

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/309375513>

AN EXPLORATORY STUDY OF THE IMPACT OF VISUAL REPRESENTATION ON PERCEPTION OF ENERGY CONSUMPTION IN UK HOUSEHOLDS

Conference Paper · September 2016

CITATIONS

0

READS

76

5 authors, including:



Emmanuel Aboagye-Nimo
Nottingham Trent University

16 PUBLICATIONS 10 CITATIONS

[SEE PROFILE](#)



Poorang Piroozfar
University of Brighton

78 PUBLICATIONS 195 CITATIONS

[SEE PROFILE](#)



Hannah Wood
University of Brighton

9 PUBLICATIONS 26 CITATIONS

[SEE PROFILE](#)



Eric R. P. Farr
NewSchool of Architecture & Design

34 PUBLICATIONS 136 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



BIM Education and Implementation [View project](#)



A Future-proof Cultural Heritage: Responsive retrofit measures for domestic listed buildings in the South East of England in a time of climate change [View project](#)

AN EXPLORATORY STUDY OF THE IMPACT OF VISUAL REPRESENTATION ON PERCEPTION OF ENERGY CONSUMPTION IN UK HOUSEHOLDS

Emmanuel Aboagye-Nimo¹, Amir Piroozfar², Hannah Wood³, Eric R.P. Farr⁴ and Colette Rayner⁵

^{1,2,3,5} School of Environment and Technology, University of Brighton, Lewes Road, Brighton, BN2 4GJ, UK

⁴ New School of Architecture and Design, 1249 F St, San Diego, CA 92101, USA

ABSTRACT

The ever increasing awareness of climate change is driving homeowners and property users to adopt essential measures when dealing with energy consumption. The Energy Performance Certificates (EPC) scheme for domestic properties in England and Wales requires homes to undergo energy surveys in order to be issued an EPC, thereby certifying their property is energy efficient. The aim of this study was to explore changes in householders' perceptions towards EPCs after being introduced to thermal images as a visual aid. Thus the effectiveness of EPCs would be assessed. 10 houses in South East England were selected and a deep qualitative study was undertaken. Semi-structured interviews were conducted in all of the households. The collected data was thematically analysed. The perceptions of householders with regard to energy consumption changed upon the introduction of thermal images. Householders also showed keen interest in fighting 'man-made' climate change. However, various barriers restrain them from contributing effectively e.g. financial restrictions. Thus thermal images alone may not be enough to change individual practices. This paper highlights why the EPC scheme is not living up to expectation, and recommends that more dynamic methods of assessment need to be introduced to replace or assist EPCs.

Keywords: climate change, domestic properties, Energy Performance Certificates, householders' perceptions, thermal images.

INTRODUCTION

The notion of the battling climate change has led to the emergence of numerous measures in addition to the ultimate goal of overall CO₂ emission reduction in all industries and even domestic settings. The UK is one of the frontiers when it comes to countries whose governments are implementing initiatives to tackle this problem. There are several initiatives currently being implemented in the UK to help this cause. The UK's Department of Energy and Climate Change (DECC) has set out a comprehensive programme aimed at reducing carbon emissions known as 'The Carbon Plan'. Under this scheme, the Government plans on cutting emissions by at least 34% by 2020 and 80% by 2050 (DECC, 2013). In the UK, many structures have

¹ e.aboagye-nimo@brighton.ac.uk

² a.e.piroozfar@brighton.ac.uk

³ hw35@brighton.ac.uk

⁴ eric.r.p.farr@gmail.com

been executed alongside the Carbon Plan to help this problem of global importance. These include Carbon Reduction Commitment (CRC) Energy Efficiency Scheme, Climate Change Act 2008, Energy Act 2011 and Planning Act 2008 (Energy Institute Knowledge Service, 2012). These policies and regulations affect all in society i.e. both public and private sectors have roles to play in energy consumption initiatives. It is argued that households play a critical role in the fight to reduce energy consumption and subsequently an overall reduction in carbon emissions (de Wilde, 2014). This is because buildings account for about 40% of the final energy consumed (Amecke, 2012). One of the most widely used schemes in the UK (as a result of an EU directive) is the Energy Performance Certificates (EPCs). EPCs are certificates issued by certified assessors who examine households based on factors such as insulation, heating systems and types of windows to evaluate a given property's energy efficiency (Parkinson *et al*, 2013). In Europe, an EPC needs to be produced every time a new occupier purchases or leases a building (Kelly *et al*, 2012) thus its importance cannot be overlooked. However, the effectiveness of EPCs alone in the reduction of 'unnecessary' energy consumption by householders has been questioned in the past (see Amecke, 2012; Kelly *et al*, 2012).

Considering the magnitude of the supposed implication of using EPCs, this study was initiated to explore householders' perception regarding energy consumption in the UK. The main aim of the study was to explore changes in householders' perceptions towards EPCs and overall energy consumption after being introduced to thermal images as a visual aid to assist them in realising how their properties perform.

ENERGY PERFORMANCE CERTIFICATES IN THE UK

In March 2007, the Energy Performance of Buildings (Certificates and Inspections) Regulations 2007 was passed for England and Wales (Parkinson *et al*, 2013). This was in response to the EU Directive 2002/91/EC; Directive on the energy performance of buildings (EPBD) (Official Journal of the European Communities, 2003).

A typical EPC shows the property details, including property address, property type (e.g. semi-detached house), date of inspection, certificate date and finally floor area (DECC, 2013). It is important to note that the total floor area does not include spaces beyond the external walls of the property.

In addition to the details of the property, there is the A to G scale where A depicts a good performance in energy efficiency and G is rated poor (see figure 1). Householders are also shown their current energy efficiency rating. The third column ('Potential') represents the potential energy rating householders could attain based on the calculations carried out by the assessor. Under the environment impact rating, householders shown how environmentally friendly their properties are. Similarly, a rating of G represents a poor environmentally friendly household, i.e. higher CO₂ emissions. Under environmental impact ratings, the householder is again advised on the potential rating the property could attain as shown below (authors will provide coloured photos upon request).

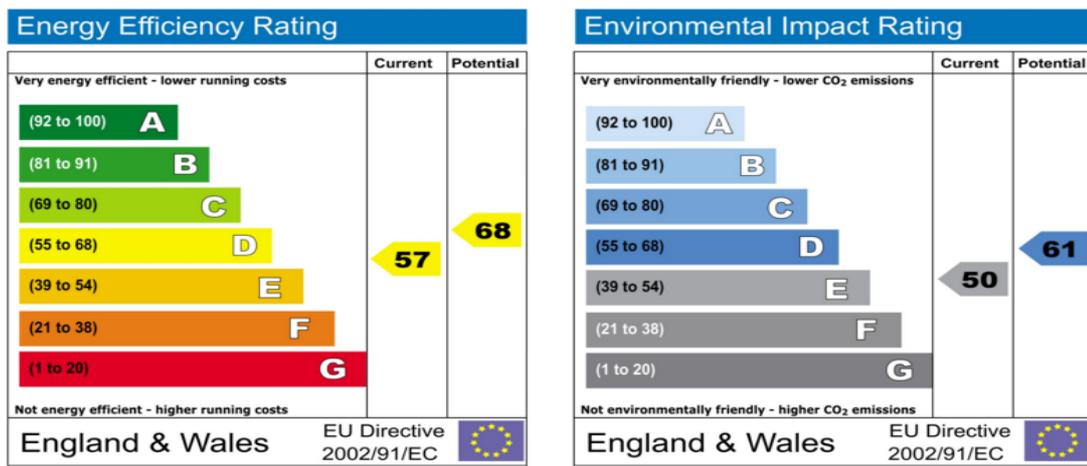


Figure 1: Energy efficiency and environmental impact rating section of typical EPC (Source: Oakwood Energy Group, 2016)

Looking at figure 1, it can be inferred that the household is currently at an energy efficiency rating of low D (57). However, the property has the potential of reaching a rating of high D (68). Also, the property's carbon emissions have a grade E rating but could be improved to grade D. In addition, EPCs show householders how much they could save financially. This feature does not specifically offer recommendations on what could or should be done or more importantly, where most of the consumption occurs.

Householders/tenants are supposed to go by these ratings to help their properties perform better. However, there are grave concerns that these depictions are not motivating people as much as it could (see DECC, 2013; Amecke, 2012; Kelly, 2012). This further supports the need for a study that seeks to encourage alternative methods to encourage householders in implementing more energy efficient practices.

Thermal images as a solution

Thermal imaging has many uses in different industries, e.g. in the military, scientific and medical research and many other industrial situations (Lloyd, 2013). It is also known to be very useful in carrying out tests on new buildings and more importantly it is effective in detecting heat loss in older buildings (Pearson, 2011).

The images produced by thermal imaging camera are commonly reproduced with a temperature colour scale bar shown alongside (Gorse *et al*, 2016). The coloured scale bar beside the image represents the comparative temperatures in the image this being shown by the colour in the image. Additionally on the right hand side of the scale a numerical value is given (Pearson, 2011). It is presumed that showing householders such thermal images will be an intriguing experience that they can relate to and subsequently understand the exact areas where their buildings are performing poorly with regard to energy performance (Gorse *et al*, 2016).

Having discussed the concepts behind the EPCs and the need for a more interesting and engaging technique that would help householders improve their practices, the next section discusses the research methods implemented in this study.

RESEARCH METHODS

In order to carry out a study with findings that are valid and reliable, it is important that robust and ethical measures are taken into consideration during the data collection methods (Fellows and Liu, 2015). A qualitative approach was adopted for this study thus the views and opinions of the respondents were sought over numerical and statistical outcomes (ibid).

Two phases of data collection was carried out. Having gained access to 10 properties in the South East region of the UK, details, photos, maps and thermal images of individual properties. The original photos and thermal images were taken from consistent locations/angles in order to give the research participants (householders) a contextualized view of their properties' heat patterns. An example of such images is shown in figure 2 below:

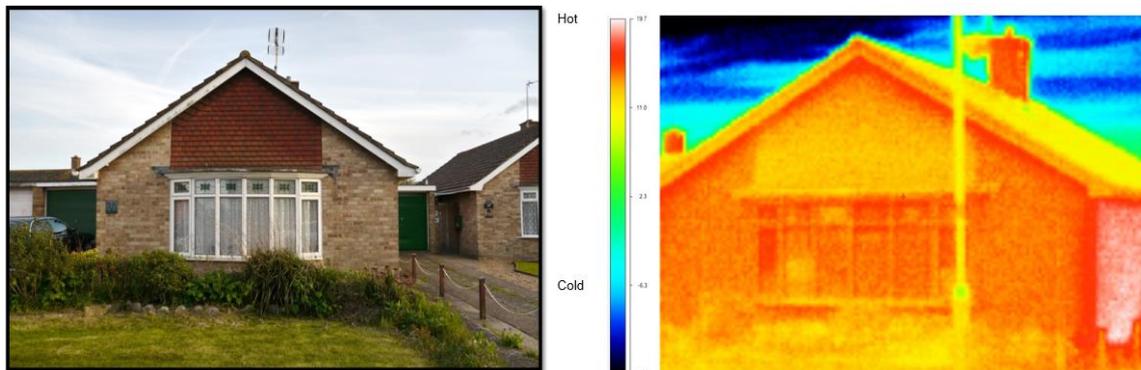


Figure 2 Examples of normal image and thermal image of visited households

As shown in figure 2, research participants were shown photos of their various properties. After they had synthesized the various images, the second phase of data collection was initiated. The second phase comprised of semi-structured interviews.

Semi-structured interviews

The semi-structured interviews were carried out with individuals that identified themselves as solely or partly responsible for making decisions in the household with regard to energy consumption. Open-ended questions were used to encourage respondents to share their views and opinions on the various topics presented. The questions and topics ranged from general issues (e.g. climate change/global warming) to very specific issues (e.g. how they had attempted to reduce energy consumption in their various properties). The interviews were recorded and transcribed verbatim. Quotes presented in the findings and analysis section of this paper are attributed to pseudonyms and not the real names of the respondents for ethical reasons.

Data analysis

After collecting data from interviews, a thorough thematic analysis was undertaken. This yielded several themes included respondents' views towards EPCs. Thematic analysis was carried out on the collected data. The various emerging themes have been consolidated into four major topics and these are presented next.

FINDINGS AND ANALYSIS

The various themes that emerged from the data analysis are discussed here.

Attitudes of respondents

When asked about their general views on climate change, there was an overall impression of its importance. Some responses are given as follows:

"[I am] very concerned that the environment is being spoiled and people haven't taken it seriously often because it's an attitude thing but also because people often can't afford to make all the changes that would make their houses efficient." Tom

"[Climate change] is important, and especially, not so much it's going to change in my time but for my kids and grandchildren as well, so yes, very important." Jane

As seen in the responses presented above, participants believe climate change is a matter of great importance. Furthermore, Jane points out that it is not only important for her generation but even more worrying for future generations.

However, not all responses showed concern for the potential issues that climate change could cause or for its importance. Brian stated: *“Well, I’m not bothered to be honest, I don’t take a lot of interest.”* Although this could mean he genuinely does not care about the climate change issues, it could also be a result of lack of understanding as stated by Ed i.e. *“It’s just too complicated for the majority of people”*.

After exploring respondents’ views or awareness with regard to climate change, the next theme focused primarily on EPCs.

Views on EPCs

All respondents except one had received an EPC before purchasing their properties. Maria did not remember receiving or looking at one when moving into her property. This goes to show that the EPC was not a priority to her because it would have played a role in her property choice. Andy and Sally who were both renting their properties were not given or shown EPCs before moving in.

With regard to the information provided by EPCs and how it affected their decisions, a few responses are given below:

“[The information] was limited, the EPC was not the main reason.” Mike

“Well it had a bearing and to be honest I viewed it as something that was interesting rather than essential, really because most things once you have moved in become apparent and then you decide whether to address those issues.” Jon

Having shown little appreciation for climate change previously, Brian stated that the EPC had no bearing on his choice.

Sally who was not presented with an EPC before moving into her residence admitted that it would have made a significant impact in her decision-making process. The only other renter, Andy, stated that an EPC would not have made a difference in his choice.

Jane claimed she made full use of the EPC she received because she wanted to make sure she had an energy efficient home. She said it gave her an indication of the things that could be changed easily to make her property more efficient.

Interestingly, none of the respondents had looked at their EPCs after moving into their various homes. The argument here is not concerned with the time period of living in their properties but purely based on the point of never revisiting or re-evaluating their properties’ energy performance. This could be a result of many factors, including people not finding enough information on the EPCs to help them improve energy performance. Additionally, it could simply be as a result of respondents not finding the EPCs dull and not intriguing enough. Beyond the EPCs, respondents were also asked about energy consumption of their households.

Energy consumption

The discussion of whether respondents had consciously made efforts to reduce energy consumption or manage it more effectively was introduced. While some interpreted it solely as reducing energy costs, others perceived the topic as both reducing energy consumption and energy costs. In other words, the former were motivated solely by financial considerations and not implication of their energy use on climatic conditions. Brian had changed his energy supplier in his quest for cost reduction. He also shared

that his previous property was considerably larger than his current home so the bills were not much of a concern in comparison. In his words: “*the property I was in before was so big and it was so expensive, this one is a minute price compared*”. In trying to reduce energy consumption, Joe, Jane and Mike had had retrofitted their cavity walls with insulation. Joe was also quoted as follows:

“The house was basically gutted and a lot of work was done internally with insulation and things, but because nobody lived here prior to having that work done, we have had no comparison...”

Understandably, Joe had made significant changes in his property but could not assess if there had been substantial changes in energy performance as there was no benchmark to compare his current situation to. Sally had also made major changes in terms of energy consumption practices. She states: “*In this property, I have done little things, just crazy little things that have made a massive difference...*” One of these changes was ensuring her property was never heated when she was not at home. Additionally, she had acquired ‘*electric blankets*’ that she used when watching television in her sofa instead of turning on the heater for the living room. Finally, she reveals the “*it’s costing me about 10 pence an hour rather than what it would cost me to heat the whole flat*”. Although the comparative figure is not given, she believes heating the flat for 10 pence is considerably cheaper than what she would have paid otherwise.

When asked about specifically about factors that affect their energy consumption practices, financial incentives was a recurring theme. However, many of them had limited awareness of whether such incentives existed. Brian and Jane were aware of such incentives and they received grants from British Gas. Tom was keen to learn more about the ‘*Green Deal*’ but felt there were too many stipulations in order to take advantage of any financial help. Sally who had more knowledge about the Green Deal professed that as a renter, “*it doesn’t particularly affect me*”. Maria was aware that tariff prices had changed relatively recently for renewable energies and therefore felt that the financial incentives were not as great as they were previously. In other words, she believed the users of renewable energy were receiving more rewards than households using traditional sources of energy.

After respondents views on the overall energy performance and other areas were explored, the impact of thermal images on participants’ perceptions was yet to be investigated.

Impact of visual images on participants’ perceptions

At this point, all participants apparently seemed aware of what the images were representing and the colour coding seemed generally understood. Maria, Brian, Andy, Mike and Jon referred to the images as showing cold, warm or hot. Tom, Jane, Ed and Sally also referred to the images as showing “*heat loss*” or “*escaping heat*”. Joe did not show as much understanding but recognized the image was different representation of his property. Further clarification of what the images represented were carried out by the interviewer in order to make sure all respondents were aware of what was being shown. Having ensured that the participants had attained working knowledge of what the thermal images were depicting, interviews proceeded regarding their views on EPCs and energy consumption.

Joe and Mike found the thermal image representation interesting and believed it would have made a significant difference. They both explained that they would have been able

to estimate whether changes could be made to reduce energy consumption e.g. through the use of new windows or even using better methods to avoid cold bridging. Jane also started openly discussing how he was going to manage energy consumption practices by working on areas around some specific windows and doors. Thus the visual representation had already started modifying his perceptions on energy consumption. Joe echoed Jane's thoughts and added that "*I think it is quite a graphic representation of what is going on in the property so I would have looked at this and at the EPC rating possibly more in detail*". This goes to show that he does not disregard the importance of EPCs but adding thermal images would help him acquire a better understanding of what needs to be done to reduce energy consumption. Sally stated she knew this would be beneficial to some people but not her. She went further to clarify that "*I'm colour blind*".

Maria stated that the thermal images in addition to the EPC would not have influenced her purchasing decision substantially because she already knew the type of amendments that were required in order to make her home more energy efficient. She added that she did not know exactly how much work was needed nonetheless. Sally, Joe and Jane also added that the images would not have influenced their final decisions but it would have given them a better understanding of how much of an extra cost they would have to allocate in their budget after moving in. Tom was quite glad he made the purchase because from the thermal images, he had deduced that there was very little heat loss and as such he had made a good decision. He subsequently encouraged that it would be helpful if such images were attached to EPCs.

Jon stated EPCs in addition to thermal images would show him specifically "*areas that need improving*". Andy, Ed and Mike added that the images would help them make specific changes rather than worrying about areas that did not need attention. The problem of not knowing where which areas to attend to was described as '*off putting*'.

Brian explained that he could understand how it would be beneficial to others but not himself. He added that he "*...still wouldn't understand what it was and if [he] was spending a lot of money on electricity and gas, [he'd] see what the problem was and try and improve it there*".

Finally, respondents were asked what would encourage them change their minds the most on the reduction of energy consumption. Thus not focusing on the proposed thermal image technique. At this point, all the changes suggested were not based on climate change. Joe, Maria, Ed, Mike and Sally were all in favour of any ideas that would reduce cost. Financial implications seemed to be very important.

However, Brian did not believe he could reduce energy consumption any further although his EPC and thermal images showed that he could make significant changes.

Andy mentioned he wanted to make changes but believed it was the responsibility of his landlord as he did not own the property. Thus if he had his own way, he would have taken measures to manage energy consumption in the property more efficiently.

CONCLUSIONS

The relevance of EPCs have often been questioned as far as their impact on reducing energy consumption and ultimately helping battle climate change. As a result, this study was carried out to qualitatively assess EPCs' impact and the views of 10 individuals who had decision making roles in their various homes. It was confirmed that the views of respondents are not mainly affected by EPCs as they find it too vague

and not informative enough in terms of measures of reducing energy consumption. However, after showing participants thermal images, the participants were able to clearly identify which areas of the properties that needed improvement.

Participants believe that thermal images make a significant impact on how they understand their energy performances in their properties. However, these images are not enough to change their decisions on purchases as they feel the changes required are less costly in the grand scheme of events i.e. the total of a house price.

Further research is proposed to track practices of members of households as they attempt to alter their energy consumption practices while using thermal images as a guide.

REFERENCES

Amecke, H. (2012) The impact of energy performance certificates: A survey of German home owners. *Energy Policy*, **46**, 4-14.

De Wilde, P. (2014) The gap between predicted and measured energy performance of buildings: A framework for investigation. *Automation in Construction*, **41**, 40-49.

DECC (2013) Final Project Report: An investigation of the effect of EPC ratings on house prices. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/207196/20130613_-_Hedonic_Pricing_study_-_DECC_template_2_.pdf [accessed: 12/02/2016].

Energy Institute Knowledge Service (2012) UK and EU energy initiatives and legislation factsheet. Available at: <https://www.energyinst.org/uploads/documents/DSI20.pdf> [accessed: 12/02/2016].

Fellows, R. and Liu, A. (2015) *Research methods for construction*. Chichester: John Wiley & Sons.

Gorse, C., Smith, M., Glew, D., Thomas, F., Shenton, D.M. and Farmer, D., (2016) Surveying and measuring the thermal properties of buildings. In *Building sustainable futures* (pp. 15-34). London: Springer International Publishing.

Kelly, S., Crawford-Brown, D. and Pollitt, M.G. (2012) Building performance evaluation and certification in the UK: Is SAP fit for purpose?. *Renewable and Sustainable Energy Reviews*, **16**(9), 6861-6878.

Lloyd, J.M. (2013) *Thermal imaging systems*. Berlin: Springer Science & Business Media.

Oakwood Energy Group (2016) *Energy Performance Certificates*. Available at: <http://www.oakwoodenergygroup.co.uk/energy-performance-certificates/> [accessed: 12/02/2016].

Official Journal of the European Communities (2003) *Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings*. Available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:001:0065:0071:EN:PDF> [accessed: 12/02/2016].

Parkinson, A., De Jong, R., Cooke, A. and Guthrie, P. (2013) Energy performance certification as a signal of workplace quality. *Energy Policy*, **62**, 1493-1505.

Pearson, C. (2011) *Thermal imaging of building fabric*. BSRIA.