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Research Methods.

Is PassivHaus Design Affordable In The UK and Does It Work In Our Climate?

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Introduction.

1.1 Background to Research

PassivHaus originally started in Darmstadt-Kranichstein, Germany in 1990. The creation of Dr Wolfgang Feist, it was brought to life by the question “*Why do we need to use so much energy?*” (Source: Wolfgang Feist, 2016) Instead of looking toward cleaner energy sources, as the rest of the world were doing in nuclear, he aimed to reduce the need for so much energy in our homes, and therefore the planet. Concerned by the finite energy sources of the time, Feist and his architect Bo Adamson collaborated to create a building almost wholly heated by the activity within the unit. PassivHaus has come a long way since then, and technological advancement has made it easier, and more practical to achieve the design criteria. From 1 single dwelling in Germany, to spanning the globe with 60,000 properties, 18,000 that have full PassivHaus certification. PassivHaus relies heavily on passive solar to heat the building, glass which is expensive, and sunshine which the UK weather doesn’t always lend to. With such high design and attention to detail in construction, PassivHaus has a reputation for being expensive.

1.2 Research Hypothesis

PassivHaus design is currently unnecessarily expensive, and not suitable for the overcast and wet climate in the UK. More can be done to make it a more desirable method of building for the construction industry.

1.2.1 Aim of Research Proposal.

In this research proposal we will consider the costs involved in PassivHaus design compared with standard building construction, and discuss whether its design, construction and living methods lend to viable usage in the UK climate.

Considering the ageing housing stock in the UK, some consideration will be given to retrofit possibilities, and the problems encountered trying to achieve the PassivHaus standard. We will also look at why people choose this method, and consider alternative energy saving build types, for financial comparison, and whether PassivHaus will become the standardised method of construction for social housing in the UK.

1.2.2 Research Objectives.

- Identify average cost of PassivHaus in UK compared with standardised construction methods in the UK
- Identify financial savings in energy vs build cost.
- Identify lack of energy savings given UK climate challenges
- Identify shortfalls in construction knowledge and capability to build PassivHaus.

1.3 Rationale for this Research

PassivHaus has masses of potential to be used on a wider scale and for social housing developments, however in an ever increasing price rise in the housing market, can it compete with standardised building methods and become as popular in the UK as it has in other countries worldwide?

In a country plagued by fuel poverty, using PassivHaus as the leading method of social housing would help reduce the increasing fuel costs, carbon footprint, and help the UK fall in line with the Paris Agreement. With the UK's increasingly wet weather is PassivHaus capable of contributing to it successfully.

"Meeting future carbon budgets and the UK's 2050 target to reduce emissions by at least 80% of 1990 levels will require reducing domestic emissions by at least 3% per year. This will require existing progress to be supplemented by more challenging measures." (Source: Committee on Climate Change)

Going further to harvest natural energy would further increase PassivHaus viability and possibly interest local housing authorities to consider using the design method.

Literature Review

2.1 Introduction.

In order to suitably research this hypothesis, we will need to make an in-depth investigation to previous research completed on comparison of PassivHaus V Standard Regulation construction, and track the UK achieved targets for greenhouse gases

2.2 Definition of PassivHaus.

The creator of PassivHaus said of it “A passive house is a building in which a comfortable interior climate can be maintained without active heating and cooling systems. (Adamson 1987 and Feist 1988).”

(For the purpose of this research we will be using the Northern Hemisphere calculations for PassivHaus Certification based on heating rather than cooling requirements in the warmer climate of the Southern Hemisphere)

In technological terms that means a PassivHaus only gains its certification if:

Heating Energy Demand of less than 15 kWh per square meter of net living space per year.

Renewable Primary Energy Demand, the total energy used for all domestic applications must not exceed 60 kWh per square meter of treated floor area per year.

Airtightness, a maximum of 0.6 air changes per hour at 50 Pascals pressure, verified by an onsite pressure test.

Thermal comfort must be met for all living areas during winter as well as in summer, with not more than 10 % of the hours in a given year over 25 °C

(This data can be found in the Passive House Planning Package. PHPP)

PassivHaus Design Method.

The PassivHaus design is very specific in its method of achieving the required specifications.

1. Well insulated building envelope
2. High energy performing doors and windows
3. Minimised heat loss through cold bridging
4. Significantly reduced air flow through the structure
5. Optimal use of internal heat gains and passive solar

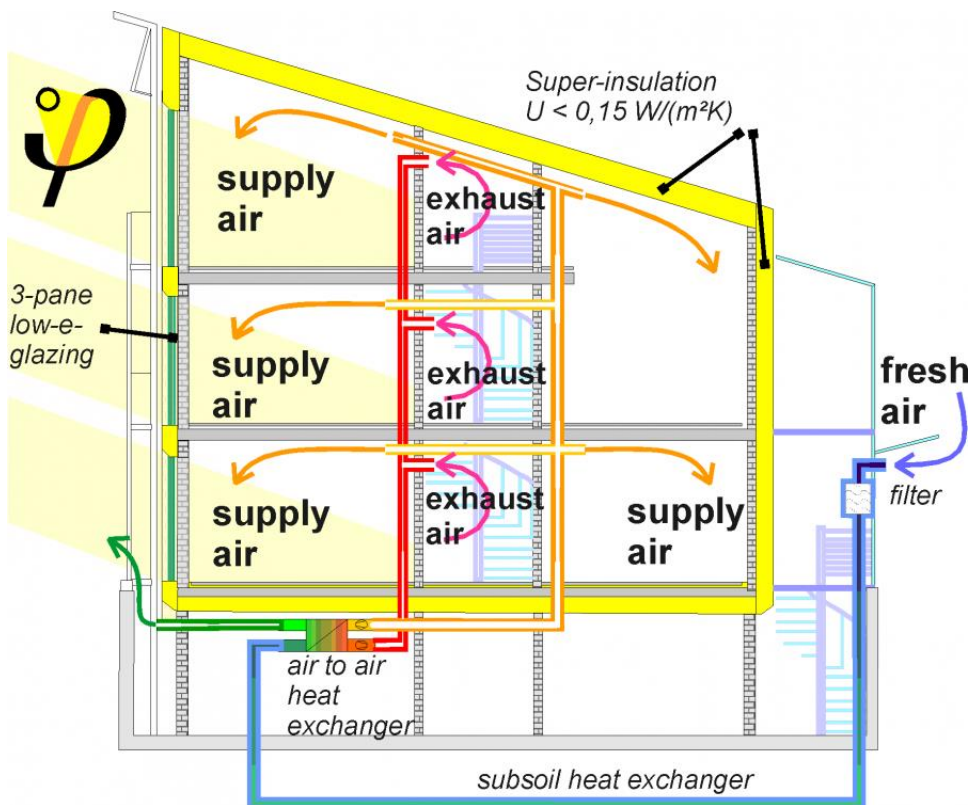


Image 1.1 Section of air flow in PassivHaus. (Source: Passipedia)

2.3 Energy Saving Technology.

PassivHaus was specifically created to provide homes that are less reliant on large amounts of energy. Data suggests that savings of between 75-90% can be made in a well designed and carefully considered layout and well constructed build.

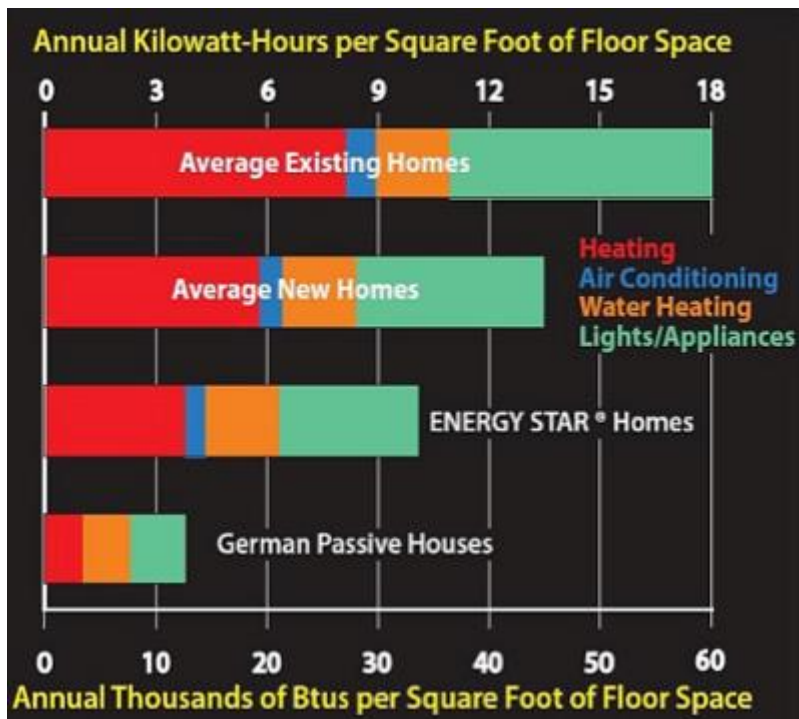


Image 1.2 Energy Comparison chart (Source: Scheercoussemance)

2.4 PassivHaus v Traditional Build.

Much research has been done comparing the cost of PassivHaus specification requirements. At the time of Kranichstein being built the difference in price was on average 50,000 Deutsche Mark more expensive to build a PassivHaus than a traditional house.

Continued research suggests that this has decreased as construction knowledge has increased, fabrication costs have reduced due to increased demand, and more considerate layouts have evolved over the last 30 years. *"From over 50 000 Euros to between 6 000 and 15 000 Euros per accommodation unit today"* (Source: Passipedia)

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%

Image 1.3 Detailed Comparison. (Source: Nick Newman 2012)

These figures may be marginally closer in the UK due to the slightly warmer climate, which would require less insulation to be fitted. This reduced cost may then be increased again at energy usage level, considering the UK cloudy wet climate would have negative impact upon the passive solar gains.

In a self build project the initial outlay would begin to see rewards upon completion and each year after that would bring the PassivHaus closer in line with the overall cost of traditional build.

More research is needed into how cost reductions would work in PassivHaus development v Traditional Housing development due to how few have been built as housing estates, and the calculated costs in differing levels of insulation.

Can these costs be reduced by building larger estates?

Ordering bulk items incurring discounts.

Could building terraced units lower the required energy due to partition heat transference?

Creating less cold bridging.

2.5 Suitability for UK.



Image 1.4 World Map of PassivHaus locations (Source: PASSIVEHOUSE-INTERNATIONAL.ORG)

It took 11 years after the first PassivHaus was built in Germany for one to be built in the UK. With a lack of specialised builders and difficulty in obtaining materials, a 2 bedroom build cost £550,000, (Source: Homes and property) compared to a traditional build at the same time of £115,000. (Source: Whatprice.co.uk)

Annual precipitation averages for the entire UK are 133 days of rain or snow, totalling **885 millimetres**. (Source: UK Met Office) Much of this weather occurs during the darker, colder months of winter. When a PassivHaus would be relying on low sitting sun heating thermal mass floors to warm the building. Heavy cloud cover in the West and extremely short days in the North could make harvesting heat this way particularly difficult. Less natural heat gained would create need for usage of the Mechanical Heat system. In turn increasing the energy expenditure of the building, but would it be enough to then exceed the PassivHaus regulations?

The concept was created in Germany, it has very cold winters and warmer summers, but its overall cloud coverage is less than that of the UK, and reflective light from the sun on snow helps in generating extra light and heat within the buildings there. The idea that PassivHaus can work anywhere is potentially flawed.

Are there only certain circumstances that PassivHaus can truly thrive at its utmost potential?

Would concessions need to be made in order to build PassivHaus in some UK climates?

Would retrofitting be more viable due to less stringent levels of measurements?

Would certain materials lend themselves better to UK built PassiveHaus?

Is PassivHaus the very best, or would UK be more suited to Bream or Zero Heating Energy?

Research Methodology.

3.1 Aim of Research.

The aim of this investigation is to determine whether PassivHaus standard is a financially viable method of building in the UK when compared to current standard building regulations. Another aim is to establish if PassivHaus functions as it was designed to in challenging climates like the UK. Lastly, we will investigate if a different method of low energy housing would perform better.

3.1.2 Research Objectives.

- Identify cost difference in PassivHaus construction.
- Identify climate limitations to successful PassivHaus construction in the UK
- Identify (Where possible) more suitable sustainable, low-energy homes.

3.1.3 Method.

Applying the correct method to this research is vital to yielding usable results. We will employ a range of data collection techniques in order to have a suitable amount of results to analyse and either prove or disprove our hypothesis

- Questionnaire. A focus group of architects, builders, PassivHaus owners.
- Interview. Architects who have worked on UK PassivHaus, gaining professional insight into the challenges encountered.
- Detailed overview of current legislation.
- Detailed cost analysis comparison PassivHaus vs Traditional

Predicted Results.

4.1 Financial outlay

With the UK being in a more temperate climate than PassivHaus usual locations the possibility for financial expenditure on construction to be slightly less than in other countries.

We also predict that because of the more overcast weather the UK is accustomed to the design method of PassivHaus will not work at its peak performance and therefore more will be spent on energy, which will open up more questions on PassivHaus performance being relevant to the country it is built in.

4.2 Climate

Our prediction is that with more than a 3rd of the year being overcast and/or precipitous, the carefully considered design will not generate enough heat in those times to warm the dwelling to a suitable level, and therefore it will become more heavily reliant upon the Mechanical Heat Recovery Ventilation system. Also the dim light conditions in winter would cause more requirement for use of interior lighting during the day.

4.3 Alternatives.

We predict further investigation will be required to determine if any other type of low energy home would work better in this climate, if it would be more or less financially viable, and think that a possible hybrid of many different technologies may be the best way to tackle UK climate and energy safe housing.

Conclusion.

5.1 Aim and Objectives.

This study will be completed in a controlled and timely manner, allowing suitable time to then analyse the results and collate them into referable data source and draw viable conclusions to the questions asked at the beginning of the project.

5.2 Adding to existing data.

Much research has been done into PassivHaus method since its inception. We believe our results will add more information for people who are looking to consider PassivHaus, and develop a more varied response to the question "Is PassivHaus right for me?"

We also hope to give further light to other low energy homes that may provide better sustainability/energy savings.

5.3 Financial variation.

We think our research will prove, that with better knowledge and increased demand, that costs of PassivHaus could be more financially suited to the UK, either by subtle changes to its method or by using a standardised shape and design, more specifically adapted to make use of the UK climate.

5.4 Lack of Use of the Method.

Our research will answer questions as to why the UK has been so reluctant to adopt PassivHaus as a design concept on a larger scale despite the call for greener more sustainable housing.

Bibliography:

Wolfgang Feist, 2016 (*Interview with iPHA*) <https://blog.passivehouse-international.org/first-passive-house-wolfgang-feist/> Accessed 20 January 2019.

Committee on Climate Change <https://www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/how-the-uk-is-progressing/>

Adamson 1987 and Feist 1988. <https://ecobrooklyn.com/passive-house-defined/> Accessed 20 January 2019.

Passipedia https://passipedia.org/examples/residential_buildings/multi-family_buildings/central_europe/the_world_s_first_passive_house_darmstadt-kranichstein_germany Accessed 10 January

Passive House Planning Package https://passivehouse.com/04_php/04_php.htm Accessed 15 January 2019

Homes and Property <https://www.homesandproperty.co.uk/> Accessed 24 January 2019

What Price <http://www.whatprice.co.uk/> Accessed 24 January 2019

UK Met Office <https://www.metoffice.gov.uk/climate/uk/data> Accessed 17 January 2019

Image 1.1 https://passipedia.org/examples/residential_buildings/multi-family_buildings/central_europe/the_world_s_first_passive_house_darmstadt-kranichstein_germany

Image 1.2 <https://sites.google.com/site/scheercoussemance/passive-house-essay>

Image 1.3 <https://www.bere.co.uk/assets/NEW-r-and-d-attachments/Larch-and-Lime-Houses-Passivhaus-Cost-Comparison-2012.pdf>

Image 1.4 <https://passivehouse-international.org/>