Green Doctors: Developing a new energy survey methodology for domestic property use

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INTRODUCTION

The UK has set an ambitious target of reducing total greenhouse gas emissions by 80% by 2050. The domestic sector is the second most energy-intensive sector in the UK (Fig.1), following on from the combined energy usage of transport [1]. The domestic sector uses almost a third of the UK's total energy consumption and it is clear that in order to meet the 2050 objective, energy-efficient measures need to be undertaken in homes to drastically cut emissions.

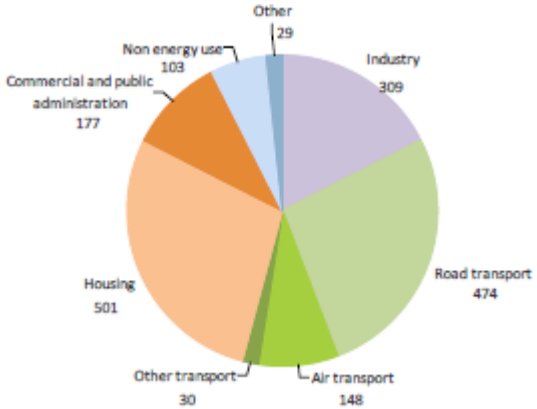

Fig 1. Chart of final energy consumption by sector in the UK in 2009 [1]

Encouraging people to 'green' their homes and be more energy-efficient has mainly been achieved through various financial incentives and awards. For example, government grants are available to aid financially in retrofitting a house with energy-efficient improvements, such as the upcoming Green Deal. There are also financial incentives to encourage the uptake of energy-efficient installations in the household, such as the government's Feed-In Tariffs for renewable microgeneration. However, these incentives to encourage the uptake of energy-efficient installations in a house are 'one-off' behaviours, which are typically carried out once. Therefore, in order to instigate significant changes in the UK's total domestic energy consumption and emissions, it is important to invoke changes in a household's everyday energy-consumption behaviour.

Changing habitual energy consumption habits is key in helping the UK lower its emissions in the long-term [2]. The number of households in fuel poverty has been rising steadily since 2003, reaching an estimated 5.5 million in 2009 [1]. This is partly due to the increase in electricity and gas prices, but is also a result of householders not knowing how to insulate or use their heating systems more efficiently to reduce their overall energy consumption [1].

As such, providing better information to householders on how to reduce their energy consumption is paramount in tackling fuel poverty and the UK's overall energy demand. This energy awareness will not only promote changes in daily energy consumption behaviour in the home, but also help to lower a household's energy bills and carbon footprint.

Various energy advice services are available to further inform and educate householders on energy-efficiency in the home. In Sheffield, one such energy advising body is *Green Doctors*. An extended service to the environmental regeneration charity organisation, *Groundwork Sheffield*, *Green Doctors* offers home visits and energy advice to help householders reduce their energy bills, as well as their environmental impact. Their service consists of a brief energy questionnaire and survey in the client's house to assess their energy consumption. However, energy advice is provided in the form of a generic information pack which the client can read in their own time. This form of energy advice fails to motivate householders in changing their energy consumption behaviour and forms the crux of the problem for the *Green Doctors* service.

There is also not a system of informing the client of the potential money and CO_2 savings they could achieve if they implemented the *Green Doctor's* recommended energy-efficiency measures. As such, there is a lack of informative and engaging energy advice to the client at the time of the home visit, and without a method of realising how much money and emissions could be saved with the new energy-efficiency measures, there is less inclination for the client to change their energy consumption behaviour in the future.

Therefore, the goal of this mini-project was to develop a new computerised energy survey methodology, which would inform a client of the possible costs, money savings and CO_2 savings of various energy-efficiency behaviours and house improvements at the time of the home visit. In this way, the client would be able to better visualise their energy spending habits and be encouraged to change their energy consumption behaviour in order to reduce their energy bills and carbon footprint.

METHOD

1. Upgrading current home energy assessment methodology

A review was undertaken of the current home energy surveys available online, to ascertain the best home energy assessment methodology. Completion of these online home energy surveys usually resulted in the immediate generation of a personalised energy action plan for the user. These energy action plans were able to detail potential energy-efficient home improvements, as well as their associated money and CO_2 savings.

Primarily provided by some of the big energy suppliers, such as EDF and British Gas, as well as the Energy Saving Trust, these online energy surveys were similar in methodology to a Standard Assessment Procedure (SAP). SAP is the UK Government's standardised methodology for assessing the energy performance of a building, measuring the energy costs associated with the physical characteristics of the building, such as space heating, heating system efficiency, water heating and the materials used for the construction of the building. However, it does not take into

account the energy costs associated with the lifestyle influences of the household's occupants [3].

The current *Green Doctor* survey consists of ambiguous YES/NO questions, which although highlight important energy-efficient measures, do not provide a *Green Doctor* with enough information to calculate the savings associated with implementing these measures. Therefore, a new energy questionnaire was developed. Consisting of 15 questions based on those asked in a SAP procedure and in the online home energy assessments, the questions focused on gathering more information on the physical characteristics of the client's dwelling. The physical characteristics of a dwelling are measurable traits, which can be linked to a dataset of associated energy costs, and so would allow a *Green Doctor* to ascertain the potential financial and environmental savings of applying certain energy-efficiency measures.

2. Retrieving dataset of energy-efficiency savings

A reliable dataset of the savings associated with various energy-efficiency measures was required. However, most datasets found only provided estimates of the energy-efficiency savings for a typical 3 bedroom, gas heated, semi-detached house. If a *Green Doctor* wanted to personalise recommendations and savings to different clients, these generalised datasets would not allow this.

However, in 2011, DECC's Carbon Emissions Reduction Target (CERT) published a spreadsheet of the individual money and CO_2 savings for different energy-efficiency measures depending on dwelling type and size [4]. The dwelling types included flats, mid-terraced houses, end-terraced houses, bungalows, semi-detached houses and detached houses, with each dwelling type further split into different numbers of bedrooms. Each different dwelling scenario had a unique set of energy-efficiency measure costings and savings attached to them, which was exactly the dataset required for a *Green Doctor* to tailor their advice to different clients and dwelling scenarios. This was one of the main reasons this spreadsheet from CERT was chosen to form the crux of the new *Green Doctors* energy survey, as well as the fact that the money and CO_2 savings data in the spreadsheet were the result of a standardised SAP procedure.

3. Linking new questionnaire to data

The new energy questionnaire had to be linked to the CERT spreadsheet. It was important that every unique answer to the survey questions was linked to the spreadsheet, so that the relevant data from the spreadsheet would be retrieved and subsequently relayed to the client.

A computerised database management system had to be developed. However, the varying number of possible scenarios and answers for each of the energy survey questions made this task difficult.

As such, an alternative solution was developed which focused more on helping the client visualise the data in a more engaging way. Instead of programming a computer to retrieve the relevant data from the CERT spreadsheet based on the client's answers to the energy questionnaire, the new system requires a *Green Doctor* to manually retrieve this data. This data is then manually inputted into a new spreadsheet, which will be referred to as the 'Input Spreadsheet'. This spreadsheet includes formulas and macros to enable the automatic analysis of the inputted data, and is linked to a Powerpoint presentation.

Thus, any changes made to the data in the Input Spreadsheet would execute immediate changes in the linked Powerpoint presentation. The reasoning for the Powerpoint was to present the data from the CERT spreadsheet in a graphical and pictorial way, allowing the client to better visualise the *Green Doctor's* recommendations and savings, rather than having to listen to a set of facts and figures.

4. Energy action plan

The linked Powerpoint presentation forms the personalised 'Energy Action Plan' for the client, based on their answers to the energy questionnaire. It is presented to the client immediately after completion of the questionnaire, and retrieves the relevant recommendations and savings data from the linked Input Spreadsheet.

The Energy Action Plan not only graphically shows how much money the client is spending every year on their energy bills and how much money and CO_2 they could be saving, but details the no cost, low cost and investment actions the client could do to achieve these reductions in their energy bills. The Energy Action Plan is divided into two categories: '*Heating and Insulation'*, and '*Electricity Usage*'. This is to highlight the fact that both heating and insulation, and electricity usage are significant contributors to a household's energy consumption and energy bills. Each category has its own set of No cost (behavioural changes), Low cost and Investment actions.

a. Heating and Insulation

The 'Heating and Insulation' category consists of graphical representations of the money and emissions savings associated with implementing certain Low Cost actions (draught proofing, hot water tank jacket, installing heating controls such as thermostatic radiator valves, room thermostats or a delayed start thermostat) and Investment actions (solid wall/cavity wall/loft insulation, upgrading boiler to a high efficiency model, switching from electric heating to gas central heating). These energy actions are tailored to the client's answers and the graphs of savings produced are retrieved from data in the CERT spreadsheet (Fig.2.).

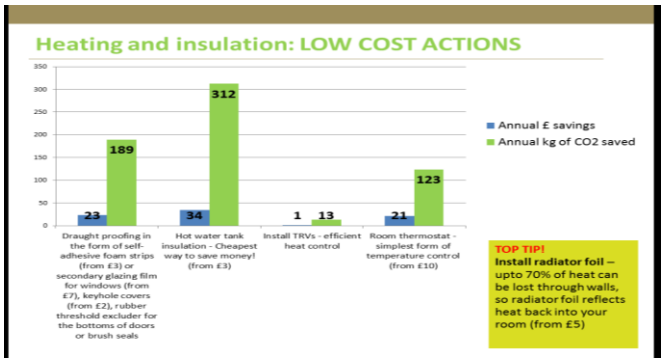

Fig.2. Powerpoint Energy Action Plan showing a graphical representation of the money and CO_2 savings of implementing tailored Low Cost energy actions

However, the No Cost actions are not linked to a dataset of savings, as these are mainly behavioural changes which are not easily measured in terms of money and emissions savings, and which vary dramatically from person to person. On the other hand, the proposed Low Cost and Investment actions can be applied to the physical characteristics of a building, and as such, can be measured in terms of cost and energy savings.

As a result, the No Cost actions are not represented graphically in terms of annual savings, but are represented pictorially, with an image of a house cross section with the No Cost energy advice in highlighted bubbles (Fig.3.).

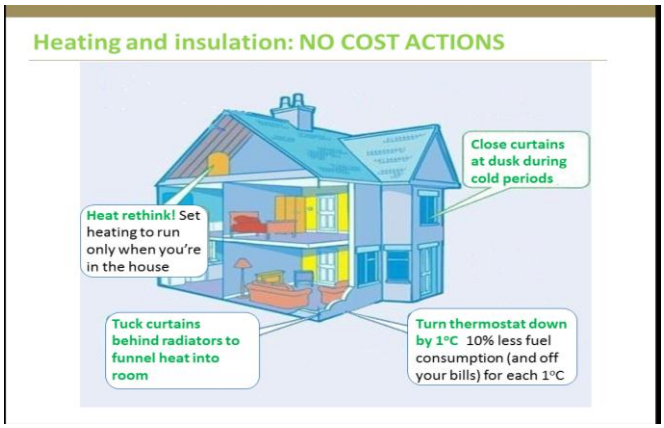

Fig.2. Powerpoint Energy Action Plan pictorially showing No Cost actions

b. Electricity Usage

The 'Electricity Usage' category only includes No Cost and Low Cost energy advice. As electricity usage is determined by a person's lifestyle choices, it was difficult to quantify the money and emissions savings associated with implementing these actions. Low Cost actions consisted of a 'top 5' list of electricity-saving gadgets which the client could purchase, such as thermal leak detectors, home energy monitors and energy-saving plugs.

As there is not currently a dataset of the savings associated with electricity usage-efficiency measures, the No Cost and Low Cost energy advice for this category mainly focuses on representing the information in a visual and interesting way, as in Fig.2. Again, the use of pictures and images is used to highlight energy saving tips.

RESULTS AND DISCUSSION

The aim of this mini-project was to develop a new energy survey methodology, which would allow a *Green Doctor* to engage a householder with their energy consumption by generating green recommendations and savings at the time of the home visit. This has been achieved through the Energy Action Plan system, which links the manually retrieved savings data from the CERT spreadsheet to a Powerpoint presentation. In this way, the linked Powerpoint presentation helps clients to graphically and pictorially visualise a *Green Doctor's* tailored recommendations, as well as helping them envisage how much money they are spending on their energy bills, and how much they could be saving, both financially and environmentally, in a more engaging and interesting way. The literature on this topic indicates that data visualisation is an important tool in promoting energy-efficient behaviour changes in the home [5], and that giving householders achievable goals that they can realistically carry out in the short term is preferable [2]. The energy advice provided by the new energy survey methodology caters for this, by listing top 5 recommendations for No Cost, Low Cost and Investment actions, although these will vary from client to client, depending on the client's answers.

However, this system is still in the early stages of development and needs more work before it can be tested out on clients. Future work would be to turn the system into a fully computerised database management system. Another problem is that there is not a method of accurately measuring a client's electricity usage in terms of money and emissions savings. This varies widely from person to person depending on their behaviour, which makes it almost impossible to come up with a standardised dataset of savings. As such, the Energy Action Plan currently only takes into account the money savings associated with a client implementing the Low Cost and Investment actions of improving their gas heating and insulation, as these are the only measures which are linked to the CERT spreadsheet. As there is no dataset of potential savings to link to the No Cost and electricity-reducing actions, a *Green Doctor* cannot inform a client of how much money they could save from carrying out these recommendations. This might make a client less inclined to carry out these actions in the long-term, and for other clients, it is not always financially feasible to carry out the proposed Low Cost and Investment actions which the Energy Action Plan takes into account.

It is clear, nonetheless, that the system has met the project brief. It is capable of generating personalised No Cost, Low Cost and Investment energy recommendations at the time of a home visit, as well as the associated money savings for the Low Cost/Investment actions, at least. It can also do this in a visually engaging way. This is an improvement from the less engaging system of providing a client with a generic information pack of energy-saving tips to read in their own time.

However, the new energy survey methodology could provide more accurate savings calculations if a method can be found to quantify the No Cost actions in terms of savings. A solution could be to incorporate more questions in the energy survey to obtain more information on the client's personal consumption behaviour. For example, how many electrical appliances do they possess and for how many hours do they leave these on standby in a day? These are questions which are not asked by the online home energy assessments, and it is easy to see the reason why. Whereas the physical characteristics of a building can be referred back to standardised SAP values based on dwelling type and size, measuring the energy costs associated with lifestyle choices are more complex and difficult.

Thus, instead of trying to calculate the annual savings associated with No Cost energy actions, an alternative solution could be to evaluate a client's energy efficiency rating instead, by following a point rating system. If extra questions were added to the energy questionnaire which dealt with a client's energy behaviour, the answers to these questions could be awarded a rating score of 1 to 3, where 1

denotes a low energy-efficiency answer and 3 denotes a high energy-efficiency answer. For this system to work, a fixed criterion needs to be set for each question to allow comparison of the energy-efficiency rating of the answers. For example, the question '*Do you switch off electrical appliances at the mains when not in use?*' could be given the criteria of '*Always/Sometimes/Never'*, whereby a score of 3 would be given to the answer of '*Always*' and a score of 1 would be given to the answer of '*Never*'. Evaluation criteria should also be set for the client's total energy-efficiency rating. For example, if a client scored top scores for all questions, then this would indicate an A-rated high energy-efficiency household, but for those falling under this, then tailored recommendations to boost this rating can be provided by the *Green Doctors.* In this way, a client is able to visualise their energy efficiency level with this rating, and it could be used as an incentive to change their energy consumption behaviour in the long-term. With this system, the motivation is not led by money savings but by increasing their energy-efficiency overall. This is a system that can be manipulated in the Input Spreadsheet and the results linked to the Powerpoint Energy Action Plan, to allow the client to visualise the recommendations and costs, in both financial terms and energy-efficiency rating terms.

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