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Anatomy of low carbon retrofits: evidence from owner-occupied Superhomes

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Executive summary

To investigate experiences and outcomes of low carbon retrofit, research has been carried out with 'Superhome' owner occupiers. These householders have renovated their homes and reduced carbon emissions by 60% or more. An on-line survey was completed by 57 Superhome owners, and 14 more detailed interviews were undertaken. Compared with typical English owner-occupiers, Superhome owners are on average younger, better educated, living in larger household groups and larger homes, and have higher incomes. They have undertaken their low carbon renovation work in a variety of ways, using different combinations of energy efficiency and renewable energy measures, employing professionals or doing DIY, with works costing from £3000 to £65,000. The timescale has varied from months to decades. Some work followed a clear plan with numerical targets, whereas other renovations emerged over time. There are many routes to successful low carbon retrofit. Motivations were multiple, and included environmental concern, desire for improved comfort and living standards, reducing waste and saving on energy costs. Superhome owners identified a variety of benefits from living in a low carbon home and reported high levels of satisfaction with their renovation work.

Introduction

This paper focuses on the experiences and decision-making processes of private homeowners who have successfully carried out low carbon retrofits which have reduced modelled CO₂ emissions by more than 60%, very largely in the absence of policy support. The group studied are 'Superhome' owner-occupiers. Superhomes is the UK's largest and most long-established open home network, where groups of owners open their homes to the public, to share their experiences and to inspire others to undertake work on their own homes (www.superhomes.org.uk). The majority (130) of Superhomes are owner-occupied with the remainder (nearly 40) owned by landlords or research organisations. Through questionnaires and interviews, this research investigates Superhome owner-occupiers, their homes, their motivations and experiences of low carbon retrofit.

This article is largely an edited version of a paper to be published in the journal *Building Research & Information* (Fawcett & Killip 2014).

Previous research

Most debates in the policy and expert energy community assume that renovation decisions are broadly rational and economic, using cost-benefit analysis to derive financial paybacks. The Green Deal (with its 'golden rule' of cost-benefit analysis) is the latest in a long line of policy initiatives based on this approach. In contrast, academic researchers have compared 'normal' home renovation with low energy or low carbon retrofits, in order to explore the motivations and decision-making of property owners. Gram-Hanssen (2014) suggests that low-energy renovations would grow in popularity if they were aligned with lifestyle choices, rather than an approach based on narrow technical information and rational economic analysis. Stieess & Dunkelberg (2013) argue for the need for regulation in the policy response, while Killip (2013) proposes a model of 'market transformation' in order to increase both demand and industry capacity to deliver high quality retrofits at scale.

Other studies have investigated the process of decision-making for home renovations (not specifically related to energy), showing how they emerge from the background conditions of everyday domestic life and unfold over time (Wilson et al 2013). This paper also explores dynamics of renovation decisions, but it does so with a group whose technical goals are considerably higher than current practice.

Method

Data was gathered in an on-line survey from 57 Superhome owners, with fourteen follow-up interviews to explore issues in greater depth. The interviews concentrated on aspects of renovation which could not be dealt with adequately in a questionnaire – namely motivation, costs and cost management – and pursued some topics in more detail, including relationships with professionals. People who completed the survey were offered a payment of £10 and feedback on the survey and copies of research outputs. An interview was also undertaken with the founder of the Superhomes network. The questionnaires were all completed during July 2013, the interviews during July and August 2013. Quotations in this paper are taken from free text in the questionnaires or as transcribed from the recorded interviews.

The survey contained seven sections: your home; timing of renovation work; planning for renovation; your role in the renovation; professions and trades; satisfaction with your renovation; about you.

Summary of findings

Profile of respondents and their homes

In this section a summary is given of a comparison between survey data from Superhomers and national statistics for English owner occupiers in Table 1 (56 respondents lived in England, and one lived in Wales). The purpose is to describe their socio-demographics and homes in comparison with the general population. Where it has not been possible to compare the sample with English owner-occupiers, comparisons have been made with the whole English or English and Welsh populations.

Table 1: Social, demographic and housing characteristics of the Superhome sample, compared with all English owner-occupiers

Characteristic	Profile of survey respondents compared with national data for owner-occupiers in England
Householder Age	More likely to be aged 35-54 than the wider population, and less likely to be under 24 or over 65.
Household size	Larger than average, with only one 1-person households and a higher proportion of 3- and 4-person households.
Property age	More likely than the general population to live in pre-1919 properties; the more recent the build date, the fewer Superhomes there are.
Built form	A relatively high proportion of detached or semi-detached houses, and relatively few terraced houses. Very few flats.
Property size	Property size distribution skewed towards larger sizes. 48% of Superhome renovations increased floor area; 4% made small reductions in floor area.
Education	Over 80% of Superhome households included at least one person educated to degree-level, compared with an average figure figure of 27% for all households in England and Wales (ONS 2012)
Ethnic background	96% were White British, similar to the figure of 93% for English owner-occupiers.
Household pre-tax income	Wide range (under £10,000 to over £100,000); 72% of respondent households had incomes above the national average for all English households (including renters, who have lower average incomes than owner occupiers). (ONS 2013)

Sources: Superhome respondents (all 57), characteristics of English owner-occupiers – DCLG 2013 (unless otherwise indicated)

Many of these characteristics are linked. Larger households do in general have higher incomes, are headed by middle-aged people, live in larger homes and the larger built forms (i.e. semi-detached and detached houses). Perhaps the most surprising finding is the wide range of incomes of Superhome owners. While many are wealthier than average, this is not universally true, and some of the respondents are on very modest incomes. The fact that there is only one single-person household is notable, compared with the quarter of English owner-occupied households in single occupancy.

Measures included in renovation

Respondents were asked which measures they had added to their homes, from a list of 21 energy efficiency, renewable energy and home improvement measures. The average number of measures installed was 9.5 (some respondents noted that the homes already had some measures when they moved in, so did not include these in their responses). The measures most commonly adopted are listed in Table 2.

Table 2: Most common measures included in renovation

Measure	Households installing this measure (%)
Loft / roof insulation	100
Wall insulation	91
High performance windows	81
Solar PV	77
Wood burner	73
Improved air-tightness	71
Solar water heating	66
Ground floor insulation	63

Base = 56 respondents

The sort of measures needed to achieve 60% or greater carbon savings are already well understood (Thorpe, 2010, Roberts, 2008) and these findings fit with existing knowledge.

Aims and motivations

Reducing energy use and carbon emissions are aims shared by almost all respondents (Table 3). Other benefits such as improving warmth and reducing bills are important to the majority, as is reducing mains water use – showing an interest in environmental issues beyond energy and climate change.

Table 3: Ranked answers to ‘which of the following did you want your renovation work to achieve?’

Answer Options	Response Percent	Response Count
Reduced energy use	96%	52
Lower carbon emissions	94%	51
Improved warmth / thermal comfort	85%	46
Reduced energy bills	76%	41
Reduced (mains) water use	61%	33
Better indoor air quality	30%	16
To become a 'Superhome'	19%	10

Base = 54 respondents

Some questionnaire respondents expanded on their reasons for undertaking low energy renovation work:

“We started to look originally at refurbishing in order to try and get a Victorian place that was dry. Because we liked the Victorian style. [...] But we wanted one where we could make sure it was healthy and out of that came, you need to insulate and you need to ventilate and that tied in quite well with my environmental concerns, and that’s what led us down the line really.”

Motivations were explored more extensively in interviews. While some were self-consciously environmental in their outlook (with a variety of scopes of environmentalism), others more focussed on reducing waste, yet others seeing energy reduction as part of a package delivering better quality of life, particularly in terms of health and comfort. Some were influenced by their professional work, others by friends and families or spurred on by initial interest in a particular technology, e.g. PV. All the interviewees saw low-energy renovation as an elegant solution to meet multiple objectives:

“[There] was an environmental driver; there were energy and cost drivers and comfort drivers as well. The last house we were in, it was very cold and suffered from mould [...] and we didn’t want that anymore.”

Planning and implementation

Fawcett (2013) argues that retrofits can be achieved in one go or as a staged process over time, and this research confirms those two broad groups: 30 retrofits were planned and 21 emerged over time. Most characteristics are similar between these groups, including income, household size, and house type. As a consequence of the way the work was undertaken, the planned group were more likely to have lived elsewhere while the work was being carried out (50% cf 19% emergent group) and achieved their results quickly (50% took less than one year, whereas all the emergent group took more than two years). The period over which low energy renovation took place varies hugely between respondents, from less than six months at one end of the scale, to over ten years at the other. The mode response (30% of respondents) was an implementation over 2 – 5 years.

Respondents were asked whether they had specific goals their renovation work in terms of building performance. There was an equal split between those who said they had a specific goal (27) and those who didn’t (27). Those with a specific goal were asked to briefly describe it. Of the goals, 17 were expressed in terms of measurable targets. Passivhaus EnerPHit was the most popular standard for very ambitious retrofits, cited by 5 respondents. For less ambitious renovations, there appears to be no leading standard, with carbon emissions reductions being the most commonly used metric (70%, 80% and 85% reductions cited).

Paid labour, DIY and project management

Respondents were asked how they and other household members were involved in the renovation work. All households were involved in choosing technologies, and 94% were involved in finding out about different technologies and products. More than half of households were also involved in choosing professionals, directly employing different trades, undertaking physical work, controlling budgets and liaising with officials. Three quarters of respondents were actively involved in managing their project. Thus, all respondents were actively engaged in their renovation project to some extent, and the majority played roles in the project team which go well beyond the conventional role of client.

Householder experiences with professions and trades was generally positive, with relationships between householders and professions and trades, and between different professions and trades being reported as either good or very good. However, there were some less positive experiences, and 16% of respondents had contractors or companies leave the project – usually they were dismissed as a result of poor quality work.

Costs & benefits

The fourteen interviewees were asked about the costs of their low carbon retrofit work, but definitive figures were difficult to obtain for two main reasons. Firstly, detailed records were not kept. This was particularly the case with renovations done over a long time period, those where costs were met out of current income, or those with a large DIY contribution. Secondly, distinguishing the additional costs of low energy work which was done at the same time as conventional renovation work (a common occurrence) is problematic. Estimates for the extra costs of low carbon retrofit depend very much on the assumptions made about marginal costs: separating out what is 'normal' from what is a low-energy 'extra'.

Cost estimates varied between £3,000-4,000 and £65,000. The certainty which can be attached to these estimates varies. There is also considerable variation in what interviewees included as an extra cost, so care must be taken in interpretation.

There was little focus on payback times or cost-effectiveness among interviewees. Where cost was a concern, it was discussed in terms that go beyond simple payback calculations:

“Everyone said, you’re mad to spend extra money, you’ll never get it back, [but] we were absolutely convinced, as it turned out exactly right, that fuel costs were only going one way.”

“...everyone always asks ‘what’s the payback?’. Actually the most important thing is I now have a house that’s warm in the winter and cool in the summer... it’s now a very nice place to live.”

Satisfaction and quality of life

Satisfaction with the results of low energy renovation was high, with 70% of questionnaire respondents being 'very satisfied' with their retrofit overall. Levels of satisfaction with particular aspects of the retrofit were somewhat less high, but in all cases the majority of respondents were either very or quite satisfied with the results of the work done, with very little dissatisfaction reported.

Comments from respondents to the survey indicate that they are aware of having increased their quality of life by doing their retrofit:

“While we'd read about the benefits of Passivhaus, we hadn't fully appreciated how nice it would be - no getting up in the cold at night when kids have nightmares, because it isn't cold. No mould in the bathroom- and washing dries in less than 12 hours whatever the weather. Even with an occupancy of 6 it is never stuffy, and the pollen count indoors is lovely and low this summer!”

Discussion & conclusions

Superhome owners are pioneers in low carbon retrofit in the UK. They are not demographically typical, but there are millions of households who fit a similar profile.

Superhome owners have undertaken their low carbon renovation work in a variety of ways, using different combinations of energy efficiency and renewable energy measures, employing professionals or doing DIY, with works costing from low thousands of pounds to several tens of thousands. The work has taken from months to decades, has followed a clear plan with numerical targets or has emerged over time (and anything in between). All of these different types of low energy renovation have achieved 60% or greater carbon savings. This information shows there are many routes to successful low carbon retrofit.

Low carbon renovations deliver much more to householders than reduced carbon emissions and energy costs, and these benefits need to be understood in more detail. Benefits identified by householders included comfort and warmth, air quality and health improvements, lack of damp and mould, and future-proofing against energy price rises. Where the energy efficiency community describes comfort and health as 'secondary' or 'co-' benefits of low-energy renovation, the interviews showed that the health and comfort advantages are often just as important – or more important – than the energy benefits.

Low carbon retrofit can be successfully achieved through a wide variety of routes. It is not necessary to spend large amounts of money, to do the renovation at one time, or to plan all the work in advance. The householders undertaking this work so far have been very involved in the process. More of the expertise may need to reside in the building industry if low carbon retrofit is to be massively scaled-up.

Superhome owners do not seem to be making decisions as 'rational economic actors', for example, they do not appear to be concerned about payback times for their energy investments. However, as the evidence shows, low carbon retrofit delivers very important benefits (tangible and intangible) beyond energy saving. Therefore, we need to move away from thinking of low carbon retrofit as primarily an economic investment to deliver energy cost savings, and recognise that it engages with many other important values and aspirations. Understanding retrofit in a more nuanced and human way, should help develop better policy in the future.

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References

- DCLG. (2013). English Housing Survey: Headline report 2011-12. London: Department for Communities and Local Government.
- Gram-Hanssen, K. (2014) Existing buildings – users, renovations and energy policy, *Renewable Energy* **61**, 136-140
- Fawcett, T. (2013) Exploring the time dimension of low carbon retrofit: owner-occupied housing. Building Research and Information Published online: 11 July 2013 DOI. 10.1080/09613218.2013.804769.
- Fawcett, T. & Killip, G. (2014) Anatomy of low-carbon retrofits: evidence from owner-occupied Superhomes. *Building Research & Information* [in press]
- Killip, G. (2013) Transition management using a market transformation, approach: lessons for theory, research and practice, from the case of low-carbon housing refurbishment in, the UK. *Environment and Planning C: Government and Policy* **31**, 876-892.
- ONS. (2012). 2011 Census: Key statistics for England and Wales, March 2011. London: Office for National Statistics.
- ONS. (2013). Regional household income: Spring 2013. Published on the web: <http://www.ons.gov.uk/ons/rel/regional-accounts/regional-household-income/spring-2013/index.html>: Office for National Statistics.
- Roberts, S. (2008). 'Altering existing buildings in the UK', *Energy Policy* **36**(12), 4482-4486.
- Stiess, I., Dunkelberg, E. (2013). Objectives, barriers and occasions for energy efficient refurbishment by private homeowners. *Journal of Cleaner Production* **41**, 250-259
- Thorpe, D. (2010). Sustainable home refurbishment. London: Earthscan.
- Wilson, C., Crane, L., & Chryssochoidis, G. (2013). *The conditions of normal domestic life help explain homeowners' decisions to renovate*. Proceedings of ECEEE 2013 Summer Study, 3-8 June 2013, Belambra Presqu'île de Giens, France.