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Passivhaus Executive Summary

Quantitative and Qualitative Impact analysis - July 2017

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1. Background

1.1 Erneley Close Passivhaus is located on the border of South Gorton and Longsight in Manchester. The area is classed as one of the top 10% most deprived areas in the UK (DCLG, 2015).

1.2 The initial driver for the scheme was:-

- To upgrade the poor thermal efficiency of the blocks
- Resolve structural issues at the blocks
- Reduce fuel costs for the tenants
- Enhance the appearance of the blocks to 'lift' the area
- Reduce Anti Social Behaviour, by design
- Create a desirable community garden area
- Develop a recycling and waste strategy

1.3 The project team encountered many challenges along the way, but by taking a partnering approach these obstacles were overcome. The project team successfully achieved the EnerPHit standard from the Passivhaus Institute in May 2015.

1.4 Erneley Close Passivhaus is the UK's first large scale Passivhaus retrofit. Due to the unique nature of the project it was important to maximise the research potential of the scheme, not only for One Manchester but for the wider industry and academic community.

2. Introduction

2.1 The University of Salford was commissioned to design a research project and the brief was to:

- Monitor internal environment of the dwellings
- Understand levels of occupant satisfaction and associated issues
- Identify lessons learned

2.2 A sample of seven flats was selected from 32 for the monitoring aspects of the research project. Four flats were selected from the larger block of 20 and three from the smaller block of 12.

2.3 Quantitative data was collected from monitoring instruments placed in the flats and qualitative data was gathered from interviews with the building occupants.

2.4 In November 2015 the installation of monitoring instruments began with combined temperature and humidity sensors being placed in the lounge, hallway and main bedroom, and with a CO_2 sensor also being placed in the lounge.

2.5 The Quantitative data was sent to a central hub located in the lounge and was available to view on a web based platform. The interviews took place in early 2017. It was envisaged that the total monitoring period would be 12 months.

3. The Project

3.1 Additionally, One Manchester collected data about tenant bills and energy consumption.

3.2 Gaining access to the flats and the co-operation/participation of the occupants was an important factor in the selection process, along with the demographic characteristics of the occupants, to ensure that we had a varied selection within the sample of properties. It was considered that this sample would produce the optimum results from the sample size.

3.3 The equipment had access to WIFI, so that the data could be gathered remotely with minimum disruption to the residents. The data was then sent to a central hub managed by Salford University and was available to view on a web based platform. The total monitoring period was carried out over 12 months ending in March 2017.

3.4 Qualitative data was gathered by a series of interviews with residents. The interviews were carried out by Dr Grahame Sheriff (University of Salford) using recording equipment. The interviews were then transcribed into an electronic document format.

3.5 Further interviews were carried out by Dean Myers as part of a separate research project. The results will be published at a later date.

4. Quantitative data results

4.1 In total, 14 months of data was collected from the monitoring instruments installed in the flats. Appendix 1 shows the lower, upper and average figures for the temperature, humidity and CO_2 data sets.

4.2 Temperature

4.2.1 We can see from the data that the average room temperatures were in the low 20s (°Celcius) and this is what you would expect to see with a Passivhaus retrofit. However, the upper range of temperatures was quite high and these figures do not show the length of time these higher temperatures were sustained for.

4.2.2 Further research is currently being carried out into the risk of overheating, as these temperatures could pose a health risk in the context of future climate scenarios where the outside summer air temperature could potentially be in excess of 30°c by 2050 and the 2003 heat wave could be '*a one in two year event by 2050. In 2070 those deadly conditions of 2003 will be considered an unusually cool summer*.' (Holdren, 2008 quoted in Nicol et al. 2012)

4.3 Humidity

4.3.1 CIBSE (2006) recommend an acceptable range for relative humidity between 40% and 70%, and the human body functions at 35% - 75% relative humidity without serious problems. They go further to say that the conditions for mould growth occur at around 80%. However, Dwyer (2011) suggested that a relative humidity above 60% could allow established mould to be sustained at lower humidity levels. Therefore, this report recommends a relative humidity of between 40% and 60%.

4.3.2 The average relative humidity levels recorded at the sample selecion of properties at Erneley Close appear to be within the normal range of 40% to 60% with the average being 50%.

4.3.3 The lower humidity levels (between 20% - 34%) and upper humidity levels (between 73% - 81%) are outside of the average range and further research will look into this in more detail.

4.4 Carbon Dioxide Levels

4.4.1 Dwyer (2011) recommends that, when added to the normal outdoor level of 400ppm, up to 1000ppm is acceptable. The average CO2 levels within the lounge area of 4 of the properties that were sampled is between 500ppm - 1000ppm and deemed as acceptable, with the exception of 3 flats with average measurements higher than 1000ppm.

4.4.2 This is not a cause for concern due to the length of time these higher levels were sustained for and further research is required to investigate the reasons for this.

5. Domestic energy use

5.4 A communal plant room was installed within each block to distribute hot water to each dwelling. Each property has a Heat Interface Unit (HIU) and an LCD panel so that customers can monitor their own energy use.

5.5 Previously, the average spend for heat and hot water was circa £1.20 per day per flat (£438 per annum).

5.6 Appendix 2 shows that the average daily spend, following refurbishment, on gas, for heat and hot water, from January 2016 to January 2017 is 0.49p per day per flat, making a daily saving of 0.71p per flat. This equates to an annual saving per flat of c£259 (£8,288 collective savings per year).

5.7 The daily gas (kWh) use at the time of monitoring was c5.2 kWh per day. This is a significant reduction of 13.8 kWh compared to the previous use of 19kWh per day, prior to completion of the works.

5.8 It is important to note that these figures are an average over the 32 flats.

6. Qualitative data results

6.4 The University of Salford report contains results of all tenant interviews that were conducted. The contents of the report can be summarised as follows:-

6.5 Positive impacts

- Customers had significantly reduced fuel bills.
- Customers felt that their indoor climate was more comfortable prior to the refurbishment works.
- They felt that there was a high standard of internal finish including new decorationg, new kitchens, bathrooms and improved space within the living area.
- Customers were happy that they were given a choice of internal finish.
- Due to the improved level of insulation, external noise levels have reduced.
- Residents are extremely happy with the improved external appearance of the blocks.
- They also have a sense of pride and ownership of the outside communal areas.
- Customers have also reported that their health and wellbeing has improved, reporting fewer instances of colds and respiratory instances.

6.6 Concerns & tensions

6.6.2 However, there were concerns from residents during and following completion of works. Feedback from tenant interviews included:

- Customers felt that there was a lack of control over certain elements, including gardens, decorations, window cleaning.
- Lack of communication was felt a key concern from the majority of tenants regarding the decant process.
- Following completion of the works, satellite TV and mobile phone signals did not work on occasions.
- Due to the requirements of air tightness, there is no letterbox on tenants' flat entrance doors. Post has to be collected from a letter box within the communal area, which residents were not happy with.
- Window cleaning became a concern following issues with pigeon guano, however this was subsequently resolved. It is worth noting that this was a major issue once the construction phase was complete and considerable time and effort was required to investigate and install measures to mitigate the problem.
- Concerns were made regarding the risk of summer overheating within an air tight property.

6.4 • The decant process of re-locating residents whilst the work was in progress also became a concern due to the length of time tenants had to put their belongings into storage and the length of time they were out of their home.

7 Social Return on Investment (SROI) and Social Impact

7.4 Baker Tilly were asked to evaluate the social impact and the Social Return on Investment at Erneley Close. The outcome of the study is highlighted as a table in Appendix 3.

7.5 It summarises that the increase in distributable income experience by residents with lower utility bills and increased spending in the local community will contribute to a significant economic impact within the area, precipitated by the additional investment in Passivhaus.

7.6 Baker Tilly also evaluated the Social Value as a cost associated with the works. The report summarises the Social Value cost of works at £21,218,870.

7.7 A breakdown of the cost assumptions can be seen in Table 1 below. This table shows how the total gains evaluated by Baker Tilly have been attributed to the work that would have taken the properties to a Decent Homes standard and the additional work that has contributed to achieving the EnerPHit Passivhaus standard.

7.8

Summary Social Values					
	Total	Decent Homes		Passivhaus	
Utility Bill Savings	£406,794	30%	£122,038	70%	£284,756
Improved Mental wellbeing	£850,875	35%	£297,806	65%	£553,068
Improved Physical Health	£54,748	30%	£16,424	70%	£38,324
Economic Impact of Building	£9,372,000	44%	£4,123,680	56%	£5,248,320
Impact of reduced ASB	£260,275	80%	£208,220	20%	£52,065
Reduction in Carbon Usage	£164,793	30%	£49,438	70%	£115,355
Total Value	**£11,109,485**		**£4,817,607**		**£6,291,878**

Table 1: Summary Social Values

8 Lessons learned

8.1 There have been many lessons learnt throughout the project and lessons that will be incorporated into future retrofit/improvement programmes, to ensure the smooth running of programmes whilst maintaining resident satisfaction, including:

- To ensure that there is effective communication to residents throughout the retrofit process, from conception to completion.
- Improve post occupancy support for all residents.

- Improve the education that is given/received to residents regarding energy efficiency measures, how to maximise those measures and how to effectively use the systems within the home (both via leaflet and electronically).
- To consider the demographic profile of tenants and residents on potentially new retrofit schemes, to ensure that extra support is provided where necessary and to question if additional measures would be beneficial for specific groups of tenants.
- Include a wider selection of residents to monitor energy use and satisfaction in future projects.
- Continuity of project staff, post occupancy is also required. This is to provide a first point of contact that residents can speak to regarding any issues or concerns that they may have.
- To manage the high expectations from tenants. It is important to work and consult with tenants in setting expectations from the outset.

9. Conclusion

9.4 The energy use and spend data shows a dramatic reduction in heating costs for residents, whilst the monitoring indicates that the flats internal conditions are highly controlled within assumed comfort boundaries. This is indicative of an extremely high performing building.

9.5 Erneley Close Passivhaus is one of the first projects of its kind in this country which pushed the boundaries of construction technology.

9.6 It is impossible to put a financial figure on the wider benefits to the industry and the academic community and some may say that this is priceless in terms of technological advancement.

9.7 A large scale Passivhaus retrofit had to be done and it took a bold step into the unknown from One Manchester to be the first to achieve this.

9.8 One Manchester therefore, will be looking at how we can improve the thermal efficiency of homes and how we can reduce fuel costs for customers through retrofit, incorporating into future investment programmes.

References

Chartered Institution of Building Services Engineers (2006) **Environmental Design CIBSE Guide A**. London: CIBSE

Dwyer T (2011) **Module 27: Indoor Air Quality. [online] April 2011. Available from** <https://www.cibsejournal.com/cpd/modules/2011-04/> [Accessed 17th July 2017]

Nicol et al (2012) **Adaptive Thermal Comfort - Principles and Practice.** London, Routledge

DCLG. 2015. ***2015 English IMD explorer.*** [ONLINE] Available at: http://dclgapps.communities.gov.uk/imd/idmap.html. [Accessed 27th July 2017]

Appendix 1 - Quantitative data results

Passivhaus Quantitative Data Results - 14 Month Period

Flat	A			B			C			D			E			F			G		
Range	Low	Up	Av	Low	Up	Av	Low	Up	Av	Low	Up	Av	Low	Up	Av	Low	Up	Av	Low	Up	Av
Temp °c																					
Lounge	15	27	21	16	29	22.5	18	27	22.5	19	30	24.5	13	30	21.5	17	30	23.5	17	27	22
Hall	15	28	21.5	17	29	23	18	27	22.5	17	31	24	15	30	22.5	15	29	22	17	26	21.5
Bed 1	18	27	22.5	18	29	23.5	18	34	26	17	27	22	15	30	22.5	17	27	22	17	26	21.5
RH%																					
Lounge	34	66	50	26	74	50	27	73	50	25	68	46.5	26	81	53.5	25	73	49	29	77	53
Hall	29	66	47.5	22	74	48	29	68	48.5	27	74	50.5	30	77	53.5	26	73	49.5	29	76	52.5
Bed	34	68	51	28	72	50	30	72	51	27	73	50	30	77	53.5	27	72	49.5	24	68	46
CO_2																					
Lounge	337	1204	770.5	352	2581	1466.5	379	1286	832.5	151	983	567	383	1358	870.5	381	1827	1104	390	1817	1103.5

http://www.iaquk.org.uk/ResourcesHumidity.html

Low = Lower
Up = Upper
Av = Average

Appendix 2 - Average daily spend for heat & hot water

Average Spend Both Blocks Jan 16 to Jan 17	
Total annual spend 20 block all properties	£3,932.08
Total annual spend 12 block all properties	£1,822.68
Average daily spend 20 block/year	£0.54
Average daily spend 12 block/year	£0.42
Highest average daily spend	£1.24
Lowest reliable average daily spend 12 (2 flats low occupancy)	£0.15
	1,822.68 + 3,932.08
Therefore	£1,822.68 + £3,932.08 = **£5,754.76 total both blocks**
	£5,754.76 ÷ 32 flats = **£179.84 total ave spend/year flat**
	£179.84 ÷ 365 = 0.49p per day/year average for 32 units
*NB variables exist e.g. low occupancy & low users	

Appendix 3 - Baker Tilly, Evaluation of Social Impact & SORI

Refits to Passivhaus standard