Passivhaus cost comparison in the context of UK Regulation and prospective market incentives

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Figure 1: PH Certified Larch House (left) and PH Certified Lime House (right) in Ebbw Vale, Wales.

1 Introduction

The Larch and Lime houses in Ebbw Vale, Wales, were bere:architects' first attempt at producing low cost social housing for the UK, and also one of our first attempts at achieving Passivhaus certification. Now fully certified, the performance of each house is being monitored with UK government funding from the Technology Strategy Board's 'Building Performance Evaluation' program [TSB 2012]. Co-heating and tracer gas tests carried out as part of the evaluation process have given early indications that the houses are performing closely in line with, and in the case of the Larch house, slightly better than the PHPP design predictions [WSA 2011].

These initial results can be seen to provide encouragement for UK housing providers wishing to consider Passivhaus construction for their future low energy buildings. However for Passivhaus to be taken up by housing providers and others, it must be seen to be commercially viable. This study therefore aims to provide some elemental line-by-line cost data to compare one of these houses (the smaller two bedroom Lime house) with an equivalent house designed to current minimum standard UK building energy performance regulations [HM Government 2010].

2 Method

The case study building is the Passive house certified Lime House, which is the smaller of the two. The building fabric was designed to meet a 10W/m2 heating load in an exposed heads-of-valley microclimate, 300m above sea level. The building was designed using 10 year worst-case weather data, as a precautionary client condition in order to address perceived risks associated with its extreme UK climate. It has however since been proposed by [Bere 2011] and subsequently supported by PHI that such an approach was “far too pessimistic, which led to insulation levels and other component properties of much higher quality than necessary”.

(1) So the Passivhaus model specification was adjusted to the ‘GB Manchester’ standard weather data set, thought to be suitably representative of the UK average climate for the purposes of the research. The specification of the model house was reduced to meet the Passivhaus ‘optimum’ heat load of 10W/m2. This became the ‘Lime House mean-climate’ test model (see Figure 2).

(2) A second test model was subjected to further reductions in fabric performance to create a building which ‘just’ met the fabric criteria of Part L 2010 UK building regulations. Junctions were also adjusted to reflect typical UK construction practice using ‘accredited construction details’ from government guidance [HM Government 2010] (see Figure 2).

(3) The two building models were then subject to independent cost analysis by e-Griffin Consulting using standard RICS elemental cost protocol. The summary of this line by line analysis is presented in the results table overleaf (see Figure 3).

	Lime house – Ebbw Vale as PHI certified	**(1) Passivhaus Test Model (mean-climate optimised)**	**(2) Regulation Test Model (UK Part L1A 2010)**
Climate data	Ebbw Vale - 10 year worst	GB Manchester	GB Manchester
Treated Floor Area (TFA)		69.1m^2 TFA, Gross internal area 78m^2 (used in RICS elemental cost summary)	69.1m^2 TFA, Gross internal area 78m^2 (used in RICS elemental cost summary)
U-Values	Floor 0.076 W/(m^{2}K) Walls 0.095 W/(m^{2}K) Roof 0.068 W/(m^{2}K)	Floor 0.103 W/(m^{2}K) Walls 0.154 W/(m^{2}K) Roof 0.089 W/(m^{2}K)	Floor 0.246 W/(m^{2}K) Walls 0.285 W/(m^{2}K) Roof 0.200 W/(m^{2}K)
Heating load		10W/m^2	57W/m^2
Ventilation		Balanced PH Ventilation, 0.04 h^{-1}@50Pa	Pure extract air 15 h^{-1} @50Pa (9.88m^3/(hm^2)eq
Cold bridges		Ψ 0.019 to-0.060W/(mK)	Not calculated
Ext. wall construction		Lime rendered fibre board Timber frame w/ mineral wool Air tightness membrane Sheep’s wool in service void Fermacell and skim	Ventilated brick cavity Timber frame w/ mineral wool Polythene vapour check Uninsulated service void Plasterboard and skim
Final energy- Gas		3489.92 kWh/a	13438.94 kWh/a
Final energy- Electricity		1212.47 kWh/a	989 kWh/a

Figure 2: PHPP model specifications of (1) Passivhaus fabric (2) UK 2010 Building Regulation fabric

3 Results

Elemental Summary	(1) Passivhaus (mean-climate)		(2) UK Reg Part L 2010	
	One-off Cost (£)	% of Cost	One-off Cost (£)	% of Cost
1 SUBSTRUCTURE	**7392.49**	**6.4**	**6710.51**	**6.7**
1.1 Foundations	1159.76	1.0	3501.43	3.5
1.2 Basement excavation	0.00	0.0	0.00	0.0
1.3 Basement retaining walls	0.00	0.0	0.00	0.0
1.4 Ground floor construction	6232.73	5.4	3209.08	3.2
2 SUPERSTRUCTURE	**55342.53**	**47.7**	**45055.33**	**45.1**
2.1 Frame	14601.60	12.6	13863.58	13.9
2.2 Upper Floors	341.45	0.3	341.45	0.3
2.3 Roofs	5211.82	4.5	4424.28	4.4
2.4 Stairs	546.00	0.5	546.00	0.5
2.5 External Walls	11336.03	9.8	7784.61	7.8
2.6 Windows and External Doors	16451.46	14.2	11241.24	11.2
2.7 Internal Walls and Partitions	4274.64	3.7	4274.64	4.3
2.8 Internal Doors	2579.54	2.2	2579.54	2.6
3 INTERNAL FINISHES	**11401.24**	**9.8**	**11401.24**	**11.4**
3.1 Wall Finishes	4569.72	3.9	4569.72	4.6
3.2 Floor Finishes	4376.12	3.8	4376.12	4.4
3.3 Ceiling Finishes	2455.39	2.1	2455.39	2.5
4 FITTINGS AND FURNISHINGS	**1787.05**	**1.5**	**1787.05**	**1.8**
4.1 General fittings, furnishings, equipment	1787.05	1.5	1787.05	1.8
5 M&E INSTALLATION	**21300.00**	**18.4**	**19243.17**	**19.2**
5.1 Sanitary appliances	3141.50	2.7	3141.50	3.1
5.2 Services equipment	0.00	0.0	0.00	0.0
5.3 Disposal installations	1390.50	1.2	1390.50	1.4
5.4 Water installations	2678.00	2.3	2678.00	2.7
5.5 Heat source	1375.25	1.2	772.50	0.8
5.6 Space heating and air conditioning	0.00	0.0	4017.00	4.0
5.7 Ventilation systems	6397.06	5.5	1081.50	1.1
5.8 Electrical installations	4140.60	3.6	4140.60	4.1
5.9 Gas and other fuel installations	309.00	0.3	309.00	0.3
5.10 Lift and conveyor installations	0.00	0.0	0.00	0.0
5.11 Fire and lightning protection	0.00	0.0	0.00	0.0
5.12 Communication, security, control sys.	257.50	0.2	257.50	0.3
5.13 Specialist installations	0.00	0.0	0.00	0.0
5.14 Builder work in connection w/ services	1216.81	1.0	1099.30	1.1
5.15 Testing and commissioning of services	393.79	0.3	355.76	0.4
TOTAL HOUSE TYPE BUILDING COST	**£97,223.00**	**83.8**	**£84,197.00**	**84.2**

10 ON COSTS		**18200.00**	**15.7**	**15760.00**	**15.8**
10.1 Preliminaries	@ 12 %	11670.00	10.1	10100.00	10.1
10.2 Overheads and profit	@ 6 %	6530.00	5.6	5660.00	5.7
TOTAL: BUILDING WORKS ESTIMATE		**£115,623.00**	**100.0%**	**£99,957.00**	**100.0%**

Figure 3: Table showing RICS elemental costs of a one-off detached 2 Bedroom Passivhaus and an equivalent sized house (same internal volume and TFA) to minimum UK Part L1A 2010 standard.

4 Analysis

Capital Investment

The UK Part L 2010 housetype building cost is £84,197. The total build cost, including preliminaries, overheads and profit margin is £99,957. The Passivhaus housetype building costs are £97,223, and £115,623 respectively. It should be noted that these figures are based on one-off house prices, and it follows that equivalent houses on a larger development would be significantly cheaper.

The additional capital investment to build the Passivhaus housetype is £13,026, rising to £15,665 with prelims etc. This equates to a 15% extra investment for the passivhaus. The difference in capital expenditure is expected to be significantly lower on a larger development, where economies of scale and more efficient design typologies can be exploited (eg. terrace or low rise apartment).

Mortgage and energy cost analysis

The Passivhaus specification requires an additional 15% capital investment in a mortgage but delivers a building with a lower running cost. The hypothesis is that the lower running costs will make the additional investment advantageous over a typical mortgage term.

To test this hypothesis, two scenarios were investigated:

(1) A potential Passivhaus home owner applies for a 25 year 3.9% APR repayment mortgage of £115,623 and pays a 15% deposit (£17,343).

(2) A potential Part L 2010 home owner applies for a 25 year 3.9% APR repayment mortgage of £99,957 and pays a 15% deposit (£14,994).

The UK Part L 2010 house purchaser would save £2350 on the deposit, which would be invested in a bank (at a compound real interest rate of 3%) for the duration of the mortgage.

The energy bills for each home owner were predicted using the Passivhaus Planning Package. The annual space heating demand and auxilliary electricity figures were multiplied by current market energy prices (7p/kWh gas and 15p/kWh electricity kept stable) to arrive at an approximate annual running cost for each house The sum of the energy bills, mortgage payments and bank account interest was calculated for each year in the 25 year period and for each home owner. The Net Present Value (NPV) of each investment was derived by discounting the resulting cashflows and subtracting the capital sum.

The NPV for the houses was -£28,518 for the UK Part L 2010 house, and -£27,225 for the Passivhaus. The negative NPVs show clearly that neither of the returns were sufficient to outweigh the expenditure on mortgage interest, however what is of significant interest is that the prospective home buyer would be £1293 richer by investing in deposit for a passivhaus instead of investing that same money into a bank account.

5 Conclusion

This study has compared a small detached Passivhaus on a single plot, with an equivalent house built to UK 2010 Building Regulation standards. It has been shown that even without taking into account economies of scale, form, potential rising fuel prices, or the inherent residual value of the house after a 25 year period, under a low interest rate scenario the Passivhaus investment in the study presented a more economically viable solution for a prospective home owner than an equivalent house built to current UK building regulations.

A key restriction of this finding is the sensitivity of the calculation to fluctuations in interest rates. The current typical mortgage rates sourced for this analysis can be considered quite low in comparison to historic rates. The Bank of England base rates in the have been at a record low of 0.5% for 36 consecutive months [MPC 2012], and there are competitive fixed deals on the market for current prospective house buyers with a reasonably-sized cash deposit which may be not be possible to source in a different economic climate .

In order to provide an incentive for increasing numbers of prospective home buyers to invest wisely in Passivhaus fabric performance, it may be that nothing more complicated is required to achieve the goal than a government backed low interest loan. This is in line with the UK's current 'Green Deal' thinking, whereby housing energy retrofit measures are financed 100% up front though low interest loans from industry, providing that they meet the 'golden' condition of creating a positive return on initial investment during the loan period.

Such a solution would encourage longer-term sustainable growth in low energy housing in a manner that is simple, economically robust and market driven. For precedent, it is necessary to look no further than the German Federal State Bank's "ESH40/Passivhaus credit", which provided a €50,000 loan, a 100% disbursement and 2.1% interest (correct as of April 2006) for each unit built to the Passivhaus standard [Feist 2007]"

6 Further study

One only needs to look at the chart overleaf (see Figure 4) comparing European build costs over the past 10 years to note how unsteady the UK construction markets appear when shown alongside the other European nations represented in the chart.

Since the financial crisis starting in 2007 how can one explain the dramatic fall in residential and non-domestic prices in the UK during a period that the building codes have only toughened and when other European prices are rising steadily?

A question for further study will be to explore whether such drastic fluctuations in the UK housing market can be stabilised through investment in low risk, longer term investments in high quality, effective low energy housing such as those provided by the Passivhaus methodology.

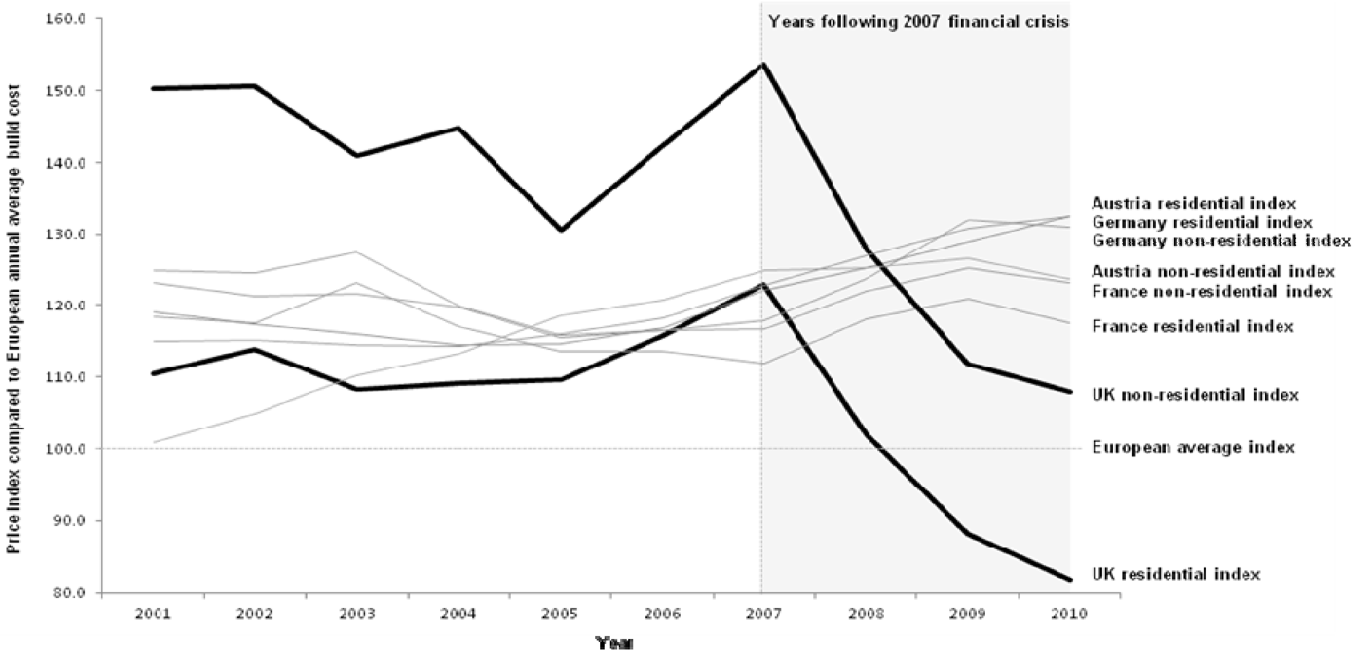

Figure 4: Chart showing 10 year fluctuation of European build costs. Data compiled from Eurostat.

7 Acknowledgement

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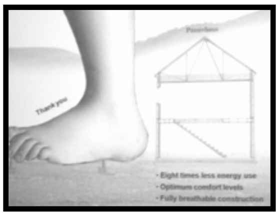

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