The Justification for Further Research into Energy Saving Behaviour in the UK: A Literature Review

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Abstract
This paper presents the findings of a literature review into energy saving behaviour. The first section examines research conducted within a domestic environment. The previous research was investigated for both limitations and correlations. The second section of this research also analyses past studies into energy saving behaviour but within a variety of different commercial companies, investigating the success rates with these initiatives and the formula for effective motivational tools. A particular emphasis was placed on the comparison of UK based research with investigations conducted over the rest of the world. It was found that at present the greatest percentage of studies focus on energy saving behaviour in households but that the scope and remit of these papers had great variations. This literature review also highlighted, that although the UK has only a small percentage of previous research conducted in a domestic environment the primary shortage of research exists in the commercial sector. This paper concludes that not only should more research be conducted in both domestic and commercial environments due to the limitations of the existing studies, but that there is a pressing need for this to be conducted in UK premises.

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Introduction

Energy conservation can be achieved through both, the adoption of technical measures and the changing of behaviour (Aini, Chan & Syuhaily 2013). Consequently, energy conservation and related environmental issues are of increasing interest for psychological research (Corradi et al 2013)& (Viklund 2004). Breukers et al (2011) commented that for energy saving strategies to be successful new research would need to take a transdisciplinary integration approach. This approach has resulted in a fast-growing field of research that focuses on both, the adaptation and resilience of buildings and the adaptation of their occupants to a changing climate (De-Wilde & Coley 2012).

It has also been proposed that if energy reduction measures are to be successful, then it is important to examine its effectiveness in three different sectors; 1) changes in direct and indirect energy use, 2) changes in energy-related behaviours & 3) changes in behavioural antecedents (Abrahamse et al 2007). Environmental concerns are tied to a person's notion of self and the degree to which they are interdependent with living things. These concerns may serve as the key motive for green behaviour because a person's attitude towards environmental concerns is usually rooted in his/ her own value system (Moon et al 2013), hence the growing importance of behavioural studies in the field of energy conservation.

Within this paper, previous research into energy saving behaviour has been examined in two broad categories; 1) Households and 2) Commercial premises, with the greater focus on the latter and the implications for UK businesses. The total number of papers investigated within this literature review are 113, all conducted since 2002.

Energy saving behaviour in households.

The residential sector accounts for one-fifth of global energy consumption, from daily needs, and has therefore gained importance in recent years (Brounen, Kok & Quigley 2013).

There have been numerous papers that investigate the link between household energy conservation and consumer behaviour. These studies have encompassed a broad range of countries.

Allcott (2011) evaluated an energy saving exercise by OPOWER a nationwide energy company in the USA. OPOWER ran a series of programmes in 600,000 households across the US that involved sending their residential customers a two part letter. The first part of the letter compared the customers personal energy usage to that of their neighbours- the customers were given one of three ratings. The ratings used a simple but effective smiley face system- "Great" received 2 smiley faces/ " Good" received one smiley face/ " Below average" received two frownie faces. The frownie faces in particular proved so emotive with consumers that high levels of customer complaints ended this practice ("Below Average" had the frownie faces removed). The second part of the letter included simple but personalised action tips for the resident that were based on the customers energy use and housing profile. Allcott (2011) evaluated the findings from the OPOWER research concluding that these simple letters and residential energy saving tips had the potential to save 20% energy usage. One of the most positive aspects of this study is it's accessibility to all residents regardless of

socio economic profile, environmental awareness, home owner status and educational level. This, therefore, makes this method worth considering in future studies and is highly applicable in future research in the UK.

Many studies have been conducted into household energy saving behaviours in China; among those was Wang , Li & Li (2011). Wang, Li & Li (2011) proposed a conceptual model of environmental responsibility affecting household energy, in a sample area of Xuzhou, China. Results showed 3 principal findings; 1) The stronger the environmental responsibility is the stronger the energy- saving behaviour intention is, 2) the stronger the energy-saving intention is, the stronger the behaviour of residence energy saving investment is & 3) the environmental responsibility has an indirect positive effect on the behaviour on the behaviour of residence energy saving investment via the energy-saving behaviour intention. This study disagreed with Yue, Long & Chen (2013), as they found no statistical relationship between any demographic variable other than ownership of house, family structure and education level. The main limitation of this study by Wang, Li & Li (2011) is the small sample size- 212 households in one area. Ma, Andrews-Speed & Zhang (2013) state that the Chinese government will need to develop new strategies and measures to inform and educate its citizens on energy saving at home.

Mizobuchi & Takeuchi (2013) conducted a study to evaluate the influences of both financial and non-financial factors on encouraging electricity-conservation behaviour, within randomly selected Japanese households over an 8 week period. Within this investigation were three groups 1) reward only, 2) reward with comparative feedback (their households performance in comparison to others & c) a control group. Both a pre and post experimental questionnaire was also conducted with all participating households. Mizobuchi & Takeuchi (2013) concluded that, like many similar studies before, a financial incentive is effective in encouraging electricity conservation but that the findings of the comparative research were inconclusive. Although this study proved statistically positive for showing the effectiveness of financial reward against energy conservation, the timeframe of 8 weeks is too short. There are also other contentious issues within this paper including the proposal of an New Ecological Paradigm (NEP). The NEP worked on participant's agreements/ disagreements (either strongly or partly) with 15 different statements. The questions used within the NEP tended to have a moral or ethical basis, rather than a scientific quality. Examples of these included: "Humans ingenuity will insure that we do not make the earth unliveable", "Plants and animals have as much right as humans to exist" & "The earth is like a spaceship with very limited room and resources".

One of the challenges that arise when comparing research completed in countries that have a markedly different culture is assessing their relevance to studies in a westernised society. For example, research by Na Na, Sung & Jeong (2012) conducted into apartment's residents' energy saving awareness and behaviour in Korea using questionnaires. However, the questionnaire options showed inequality between male and female participants. This inequality would be unacceptable in a westernised society so puts the validity of the findings into question when considering it's suitability for testing in the UK.

Numerous energy conservation research papers have been published from studies in Europe, with the majority of research hailing from Sweden and The Netherlands. Back in 2006 Linden, Kanyama & Eriksson, conducted a questionnaire study within 600 Swedish households to provide an insight to current energy saving behaviour patterns. It was found that many of the households questioned had energy inefficient behaviours that existed, either due to a lack of education/ awareness or even through "habit". Linden, Kanyama & Eriksson (2006) concluded that further work was necessary and suggested that a combination of information, economic measures, administrative measures, more user friendly technology and equipment with a better aesthetic quality. The two main limitations of this study was that all the 600 households questioned live in the same city and secondly that the combination of measures to improve residents energy saving behaviours suggested by Linden, Kanyama & Eriksson (2006) have not been tested and only existed as an untested theory.

Han et al (2013) conducted a study to investigate how local government in the Netherlands could use interventions effectively to stimulate local residents to save energy. It was found that feedback, rewards and financial incentives are the most positively effective, whilst information, demonstration, free products and commitment were not. Limitations within this analysis included a low response rate, small geographical area sampled and detailed technical characteristics of the dwellings themselves were absent, so it would have been unclear how this would have affected the behaviour of the residents. Wood & Newborough (2003) agree with Han et al (2013) that regular feedback was vital to increasing energy conservation behaviour.

Sardianou (2007), conducting research in Greece, partially agreed with both Martinsson, Lundqvist & Sundstrom (2011) and Mills & Schleich (2012). The Greek research examined seven energy saving variables and compared the responses against the demographics of the respondents. Several results were found. Firstly the results indicated that as income increased households tended to be more willing to conserve energy as with their higher levels of affluence they could afford to invest in more energy saving technologies. Secondly sex, educational level and marital status do not affect householders choice with regards to the combination of energy saving activities undertaken. Thirdly, home ownership status has a positive correlation with energy conservation behaviours/ activities. Next, Sardianou (2007), found that age was a statistically significant variable, as the age of the respondent increases, the number of reported energy saving conserving actions decreases. Lastly, environmental awareness was found to be a strong predictor of energy saving behaviour, which agrees with many previous studies. The main limitations with this research was that the questionnaires used were only limited to seven variables which only consisted of one simple question each. Martínez-Espińeira, Garćia_Valińas & Nauges (2014) agreed with the findings of Sardianou (2007) stating that both affluence and environmental awareness could have both a direct and an indirect effect of households energy saving behaviour. The research conducted by Martínez-Espińeira, Garćia_Valińas & Nauges (2014), in Spain, stated that campaigns to raise environmental awareness should take into account differences in terms of socio-demographic household characteristics and would therefore be made more targeted for each individual household, depending on their differing circumstances. However, Martínez-Espińeira, Garćia_Valińas & Nauges (2014) did note that in most circumstances this would be prohibitively expensive and therefore not cost effective. The main limitation of this research was

that only six energy conservation variables were used to test the households environmental awareness and these variables were very simple in nature, an example being do you fill, (to the top), the washing machine before using it.

Energy conservation within a domestic environment in the UK, has also been a growing concern for research in recent years, with the frequency of published papers increasing every year.

Scott, Jones and Webb (2014) designed a research framework to improve understanding of how people living in deprived communities, (in Yorkshire and The Humber), think about energy use and, in particular, what they think about different household energy efficiency interventions that were being proposed as part of a project known as "The BIG Energy Upgrade". Different communities received different household energy efficiency interventions depending on eligibility and funding from external sources. These interventions included cavity wall insulation/ Loft insulation/ External solid wall insulation/ Fuel switching/ Heating controls/ Solar water heaters/ PV panels/ Boiler replacements/ Window glazing improvements/ Voltage optimisation/ Smart meters and Energy advice provided by Yorkshire energy services. It is worth noting that all the various communities received energy advice from Yorkshire Energy Services. Scott, Jones and Webb (2014) the Theory of Planned Behaviour (TPB) as a framework to analyse how residents felt about a particular development. FIG 1 shows the items used to measure perceived benefits, familiarity, and beliefs specified by the TPB.

Their responses were then measured against various factors such as; home ownership/ membership of a community organisation/ Exhibition of green behaviours/ Belief in our ability to tackle global climate change/ Belief that global climate change is currently affecting or will affect you/ Income/ Educational attainment/ Belief in global climate change/ membership of an environmental organisation and familiarity with energy conservation interventions.

Scott, Jones and Webb (2014) made the following conclusions;

- Home ownership had a positive correlation with the intention to invest in the energy saving interventions.
- Belief in global climate change itself had no significant effect on intentions but both, belief in humans being able to tackle global climate change and belief that global climate is currently affecting/ going to affect had a positive effect on respondents attitude to the energy conservation interventions.
- Familiarity with energy efficient interventions had a positive effect on respondents willingness to adopt said interventions.
- Income, educational attainment and membership of local community group did not have a significant effect on willingness to adopt any of the interventions.

Construct	Items
Perceived Benefits	-To what extent do you feel the proposed improvements will benefit your household? - To what extent do you feel the proposed improvements will benefit your community? - To what extent do you feel the proposed improvements will benefit your council?
Attitudes	- "X" would help me to reduce my energy bills - I would feel good about having "X"
Subjective norms	- People who are important to me would want me to have "X"
Perceived behavioural control	- It would be easy for me to have "X" installed in my home
Familiarity	- How familiar are you with "X" as a way to conserve energy?
Intentions	- I would be willing to have "X" installed in my home - I would be willing to contribute financially to have "X" installed in my home

Fig 1. Table deomstrating Items used to measure perceived benefits, familiarity, and beliefs specified by the Theory of Planned Behaviour (TPB) taken from Scott, Jones and Webb (2014), pp340, Table 4.

One of the main limitations of this research is the differences in the interventions between the various communities. For example, deprived communities in Leeds only received external solid wall insulation and energy advice whereas deprived communities in North East Lincolnshire received External solid wall insulation, Fuel switching, Heating controls, window glazing update, Voltage optimisation, smart meters and energy advice. The second limitation was that of the targeted 1121 households only 279 questionnaires were returned, so there was only a percentage response rate of 25%. It also worth noting that of the return questionnaires the responses varies greatly between the different communities (see Fig 2) and this would have had effects on the results that were not taken in to account.

Local Authority	Targeted Households	Questionnaire responses received	Percentage response rate (%)	Percentage of total sample (%)
Barnsley	271	63	23	23
Doncaster	288	147	51	53
Kirklees	201	39	19	14
Leeds	60	10	17	4
North East Lincolnshire	50	5	10	2
North Lincolnshire	251	15	0.2	5
Total	1121	279	25	100

Fig 2. Table to show Questionnaire distribution and response in each local authority area adapted from Scott, Jones and Webb (2014), pp 339, Table 3.

Not only, is there several conflicting opinions on the barriers and drivers in motivation of householders to engage in energy saving activities but there is also s distinct lack of research being carried out in the UK, Table 3.

Energy saving behaviour in commercial premises.

Employees constitute an important target group for energy saving, but only a few research efforts have been paid to study what drives employee energy saving behaviour in organisations (Zhang, Wang & Zhou 2013). Janda (2014) suggests that a significant challenge exists when improving the energy performance of commercial buildings as it is necessary to understand and tackle the complexity that stems from the inter-relationships between 3 different factors. Janda (2014) proceeds to list these factors as;

a) Physical and technical factors (The range and variety of commercial building stock, the existing technologies they were designed to contain, the state of current operational systems.
b) Social and organisational factors (The number of stake holders- investors, developers, agents, owners, tenants, facilities managers, users of the space [employees and customers] and mixtures of these groups.
c) Legal factors (lease hold etc).

It is imperative that working environments should not only provide comfort to occupants but, they should also be in line with energy saving practices and promote energy conservation and energy efficiency (Nisiforou, Poullis & Charalambides 2012). Teng et al (2012) stated that for energy conservation strategies to work in organisations then effective communication and participation with both internal and external stakeholders was vital. These communications should include raising-awareness, training, educating and even offering incentives to increase motivation. Cagno (2013) identified barriers to energy conservation in industry. Two of the barriers were stated as “Lack of information” and “Financing”.

Since the Japanese tsunami in 2011 and subsequent energy shortages, there has been an increasing number of research papers into energy conservation behaviours in Japan (Hori et al 2013), (Mizobuchi & Takeuchi 2013) and (Hamamoto 2013). Energy conservation has been made number one priority with Japanese companies, even changing traditional cultural practices to facilitate greater energy efficiency (Davies 2013).

Jiang & Tovey (2009) introduce a sustainability approach, tested in a commercial environment in Japan. This approach concentrates primarily on three complementary aspects: a) the introduction of an effective energy management system, b) the incorporation of relevant advanced energy saving technologies and measures and c) the promotion of awareness among occupants to make changes in their behaviour towards a more environmental-friendly behaviour. Unfortunately the behaviour management was not investigated in detail within this study as the paper only made reference to three aspects of change; closing windows and doors, turning off lights and appliances and lastly wearing different “summer” clothes to work in place of a conventional suit.

Zhang, Wang & Zhou (2013) proposed a theoretical model of employee energy saving in China, using a research model where personal norm and electricity saving as

predictors of employee energy saving behaviour (personal norm referring to an employee's moral obligation to save electricity in one's company). Through the literature review 7 hypotheses were constructed and statistical analysis showed that people's personal norm positively influences electricity saving behaviour. There were limitations to this research; only office workers were enlisted to take part in this study and the study only conducted in one region in China and may not have the same implications for studies carried out in more westernised societies.

Prukvilailert & Wangskarn (2011) reported analysis of an energy-conservation-participation-scheme governmental initiative in Thailand. The scheme was ran as the Thai government had suggested that "most small-and-medium sized organisations are not able to perform energy conservation activities by their own because lacks of technical skills and workers", however, the evidence for this statement was not included within this study. The government participation scheme was set to run throughout 2009-2010, although the evidence used within the surveys was actually collected over a single month within this time-frame (February 2010-March 2010). Workers within these factories (117)/ commercial premises (18) were asked to attempt to make 830 energy saving measures. After the energy saving measures were implemented the workers were then asked to provide their opinion of the measures and their importance. This study was limited in several ways; as already mentioned the lack of evidence for the original statement on which the investigation is based, it was limited to 135 companies, the majority of the companies used were factory based and the short time-frame for gathering research, but it was also limited in other approaches. The surveys used to assess the workers attitudes to the implemented measures were restricted to only 5 categories of priority, (very-high, high, medium, low and very-low) and the surveys themselves were also limited (opinions on the activities themselves, improvements to these activities and satisfaction from these activities). It is worth noticing that the study highlights that future support within Thailand should include training, raise-awareness (within companies) and the introduction of new technologies.

Although a number of strategies have been advocated to foster carbon reduction in the built environment but few studies have acknowledged that strategy adoption is a matter of organisational culture. Wong & Zapantis(2013) developed a theoretical model to examine the relationship between carbon reduction drivers , strategies adoption and organisational culture. It was concluded that significant relationship between the carbon tax and adoption of carbon reduction strategies can be further enhanced by organisational culture in terms of goal clarity, rewards and innovation, however, it was also noted that much more research is needed, particularly relating to policy implementation (Wong & Zapantis 2013).

Peschiera & Taylor (2012) analysed feedback on employees' energy usage, through a peer feedback network. It was commented that within an office environment when participants received energy consumption feedback there was a positive effect as it promoted the implementation of more energy saving practices as more peers share energy information. This research was conducted in New York but was limited as the sample size was 22 rooms within an office environment. Another limitation was the fact that when a room had more than one occupant the energy usage total would just be divided between number of occupants, rather than establishing a true figure for each employee. This had implications, due to the fact that if an energy conservation

consequence employee occupied the same room as an energy wasteful employee, they would cancel the effects of each other's energy consumption levels.

Carrico & Riemer (2011) also conducted a study into the energy-saving behaviour within employees in 24 office buildings within a southern state university. (It should be noted that this study is included within the commercial premises section and not the educational establishment section as the students that attended the university were not surveyed within the research). The research employed two different but "easy to implement" intervention techniques to assess energy-saving potential, in the form of electricity use. Carrico & Riemer (2011) justified that research stating that behaviour within an organisational setting poses a particular challenge to those wishing to promote energy conservation because employees typically have no direct financial incentive to reduce energy use and rarely have access to information regarding their level of consumption. The first method used group-level feedback on energy used over the last month and reinforced this with a positive encouragement statement "Keep up the good work" if the building had achieved a reduction in electricity use. The second method used "peer-education", from 15 who had received training prior to the study. A control measure was used within the study, employees within buildings that received neither of the intervention techniques were targeted by an information campaign. This consisted of a series of four postcards delivered to the occupants' mailboxes. The results of the research indicated that feedback and peer education resulted in a 7% and 4% reduction in energy use, respectively. It was also found that buildings that received the control measure actually experienced a 4% increase in energy use. Carrico & Riemer (2011) concluded that further work would be needed to explore these results. Limitations of this study include the use of volunteers who only received a short training session were used to conduct the peer education sessions. These volunteers received no payment or incentives for their efforts, nor were they screened prior to their training to see whether they were likely to be successful in motivating other staff members or to assess their prior knowledge. This short-coming was demonstrated by only 2 out of the 15 peer educators complying fully with the demands of the program instructions. A different, but major, limitation in this research was that monthly electricity bills, for each building, were used to assess energy savings made but that how these energy saving measures were achieved were not tested or measured or even included in the study.

Paille & Mejia-Morelos (2014) assessed employee energy conservation behaviour within companies in Canada using several psychological frameworks, regarding Pro-environmental behaviour (PEB) in the work place. One of the conclusions made from this study was that there is a positive correlation between employee commitment to an organisation, job satisfaction and PEB. The main limitation of this study was that even though real participants and their attitudes/ behaviours were surveyed no energy data, (gathered, utility bills or even historical library data) was used to calculate actual energy saved through behavioural measures.

There have been numerous studies conducted within Europe to assess energy conservation and the cost effectiveness of energy conservation measures within various companies; an example being Burke & Blesl (2014), who investigated energy saving measures in the steel industry, but few of these studies relate this research to the behaviour of the staff themselves. Research from Sweden identified that expressing environmental friendly attitudes, within the work place, significantly

increase the adoption of energy saving and renewable technologies and also result in a greater engagement in energy-efficient behaviours (Borgstede, Andersson & Johnsson 2013). Tabi (2013) disagreed with these findings, stating that in Hungary there was no significant difference the energy consumption between environmentally aware employees and non-environmentally aware employees. The study by Tabi (2013) was limited to questions based on monthly energy expenses and the research by Borgstede, Andersson & Johnsson (2013) was based on the analysis of surveys from two opinion polls only.

Nisiforou, Poullis & Charalambides(2012) presented a study that investigated the energy usage habits of a large commercial company in Cyprus. A detailed questionnaire was circulated to all staff to assess behaviour, attitude and opinion on energy usage and energy saving measures. Nisiforou, Poullis & Charalambides(2012) also analysed decisions made by the upper management and its role in energy management. Five simple actions were recommended to improve both energy efficiency and the image of the company to its employees. These recommendations were deliberately kept simple so they could be adapted and applied to a variety of commercial buildings. Nisiforou, Poullis & Charalambides(2012) also highlight the lack of promotion of energy saving measures by upper management.

There has been very little research documented within UK commercial premises. Currently UK non-domestic building stock contributes 18% of the UK total carbon emissions (Carbon Trust 2009). Murtagh et al (2013) investigated the effect of individual feedback on energy use at the workdesk, to test the relationship between individual determinants, energy use and energy reduction. They conducted a field trial with 83 office workers in the same work place. It was found that energy saving behaviour through feedback diminished overtime and that an absence of motivation to undertake energy reduction actions were in evidence. Despite national plans in the UK to save energy in small and medium businesses there is little knowledge of occupant energy use in office buildings and individuals commitment to energy conservation (Murtagh et al 2013). Delmas, Fischlein & Asensio (2013) also agreed with this finding. Limitations of this study to be noted include the small sample size and and short time frame of 16 weeks.

Discussion

Various research articles concerned with reducing energy consumption and achieving energy efficiency in different environments have been discussed in this paper. Fig 3 shows the breakdown of percentages of the different studies in the three environments. It is clear from these results that the commercial are deficient when assessing energy saving strategies, with 80% of past research focusing on the domestic environment. The evidence clearly shows that the UK needs to fund research in all three sectors but especially the commercial sector.

Breakdown in continent/ country	Percentage breakdown of journal studies published in the last 10 years into Energy-conservation behaviour, type of building and country of field trial.(%)	
	Domestic	Commercial
World-wide	80	20
Europe	42	8
UK	14	3
Rest of the world	38	12

Fig 3.Table to demonstrate the distribution of field trials into energy conservation behaviour and the percentage of studies between different building type,* based on 113 research papers into Energy conservation behaviour.

Fig 4 presents the percentage breakdown of number of questions used in research that had questionnaires in their methodology. The greatest percentage of questionnaires contained over 20 questions. This number would allow the researchers to elicit the required information from participants. Questionnaires that were restricted to a smaller number of questions were only capable of eliciting simple information such as Jiang & Tovey (2009), whose research asked three simple questions; closing windows and doors, turning off lights and appliances and lastly wearing different "summer" clothes to work in place of a conventional suit.

Number of questions used in questionnaire	1-5	5-10	11-20	20+
Percentage of past research papers (%)	29	15	13	43

Fig 4 Table Demonstrating a breakdown of number of questions asked on the questionnaires (if applicable).

The previous research, examined in this literature review, used a raft of different questionnaire styles and a variety of different questions. Although varied the questions could be categorised in three broad classes: Physical, concepts and Perceptions (Fig 5). Future studies would have to ensure that latter questionnaires had an equal spread across the categories to ensure that no important information was absent.

Examples of questions used within questionnaires in past research papers	
Physical Instructions/ Interventions	• Energy efficient light bulbs • Turn lights off • Use car less • Open windows • Choose Environmentally Friendly Products • Turn computers off • Recycle- various • Use a full washing machine
Understanding of concepts	What is meant by: • Renewable energy • Global climate change • Global warming • Saving energy • Integration of renewables
Perceptions	• Do you care about energy wastage? • How will saving energy effect you? • Is energy saving worth it? • Can saving energy save you money? • Do you family / friends you energy efficient products • Do you know what is meant by energy efficient appliances?

Fig 5 Table showing examples of questions used within past questionnaires divided into three broad categories.

The vast majority of research was limited by the short time frame in which the research was conducted (Fig 6). 60% of the research was conducted under 2 month timeframe. 90% was conducted in under a year. This has ramifications for the scientific basis for the research. To ensure that trends within energy data are reliable then energy audits should be completed for each of the case studies buildings used, which will take a whole year of data collection. The ideal scenario is that energy audits are completed over three years to give a realistic figure of energy consumption for that particular case study.

Time scale for duration of research	2 weeks and under	2 months and under	2 months + to 1 year	1 year +
Percentage of past research papers (%)	5	60	25	10

Fig 6 Table to show the percentage duration of study times between the varying studies.

The greater the number of participants used for data collection the more reliable the results, which was clearly the rationale behind the greatest percentage of past research in this field (Fig 7).

No. of participants used in the research project	0-20	21-50	51-100	100-200	200+
Percentage of past research papers (%)	5	27	9	14	45

Fig 7. Table listing the percentage of research studies with varying numbers of participants.

The greatest percentage of studies were conducted using secondary evidence or based on theoretical modelling techniques rather than actual primary data (Fig 8). This would therefore provide the justification for further study within this field.

Method of data collection/ theoretical modelling only that research was based upon.	Primary evidence	Secondary evidence	Theoretical modelling only- no evidence collected from participants/ case studies.
Percentage of past research papers (%)	21	45	34

Fig 8 Table to show percentage of data collection methods

A variety of motivational tools were used within the past research papers (monetary savings have been omitted from the Table, Fig 9). As you can see from Fig 9 the split across the categories was fairly even but future research should include specific success rates each of the categories.

Type of motivation used to engage participants in energy saving schemes/ projects.	Feedback (Various)	Posters/ leaflets	Social networking	All three
Percentage of past research papers (%)	36	22	20	22

Fig 9 Table to demonstrate different types of motivation used to motivate participants.

Fig 10 demonstrates minor categories used within research papers. These sections should all be included in future work to compare and contrast the differences that exist within them.

Various minor categories include in research papers	Percentage of past research papers (%)
Actual data from energy meters used in the research	29
Research relied upon participants self-reporting evidence	43
Research used feedback "smilie" / "frowny" faces	6
Research limited to a particular field ie electricity only/ water only/ travel efficiency only	23
Research specifically limited to one demographic group ie teenagers	8
Research investigated barriers involved in achieving energy efficiency/ carbon reduction	4
Research not linked to any actual or forecast energy savings	40
Research that employed the use of categorisation by socio-economic groups	83

Fig 10 Table to demonstrate percentages found in various minor categories in past research papers.

Conclusion

This literature review concludes that not only should more research be conducted in both domestic and commercial environments due to the limitations of the existing studies, but that there is a pressing need for this to be conducted in UK premises

Recommendations for further work

- Increased research within the UK, with a particular emphasis on commercial case studies

- Further studies should include 20 questions minimum that encompass three braod categorise
- Research that makes recommendations for a reduction in energy consumption should be conducted over at least a 12month period, employee over 200 participants and gather primary evidence/ data.
- Not only should further work be carried out into motivational tools used for energy reduction but also incorporate an examination of barriers against energy reduction.

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