

# **AN INTRODUCTION AND REVIEW OF THE CHALLENGES FACING A REGISTERED SOCIAL LANDLORD AND THEIR STAKEHOLDERS IN RELATION TO THE DESIGN AND CONSTRUCTION OF AN EXEMPLAR LOW CARBON, ECOLOGICAL DEVELOPMENT IN A RURAL AREA OF WALES**

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In October 2010 Pembrokeshire Housing Association (PHA) completed a development of six residential units, as part of the Welsh Government pilot project scheme to promote the development of sustainable housing in Wales. Researchers from Cardiff Metropolitan University, are working in collaboration with PHA to understand the obstacles that were encountered in developing their pilot project, and consider the effectiveness of the scheme in achieving its low carbon objectives. This paper explains the methodology and results of structured interviews that were conducted with the design and construction team considering their approach to low energy design; the development of the environmental strategy of the project; perception of obstacles to the design process; and interaction of the design with the building users. The initial results of the interviews highlight the problems associated with developing low carbon schemes to a tight budget and also suggest that there is a degree of dislocation between the design team and the end users. The broader implications of the results are discussed with regard to a three year research project to develop a best practice model to develop innovative, affordable, low carbon housing in rural areas of Wales.

Keywords: Design, Green Buildings, Housing, Post-occupancy evaluation, Sustainability.

## **INTRODUCTION**

In March 2010 Pembrokeshire Housing Association (PHA) completed a development of six residential units on Britannia Drive, in Pembroke Dock, built to Code for Sustainable Homes level four, as part of the Welsh Government Code for Sustainable Homes (CfSH) pilot project. The Welsh Government CfSH Pilot Project started in

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2008 and used a portion of the Social Housing Grant programme to support twenty two schemes throughout Wales to understand issues arising from developing dwellings to meet levels four and five of the CfSH (Welsh Government 2011). The initiative formed part of a broader strategy by the Welsh Government to move towards zero carbon construction based on the CfSH and culminated in amendments to Planning Policy, in September 2009, requiring all new housing developments of over five units in Wales to meet code level three of CfSH to receive planning permission (Welsh Assembly Government 2010). It was hoped that the exemplar pilot projects would help the industry develop the skills and supply chains required to deliver low carbon dwellings and assess the implications of building to higher standards of the CfSH. In addition, it was also believed by the Welsh Government that these projects would inform the timetable for achieving the aspiration for all new homes to be zero carbon (Welsh Government 2011a).

Funding was not provided within the pilot project initiative to investigate the differences between developing housing in urban areas of Wales compared with rural areas, such as Pembrokeshire; consider the relationship of the designers to the end users; or review whether the standards set by the initiative were being achieved in the completed buildings. An extensive on-site monitoring was envisaged as part of this scheme but was restricted due to economic constraints (Welsh Government 2011). This means that many of the project's ambitions of assessing the implications of building dwellings to higher standards of the CfSH and looking at the impacts of higher standards will have on fuel costs and carbon emissions have been largely undermined. This failure to provide widespread monitoring of the pilot projects is significant in light of increasing evidence that designs produced for low and zero carbon housing are not achieving their expected designed performance on completed buildings (Zero Carbon Hub 2010).

In order to consider how the issues of design and building performance were being addressed on the PHA's own pilot project researchers from the Ecological Built Environment Research & Enterprise group at Cardiff Metropolitan University are working with PHA to develop a monitoring programme of their scheme. This monitoring programme forms part of a doctoral research project to develop a best practice model for affordable, ecological, low carbon dwellings in rural areas of Wales. A first step in approaching the evaluation of PHA's Pilot project which reached practical completion in March 2009 is to consider the following questions:

- Are the final dwellings achieving the standards set by the design?
- What are the barriers to low carbon design in rural areas?
- What are the factors that influenced the design of the project?
- What was the nature of the relationship of the design team with the tenants?
- How successful have the designs been in meeting the user's (tenants) comfort requirements?

This paper discusses the methodology and results of structured interviews with the design and construction in relation to the questions above and provides an insight into their approach to the low energy design of the scheme. Structured interviews were also prepared for the tenants considering a range of issues including occupant behaviour, occupant attitudes, energy use, perception of comfort and interaction with building control systems but at the time of writing this paper none of the occupants have volunteered to take part in the study.

## METHODOLOGY

A combination of open and closed questions was used for the structured interview questionnaire, which were designed to last between forty minutes to an hour. The questionnaire was divided into five sections, which are as follows:

- the first section asked for contact information;
- the second investigated the participants general approach to low carbon housing design;
- the third section was specific to the pathfinder house and asked about various influences on the low carbon design;
- the fourth was again specific to the pilot project and asked about obstacles to the scheme's development;
- the final section asked about consideration for the building users in the design process.

Closed questions were used to establish the theme of each section and to provide easily comparable results and open questions were used to provide more detailed answers. Interviewees were provided with opportunities to qualify their responses to the closed questions at the end of each section; however, in practice, as the interviews were recorded, the interviewees generally explained their answers as they responded to each question.

This approach of using open and closed questions can be criticised for making the examination of results more difficult and there is evidence that using a combination of open and closed questions can mean that interviewee's shorten their responses to the open questions (Vitale et al 2008). However, in practice it provided a useful means to raise points in structured manner that the interviewee might not have otherwise considered. This approach proved particularly effective with regard to questions about the relationship of the design team with the building users.

A seven point Likert item approach was employed for the closed questions with interviewees asked to rate various factors such as, for example, 'whether they saw planning policy as an obstacle to development' from 1("None at all") to 7 ("A lot") (Johns 2010). The open ended questions were generally related to the closed questions and asked questions such as 'Do you think that user behaviour will be a significant factor in the energy efficiency of the pathfinder houses since construction?' To overcome some of the problems of consolidating data generated by open and closed questions the software package NVivo was used to analyse the results.

The small sample of seven key members of the design team allowed one to one interviews to be employed to gather information for this stage of the research. The interviewees included the following professionals:

- Development Officer
- Quantity Surveyor
- Architect
- Mechanical Engineer
- Electrical Engineer
- Clerk of Works
- Contractor

Because of the ongoing nature of the research with PHA the interviewer had met most of the interviewees on previous occasions. The fact that the interviewees were aware of the research could well have resulted in some social desirability bias in responses (Marlowe and Crowne 1961) and there is evidence that it is socially desirable to be seen to promote sustainability in the work place (Payne and Raiborn 2001). However, given the context of the research project it would have been difficult to design social desirability bias out of the questionnaire and there is evidence that researchers who are familiar with their respondents can arrive at a level of understanding that will result in their answers being more honest (Miyazaki and Taylor 2007).

It was recognised in preparing the questionnaires that the specific nature of some of the questions and the broad nature of the different disciplines in the design team may mean that not all of the participants would be in a position to answer the questions to the same level of detail. This aspect of the data gathering would be difficult to design out and, for example, another approach might have been to prepare separate questionnaires for each one of the different disciplines each individually catered to their approach. However, this would have been time consuming to prepare and, more importantly, would have made comparison of results difficult.

## **RESULTS**

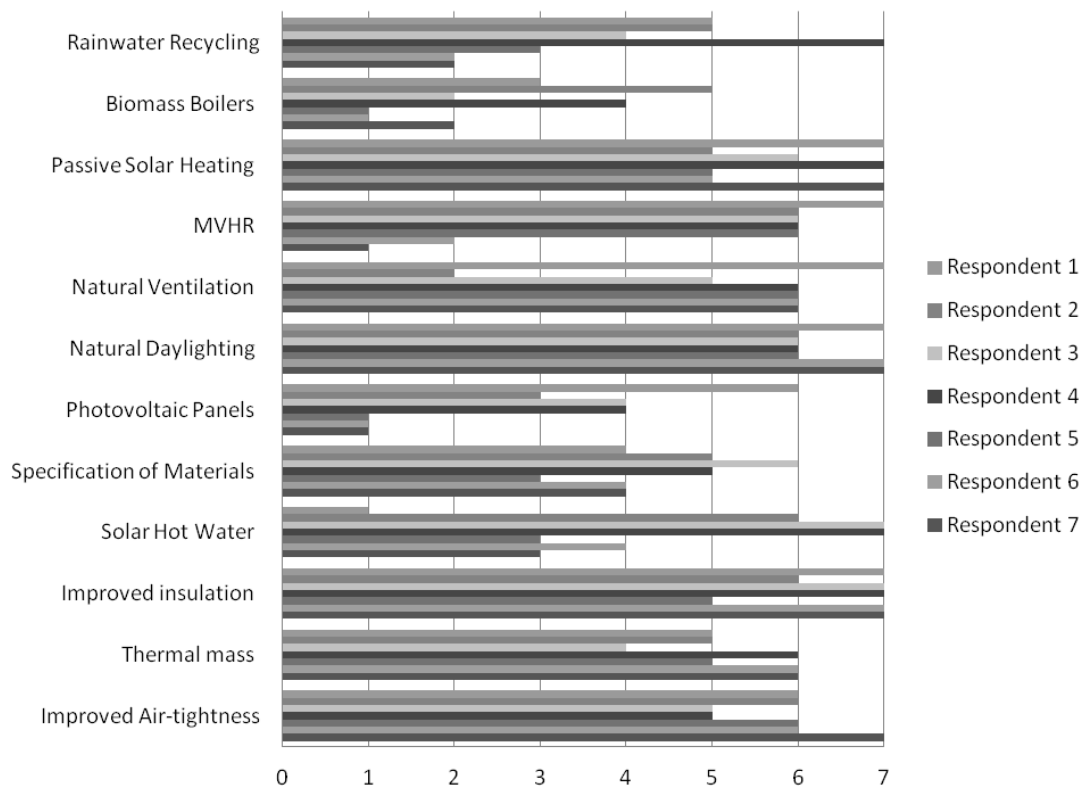
As mentioned in the previous section, the nature of the interview topic meant that there was potential for social desirability bias; however, the evidence for this is limited to some of the responses in the last section about consideration for the building users in the design. For example, a socially desirable response was evident in the answer to the question of ‘whether user attitudes were a consideration in design process?’ One interviewee answered that ‘I would like to say yes but I am just trying to think where we actually applied that to our design process - I would say yes.’ Un-evidenced responses, such as this, especially when they go conflict with other answers, suggest that in this case the interviewee was providing a socially desirable response.

With regard to acquiescence bias, whereby the interviewee has a tendency to agree with all the questions or indicate a positive connotation, there is some evidence of this from one of the participants. However, the acquiescence bias of this participant appears to be limited to sections three and four.

### **General Approach to Low Carbon Housing Design**

With regard to the initial questions about the interviewees general approach to the design of low carbon housing and what they considered as cost effective approaches there was a high level of agreement, which is interesting considering the range of disciplines interviewed. Virtually all of the participants rated passive solar heating, natural ventilation, natural daylighting, improved insulation, improved levels of airtightness and thermal mass as cost effective measures with ratings of five or higher in the closed questions (see chart one below). The fact that there was so much agreement on the cost effectiveness of these passive design approaches in the development of low carbon housing raised the question with the interviewer of why these approaches had not played a greater role in the exemplar project which relied on photovoltaic panels (PV) to achieve CfSH level four.

Chart 1: Perception of the relative cost effectiveness of various design approaches to achieve low carbon housing



As previously mentioned, PV played a considerable part in the pilot project achieving CfSH level four; however, the closed question responses gave this technology the second lowest overall score of all the options presented. However, as the interviews progressed the justification for using PV on Britannia Drive became apparent in responses such as the one below:

*“That’s [referring to PV] better for the housing association because of feed in tariffs - if we can ever get them sorted out. So I would say that’s a win win for the both housing association and end user so I would rate that quite highly.”*

In addition, it was apparent that various members of the design team saw PV as suitable for social housing projects, for its ease of use and the fact that it requires little or no interaction with the tenants. This was explained in one of the responses below:

*“the reason why we got to PV and solar was because we considered that you could have other systems there; you open up the cupboard and it’s like a NASA control centre and they’ll [the tenants] just shut the door and say oh my God what’s that - its like their worst nightmare.”*

With regard to other approaches biomass scored the lowest and there was a mixed response within the design team about the cost effectiveness of technologies such as rainwater harvesting and solar hot water. As might be expected, there was some differences in the interviewee’s experience of the technologies and approaches offered, with some participants having had first hand experience of these technologies and approaches and others merely having read about them in industry publications which had to be considered when examining the results.

## **Influences on the Low Carbon Design of the Pilot Project**

With regard to the various influences on the low carbon design of the project and its location in Pembroke Dock there was a high level of agreement that the locality of the scheme was not a significant influence. The response from the design team to the question of whether the rural location of the project had been important was that they did not consider the setting of the scheme as especially rural. Several of the responses pointed out that the availability of mains gas was a significant factor in defining a project as rural and one interviewee explained that the availability of mains gas at Pembroke Dock was probably influential in the site being used for the pilot project:

*“I think that if it was any more rural as in outside of an area served by gas it would never have been picked as the pilot scheme to achieve code four because it’s too difficult with oil or other forms of heating.”*

There was general agreement among the interviewees that the houses designed for Britannia Drive did not differ significantly from conventional houses developed by PHA. A number of interviewees used the question of whether they saw the houses as significantly different to a conventional scheme by PHA, as a means to describe, and in some cases justify, the approach that had been taken, as explained below:

*“I would say that it doesn't differ greatly... Which is in a sense a good thing because you haven't got to push the boundaries and do silly things. You can do the low carbon solution with just standard kind of approaches. Obviously the M&E isn't standard any longer - but all the building form can be very similar.”*

Experience of the design team on an earlier low carbon scheme, that went significantly over budget appears to have contributed to a desire not to deviate from their typical approach and was referred to by a number of interviewees in reference to the pilot project. Nevertheless, it is interesting that a micro-renewable led design strategy was adopted to meet the project's low carbon aspirations despite there being debate within the construction industry about the merits of this approach (Energy Saving Trust 2010). Several interviewees gave detailed accounts of the micro-renewable led approach and why it was adopted on the Britannia Drive scheme:

*“ I think the way we approached it [was] a little like stepping into the unknown - going from the BREEAM standard of Eco homes... we stuck with our traditional 140 stud so the fabric of the building and the general details didn't change too much. What we looked upon was the eco-bling... to achieve code four taking our standard unit and possible looking at... [adding] the PV system and an efficient gas boiler.”*

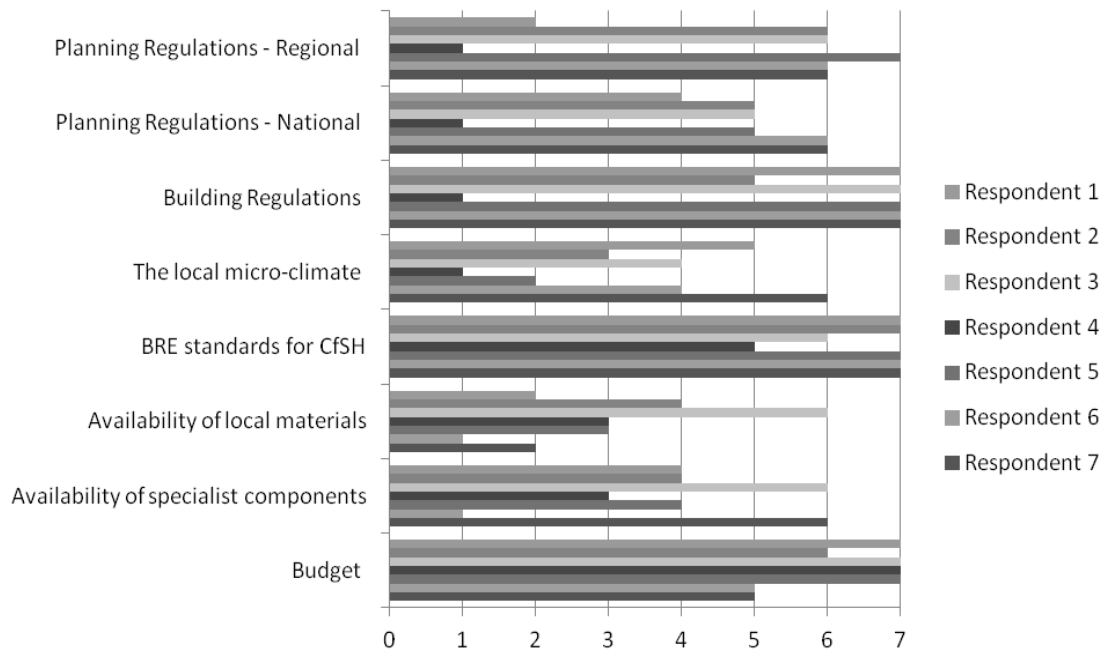
As discussed above, there has been debate within the construction industry about the viability of micro-renewables led approach and these arguments were reflected in the responses of the design team. While some interviewees defended the approach that was taken on the project, others were more critical explaining that if the PV failed for whatever reason it would undermine the environmental strategy of the scheme:

*“But you think that it has achieved code four it’s just with the bolt-ons, with all the PV - it’s not really which the right approach - is it? Because if the PV fails the house doesn't perform with regard to code four and all the aspirations.”*

Chart Two below illustrates a high level of agreement that the building regulations and the CfSH were significant influences on the development of the low carbon design of the pilot project; however, the budget stood out as the most important factor. This was an interesting response for a project that was supposed to be designed as an

exemplar low carbon scheme, but perhaps representative of the issues facing the development of low carbon housing by Registered Social Landlords and the difficulty of developing low carbon dwellings within the social housing budget was recognised in the Welsh Government Pilot Project Interim Report (Welsh Government 2011).

*Chart 2: Perception of the influence of various factors in the development of the low carbon design of the pilot project houses.*



The significance of budget on the development of the scheme was an aspect of the design that all of the interviewees felt was worthy of comment and the importance of the social housing budget in the approach of PHA to development is discussed in the quote below:

*“Affordability is really at the forefront of thinking in most cases. We operate on very tight margins - I mean our main source of income is obviously the rent which is often bench marked... our grant funding comes conditioned with meeting DQR and the code and everything now I think... budget is really something which we...[it] is a big issue.”*

From the response to questions about the influence of various factors on the development of the low carbon design of the pilot project it was apparent that one of the chief drivers for adopting a micro-renewables led approach was that it was seen as simple, cost effective means to achieve CfSH level four. This initial finding was confirmed in the next section where obstacles to the development of the pilot project were considered.

### **Obstacles to the Development of the Pilot Project**

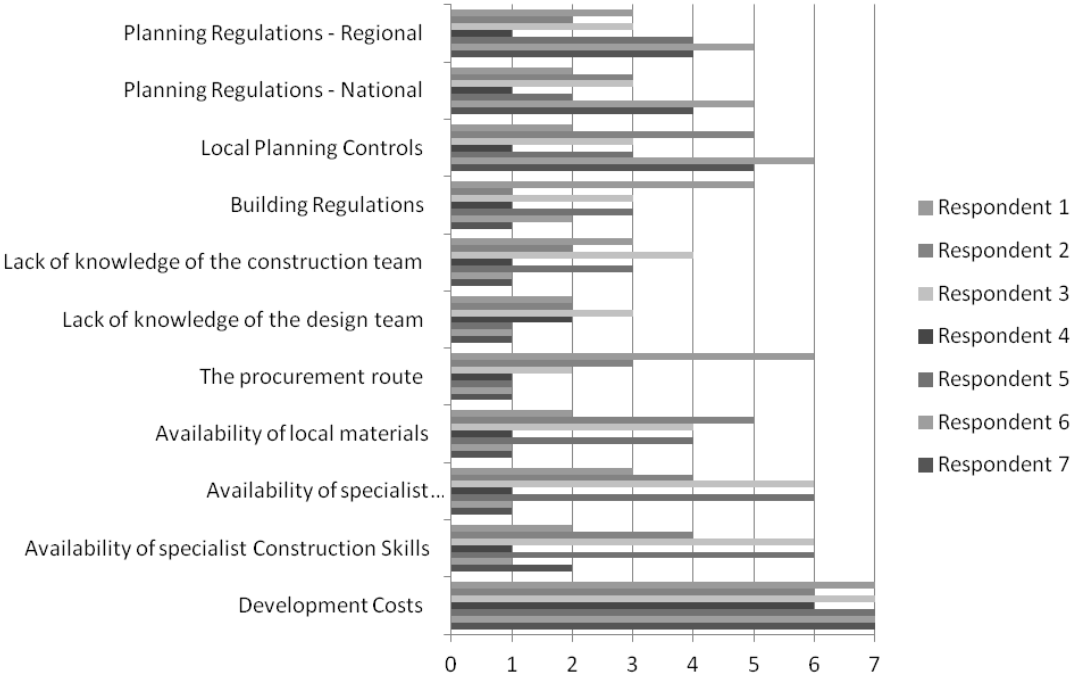
With regard to questions on obstacles to the development of the pathfinder houses, in contrast to the answers in previous section, there was evidence that interview responses were more contextualised. Answers appeared to be much more influenced by the role of the interviewee in the design team and their professional background. However, as with the questions about influence on the design strategy, it was apparent that there was a consensus on the role of the budget which was perceived as the chief obstacle to development (see chart three below). Additional anecdotal evidence about

the importance of developments costs was provided by the fact that Development Officer and Quantity Surveyor's responses to the closed question were very similar in this section suggesting a degree of accord between the project leader and the professional charged with ensuring that the project is within budget. A detailed explanation for the reason why development costs can be a significant obstacle was provided in the response below:

*“I'd say development costs are often an obstacle on all schemes that we deal with. The problem we have, if I can elaborate on that, is that a lot of the land that we source tends to come predominantly from the local authority - former garage sites scrappy bits of land which have often not been developed for the reason that from time when the local authority used to develop housing it was often deemed to be undesirable. Consequently we have a lot of abnormal costs with developing these sites.”*

With regard to the other responses to questions about obstacles to the development of the pilot project it is more difficult to find a clear consensus. Lack of knowledge of the design team was not perceived as an obstacle and most interviewees, with the exception of the Clerk of Works, did not perceive the procurement route (which was design and build) as a hindrance to the development of the scheme. The role of planning controls as an obstacle had a mixed response as did the role of building regulations and, as explained above, these responses often had a professional context.

Chart 3: Perception of obstacles to the development of the pathfinder houses



Only the Quantity Surveyor and Development officer, and to a lesser extent the Architect perceived a lack of skills and availability of specialist materials to be an obstacle on this project. This was in spite of problems gaining Micro-generation Certification Scheme (MCS) accreditation for the PV to take advantage of the feed-in-tariff. The experience of getting a suitably qualified contractor to install and commission the PV, which is a fundamental element of the low carbon strategy, would support the case for a lack of skills. The problem with regard to taking advantage of the feed-in-tariff, and it's implications in gaining revenue, is described below:



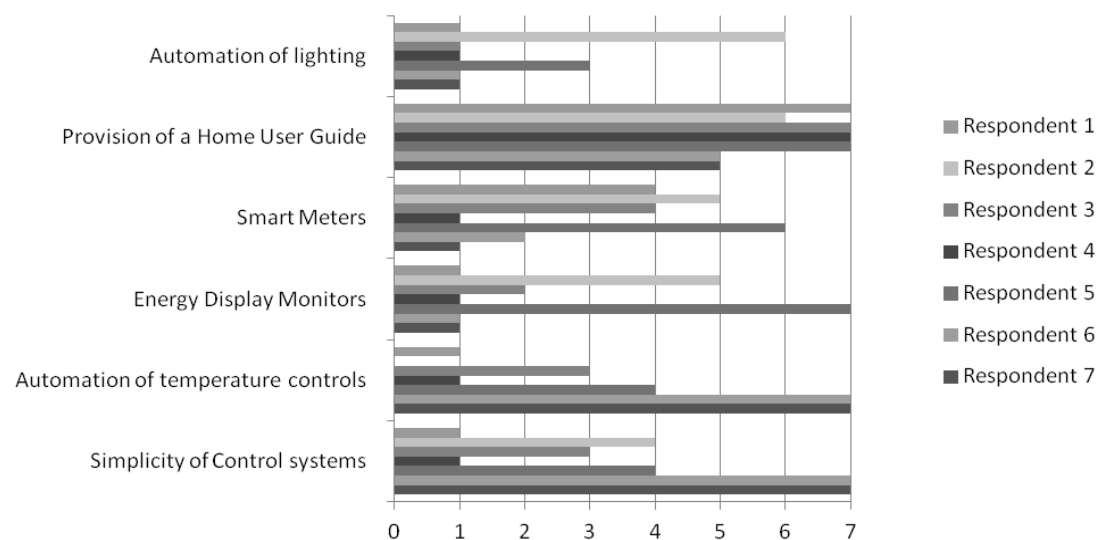
*“I suppose at Britannia the problem we have... we didn't have the MCS accreditation at the time and we are now sourcing that through another contractor so I guess we have now missed out on twelve months of generation tariff so hopefully once we get the other contractor and get certified, we've had all the quotations in now, get the generation meters fitted; then yes we will see some payback on it.”*

The difficulty in gaining revenue from the feed-in-tariff suggests that in the short term one of the advantages of adopting a micro-renewable led approach has been partially undermined. In addition, an issue surrounding the installation of the photovoltaic panels on a scheme that is dependent on its micro-renewable technologies to meet its low carbon objectives raises questions about their performance; however, further monitoring would be necessary to confirm their effectiveness.

### Consideration for the Building Users in the Design Process

It was apparent from the answers in the final set of questions that, aside from provision of a home user guide, the consideration of many aspects of user behaviour had been neglected in the design of the pilot project. Of the thirty-five answers provided by all of the participants in this section fifteen were given a one rating meaning that the interviewee believed that the particular item had not been considered at all. In addition, as mentioned previously, there was evidence that positive responses were given in a number of cases because it was socially desirable and in one instance the interviewee refused to answer a question, citing the fact that he felt that it was outside of his field of expertise.

*Chart 4: Consideration of user behaviour in the development of the pilot project houses*



Even where some aspects of interaction of the design with the building users had been considered, such as simplicity of the control systems, there was debate about just how effective these measures had been. The statement was made that ‘we try and make things as user friendly as possible, we avoid as many controls and gadgets - things that can be messed with and altered’. However, there was still a belief by those members of the design team that interact with the tenants’ post-practical completion that control systems were still too complicated. This opinion is expressed below:

*“You've got central heating systems where we're zoning upstairs from downstairs because we get an extra point for the code if we've got them as two separate systems;*

*but then we've got a digital control... in the sitting room for the downstairs and then we've got another digital control in the kitchen that runs the upstairs with a separate room stat upstairs and its just far too complicated to get people to understand and the water's controlled off one for both but the heating is controlled off two separate ones and they're not the same make... well they're the same make but they're not the same model so its far too complicated."*

As suggested by the quote above, several interviewees questioned whether focusing on the requirement to achieve CfSH level four to meet the pilot project objectives had led to the neglect of consideration of the users as part of the energy efficiency strategy. The opinion that focusing on achieving CfSH requirements by the most cost effective means had led to the neglect of some fundamental low carbon design considerations was reflected in other comments, such as the one below:

*"The only reason why they're putting them in [energy saving technologies] now is because they can't achieve the code for sustainable homes - they can't achieve the ratings without putting them in and that's driving it rather than anything else. Rather than thinking well if we put them in it would be better for our tenants... I think we're designing it to achieve a code pass and that's what I was saying earlier about they need to rethink the whole design for it to start including some of these things into the design... light levels and laying the site out to work best with the way the sun is shining... you need to start doing that to make some of this stuff work - the more cost effective stuff"*

Whatever the validity of the criticisms above they do mirror the remarks of some commentators that the CfSH's focus on reducing emissions rather than energy saving make micro-renewable led approaches more desirable often to the detriment of passive design approaches (Climate Works 2011).

## **CONCLUSION**

The results of the interviews highlight the problems associated with developing low carbon schemes on a social housing budget and also suggest that even on exemplar schemes, such as the one described in the paper, that affordability can be the primary concern. No doubt part of this concern was derived from earlier unsuccessful low carbon schemes; however, there is evidence that budget will be a significant factor in the development of low carbon dwellings in England and Wales (Osmani M and O'Reilly A 2009). The results of this paper indicate it is likely that many housebuilders will take a path of least economic resistance in the development of these schemes (Ibid) and thus the micro-renewable led approach taken by PHA on this project could be representative of future affordable housing as long as the focus of legislation remain on reducing emissions rather than energy saving. There is evidence that in the development of Welsh Building Regulations that this issue will be addressed and the Welsh Government Policy Document explains that the objective will be reducing demand through passive measures such as an efficient fabric before consideration is given to renewable generation (Welsh Government 2010b).

A number of interviewees expressed the opinion that some approaches to low carbon design that could have produced significant energy saving were neglected in the development of this project. From the interviews, it was apparent that budget restraints and adherence to the CfSH did go some way to answering the question of why passive design approaches, which had been considered cost effective by most members of the

design team, had been ignored in the final design solution in favour of micro-renewable led approach. However, it is also true that many of the participants maintained that the approach that was taken was the most suitable given the constraints of the project. Ultimately the success of the micro-renewable led approach adopted by PHA can only be confirmed by further investigation, including interviews with the tenants and building performance monitoring which would provide the opportunity to benchmark the scheme against its own aspirations and other similar projects that have taken a fabric first approach to meet their low carbon objectives.

Although the project is located in a rural town in Pembrokeshire there was a perception among the design and construction teams that because the site had access to mains gas rather than solid fuel that this project was not fully representative of the issues facing developers in rural areas of Wales. In part, this response could be explained by the relative experience of the members of the design team and the fact that, generally, the scope of their businesses does not extend to the more metropolitan areas of south Wales, such as Swansea or Cardiff. However, this result is significant for the development of a best practice model for affordable low carbon dwellings in rural areas of Wales because it raises questions about what constitutes a rural project. One of the biggest obstacles mentioned in interview responses was the availability of gas in an area and initial evidence suggests that the availability of mains gas will be a significant factor in defining an area as rural, in the context of the research project, and a significant obstacle to low carbon development (Baker 2011).

The results indicate that beyond the requirement of the CfSH to provide a home user guide little consideration is given to user behaviour in the development of the design this is despite evidence that the building users can play a considerable part in the energy efficiency of a project (Combe et al 2011) and that design can be a tool to influence user behaviour (Lockton et al 2009). The results suggests that there is a degree of dislocation between the design team and the end users that means that even when the professionals believe that they are delivering simple user interfaces they can nevertheless be too complicated for the occupants.

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