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One Planet Living – A better way to produce sustainable buildings?

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Abstract

This research examines the One Planet Living initiative (OPL) developed by the charities BioRegional and WWF as a tool to guide the development of sustainable communities. It appraises the targets of OPL, highlighting disparities between it and more established Environmental Assessment Methods (EAM's), to assess the effectiveness of this approach at producing communities where resource use can be limited to a 'one planet level'. As part of the research, a post-occupancy-evaluation of the One Brighton development, the first fully-endorsed One Planet Community to be built in the UK, is undertaken using primary energy data collected from the development.

The paper concludes firstly that using OPL can create buildings with lower energy consumption than those produced using other EAM's; it also goes beyond the limits of building design to influence the behaviour of inhabitants. Secondly the paper concludes that, whilst showing potential, the One Brighton development must make improvements in the future to fully satisfy the One Planet Living targets.

Keywords: One Planet Living, Post-Occupancy Evaluation, Environmental Assessment Methods

1.0 Environmental Assessment Methods (EAM's)

EAM's are the primary means of ascertaining the environmental performance of new buildings. However, research indicates that a gap generally exists between the predicted and actual performance (RIBA/CIBSE, undated). This can be due to a myriad of factors, including inaccurate energy modelling and unexpected usage patterns. There exists a real danger that new buildings will always under perform and that the reduction in CO₂ levels required to avoid catastrophic climate change will not be achieved. As this performance gap is known to exist, it is apparent there are problems with the assessment methods being used and difficulties in getting reality to meet prediction.

This paper examines a less well-established approach to guiding building design towards more sustainable outcomes – the One Planet Living initiative. The hope is that this approach can produce better buildings in the future, in order that the carbon reduction targets set worldwide can begin to be met. A case study of a development built to satisfy the One Planet Living initiative (OPL) is examined in order to establish whether OPL is able to convert its aims into reality and whether the case study can be considered a success on which to model future developments.

2.0 Development of the One Planet Living initiative (OPL)

The BedZED development was completed in 2002 and is the UK's best known 'eco-village'. As Hodge & Haltrecht (2009) report, the development was designed to reduce heat losses, energy demand and the ecological footprint of its residents. The One Planet Living initiative was developed as a result of BedZED and consists of ten

principles against which future projects can be measured: Zero Carbon, Zero Waste, Sustainable Transport, Sustainable Materials, Sustainable & Local Food, Sustainable Water, Land Use & Wildlife, Culture & Heritage, Equity & Local Economy and Health & Happiness.

3.0 One Brighton

One Brighton, the case study examined in this paper, is a mixed-use development in the New England Quarter of Brighton. It was completed in 2010 and is the first community in the UK to be fully endorsed as a One Planet Community. Communities can be certified if they commit to achieve all of the OPL targets. The developer behind One Brighton was 'Crest Nicholson BioRegional Quintain LLP' with Feilden Clegg Bradley Studios as the appointed architects.

4.0 Comparison of OPL with the Code for Sustainable Homes (CSH)

CSH is the national standard within the UK for the sustainable design and construction of new homes (Code for Sustainable Homes, 2012) and became mandatory in 2008 for all publicly funded new dwellings. This widespread adoption of CSH makes the scheme an important reference point for OPL to evaluate the latter's potential as an environmental assessment method.

The question that remains about OPL is whether its unifying approach is specific enough to be workable in practice. Unlike CSH which records a final evaluation of the project post-construction, but not post-occupancy (DCLG, 2010), the OPL initiative includes an annual review as part of its process. This should help to mitigate some of the problems found with the difference between CSH in theory and in practice and indicates a more reflective attitude to encourage continual improvement.

The following section discusses how OPL and CSH compare on their approach to assessing/controlling carbon emissions and energy consumption. This analysis forms part of a more broad study in which the two standards were compared on a greater number of criteria.

5.0 Carbon Emissions

Carbon emissions and energy use are inherently intertwined, with one being an indication of the other. OPL requires buildings to be zero carbon by the year 2020 (BioRegional Development Group, 2011), defining zero carbon as follows:

- All buildings shall be powered and heated by renewable energy only (to be supported by minimising energy demand and providing an efficient building fabric)
- Energy efficiency levels must meet country-specific best practice standards.

This corresponds with the recommendations of Delay et al (2009) that all cost effective energy efficiency potential should be exploited before 2020 due to increased scarcity of oil beyond this point.

The criteria for the Code for Sustainable Homes' Energy and CO₂ Emissions category is outlined in the CSH Technical Guide published by DCLG (2010). The requirements to satisfy the highest levels are detailed below:

- Level five of CSH requires at least a 100% improvement over the requirements of the Building Regulations. Level six requires there to be zero net CO₂ emissions.
- Fabric energy efficiency must be calculated using SAP software. The minimum standards for levels five and six are 39kWh/m²/year (apartments or mid-terrace) or 46kWh/m²/year (end-terrace, semi-detached or detached), which equates to an 80-

85% reduction in energy use and CO₂ emissions over the current UK housing stock (May et al, 2009b).

CSH uses the definition of zero carbon as defined by the UK government; this was originally intended to be 'net carbon emissions from all energy used to be zero or better' (DCLG, 2006). However, after consultation the targets were diluted on grounds of cost, as highlighted by McLeod et al (2012). Currently the definition allows for 'allowable solutions' to be carried out (or funded) off-site, in order to offset the emissions caused and achieve a net total of zero carbon emissions (DCLG, 2008). Reliance on a national standard developed in conjunction with various parties with vested interests is questionable, as business leaders rarely consider environmental concerns to be as important as their profit margins. As OPL is used internationally it does not use a specific benchmark, although it does state that country-specific best practice standards should be obeyed. The following sections contain analysis of how the One Brighton project is performing in practice which acts as an indication of whether the OPL approach is effective.

6.0 Zero Carbon

This section contains analysis of the following:

- Energy used for heating and hot water
- Electricity used
- Comparison of the sources of energy used for heating and hot water

6.1 Heating and hot water

OPL aims to limit the energy used for space heating and hot water provision. The graph below indicates the energy expended on these outputs.

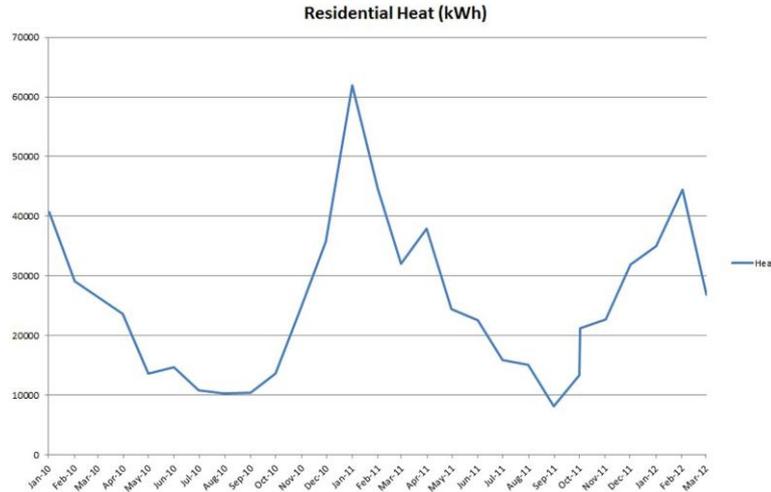


Figure 1. Residential heat consumption at One Brighton

From the graph, the following observations are noted:

- The lowest monthly load was 9000kWh which was during summer. As space heating should not have been required at this time, it is assumed this figure represents the hot water requirement for the development.
- The heat demand peaked in December 2010 at approximately 60,000kWh per month, corresponding with the coldest month of the year.
- The average annual energy requirement calculated from the data supplied was 1637kWh per dwelling (there are 172 dwellings in the development) for the period April 2011 to March 2012.
- The average consumption was 30.8 kWh/m²/year.

Benchmarks used for gas consumption are as follows:

- Ofgem, the energy supply regulator, (2011) states the typical consumption figures for gas as 16,500kWh per year for domestic buildings in the UK. One Brighton should be more energy efficient than this average figure due to more stringent modern building regulations and the design approach which aimed for improved performance over and above the requirements of the Building Regulations.
- DECC (2011b) has calculated average consumption of gas within each local authority and states Brighton's average as less than 16,000kWh. This is lower than Ofgem's average figure, and is likely to be due to its location in the south of England which has a milder climate than other areas in Britain (Met Office, undated).

The target for space heating and hot water requirements were set at 75kWh/m²/year in the sustainability action plan for the project (BioRegional Quintain, 2006). One Brighton is therefore performing at a much lower energy consumption for heating and hot water than the average figures. 1637kWh represents a 90% reduction on DECC's average figure given for the Brighton area. The development is also performing better than the aim set at the project outset, consuming only 30.8 kWh/m²/year for residential heating and hot water. This is an improvement of almost 60% over the target value.

6.2 Electricity Usage

OPL also aims to limit energy expended in electricity consumption. The graph shown below indicates usage patterns from January 2010 to March 2012.

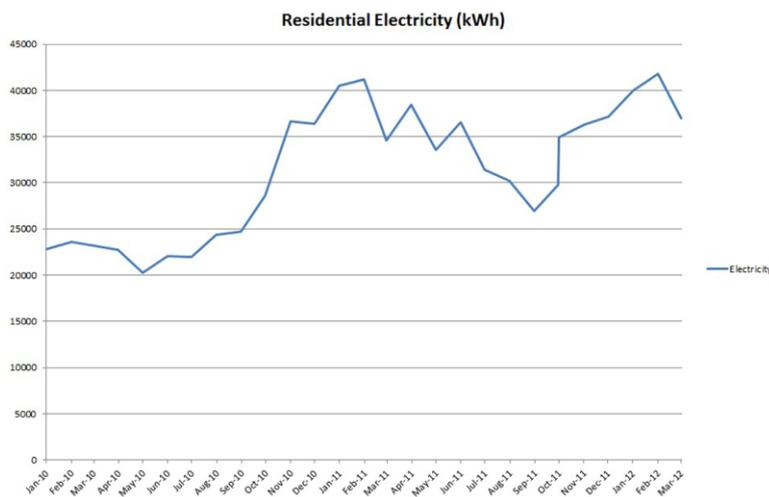


Figure 2. Residential electricity consumption at One Brighton

Observations from figure 2:

- The graph indicates a general rise in the use of electricity since 2010
- Electricity loads have averaged approximately 34,000kWh per month over the past twelve months, up until March 2012.
- The average quantity of electrical energy consumed annually has been measured at 2841kWh for the period April 2011 to March 2012.
- The average consumption was 53.5kWh/m²/year.

Benchmarks used for electricity consumption are as follows:

- Ofgem (2011) states typical UK electricity consumption levels are 3300kWh per year.

- A review undertaken by DECC (2011a) indicates that properties in the Brighton area have an average consumption of less than 4000kWh per year. This figure was based on data from a 2009 study, therefore Ofgem's figure is more current.
- The target for electricity consumption was set at 45kWh/m²/year in the sustainability action plan for the project (BioRegional Quintain, 2006).

In interview, Butler (2012) indicated that the increase in electricity demand from 2010 onwards could be due to more dwellings being occupied. Even considering this increase, average consumption at One Brighton of 2841kWh per year represents a 14% reduction from Ofgem's stated average electricity consumption for the country. However, though successfully beating Ofgem's figure, the project has not yet satisfied the OPL target for electricity consumption. The actual consumption has been calculated at 53.5kWh/m²/year which exceeds the OPL target by 19%.

6.3 Comparison of the energy sources providing heating and hot water

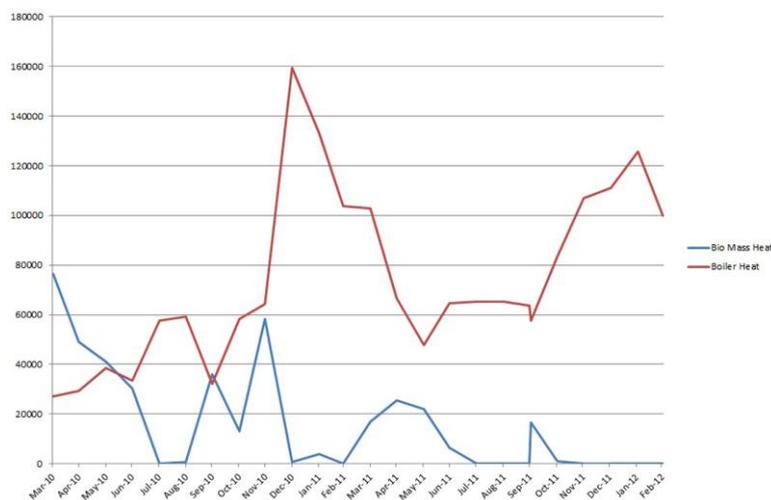


Figure 3. Graph indicating the amount of energy used for heating and hot water for the residential blocks at One Brighton which is supplied via biomass and gas boilers.

This graph compares the sources of energy used for space heating and hot water at One Brighton. The strategy set out by the OPL targets is for renewable energy (in this instance biomass) to be used as the main supply with fossil fuels (gas) as backup. However it can be seen that gas use outweighed the use of biomass for the majority of the year. Desai (2012) indicated there had been some problems with the operation of the biomass boiler since completion. Problems with fuel suppliers had led to the boiler being converted from woodchip use to wood pellet, which required it to be re-commissioned.

The document *Conversion factors* (Carbon Trust, 2011) provides values for the carbon equivalent content of various fuels. For natural gas this value is 0.1836 kgCO₂e/kWh, for wood pellets it is 0.039 kgCO₂e/kWh which is a significantly lower value. This comparison shows that One Brighton is more likely to achieve its target of zero carbon if the biomass boiler can be kept fully operational. Using these coefficients, the use of gas at One Brighton has caused an extra 138,496 kgCO₂e to be emitted than if biomass had been used in its place.

However, the carbon coefficient used for biomass has been questioned by the AECB; Grant & Clarke (2010) highlight that the figure of 0.039 kgCO₂e/kWh takes into account carbon sequestration as the biomass is grown; this offsets the carbon emissions during combustion resulting in the figure being less than gas. If the biomass

was not burned and gas used instead, the carbon sequestration effect from the biomass would still exist and would offset the carbon emitted from combustion of the gas. As gas emits less carbon during combustion than biomass, this would result in lower carbon emissions overall.

7.0 Conclusion

It is felt that the use of OPL is likely to result in more sustainable solutions, partly due to the fact that OPL takes a long-term approach, specifying what must happen by 2020 for a number of factors that are outside the scope of CSH. It then makes the commitment to manage the process of achieving these factors once building work is complete. In this, OPL will not only provide better buildings, but will also act to guide the behaviour of residents toward a more sustainable lifestyle. The One Planet Living initiative is therefore considered to have the potential to be a superior environmental assessment method that will produce more sustainable buildings.

The analysis in section 6.0 indicates that although One Brighton has achieved its targets for consumption of energy used for space heating and hot water, it has not yet achieved its targets for electricity consumption, with a trend for increasing consumption over the past year. The unreliability of the biomass boiler has also potentially caused many more greenhouse gases emissions and has meant the target to use only renewable energy has not been met. However, although One Brighton does not yet meet the targets required to fully satisfy OPL, it is felt that the annual review process inherent to the standard will lead to the targets being met over time.

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