation, and the use of active solar technologies, along with the communal biomass heating system. The fact that the flats along with common areas, share the renewable energy features also reduces demand for fossil-fuels for heating and hot water provision. The remaining energy requirement is for electricity for lighting, cooking and appliances.

7. Key points

Summarise or highlight a few of the most important points to have emerged from documenting this case.

In the three years plus of its operation, Plas y Môr has provided a warm, comfortable and airy environment for its tenants and has proved popular with both staff and residents as the space includes both natural lighting and ventilation.

The scheme has been a success in moving towards carbon neutral housing but, it will require a considerable number of additional features to achieve the Welsh Assembly Government's target of carbon neutral buildings by 2011.

Seeking approval to construct this building in 2002 was a considerable challenge, as the government was not at that time, very willing to support the costs of the environmental features of the scheme, even though, at £758 per square metre construction cost it was exceptional value for money. Today the challenge is just as demanding, for although there is now a greater willingness to embrace environmental technologies, there needs to be a massive shift in standards if the target of carbon neutral housing in Wales by 2011 is to be met.

Some lessons learnt in relation to the project include:

- Monitoring and evaluation of energy costs by way of utility bill comparisons will be required in the future. At the moment, the figures are not readily available, provision should be made to collating and archiving this data in a readily accessible form.

- Commissioning monitoring equipment for the solar thermal and biomass systems would be beneficial, as comparisons between predicted and actual use, is then possible. Keeping checks on system performance is going to be an increasingly valuable investment in the low and zero carbon economy.

- Great care must be taken in the choice of biomass boilers to ensure that they are the most reliable and efficient on the market and that they require as little manual attention as possible.

- The choice of fuel provider is critical and wherever possible, pellets should be sourced locally to reduce their carbon footprint. Users need to ensure that pellets have a moisture-content below 10% and are as near to natural as possible and correctly stored.

- A backup source of heating should be provided, that should preferably also be from a renewable source.

References

[1] The Integrated Care Scheme for the Elderly at Burry Port, Llanelli – a presentation given to the Energy Saving Trust by Phil Roberts, November 2004. (Available on www.gwalia.com).

[2] Gwalia Case Studies Report: Plas y Môr Integrated Care for the Elderly Scheme. (Available on www.gwalia.com).

[3] Plas y Môr Building Performance Review, Unpublished Draft Report, Haf Roberts, April 2007.

[4] Gwalia Finance Directorate: Figures for Plas y Môr tonnage delivered, By Financial Year 2003 – 2007.

[5] Gwalia Finance Directorate: Figures for Plas y Môr tonnage delivered, By Heating Season 2003 – 2007.

[6] Gwalia Finance Directorate: Payments for Plas y Môr pellet delivered, 2003 – 2007.

[7] Gwalia Finance Directorate: Electricity bills for Plas y Môr Day Centre and communal areas 2003 – 2007.

Questions

Size and number of images

References

Number of cases