EnerGAware
Energy Game for Awareness of energy efficiency in social housing communities

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D2.1 – User requirements

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Executive summary

This report represents Deliverable 2.1 User requirements developed in the course of WP2 Specification of user, building and game requirements of the EnerGAware project. This deliverable is one of three complimentary reports produced in WP2 that define the requirements for the design of the EnerGAware integrated serious game and metering system solution. For building and game requirements refer to Deliverables D2.2 Building requirements and D2.3 Game requirements.

Deliverable 2.1 presents the user requirements of the EnerGAware serious game and the categorisation of the social housing community obtained from the analysis of the socio-economic characteristics, energy use habits, energy efficiency and IT awareness, collected by means of a large-scale, city-wide survey, undertaken in Plymouth (UK) during 2015, which was administered to all the 2,772 social houses managed by project partner DCH in the city. 537 completed surveys (20% response rate) were analysed and the results were transformed into requirements for the EnerGAware serious game functionalities, design, as well as didactical approach and content.

Results suggested that the EnerGAware serious game virtual world should be based on a domestic environment (e.g. virtual home), so as to help the players to relate to. Results revealed the existence of a large group of older people, high presence of retired people and a large group with low educational level, suggesting that the EnerGAware game should put special attention when designing the visual aspects of the game to those requirements derived from human aging process and novice users. In relation to the didactic approach of the game, it is suggested that the game should adapt to different learning levels and provide clear and easy to understand goals. Regarding the educational content, the game should allow users to learn how to balance the energy consumption, comfort and financial cost of a house; gain knowledge on how much energy is used by the typical end-uses existing in a domestic environment, poor practices of use that might increase the energy consumption, as well as the most efficient ways to use them to save energy; and could also help to understand energy tariffs and compare fictional energy suppliers in different situations. The game should also help the player to assess the potential energy savings from different behaviour actions and energy-efficient changes to the virtual house. From the game functionalities point of view, the link to social media platforms to enhance communication and information sharing amongst players was found relevant.

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Glossary and abbreviations

A' level	General Certificate of Education (GCE) Advanced Level. It is a secondary school leaving qualification in the United Kingdom. Normally undertaken at the age of 18.
BA	Bachelor of Arts. Bachelor's degree awarded for an undergraduate course or program focused on liberal arts disciplines.
BSc	Bachelor of Science. Bachelor's degree awarded for an undergraduate course or program focused on science-related disciplines.
GCSE	General Certificate of Secondary Education (GCSE). It is an academically rigorous qualification awarded in a specified subject in the United Kingdom normally at the age of 16.
GP	General Practice or General practitioner. Term used to refer to a General practice surgery or doctor.
HRP	Household representative person. Generally understood as the higher income earner in a household.
IT	Information technology.
NVQ	National Vocational Qualifications. Work based awards in England, Wales and Northern Ireland that are achieved through assessment and training.
O' level	Ordinary Level. Subject-based qualification conferred as part of the General Certificate of Education (GCE).
UK	United Kingdom.

1. Introduction

This report represents Deliverable 2.1 – User requirements developed in the course of Work Package 2 – Specification of user, building and game requirements of the EnerGAware project.

The Work Package (WP) 2 tasks (T2.1-2.4) have provided a comprehensive identification and analysis of the specific user, building and game requirements that are necessary to design the EnerGAware integrated serious game and metering system solution. The WP2 tasks focused on understanding, together with the social tenants, what they want and what their priorities and ideas are in relation to a serious game that could help them save energy at home (T2.4 Game requirements). WP2 also aimed to obtain a deeper understanding about social tenants' motivations, behaviour and perceptions regarding their energy use at home (T2.2 User requirements). Furthermore, a detailed analysis of the technical characteristics (building envelope, building services and controls and renewable energy generation) of the social housing stock was undertaken (T2.3 Building requirements).

Requirements were defined using a range of different datasets and methods:

- Literature review; a detailed review of previous projects, publications and reports related to the design and use of IT in social housing was undertaken and used as starting point for the definition of requirements.
- Socio-economic characteristics; energy consumption motivations, behaviour and perceptions; and game experiences and IT literacy; collected during a large-scale, city-wide survey, undertaken in Plymouth, UK, during 2015, which was administered to all the 2,772 social houses managed by project partner DCH in the city (EnerGAware Social Housing Survey).
- Game experiences and game features preferences; collected during three focus groups undertaken with social housing tenants in Plymouth, UK, during 2015 (EnerGAware Gameplay Scenarios Focus Groups).
- Building characteristics of all the DCH social housing stock in Plymouth gathered and managed by project partner DCH (Building Stock Condition Database).

Figure 1 shows the relationship between Tasks, datasets used and Deliverables in WP2.

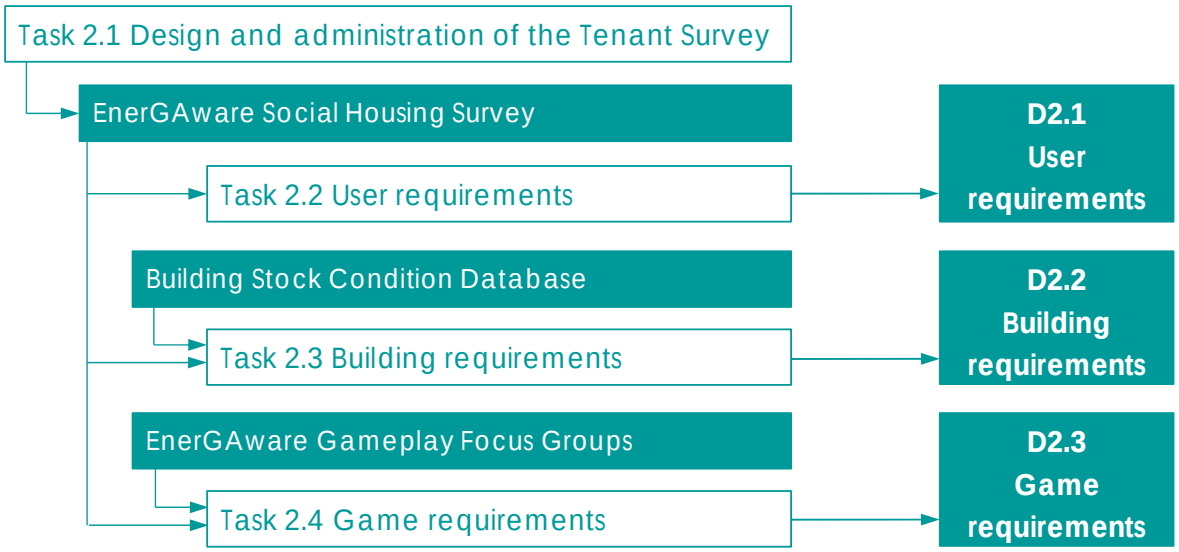

Figure 1. Relationship of Tasks, Datasets and Deliverables in WP2.

Deliverable D2.1 – User requirements is one of three complimentary reports produced in WP2 that define the requirements for the design of the EnerGAware integrated serious game and metering system solution. For building and game requirements refer to Deliverables D2.2 – Building requirements and D2.3 – Game requirements.

The data used to define the user requirements outlined in this report were collected during a large-scale, city-wide survey, undertaken in Plymouth, UK, during 2015, which was administered to all the social houses managed by project partner DCH in the city.

The outcomes of WP2 will directly influence the design of the integrated serious game and metering system solution in WP3, and will be used to define the baseline for the monitoring and evaluation of the impact indicators in WP5.

2.Serious game user requirements

Unlike the usual approach to developing games, where the design is driven by the vision of the development team to create an entertainment product that has market potential, the EnerGAware game is aimed to not only be engaging but also to address actual user needs, i.e. increase awareness and understanding of energy efficient practices of the social housing community. To do so, it is not enough to have a well-defined vision owned by the developers

alone. It is necessary to identify and analyse any requirements that the users have, including their educational needs, current knowledge on the subject and their concerns and motivations.

There is limited literature focused on the requirements for the development of serious games. Existing research on these requirements is very sparse, and literature mostly focuses on influencing factors in serious games, which directly or indirectly affect the motivation and learning success of players (Thillainathan and Leimeister, 2014; Annetta, 2010; Kazimoglu et al., 2010; Lin and Chiou, 2010; Yessad et al., 2010; Yusoff et al., 2010; Zaibon and Shiratuddin, 2010; Linehan et al., 2009; Wilson et al., 2009; Sørensen and Meyer, 2007; de Freitas and Jarvis, 2006; Habgood et al., 2005; Kirriemuir and McFarlane, 2004; Owen, 2004; Garris et al., 2002). These factors can be classified in the following categories (Thillainathan and Leimeister, 2014):

- Learning and didactical approaches of the game to effectively achieve learning success (Annetta, 2010; Kazimoglu et al., 2010; Yusoff et al., 2010; Zaibon and Shiratuddin, 2010; de Freitas and Jarvis, 2006; Kirriemuir and McFarlane, 2004) (e.g. A serious game should convert a difficult learning objective into repeated game tasks to enhance knowledge retention);
- User freedom and learner control, described as the player's degree of freedom of action within the game (Yessad et al., 2010; Garris et al., 2002) and the ability to self-explore the environment based on individual pace and experience (Yusoff et al., 2010; Garris et al., 2002), at the same time as there are game rules in place to determine what the player is allowed to do or not;
- Communication, understood as the ability to interact and talk with other characters within the game or other players;
- Assistance, related to the need of the game to provide information, assess progress and provide feedback and support from and of the virtual world that helps the player orientate and solve problems as well as get feedback on the player's state and progress. Feedback is a key aspect of interaction and influences the motivation of the player (Kazimoglu et al., 2010; Lin and Chiou, 2010; Yusoff et al., 2010; Zaibon and Shiratuddin, 2010; Linehan et al., 2009; Wilson et al., 2009; Sørensen and Meyer, 2007; Kirriemuir and McFarlane, 2004);
- Goal, related to the design of the game tasks and their goals, which must be solvable, clear and understandable (Yessad et al., 2010; Wilson et al., 2009; Sørensen and Meyer, 2007; Kirriemuir and McFarlane, 2004);
- Adaptation, related to the ability of the game to accommodate to different learning styles (Yusoff, 2010) and learner's learning progress and skills, at the same time it provides challenging tasks with ideal amount of difficulty (Owen, 2004; Garris et al., 2002);

- Representation, which relates to the representation of content knowledge within the serious game by means of a combination of sensory modalities (visual, auditory, etc.) to ensure authentic learning and gaming experience. Also, it relates to the ability of the game to establish a virtual world, with objects and characters, that relate to the player (Annetta, 2010; Lin and Chiou, 2010), fosters player's motivation and curiosity to explore (Garris et al., 2002; Wilson et al., 2009; Sørensen and Meyer, 2007) whilst not having consequences on the real world (Yessad et al., 2010; Wilson et al., 2009; Habgood et al., 2005; Owen, 2004; Garris et al., 2002).

Based on these factors, Thillainathan (2013) and Thillainathan and Leimeister (2014) developed a serious game logic and structure modelling language that would allow educators with limited programming knowledge to design and develop their own serious games tailored to their learning objectives. As part of the model, the authors identified 24 requirements for the development of serious games. The full list of requirements is listed below:

- A serious game must provide object-focused interaction mechanisms and could give the possibility to learn/play in social groups.
- A serious game should convert a difficult learning objective into repeated game tasks to enhance knowledge retention.
- A serious game must have player-world interaction mechanisms to introduce learning objectives to the player.
- A serious game should provide a progressive way of incremented use of new skills.
- A serious game must provide players virtual worlds they can relate to and match to the represented content.
- A serious game must provide game mechanics to enable the player to have control over his gaming experience and to explore the virtual world.
- A serious game must base on game rules.
- A serious game should allow the player to communicate with characters within the game.
- A serious game must have a feedback system to give feedback on user actions.
- A serious game must have a Graphical User Interface (GUI) system to show texts and textures.
- A serious game must have a system to assess and measure learner's progress.
- A serious game must have a system to manage achievements.
- A serious game must have solvable, clear and understandable goals.

- A serious game should accommodate to learner's style.
- A serious game must have a system to measure players' learning progress and adjust to learner's skill.
- A serious game must have different difficulty levels to solve tasks.
- A serious game should have game world which reflect the content they represent.
- A serious game must have the ability to display videos.
- A serious game must have the ability to play audio.
- A serious game should have a character to which the player can identify to.
- A serious game must have objects and characters.
- A serious game must have virtual worlds that are authentic and exciting for the player with curious and surprising elements.
- A serious game should have a virtual world parallel to the real world without having consequences on the real world.
- A serious game must have a virtual world limited in space and time.

It is also important to bear in mind that requirements have to be based on and derived from the characteristics of the user groups for whom the system and service are to be designed and developed (eSESH, 2012). As the EnerGAware serious game is intended to be designed to help social tenants to have a better understanding of energy efficient practices and behaviours, the definition of requirements should also take into consideration the specific characteristics of this group. Research into social housing tenants' energy consumption behaviour, attitudes and information requirements is essential for selecting options in respect of game functionalities, content and design.

Previous European projects addressing energy efficiency in social housing by means of different IT solutions have studied the characteristics of this group and identified specific non-functional requirements for the development of the IT solutions. The SAVE@Work4Homes project (SAVE@Work4Homes, 2008) aimed to help tenants improve their energy awareness by encouraging them to monitor consumption and by providing them with information including heating data and data analyses. As part of the project a large-scale survey of 2,637 social housing tenants was carried out in three European countries in 2007. The results showed that:

- Most respondent tenants of social housing are 60 or more years old. In general they live on low income levels and/or social security benefits. Often they have no private access to a computer and no access to internet.

- Most tenants are worried about climate change and feel themselves as being aware of environmental issues. Saving money motivates tenants to save energy more than protecting the environment.
- Most tenants value their own energy consumption as medium. On the other hand the collected data show a set of possibilities to tap the full potential of energy saving - for example improvements in ventilation and heating behaviour. It was identified that a lot of tenants cannot adjust the setting of their heating/radiators by themselves.
- Although most tenants feel well informed about environmental issues in general, they otherwise describe gaps in knowledge about the consumption of energy in their flats/houses and about the possibilities of saving energy. Results showed that they get information from TV, newspapers and brochures, but often consider these channels as insufficient to satisfy their information need.
- Most tenants are interested in a service which gives an exact overview of their energy consumption and hints about how to save energy. Tenants are mostly interested in current consumption figures and information about how to save electricity, water heating and space heating.

Similar to the SAVE@Work4Homes project, the eSESH project (eSESH, 2012) developed Advanced Energy Awareness Services to provide direct, timely and comprehensible feedback on energy consumption, to enable social housing tenants to adapt their energy consumption behaviour. In addition, a comprehensive set of Energy Management Services were used to help reduce consumption peaks and optimise the timing of domestic consumption. The eSESH, based on the social housing tenants characteristics identified by the SAVE@Work4Homes project, identified a series of non-functional requirements for the development of the Advanced Energy Awareness Services tools. They particularly focused on the abilities and limitations of elderly people, individuals with little IT-experience, low literacy level or disabilities (e.g. vision), when interacting with IT tools (Fisk et al., 2004). The non-functional requirements identified are summarised as follows:

- System/service design and dialogues should be compatible with user expectations (e.g. consistent dialogues)
- Users should be able to determine pace and sequence of the interaction with the system/service
- Similar functions should act the same throughout the system/service
- Avoid memory overload through avoiding multiple steps to perform an action
- Minimise workload through well organised desktop / displays

- High contrast between characters and background
- Alerts and warning messages: flash rather than have it come on and stay on
- Avoid extraneous design: display only relevant graphics
- Use familiar icons and symbols, e.g. traffic lights; avoid long text messages
- Positioning of labels, icons, text messages should be consistent
- Avoid jargon or unfamiliar terms; use non-technical language
- Text on buttons should be descriptive ("send message" instead of "send")
- Use colours thoroughly and bear in mind colour blind people.

The serious game design requirements previously mentioned, as well as the non-functional requirements for IT tools specifically designed for groups of people with limited experience with IT tools, were used as the basis for the definition of requirements for the development of the EnerGAware serious game. However, in order to ensure that the requirements were specific to the EnerGAware serious game user group, a large-scale EnerGAware Social Housing Survey was administrated to all DCH tenants in Plymouth and the results were used to have a better understanding of the characteristics of the social housing tenant group.

Both results from the EnerGAware Social Housing Survey and the EnerGAware Game User Requirements are described below.

3. The EnerGAware Social Housing Survey

The EnerGAware Social Housing Survey was a large-scale, city-wide, housing survey, administered to all the social houses managed by DCH in the city of Plymouth, UK.

A self-report survey was employed as it could generate quantitative data from a large sample that was suitable for statistical analysis. The self-report survey provided a fast and economic means to gain data representative of the large DCH social housing stock in Plymouth. Standardised closed questions were used to gain descriptive (e.g. socio-demographics, technical building characteristics) and interpretive data (e.g. explanations of phenomena and correlations). The survey took about 15 minutes to complete and contained 12 pages and 68 questions.

The UK was specifically targeted because it has the 4th largest social housing stock in Europe, and therefore is an essential target for energy and emissions reductions in order to achieve Europe's 2020 targets. Plymouth was the case study city chosen by the EnerGAware project consortium, as it

is has one of the largest social housing stocks in the UK, accounting for 20.8% of the total housing stock of the city.

A paper-based survey was administered to all 2,772 social houses managed by DCH in the city of Plymouth (i.e. 12.3% of the 22,500 social houses managed by DCH across Devon and Cornwall). The survey was devised by the EnerGAware team based on similar surveys developed in previous European (BECA project (Collins, 2013), eSESH project (2011, 2012), and 3e-Houses project (2011)) and UK-funded (eViz project (2015), CaRB project (2004) and 4M project (2008)) research projects. The paper-based survey, accompanied by a letter, a one-page flyer about the EnerGAware project and a pre-paid returning envelope was sent by post to the households on 18th May 2015. The letter invited households to either complete the paper-based survey and return it in the pre-paid returning envelope or undertake the survey on the Internet at www.research.net/s/energaware2015. A further letter to remind households to complete the survey was sent out on the 1st June 2015. See accompanying letter in Appendix A, the project flyer in Appendix B, the Social Housing Survey in Appendix C and the reminder letter in Appendix D.

To encourage households to complete and return the survey, a prize draw was used as an incentive. All surveys received before the 25th June 2015 were entered into the prize draw to win one of ten prizes, including family days out in Plymouth and £50 Love2Shop vouchers.

In total, 537 of the households completed the survey by the 25th June 2015 (504 paper-based and 33 Internet-based), giving an overall response rate of 20%.

The paper and Internet survey responses were manually input, cleaned and organised in an IBM SPSS Statistics 21 database. Two versions of the database were created, an anonymous version for wider public access and a confidential version with limited access for only those project partners requiring access to the confidential information. The anonymous database is planned to be used to label the energy consumption data collected in later stages of the project for third parties to understand and re-use the data easily, and it is intended to be deposited in existing open access data repositories such as eeMeasure (2015) or EMBED (2015) (still to be decided) to ensure maximum distribution of the datasets. A separate non-disclosure agreement was established for those requiring access to the confidential database. There were 257 anonymous and 3 confidential variables in the complete dataset. The confidential variables related to the contact details (telephone, mobile and email) of those tenants interested in participating in future EnerGAware activities.

The EnerGAware Social Housing Survey has provided information about the social housing tenants' motivations, behaviour and perceptions of their energy use at home, as well as their socio-economic and health status.

At the end of the survey, the households were asked whether they would be interested in partaking in further follow up studies as part of a programme of research with the EnerGAware project. From the 537 households completing the survey, 237 stated that they would be interested and now form a pool of willing participants for the next EnerGAware studies (i.e. the control trial of the EnerGAware integrated serious game and metering system and game design and game testing focus groups).

4.Results of the Social Housing Survey

4.1 Socio-economic characteristics

4.1.1 Age of the Household Representative Person (HRP)

Respondents had a mean age of 58 (ranging between 18 and 96), fifty-three respondents did not report their age. As can be seen from Figure 2, the majority of respondents (70%) were over 45 years of age. Most householders who responded to the survey fell in the 55-64 (18%) or 65-74 (18%) age category.

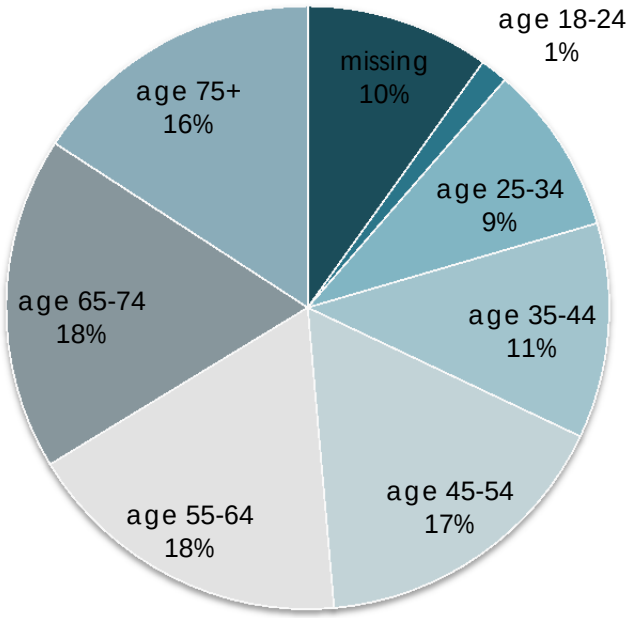

Figure 2. Percentage of respondents (of the total) in each age category.

4.1.2 Gender of the Household Representative Person (HRP)

Out of the 537 householders who responded to the survey, 198 (37%) were male, 298 (55%) were female, and 41 (8%) did not provide their gender.

4.1.3 Family structure

In total, 271 respondents (50.5%) provided age and gender information on the other members of their household, the remaining 266 (49.5%) respondents either lived on their own or did not report any details on the other members of their household.

One hundred and fifty-four respondents reported living with one other person. As can be seen from Figure 3, respondents in two-person households mostly reported living with another adult.

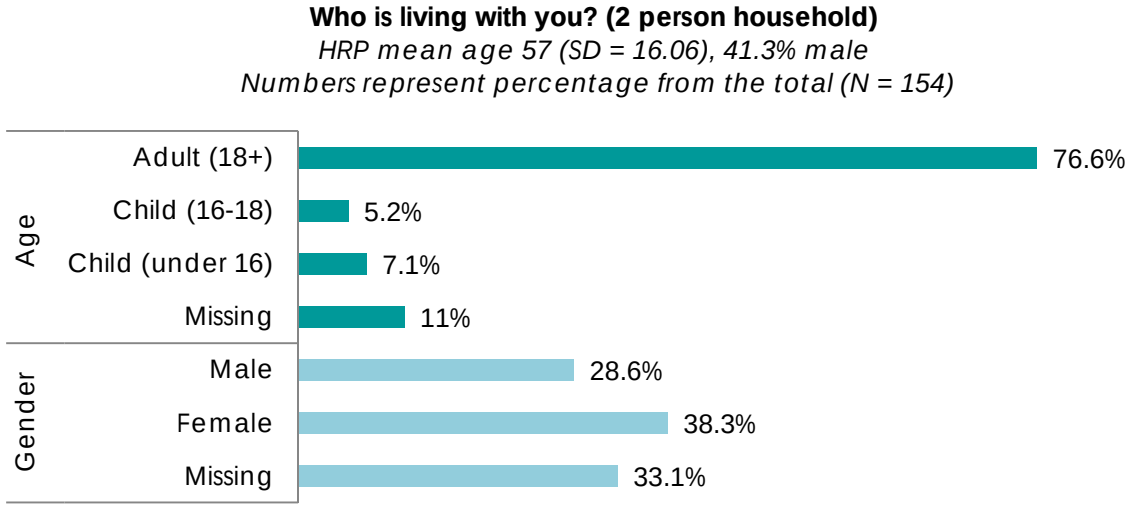

Figure 3. Responses to the question "who is living with you" for 2-person households.

Fifty-eight respondents reported living with two other persons. As can be seen from Figure 4, respondents in three-person households mostly reported living with another adult and a child under 16 years of age.

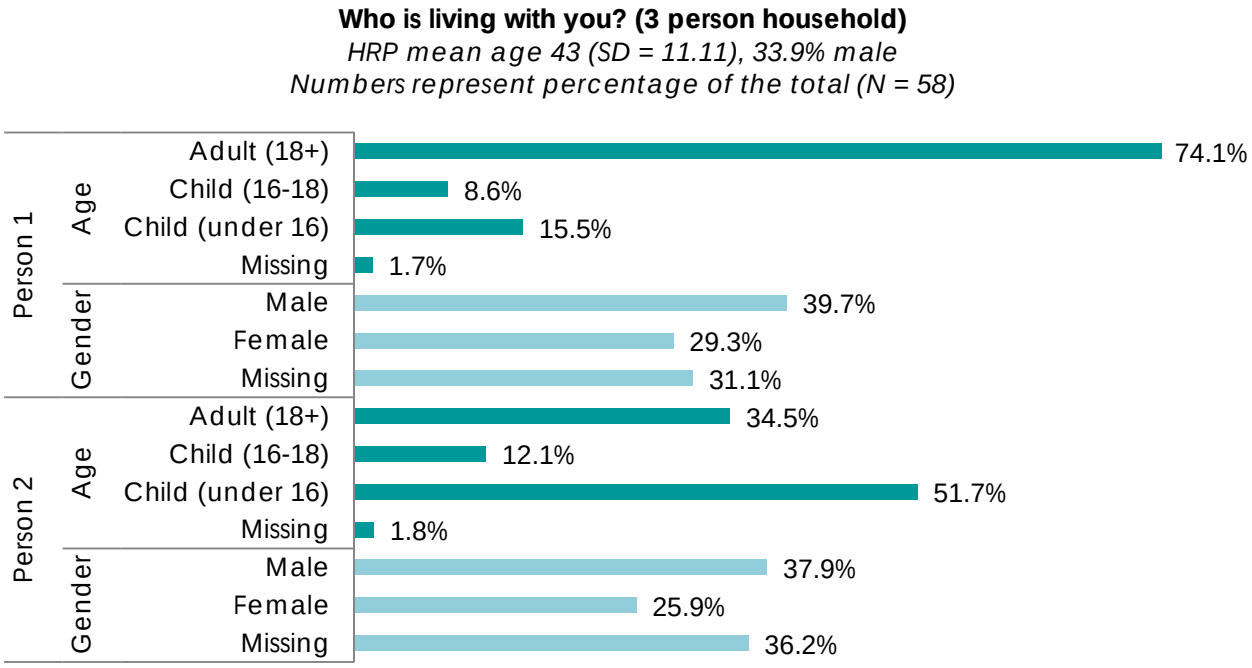

Figure 4. Responses to the question "who is living with you" for 3-person households.

Thirty-five respondents reported living with three other persons. As can be seen from Figure 5, respondents in four-person households mostly reported living with another adult and two children under 16 years of age.

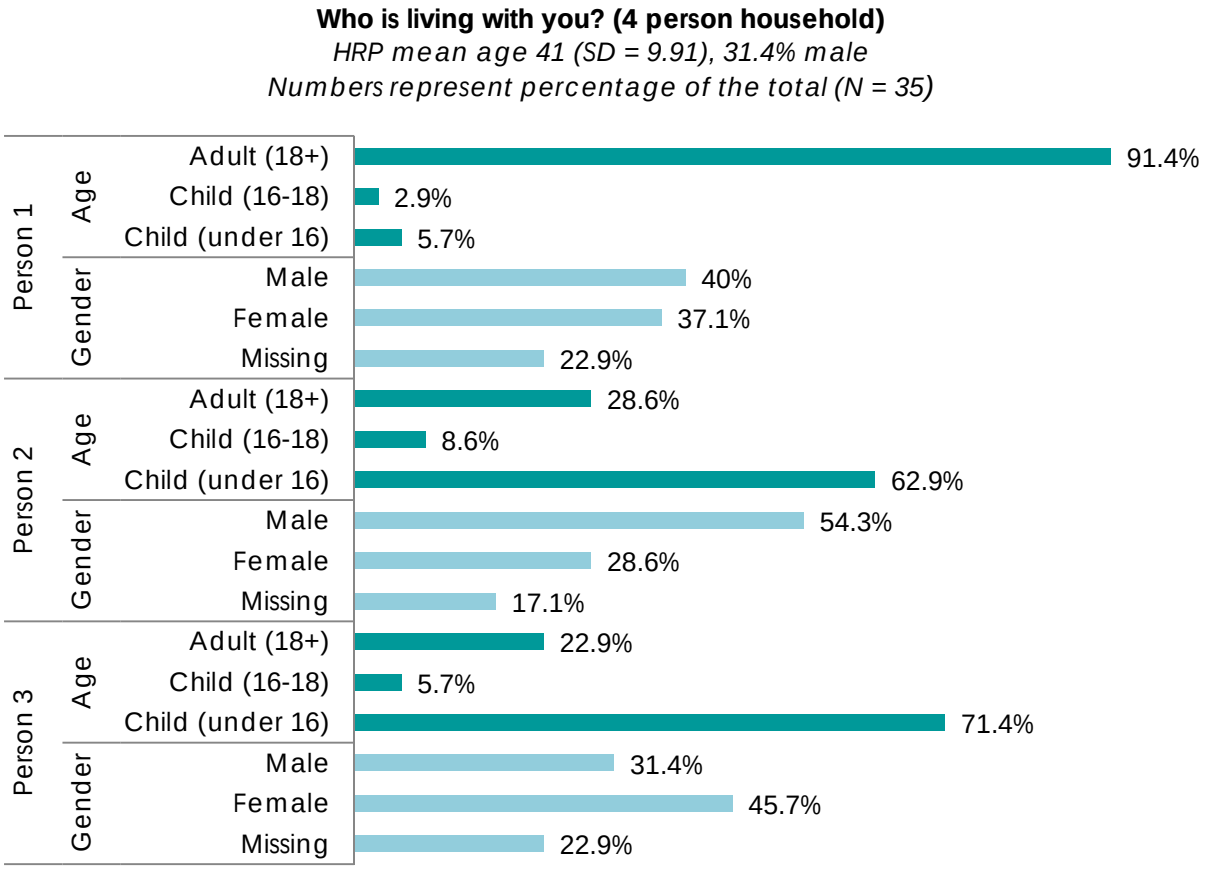

Figure 5. Responses to the question "who is living with you" for 4-person households.

Seventeen respondents reported living with four other persons. As can be seen from Figure 6, respondents in five-person households mostly reported living with another adult and three children under 16 years of age.

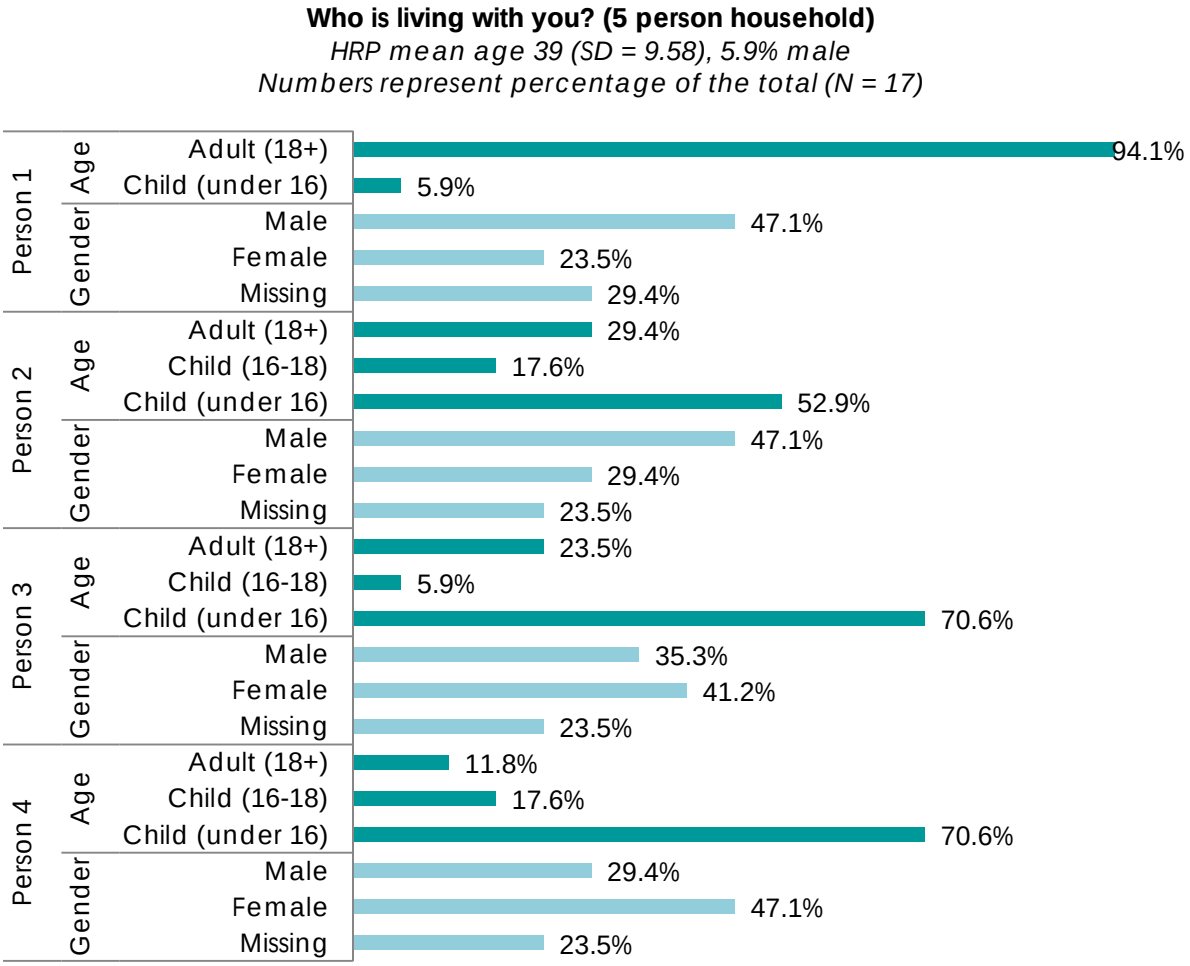

Figure 6. Responses to the question "who is living with you" for 5-person households.

Seven respondents reported living with five other persons. As can be seen from Figure 7, respondents in five-person households mostly reported living with two other adults and three children under 16 years of age.

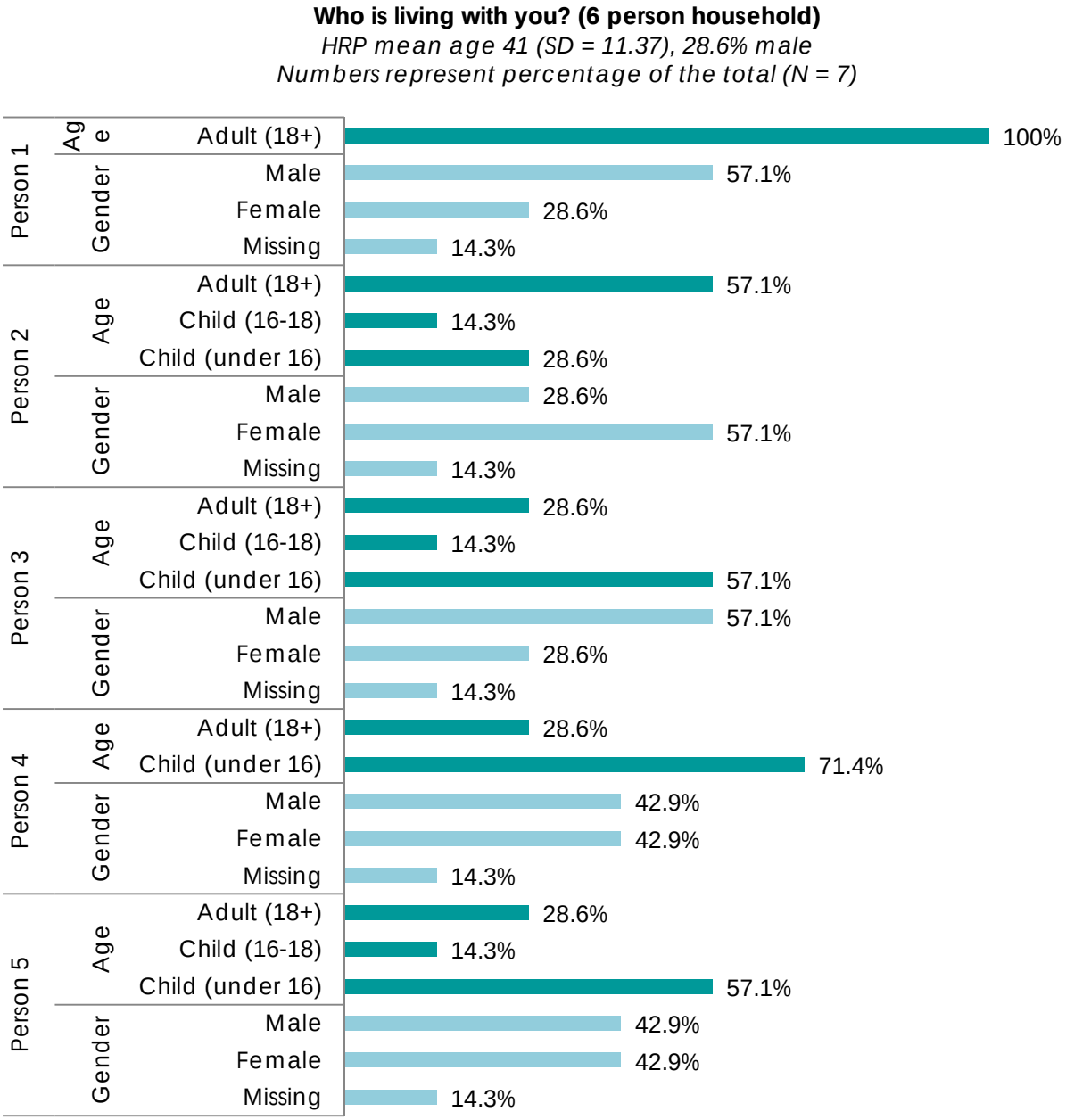

Figure 7. Responses to the question "who is living with you" for 6-person households.

4.1.4 Employment status of the Household Representative Person (HRP) and other family members

As can be seen in Figure 8, the household representative person was most likely to be retired (37%) or employed (32%), with smaller groups of respondents unemployed (8%) or looking for work (3%).

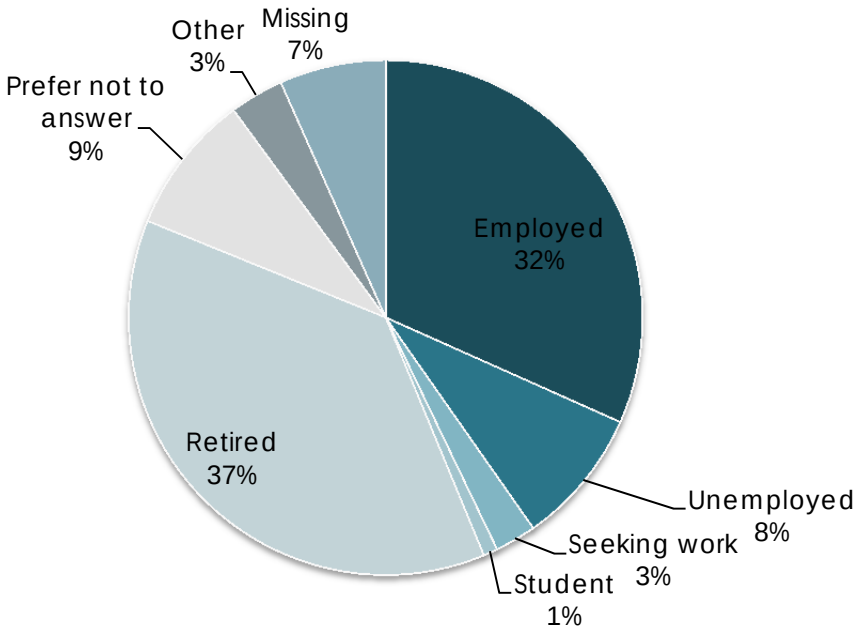

Figure 8. Employment status of the household representative person (percentage of the total).

The household representative person was asked to report the employment status of other household members; the responses are summarised in Table 1. Similar to Figure 8, the highest number of responses was given for the 'employed' and 'retired' category.

Table 1. Employment status of other members of the household.

How many people in your household are…	Number of responses in each category
Employed	289
Unemployed	65
Seeking work	20
Student	100
Retired	207
Other	54
Prefer not to answer	20

4.1.5 Qualifications of the Household Representative Person (HRP)

The household representative person was asked whether they had any educational qualifications for which they received a certificate, 501 householders provided an answer to this question of which 50.7% answered yes, and 40.7% answered no. The HRP was also asked whether they had any professional, vocational or other work-related qualifications for which they received a certificate, 484 householders provided an answer to this question of which 46.7% answered yes, and 44.8% answered no. Finally, the HRP was asked to indicate their highest qualification level. Figure 9 shows that 19% of the householders who responded to the survey held an O'level, GCSE, NVQ level 2 or equivalent[1], 14% held an A'Level, NVQ level 3 or equivalent[2], and 10% held a higher education degree level or above. A quarter of householders indicated that the question was not applicable to them.

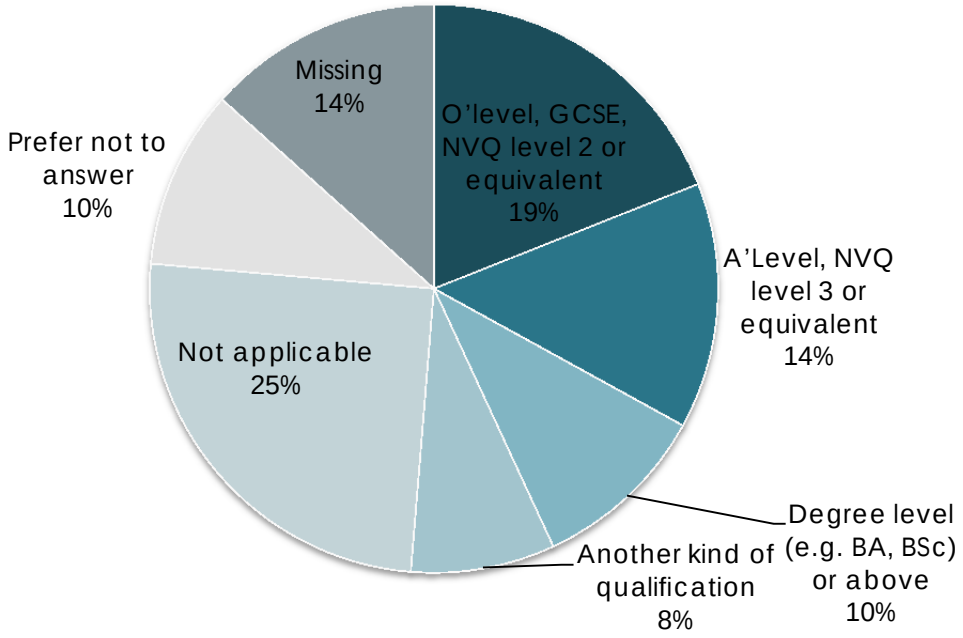

Figure 9. Highest qualification level of the household representative person (percentage of the total).

[1] O'level (Ordinary Level), GCSE (General Certificate of Secondary Education), and NVQ (National Vocational Qualification) Level 2, are academic and work-based qualifications up to the age of 16 years old.

[2] A'Level (General Certificate of Education Advanced Level) is awarded to students completing secondary or pre-university education. NVQ (National Vocational Qualification) Level 3, is the equivalent work-based qualification.

4.1.6 Welfare benefits

Out of the four-hundred and seventy householders who responded to the question, 52.1 percent selected 'yes' to the question whether they or members of their household were in receipt of welfare benefits, such as unemployment allowance or housing benefit.

4.1.7 Health of the Household Representative Person (HRP)

The majority of householders who responded to the survey rated their health, in general, over the last 12 months as good (26%) or fair (27%) – as can be seen in Figure 10.

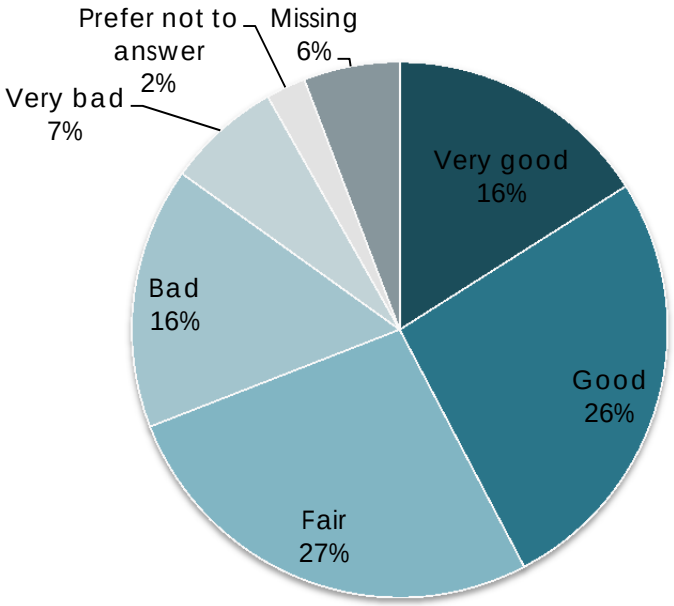

Figure 10. Responses to the question 'how was your health in general in the last 12 months' (percentage of the total).

Three hundred and ninety-nine respondents provided an answer to the question 'how many times have you visited your General Practice (GP) surgery in the last 12 months'. Three hundred and sixty householders provided a number: on average they visited their GP five times in the last 12 months (*SD* = 7.23). Numbers ranged from zero to fifty-two. Thirty-nine householders provided a written answer (e.g. 'never') these were coded into common responses and are displayed in Table 2. Most commonly, householders reported visiting the GP 'often' in the last 12 months (35.9%), or being 'unsure' about how often they had visited the GP (28.2%).

Table 2. Percentage of responses for each written category of General Practice (GP) visits.

How many times have you visited your GP surgery in the last 12 months	Percentage of responses (of the total *N* = 39)
None/never	5.1%
Rarely/a few times	12.8%
Several times	10.3%
Often/a lot	35.9%
Don't know/unsure	28.2%
Other	7.7%

On average, householders who responded to the survey felt fairly satisfied with life nowadays, with a mean score of 6.31 (*SD* = 2.65) on a scale ranging from 0 (Not at all satisfied) to 10 (Completely satisfied), based on 498 responses. A one-sample t-test indicated that the mean score was significantly above the neutral midpoint of the scale, $t(497) = 11.06$, $p<.001$.

Finally, 34.3% of respondents considered themselves to have a disability, and 14.3% reported that another member of their household considered themselves to have a disability.

4.2 Energy consumption motivations, behaviour and perceptions

4.2.1 Motivations

Householders who responded to the survey tended to agree or strongly agree with the statement 'I am prepared to save energy with the right support'. And householders indicated that they quite often think about how they could save energy. At the same time, householders tended to agree or neither agree or disagree with the statement 'I am not able to save anymore energy'. See Figure 11 for an overview of all responses.

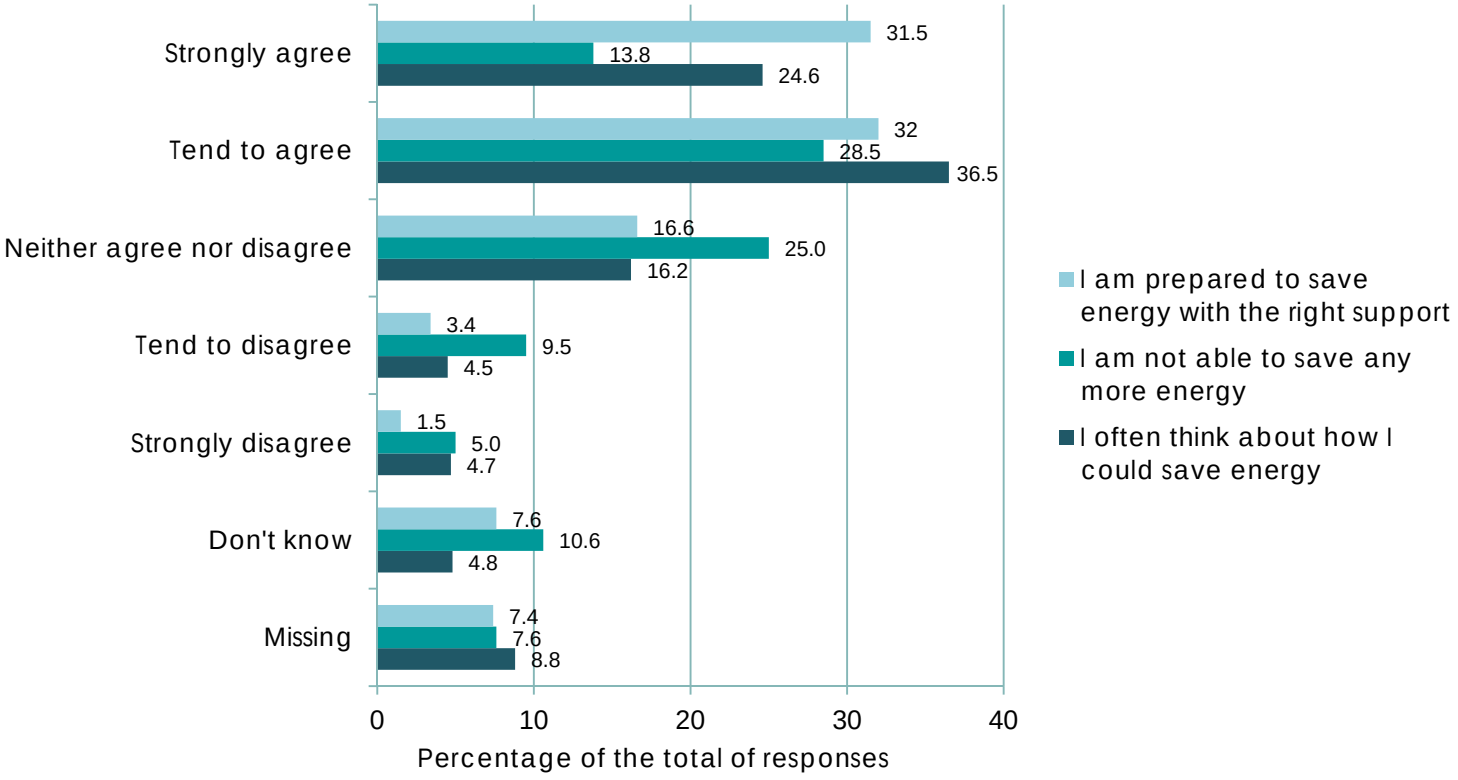

Figure 11. Responses to three questions measuring energy saving motivations.

4.2.2 Behaviour

4.2.2.1 Payment of energy bills

In this sample of householders, electricity was paid mainly by direct debit (43%) or by a pre-payment meter (40%) as can been seen in Figure 12. For gas, direct debit (34%) and a pre-payment meter (23%) were also commonly reported forms of payment (see Figure 13). In addition, just under a quarter of respondents (23%) reported not having gas supplied to their property.

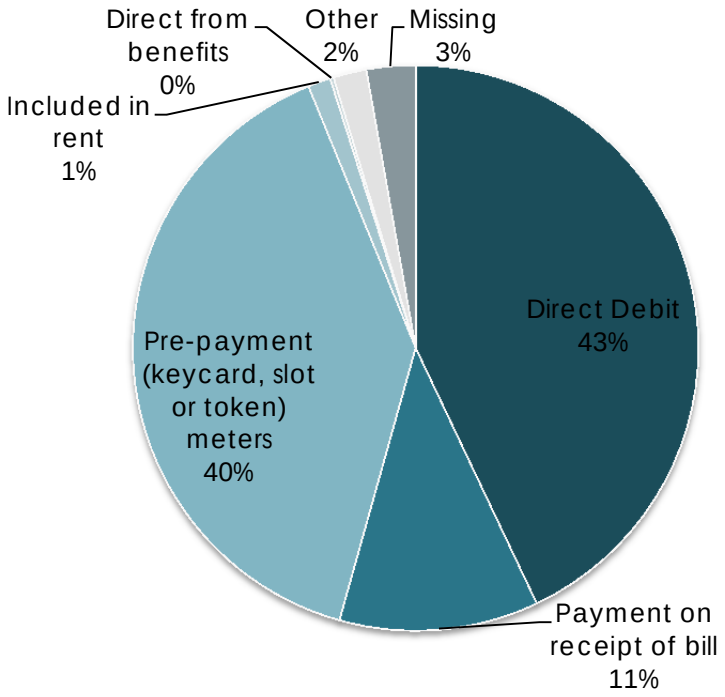

Figure 12. Payment method for electricity (percentage of the total).

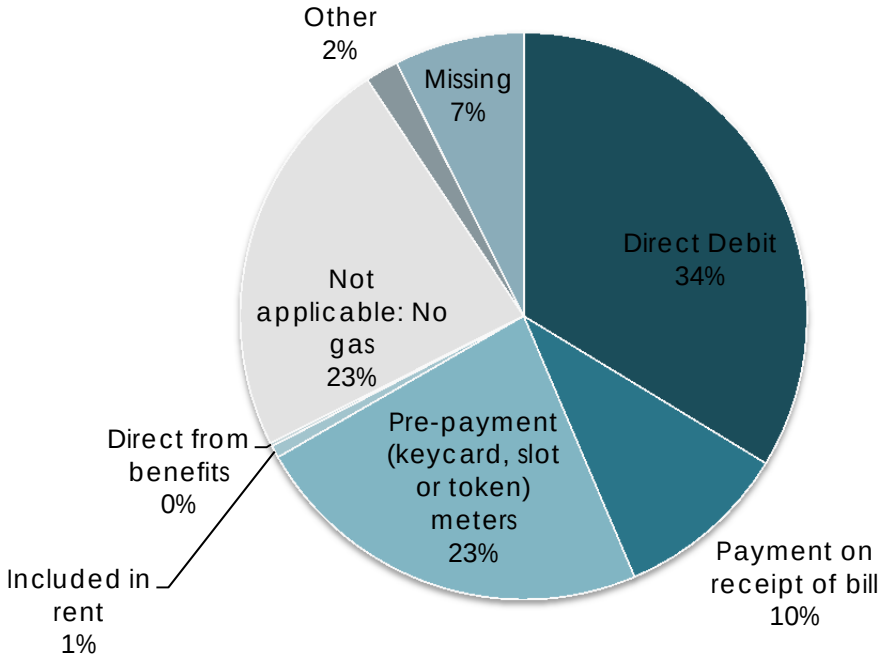

Figure 13. Payment method for gas (percentage of the total).

Just under half (44.7%) of the householders who responded to the survey reported having changed energy supplier at some point, 51.6% had never changed supplier and 3.7% did not provide an answer. Furthermore, approximately a third of householders (33.1%) had used a comparison website in the past to compare energy prices, while the majority (65.6%) had never used a comparison website and 3.7% did not provide an answer.

In total, 35.2% of respondents found it fairly, or very, easy to afford their energy bills – but a total of 23.3% respondents found it fairly, or very, difficult to afford their energy bills. The largest group of householders reported finding it neither easy nor difficult to afford their energy bills (36.9%). See Figure 14 for an overview of all responses.

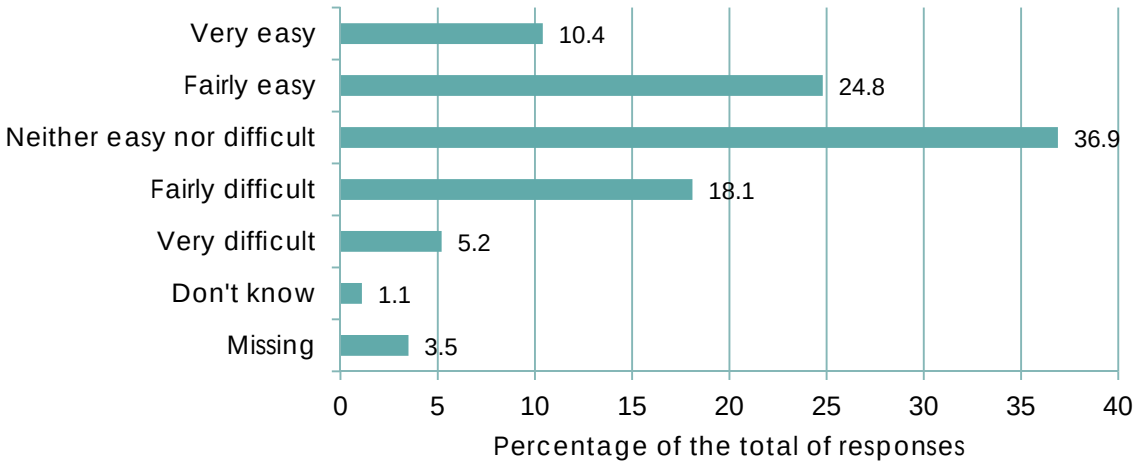

Figure 14. Responses to the question 'how easy or difficult is it for you to afford your energy bills'.

4.2.2.2 Energy-related behaviours

Figure 15, Figure 16 and Figure 17 show the frequency of heating-related, appliance-related and other energy behaviours in the home, respectively. Across these categories the five most common behaviours (i.e. rated most commonly as something that householders *always* did) were:

1. *I make sure that the fridge and freezer doors are not open for longer than necessary*

   Rated 'always' by 84.9% of respondents.

2. *When I am the last to leave a room I turn the lights off*

   Rated 'always' by 83.4% of respondents.

3. *I make sure that the windows are closed when the heating is on*

Rated 'always' by 74.3% of respondents.

4. *I make sure that the curtains are open when the sun is shining in winter*

Rated 'always' by 71.7% of respondents.

5. *I make sure that I use the right sized hob ring for each pan when cooking*

Rated 'always' by 66.3% of respondents.

The five most uncommon behaviours (i.e. rated most commonly as something that householders *never* did) were:

1. *I tell other people to do things to save energy*

Rated 'never' by 22.3% of respondents.

2. *I adjust the temperature on my radiators*

Rated 'never' by 17.5% of respondents.

3. *I try to minimise my shower time to 5 minutes*

Rated 'never' by 15.6% of respondents.

4. *I close the doors between rooms*

Rated 'never' by 13.6% of respondents.

5. *I turn off the heating in rooms that are not normally used*

Rated 'never' by 12.1% of respondents.

Three behaviours were often rated as 'not applicable'. One behaviour in particular is worth highlighting here, namely: 'I only use my dishwasher when it is full', which was rated as not applicable by 77.5% of householders. Secondly, 'I shut down my computer when it is not in use' was rated as not applicable by 27.2% of householders. And thirdly, 'I use energy saving modes on my appliances' was rated as not applicable by 20.1% of householders.

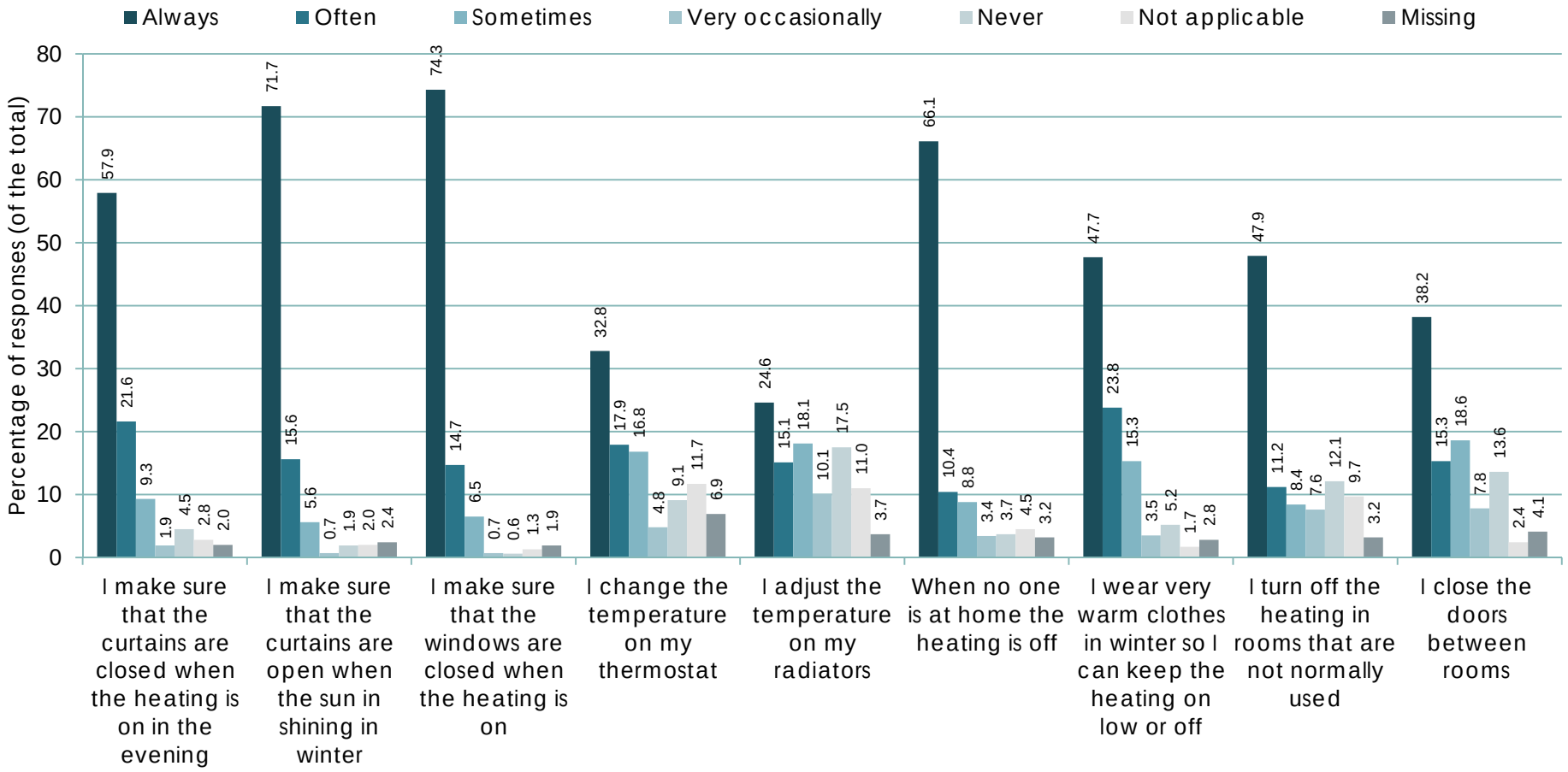

Figure 15. Heating related behaviours.

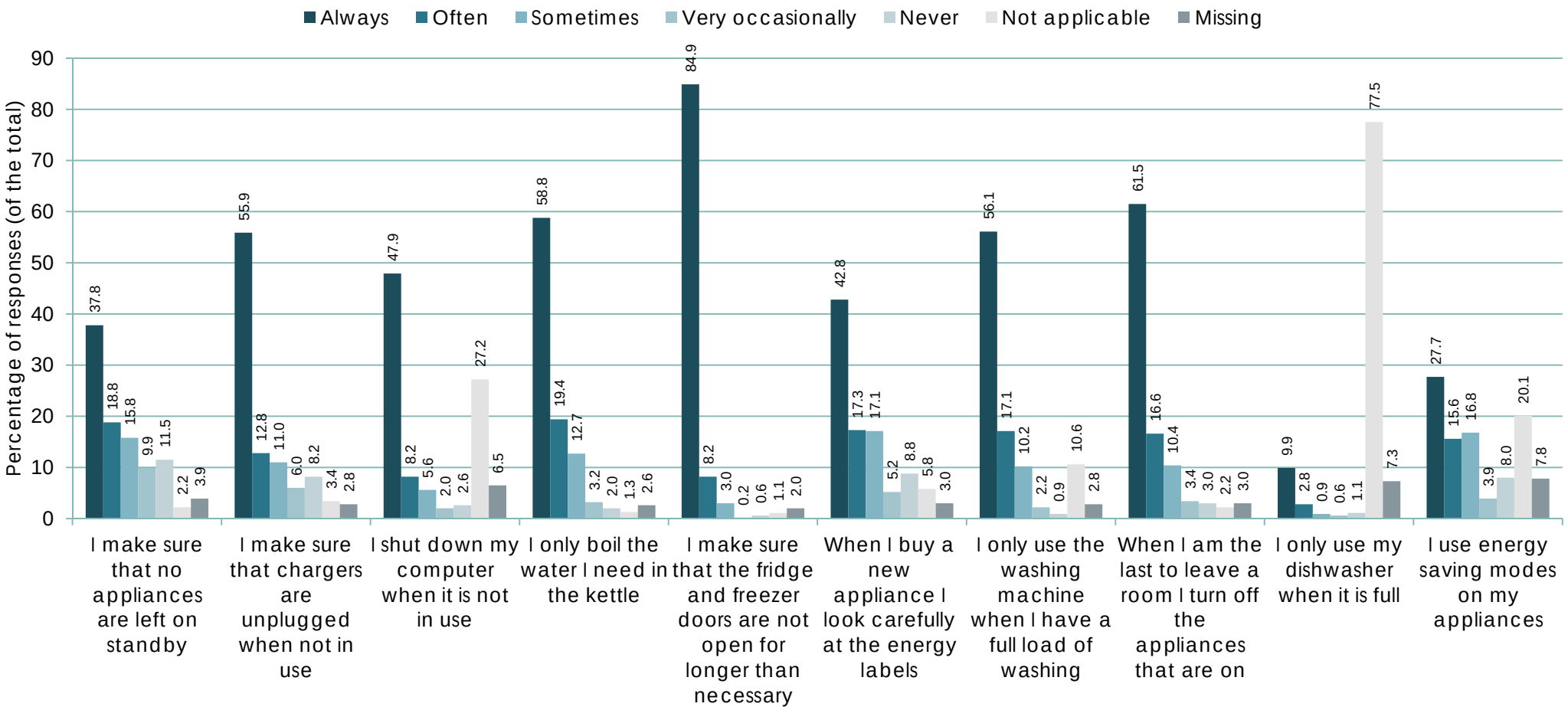

Figure 16. Appliance related behaviours.

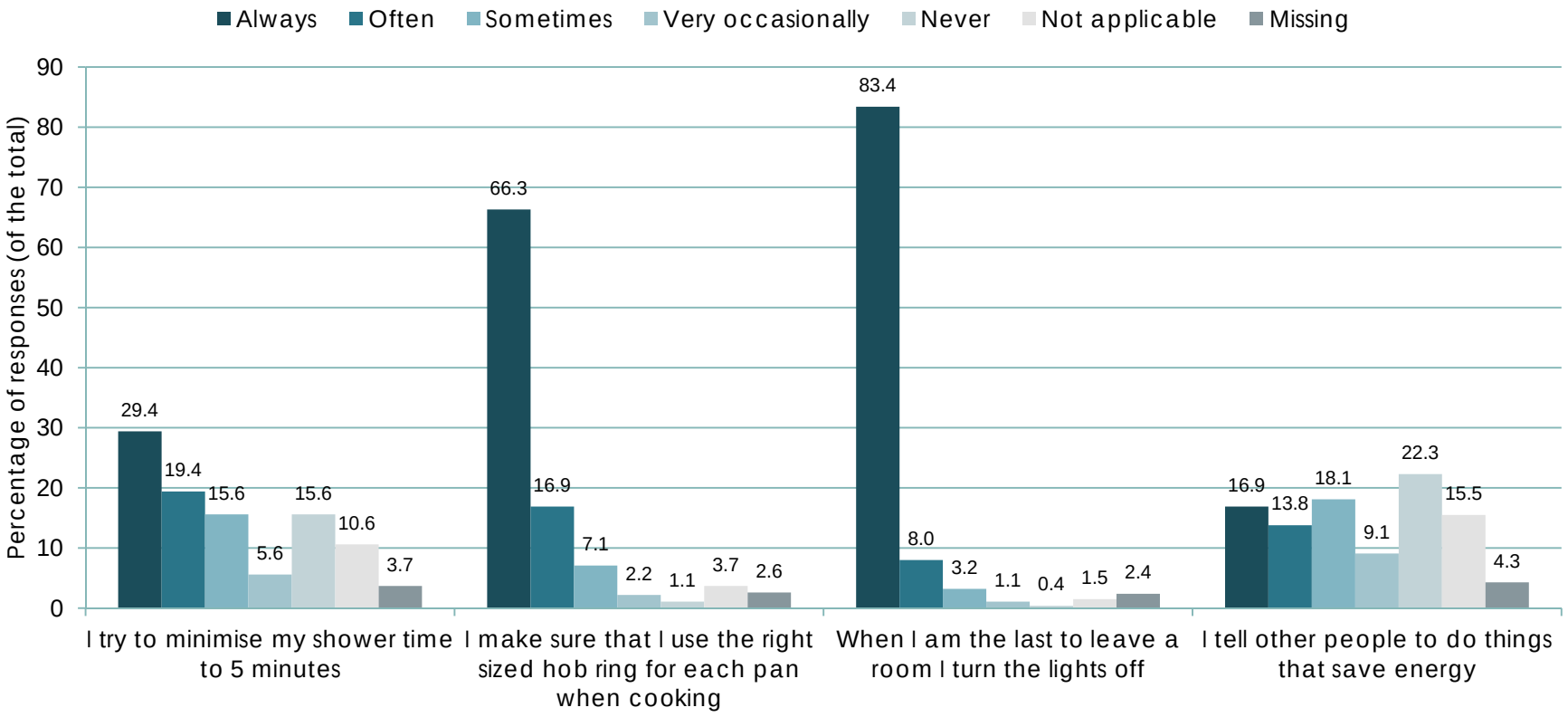

Figure 17. Other energy-related behaviours.

4.2.3 Perceptions

As can be seen in Figure 18, responses to the question whether householders did not understand how their home uses energy were mixed, but the largest group of respondents answered neither agree nor disagree or tend to agree. Moreover, householders tended to be worried about their energy bills. Householders did however feel in control over how much energy is consumed in their home.

Most householders agreed, at least to some extent, that their friends and family said it is important to save energy. With regards to trust in the energy supplier responses were ambivalent in nature, with the largest group of householders selecting neither agree nor disagree.

Overall, householders strongly agreed or tended to agree that they could easily imagine how much energy their home uses. Although, around 30% of householders seemed unsure about their ability to imagine their energy use and selected neither agree nor disagree for this item.

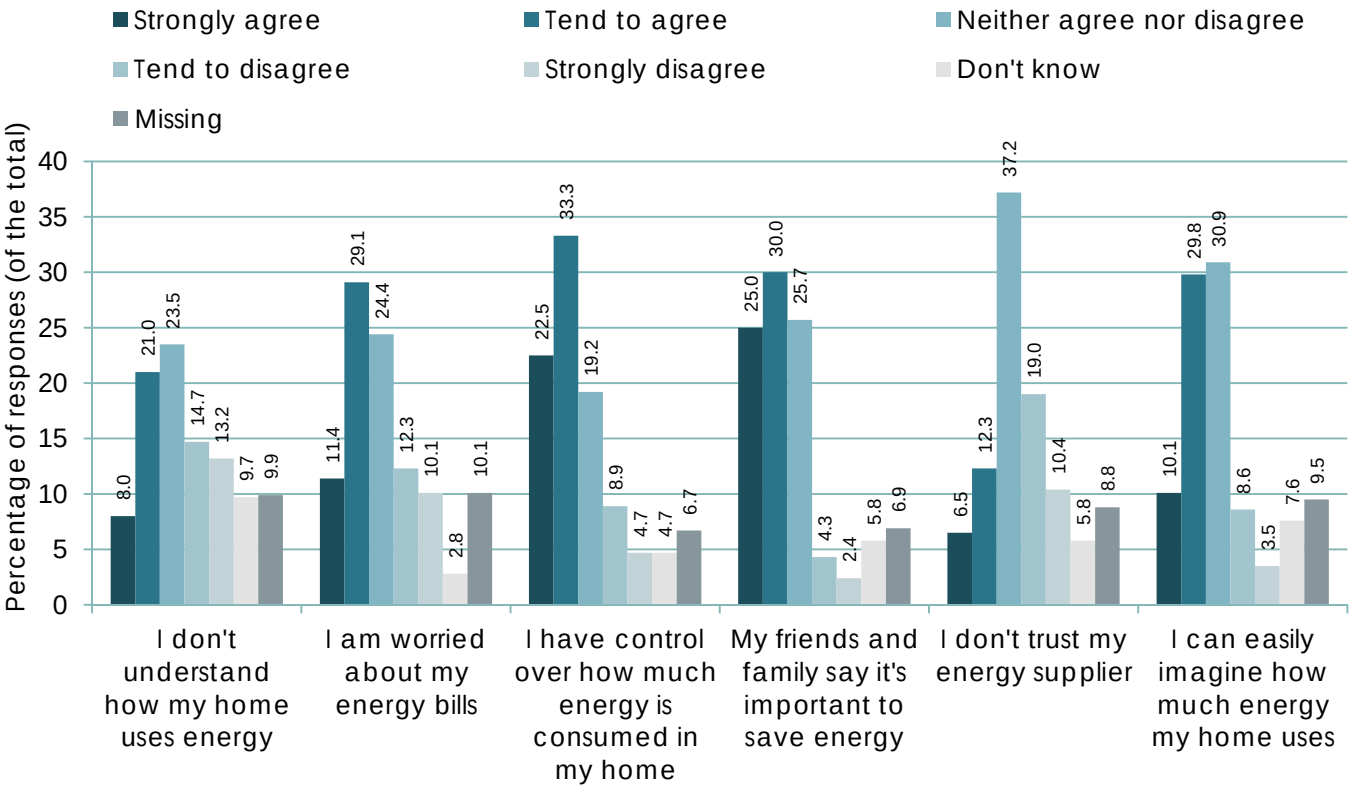

Figure 18. Responses to six questions measuring energy perceptions.

4.3 Exploratory comparisons between samples

Out of the 537 householders who responded to the survey, 237 indicated that they would be interested in partaking in further follow-on studies. As the participants for further stages of the research project will be sampled from these 237 householders, additional analyses were undertaken to gain more insight into this group of householders. The purpose of this analysis is to inform the generalisability of the findings at later stages of the project to the wider population of householders in social tenants homes managed by DCH in Plymouth.

Specifically, this section examines potential differences between those householders that are interested in taking part, and those that are not, in terms of socio-economic characteristics, energy motivations and perceptions. Table 3 provides an overview of all the comparisons that have been undertaken for this analysis. On most of the variables there were no statistically significant differences between the two samples, suggesting there is no difference on these variables between those householders that are interested in being involved in other aspects of the research and those that are not interested. Only minor differences were found on some of the variables. In particular, when evaluating the use of the game later in the project, we should take into account that the sample of householders interested in partaking in the research were (perhaps not surprisingly) slightly more motivated to save energy with the right support, and thought about ways to save energy more often. These findings are discussed in more detail in Section 4.3.1 and 4.3.2.

4.3.1 Comparing socio-economic characteristics

In terms of socio-economic characteristics, for households who indicated that they were interested in partaking in further follow-on studies, compared to those who did not:

1. The mean age of the household representative person was lower
2. The mean number of occupants in the household was higher
3. The household representative person was more likely to be employed
4. The household representative person tended to be slightly higher educated
5. The percentage of householders indicating they were in good health was lower

4.3.2 Comparing motivations and perceptions

In terms of motivations, householders who indicated that they were interested in partaking in further follow-on studies, compared to those who did not, were more likely to strongly agree with the statement ‘I am prepared to save energy with the right support’ and ‘I often think about how I could save energy’.

In terms of perceptions, householders who indicated that they were interested in partaking in further follow-on studies, compared to those who did not, were more likely to strongly agree with the statement 'My friends and family say it's important to save energy'.

Table 3. Comparisons on socio-economic characteristics and energy motivations and perceptions between sample of householders interested to participate further, and those that are not interested.

Variable	Interested to participate (*N* = 237)	Not interested to participate (*N* = 246)	Statistical analysis*
Socio-economic characteristics			
Age	*M* = 52 (*SD* = 15.95)	*M* = 63 (*SD* = 16.54)	$t(440) = -7.24$, $p < .001$
Gender	No significant difference	No significant difference	X^2 (2, *N* = 456) = 0.30, exact $p = .924$
Number of occupants	*M* = 2.02 (*SD* = 1.19)	*M* = 1.45 (*SD* = 0.78)	$t(249) = 4.31$, $p < .001$
Employment status of HRP	Within this sample: 41.3% employed 27.4% retired	Within this sample: 28.4% employed 50.2% retired	X^2 (6, *N* = 459) = 30.33, exact $p < .001$
Highest qualifications of HRP	Within this sample: 16.7% degree level or above 18.6% not applicable (i.e. no degree)	Within this sample: 6.0% degree level or above 39.5% not applicable (i.e. no degree)	X^2 (5, *N* = 430) = 34.08, $p < .001$
Welfare benefits	No significant difference	No significant difference	X^2 (1, *N* = 437) = 0.21, $p = .647$ (with 'prefer not to answer' category omitted, otherwise $p = .054$)
General health	Within this sample: 23.3% good	Within this sample: 35.3% good	X^2 (4, *N* = 456) = 9.97, $p = .041$ (with 'prefer not to answer' category omitted, otherwise $p = .022$)
GP visits (numerical answers)	No significant difference	No significant difference	$t(335) = 0.10$, $p = .925$
Life satisfaction	No significant difference	No significant difference	$t(459) = -1.34$, $p = .182$
Disability HRP	No significant difference	No significant difference	X^2 (1, *N* = 459) = 0.58, $p = .447$
Disability other household members	No significant difference	No significant difference	X^2 (1, *N* = 454) = 1.49, $p = .223$
Motivation and perception			
Motivation: I am prepared to save energy with the right support	Within this sample: 42.4% strongly agree 13.4% neither agree nor disagree	Within this sample: 26.1% strongly agree 21.7% neither agree nor disagree	X^2 (5, *N* = 457) = 27.00, exact $p < .001$
Motivation: I am not	No significant	No significant	X^2 (5, *N* = 452) = 0.47,

able to save any more energy	difference	difference	p = .993
Motivation: I often think about how I could save energy	Within this sample: 32.5% strongly agree	Within this sample: 19.9% strongly agree	X^2 (5, N = 449) = 17.10, p = .004
Perception: I understand how my home uses energy	No significant difference	No significant difference	X^2 (5, N = 443) = 8.82, p = .116
Perception: I am worried about my energy bills	No significant difference	No significant difference	X^2 (5, N = 440) = 3.12, p = .682
Perception: I have control over how much energy is consumed in my home	No significant difference	No significant difference	X^2 (5, N = 454) = 8.48, p = .132
Perception: My friends and family say it's important to save energy	Within this sample: 31.1% strongly agree 23.2% neither agree nor disagree	Within this sample: 20.5% strongly agree 32.8% neither agree nor disagree	X^2 (5, N = 457) = 12.94, p = .024
Perception: I don't trust my energy supplier	No significant difference	No significant difference	X^2 (5, N = 449) = 2.58, p = .765
Perception: I can easily imagine how much energy my home uses	No significant difference	No significant difference	X^2 (5, N = 444) = 5.63, p = .344

*Note: a p-value of $p < .05$ is considered to be indicative of a statistically significant effect.

5.EnerGAware game user requirements

The detailed results of the EnerGAware Social Housing Survey were analysed and transformed into requirements for the EnerGAware serious game functionalities, design, as well as didactical content and learning approach. Serious game requirements and non-functional requirements previously identified in the literature review (Section 2) were considered when appropriate.

Table 4 presents the social housing tenant characteristics identified in the survey, the serious game requirements related to the user characteristics and the approaches that the EnerGAware serious game could adopt to meet these requirements. The importance of the requirements for the success of the project is ranked following the MoSCoW method. MoSCoW stands for Must, Should, Could and Would:

- M - Must have this requirement to meet the project needs.
- S - Should have this requirement if possible, but project success does not rely on it.
- C - Could have this requirement if it does not affect anything else in the project.
- W - Would like to have this requirement later, but it won't be delivered this time.

Table 4. Definition of the EnerGAware serious game user requirements

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Socio-economic characteristics			
Age	**Large group of older people** The majority of respondents (70%) were over 45 years of age. Most householders who responded to the survey fell in the 55-64 (18%), 65-74 (18%), or 75+ (16%) age category.	**(S)** Requirements related to the abilities and limitations of elderly people, individuals with little IT-experience, low literacy level or disabilities (e.g. vision), when interacting with IT tools identified by Fisk et al. (2004), SAVE@Work4Homes project and the eSESH project should be considered (See Section 2)	Although the EnerGAware game is **intended for all age groups**, special attention should be placed to those **requirements derived from human aging process** and novice users.
Gender	**All genders represented,** 37% were male; 55% were female; and 8% did not provide their gender.	No specific requirement identified.	The EnerGAware game is **intended for all gender groups**.

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Number of occupants	**All household compositions represented** **Presence of people living alone** **Presence of children** 50.5% live with at least one other person (28.7% live with another adult only; 21.8% live with another adult and at least one child under 16 years of age); 49.5% lived on their own or did not report any details on the other members of their household.	**(S)** The game should not only provide the game player the possibility to learn/play on his/her own but also in social groups (e.g. a family environment). **(C)** For people living alone (in most occasions being elderly people), the game could provide an opportunity to interact with other game users and share concerns and advice on energy efficient practices. **(W)** The game would allow family members or friends of people who live alone to join the game, or at least play a role, therefore allow players to create their own game play community.	A **multiplayer variant** of the EnerGAware serious game should allow individual users to interact with others also playing the game by means of social media platforms. The game could provide the users the opportunity to compete with each other, as well as, join together to form virtual energy communities, sharing energy or combining in-game currency to invest in large-scale energy efficiency measures.
Employment status of HRP	**High presence of retired people** 37% are retired; 32% are employed; 8% unemployed; 3% looking for work.	**(S)** Same requirements related to "Age". **(S)** The game should accommodate different lifestyles, allowing longer (i.e. at home) and shorter game play sessions (i.e. while travelling to work on public transport) without compromising the game and learning experience.	The EnerGAware game could have a background story where the player will experience progress slower and in a **longer term**, but it could also provide game play scenarios that will allow the player to experience **instant progress** and feedback that can be played multiple times on a day.

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Highest qualifications of HRP	**Large group with low educational level** Only 24% have further educational qualifications (higher qualifications than UK compulsory education)	**(C)** The game could accommodate different education levels and learning abilities, be able to measure players' learning progress and adjust to learner's skill.	The EnerGAware game could monitor the learning achievements of the players and **increase/decrease the level of difficulty** accordingly.
		(C) The game could have a system to assess and measure learner's progress, and provide different difficult levels to solve tasks.	
		(M) The game must have solvable, clear and understandable goals.	The EnerGAware game must **explain the goals** of the game by means of clear and easy to understand messages.
		(S) The game should convert difficult learning objectives into repeated game tasks to enhance knowledge retention.	The EnerGAware game should consist of a group of actions related to energy efficiency behaviours that the player need to repeat in different situations to achieve the game goals. This could help to retain knowledge.
		(C) The game could allow users to reach out to other players to help them with tasks or goals, as this could enable collaborative learning within the game.	The EnerGAware game could provide this game mechanics by means of the social media platforms linked to the game.

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Welfare benefits	**Large group in receipt of welfare benefits, most likely due to low income or long term health problems** From 417 respondents, 52.1% were in receipt of welfare benefits	**(S)** The game should be able to explain the economic and health related benefits and consequences derived from correct or poor energy management practices in the homes.	The EnerGAware game should include these learning objectives as part of the didactic content of the game. The EnerGAware game should allow users to learn how to optimise the energy consumption of their virtual house, whilst maintaining the comfort of their character. The successful **balancing of energy consumption, comfort and financial cost** could lead to the user to progress in the game. The game could have economic, comfort and energy consumption as the performance indicators.

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Health of the Household Representative Person (HRP)	**Large group with long term illness, disability or mental health problems** 34.3% considered themselves to have a disability, and 14.3% reported that another member of their household considered themselves to have a disability. 26% rated their health, in general, over the last 12 months as good; 27% as fair.	**(S)** The game should be inclusive and be able to provide a fun and learning experience for those with disability or learning difficulties. Similar requirements related to "Age". Similar requirements related to "Highest qualifications of HRP". **(S)** The game should be able to explain the concept of "comfort" and health related benefits and consequences derived from correct or poor energy management practices in the homes.	Same approach as "Age", "Highest qualifications of HRP", and "Welfare benefits".

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Motivation and perception			
Motivation	**Large group motivated to save energy with the right support** The majority of social tenants strongly agree that they are prepared to save energy with the right support. Tenants indicated that they quite often think about how they could save energy. Tenants agree or neither agree or disagree that they are able to save anymore energy.	**(S)** The game should motivate people to save energy in their own homes as well as in the virtual world by means of fun and educational features.	The EnerGAware game should **have virtual worlds that are authentic and exciting for the player** with curious and surprising elements that will keep them motivated at the same time they learn about energy efficient practices that could help them to save energy in both the virtual world and their own homes.
		(S) The game should be able to provide useful and easy to understand information in the form of game actions or messages to teach people tips to save energy.	
		(S) The game should provide a platform for game players to communicate and exchange ideas with others, provide support to others and create an EnerGAware community.	The EnerGAware game should be **linked to social media channels** where game players and other relevant organisations (e.g. the social housing provider) could **exchange ideas and advice**.
		(S) People's motivation to save energy in the real world should be rewarded in the virtual world in the game. This would keep game users' motivated.	The EnerGAware game should be **linked to the real energy consumption of the household**, and in the event of saving energy, it would reward the game player with further currency in the game and/or unlocking levels. The same concept could be implemented in the virtual world.

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Perception	**Poor knowledge on energy use in their homes** The majority of tenants neither agree nor disagree or tend to agree that they do not understand how their home uses energy. Tenants tend to be worried about their energy bills.	**(M)** The game must allow game users to understand where and how much energy is used in a domestic environment. **(S)** The game should be able to quantitatively show the energy consumption associated with typical actions undertaken in a daily basis, such as the use of appliances or heating. Game players should be able to appreciate the increase or decrease of energy consumption depending on the duration of use, appliances mode or heating settings, for example.	The EnerGAware game should set the virtual world on a **virtual household containing the usual energy end-uses existing in a domestic environment** such as appliances, heating system, lighting etc. Game players could appreciate how much energy is used by these end-uses, poor practices of use that might increase the energy consumption, as well as the most efficient ways to use them to save energy. **A building energy consumption and thermal comfort simulation engine built in the game** should calculate the current energy consumption of the virtual house and provide the potential options for improving its energy efficiency or change the behaviour of the avatar.

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Energy-related behaviours			
Heating related behaviours	The majority of respondents (more than 50%) reported they "always": - Make sure that the curtains/blinds are closed when the heating is on in the evening. - Make sure that the curtains are open when the sun is shining in winter. - Make sure that the windows are closed when the heating is on. - Make sure the heating is off when no one is at home. However, a big group of respondents reported that they "very occasionally" or "never": - Change the temperature on the thermostat. - Adjust the temperature on the radiators. A mixed behaviour was also reported for the following behaviours: - Wear very warm clothes in winter to keep the heating on low or off. - Turn off the heating in rooms that are not normally used. - Close the doors between rooms.	**(S)** By means of the game, users should be able to learn the impact of heating related behaviours on the energy consumption and comfort of their homes. **(S)** The game should include all heating related behaviour practices included in the survey, even those that are generally accepted and always implemented by the majority of households. **(S)** The game should emphasise those practices that, according to the survey, are not always implemented. **(C)** The game could have a system to assess and measure the user's learning progress, to be able to reinforce by means of different game functionalities those practices not yet understood by the user.	The EnerGAware game should **use the virtual house to teach in a fun way heating related behaviours**. The users would not only appreciate the benefits of undertaking these practices but also the consequences of not doing it correctly. The EnerGAware game could give feedback on the users' actions and the impact of these heating related behaviours on the energy costs, energy consumption and occupant comfort of the virtual home. The EnerGAware game could allow the user to understand how to use a thermostat and adjust the temperature on the radiators in the different rooms of the house depending on their use.

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Appliances related behaviours	The majority of respondents (more than 50%) reported they "always": - Make sure that the fridge and freezer doors are not open for longer than necessary. - Turn off the appliances that are on when they are the last to leave a room. - Only boil the water they need in the kettle. - Only use the washing machine when they have a full load of washing. - Make sure that chargers are unplugged when not in use. However, a big group of respondents reported that they "very occasionally" or "never": - Only use the dishwasher when it is full. - Use energy saving modes on their appliances. - Shut down the computer when it is not in use. A mixed behaviour was also reported for the following behaviours: - Look carefully at the energy labels when they buy a new appliance. - Make sure that no appliances are left on standby.	**(S)** By means of the game, users should be able to learn the impact of appliances related behaviours on the energy consumption and comfort of their homes. **(S)** The game should include all appliances related behaviour practices included in the surevy, even those that are generally accepted and always implemented by the majority of households. **(S)** The game should emphasise those practices that, according to the survey, are not always implemented. **(C)** The game could have a system to assess and measure the user's learning progress, to be able to reinforce by means of different game functionalities those practices not yet understood by the user.	The EnerGAware game should **use the virtual house to teach in a fun way appliances related behaviours**. The users would not only appreciate the benefits of undertaking these practices but also the consequences of not doing it correctly. The EnerGAware game could give feedback on the users' actions and the impact of these appliances related behaviours on the energy costs, energy consumption and occupant comfort of the virtual home. The EnerGAware game could allow the user to understand the energy labels of new appliance, the different appliances energy saving modes and the consequences of standby appliances.

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Other energy related behaviours	The majority of respondents (more than 50%) reported they "always": - Make sure that I use the right sized hob ring for each pan when cooking. - Turn the lights off when they are the last one to leave a room. However, a big group of respondents reported that they "very occasionally" or "never": - Try to minimise their shower time to 5 minutes. - Tell other people to do things that save energy.	**(S)** By means of the game, users should be able to learn the impact of energy related behaviours on the energy consumption and comfort of their homes. **(S)** The game should include all these energy related behaviour practices included in the survey, even those that are generally accepted and always implemented by the majority of households. **(S)** The game should emphasise those practices that, according to the survey, are not always implemented. **(C)** The game could be have a system to assess and measure the user's learning progress, to be able to reinforce by means of different game functionalities those practices not yet understood by the user.	The EnerGAware game should **use the virtual house to teach in a fun way other energy related behaviours, such as cooking or use of lights**. The users would not only appreciate the benefits of undertaking these practices but also the consequences of not doing it correctly. The EnerGAware game could give feedback on the users' actions and the impact of these behaviours on the energy costs, energy consumption and occupant comfort of the virtual home.

Variable	Characteristic of user group	Requirement (Must (M); Should (S); Could (C); Would (W))	Approaches to meet the requirements
Payment of energy bills			
Payment method	Electricity was paid mainly by direct debit (43%) or by a pre-payment meter (40%) Gas was paid mainly by direct debit (34%) or by a pre-payment meter (23%). (23%) reported not having gas supplied to their property.	No specific requirement identified for the game design.	
Comparing and changing energy suppliers	**Comparing and changing energy supplier is not a common practice amongst social housing tenants** 44.7% respondents had changed energy supplier at some point, however 51.6% had never changed energy supplier. 33.1% had used a comparison website in the past to compare energy prices, while the majority 65.6% had never used a comparison website.	**(C)** By means of the game, users could gain an understanding of the energy tariffs and learn how to compare energy tariffs from different energy suppliers in order reduce their energy bills.	The EnerGAware game could facilitate a **functionality to understand energy tariffs and compare fictional energy suppliers** in different situations.
Affordability of energy bills	**Large group with difficulties to afford energy bills** Only 35.2% of respondents found it fairly, or very easy to afford their energy bills. The largest group of householders reported finding it neither easy nor difficult to afford their energy bills (36.9%). However, 23.3% respondents found it fairly, or very difficult.	A combination of previous requirements	The EnerGAware game linked to the real energy use of the game players' homes should provide functionalities and didactic content to help social tenants to **change their energy efficiency behaviour, increase their understanding and awareness of the options for reducing energy consumption in their homes and ultimately help them to reduce their energy consumption**.

It is worth mentioning that the EnerGAware game should not encourage social tenants to improve their understanding of the effects of small behaviour changes on energy consumption (e.g. reducing heating and cooling temperatures or durations; leaving appliances in standby mode), but also should be able to demonstrate the potential energy savings from upgrading energy efficiency measures (e.g. No insulation - cavity wall insulation - solid wall insulation), by replacing the existing domestic appliances and lighting (e.g. incandescent bulbs - CFL bulbs - LED bulbs) and implementing renewable energy solutions.

This Deliverable D2.1 User requirements has identified those requirements related to behaviour change. Requirements related to the energy efficiency measures and renewable energy are presented in Deliverable 2.2 Building requirements.

6. Conclusions

This deliverable is one of three complimentary reports produced in WP2 that define the requirements for the design of the EnerGAware integrated serious game and metering system solution. Deliverable 2.1 has presented the user requirements of the EnerGAware serious game and the categorisation of the social housing community obtained from the analysis of the socio-economic characteristics, energy use habits, energy efficiency and IT awareness, collected by means of a large-scale, city-wide survey, undertaken in Plymouth (UK) during 2015, which was administered to all the 2,772 social houses managed by project partner DCH in the city. 537 completed surveys (20% response rate) were analysed and the results were transformed into requirements for the EnerGAware serious game functionalities, design, as well as didactical approach and content. The requirements were then ranked following the MoSCoW method (Must - Should – Could - Would).

Results identified two Must requirements, twenty-two Should requirements, eight Could requirements and one Would requirement. In general, results suggested that the EnerGAware serious game virtual world should be based on a domestic environment (e.g. virtual home), so as to help the players to relate to. Results also revealed that the design of the visual aspects of the game should take into account those requirements derived from human aging process and novice users. In relation to the didactic approach of the game, it is suggested that the game should adapt to different learning levels and provide clear and easy to understand goals. Regarding the educational content, the game should allow users to learn how to balance the energy consumption, comfort and financial cost of a house; gain knowledge on how much energy is used by the typical end-uses existing in a domestic environment, poor practices of use that might increase the energy consumption, as well as the most efficient ways to use them to save energy;

and could also help to understand energy tariffs and compare fictional energy suppliers in different situations. The game should also help the player to assess the potential energy savings from different behaviour actions and energy-efficient changes to the virtual house. From the game functionalities point of view, the link to social media platforms to enhance communication and information sharing amongst players was found relevant.

Appendix A. EnerGAware Social Housing Survey Accompanying Letter

123456789

Mr AB Sample
1 Sample Street
Sample Town
Sample City
AB1 2CD

DCH in partnership with Plymouth University would like to help you save energy, get online and win prizes. We want to hear your views.

This survey is the first step in helping us to understand your energy use and any energy related issues you may be currently experiencing in your home and whether you are connected to the Internet and what digital devices you use. **It should take less than fifteen minutes to complete and almost all of the questions are tick boxes.**

Everyone who completes the survey will be entered into a prize draw as a small thank you for your time. **There are ten prizes to be won, including family days out in Plymouth and £50 Love2Shop Vouchers.** If you are a winner, you can choose which prize you wish to receive.

Simply fill in the survey and return it in the pre-paid envelope provided as soon as you can. The prize draw will take place on **Monday 25 May 2015**, therefore we need to receive your completed survey before this date to be in with a chance of winning.

You can also choose to complete the survey online at **www.research.net/s/energaware2015**

All completed surveys, either by post or online will be entered into the prize draw.

If you have any questions about the survey please contact us by telephone on **0300 123 8080** or by email at **environment@dchgroup.com**

Thank you in anticipation. Your support is vital to the success of the project.

The information you provide will be treated in strict confidence and held securely by DCH. Data given to Plymouth University will not contain your name or contact details unless you give your explicit permission as part of joining the project. No one will be identified in the results of the project. Your personal details will not be passed to other people or organisations. The project will be carried out in accordance with the Data Protection Act. Both DCH and Plymouth University have strict ethics procedures to control how the project is carried out and used.

Appendix B. EnerGAware Project Flyer

EnerGAware

dch IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

Do you want to **save money** on your **energy bills?**

Do you want to **get online?**

Would you like to **design and test a game** for smartphones and tablets **to help you and others to save energy?**

DCH in partnership with Plymouth University have received a grant from the European Union to research energy use in the home. The grant is part of a European project called **EnerGAware**, which aims to help households in three main ways:

1. Helping DCH understand and deal with any energy related issues you may be experiencing in your home, for example, damp, condensation, high indoor temperatures
2. Helping you to understand and reduce your energy use
3. Helping you to get online and learn how to use digital devices

EnerGAware is a three year project that will involve a range of activities, from discussion groups, to learning about your home energy use and involves the design and testing of a game for smartphones and tablets to help you and others to save energy. By joining the project, you can get involved in as many or as few activities as you wish.

There will also be many opportunities to win prizes throughout the project, including family days out in Plymouth, Love2Shop vouchers, and tablets with internet connections.

Join the project and tell us about your energy use and access to the internet and together we can make a difference.

To find out more contact 0300 123 8080 or email environment@dchgroup.com

Please find overleaf some helpful contacts to reduce your energy bills and get online now.

Getting online

People with regular access to the internet have greater opportunities to get advice, access services and save money. If you want to improve your internet skills, ask a friend or family member who does have internet access to visit the **Plymouth Online Directory** **www.plymouthonlinedirectory.com** to find out where to get free online training in your area.

Get connected with a DCH digital bundle

DCH are offering residents the chance to apply for one of 10 digital bundles, which include a Google chromebook laptop, 6 months internet access and training and support.

For full details see our spring edition of **Open Door magazine**, offer closes on 22 May 2015 or contact:

Rose Hunter
Involvement Manager
Tel: **01392 814 471**
email **rose.hunter@dchgroup.com**

Reduce your energy bill

Be sure to contact your energy provider and ask them for the best deal and find out what help they can offer you; for example you could save £140 from your annual bill with the **Warm Home Discount**, visit **www.gov.uk/the-warm-home-discount-scheme**.

For advice on what other help is available contact the Home Heat Helpline **www.homeheathelpline.org.uk** and **0800 336 699**.

Getting a better price

Switching energy supplier is easy using one of the online comparison sites as they manage the switch for you, for more information visit **www.goenergyshopping.co.uk**.
If you would like to support a local energy provider talk to **Plymouth Energy Community Cooperative**. They aim to offer the best energy deal for low income households and also provide advice with dealing with fuel debt. Visit **www.plymouthenergycommunity.com** to find out more; call **01752 477 067** to talk about finding the best tariff, or **01752 477 117** for fuel debt advice.

Water debt and general debt

Don't struggle with paying your water bills, ask for help. Contact the water debt gateway on **01752 502 697 / 01752 502 698**, **freshstart@plymouthcab.org.uk** or visit **www.plymouthcab.org.uk/help-with-water-debt**

For general debt and housing advice contact **Advice Plymouth**, visit **www.adviceplymouth.org.uk** or call **03444 111 444**.

Cold Home

If you find your home is difficult or expensive to heat or you don't know how to use your heating system please contact your DCH Neighbourhood Team on **0300 123 8080**.

Power cuts and gas leaks

For electricity blackouts telephone
0800 365 900

For emergency gas leaks telephone
0800 111 999

Appendix C. EnerGAware Social Housing Survey

123456789

Your Home

dch IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

The first section of this survey is about any energy related issues that you are currently experiencing in your home. This includes problems with keeping warm in winter, being too hot in summer and issues with condensation, damp or mould. There is also space at the end of the section, where you can tell us about any other problems that you are currently experiencing in your home.

1 **How satisfied are you with your home?**

Very satisfied	Fairly satisfied	Neither satisfied nor dissatisfied	Slightly dissatisfied	Very dissatisfied
☐	☐	☐	☐	☐

2 **During the cold winter weather, can you normally keep comfortably warm in your living room?**

Yes	Yes, but it costs a lot	No	Don't know	Not applicable
☐	☐	☐	☐	☐

3 **If you cannot keep comfortably warm in your living room in winter, is this because...**

- It costs too much to keep the heating on ☐
- It is not possible to heat the room to a comfortable temperature ☐
- Don't know ☐
- Other reason (Please explain) ☐
- Not applicable ☐

4 **During the warm summer weather, do you sometimes feel too hot in your living room?**

Yes	No	Don't know	Not applicable
☐	☐	☐	☐

5 **During the warm summer weather, do you sometimes feel too hot in your bedroom when you are going to sleep?**

Yes	No	Don't know	Not applicable
☐	☐	☐	☐

6 **Do you have any problems with condensation, damp or mould in your home?**

Yes	No	
☐	☐	**If you answered "No", go to Question 13.**

7 **If you have issues with condensation, damp or mould, in which rooms does it occur? (Tick all that apply)**

Living room	Main bedroom	Hall	Kitchen	Bathroom	Other bedrooms
☐	☐	☐	☐	☐	☐

8 **In your living room, do you have any of these issues? (Tick all that apply)**

- Steamed up windows ☐
- Steamed up / wet walls ☐
- Mildew / rot / mould on window frames ☐
- Stains / rot / mould on walls or ceilings ☐
- Stains / rot / mould on floors, carpets or furniture ☐
- Other problems with condensation, damp or mould ☐
- No problems ☐

9 **In your main bedroom, do you have any of these issues? (Tick all that apply)**

- Steamed up windows ☐
- Steamed up / wet walls ☐
- Mildew / rot / mould on window frames ☐
- Stains / rot / mould on walls or ceilings ☐
- Stains / rot / mould on floors, carpets or furniture ☐
- Other problems with condensation, damp or mould ☐
- No problems ☐

10 **Are the issues in your living room with condensation, damp or mould there all year round, or only in winter?**

All year	Winter only	Don't know	Other (please specify below)	Not applicable
☐	☐	☐	☐	☐

11 **Are the issues in your main bedroom with condensation, damp or mould there all year round, or only in winter?**

All year	Winter only	Don't know	Other (please specify below)	Not applicable
☐	☐	☐	☐	☐

12 **How much do the issues with condensation, damp or mould affect you?**

A great deal	A fair amount	Not very much	Not at all	Don't know
☐	☐	☐	☐	☐

13 **Are there any other energy issues with your home that you would like to tell us about?**

Your Energy

IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

This section of the survey is about your energy use at home. We would like to know your views and concerns about your energy use and costs. Your answers will help us to better understand your energy use and how you could save money on your energy bills.

14 How do you pay for your electricity?

- Direct debit ☐
- Payment on receipt of bill ☐
- Pre-payment (keycard, slot or token) meters ☐
- Included in rent ☐
- Direct from benefits ☐
- Other (please specify) ☐

15 How do you pay for your gas?

- Direct debit ☐
- Payment on receipt of bill ☐
- Pre-payment (keycard, slot or token) meters ☐
- Included in rent ☐
- Direct from benefits ☐
- Not applicable: No gas ☐
- Other (please specify) ☐

16 Have you ever changed your energy supplier?

Yes ☐ No ☐

17 Have you ever compared energy prices using a comparison website?

Yes ☐ No ☐

18 How easy or difficult is it for you to afford your energy bills?

Very easy	Fairly easy	Neither easy nor difficult	Fairly difficult	Very difficult	Don't know
☐	☐	☐	☐	☐	☐

19 How much do you agree or disagree with these statements? (Tick one answer for each statement)

	Strongly agree	Tend to agree	Neither agree nor disagree	Tend to disagree	Strongly disagree	Don't know
I don't understand how my home uses energy	☐	☐	☐	☐	☐	☐
I am worried about my energy bills	☐	☐	☐	☐	☐	☐
I often think about how I could save energy	☐	☐	☐	☐	☐	☐
I have control over how much energy is consumed in my home	☐	☐	☐	☐	☐	☐
I am not able to save any more energy	☐	☐	☐	☐	☐	☐
I am prepared to save energy with the right support	☐	☐	☐	☐	☐	☐

	Strongly agree	Tend to agree	Neither agree nor disagree	Tend to disagree	Strongly disagree	Don't know
My friends and family say it's important to save energy	☐	☐	☐	☐	☐	☐
I don't trust my energy supplier	☐	☐	☐	☐	☐	☐
I can easily imagine how much energy my home uses	☐	☐	☐	☐	☐	☐

20 **How often do you take the following actions? (Tick one answer for each statement)**

	Always	Often	Sometimes	Very occasionally	Never	Not applicable
I make sure that the curtains/ blinds are closed when the heating is on in the evening	☐	☐	☐	☐	☐	☐
I make sure that the curtains are open when the sun is shining in winter	☐	☐	☐	☐	☐	☐
I make sure that the windows are closed when the heating is on	☐	☐	☐	☐	☐	☐
I change the temperature on my thermostat	☐	☐	☐	☐	☐	☐
I adjust the temperature on my radiators	☐	☐	☐	☐	☐	☐
I try to minimise my shower time to 5 minutes	☐	☐	☐	☐	☐	☐
I make sure that no appliances are left on standby	☐	☐	☐	☐	☐	☐
I make sure that chargers are unplugged when not in use	☐	☐	☐	☐	☐	☐
I shut down my computer when it is not in use	☐	☐	☐	☐	☐	☐
I only boil the water I need in the kettle	☐	☐	☐	☐	☐	☐
I make sure that I use the right sized hob ring for each pan when cooking	☐	☐	☐	☐	☐	☐
I make sure that the fridge and freezer doors are not open for longer than necessary	☐	☐	☐	☐	☐	☐
When no one is at home the heating is off	☐	☐	☐	☐	☐	☐
When I am the last to leave a room I turn the lights off	☐	☐	☐	☐	☐	☐
I wear very warm clothes in winter so I can keep the heating on low or off	☐	☐	☐	☐	☐	☐
When I buy a new appliance I look carefully at the energy labels	☐	☐	☐	☐	☐	☐
I turn off the heating in rooms that are not normally used	☐	☐	☐	☐	☐	☐
I close the doors between rooms	☐	☐	☐	☐	☐	☐
I only use my washing machine when I have a full load of washing	☐	☐	☐	☐	☐	☐

	Always	Often	Sometimes	Very occasionally	Never	Not applicable
When I am the last to leave a room I turn off the appliances that are on	☐	☐	☐	☐	☐	☐
I only use my dishwasher when it is full	☐	☐	☐	☐	☐	☐
I use energy saving modes on my appliances	☐	☐	☐	☐	☐	☐
I tell other people to do things that save energy	☐	☐	☐	☐	☐	☐

21 **At what temperature do you normally set your thermostat to during the winter? (For example 21°C)**

°C Don't know ☐ Not applicable ☐

22 **At what level do you normally set your living room radiator to during the winter? (For example 3)**

Don't know ☐ Not applicable ☐

23 **At what level do you normally set your main bedroom radiator to during the winter? (For example 3)**

Don't know ☐ Not applicable ☐

24 **When do you normally have your heating on during a typical winter week day (Monday to Friday)? Use 24 hour clock (For example: ON 07:00, OFF 08:00, ON 18:00, OFF: 22:00)**

ON	OFF	ON	OFF	ON	OFF

All day ☐

25 **When do you normally have your heating on during a typical winter weekend day (Saturday and Sunday)? Use 24 hour clock (For example: ON 07:00, OFF 08:00, ON 18:00, OFF: 22:00)**

ON	OFF	ON	OFF	ON	OFF

All day ☐ Same as weekday ☐

26 **Generally speaking, during winter when heating needs are greatest, at which of these times are you or someone else in your household regularly at home? (Tick all that apply)**

All day/all the time ☐
Weekday morning (9am-12pm) ☐
Weekday lunchtime (12pm-2pm) ☐
Weekday afternoon (2pm-5pm) ☐
Weekday evenings (after 5pm) ☐
Weekend daytimes ☐
Weekend evenings ☐
Highly variable ☐
Don't know ☐

27 **Is there anything else about your energy use at home that you would like to tell us?**

Your Connections

dch

IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

This section of the survey is to understand if you already have access to the Internet, and if not, whether you would like to. We are also interested in which digital devices you might already use and if you are a member of any social networks. Your answers will help us to understand whether you are already an experienced user of the Internet and other digital devices or if you may need some further help.

28 **Do you have regular access to the Internet?**

Yes, at home	Yes, elsewhere, e.g. at the Library	No, but I would like to	No, not interested
☐	☐	☐	☐

29 **What types of Internet connection do you or any other members of your household have at home? (Tick all that apply)**

Wireless broadband	☐	Don't know	☐
Wired broadband	☐	Other (please specify below)	☐
Mobile 3G	☐	Not applicable	☐
Mobile 4G	☐		

30 **When you are on the Internet, on average how long do you spend during a single session?**

Hours	Minutes	Not applicable
		☐

31 **On average, how much time do you and any other members of your household spend on the Internet each day?**

Hours	Minutes	Don't know	Not applicable
		☐	☐

32 **How often do you and any other members of your household use the Internet?**

Several times a day	☐	Less than once a month	☐
Once a day	☐	Never	☐
Several times a week	☐	Don't know	☐
Several times a month	☐		

33 **What devices do you or any other members of your household use to access the Internet at home? (Tick all that apply)**

PC	☐	TV	☐
Laptop	☐	Video games console	☐
Smartphone	☐	Other (please specify below)	☐
Tablet	☐	Not applicable	☐

34 **Which of these brands of smartphone do you or any other members of your household own? (Tick all that apply)**

Apple	☐	Samsung	☐
HTC	☐	Sony	☐
Windows	☐	Other (please specify below)	☐
Blackberry	☐	Don't know	☐
Nokia	☐	None	☐

35 **Which of these brands of tablet do you or any other members of your household own? (Tick all that apply)**

Apple	☐	Sony	☐
Google	☐	Other (please specify below)	☐
Microsoft	☐	Don't know	☐
Amazon	☐	None	☐
Samsung	☐		

36 **Which of these video games consoles do you or any other members of your household own? (Tick all that apply)**

Microsoft Xbox 360	☐	Nintendo Wii	☐
Microsoft Xbox One	☐	Nintendo Wii U	☐
Sony Playstation 4	☐	Other (please specify below)	☐
Sony Playstation 3	☐	Don't know	☐
Sony Playstation Vita	☐	None	☐
Nintendo 3DS	☐		

37 **Do you or any other members of your household play games (e.g. on computers, smartphones, tablets, video games consoles, etc.)?**

Yes	No	
☐	☐	If you answered "No", go to Question 49.

38 **On which devices do you or any other members of your household play games? (Tick all that apply)**

Computer	Smartphone	Tablet	Video games console	Other (please specify below)
☐	☐	☐	☐	☐

39 **How often do you and any other members of your household play games?**

Several times a day	Once a day	Several times a week	Several times a month	Less than once a month	Don't know
☐	☐	☐	☐	☐	☐

40 **When playing a game, how long on average do you play?**

Hours	Minutes	Not applicable
		☐

41 **On average, how much time do you and any other members of your household spend playing games each day?**

Hours	Minutes	Don't know
		☐

42 **Where do you or any other members of your household play games? (Tick all that apply)**

At home	☐
At friends' and family's homes	☐
During short journeys by car, train, bus etc.	☐
During long journeys by car, train, bus etc.	☐
Outside	☐
Other (please specify below)	☐

43 **How often do you and any other members of your household play games with other people (family, friends, online)?**

Everyday	Several times a week	Several times a month	Several times a year	Never	Don't know
☐	☐	☐	☐	☐	☐

44 **Have you or any other members of your household ever played a serious game (educational games, games for health, games for training, etc.)?**

Yes (please specify below)	No	Don't know
☐	☐	☐

45 **Do you or any other members of your household use social networks to play games? (Tick all that apply)**

Yes, alone	Yes, with friends	Yes, with family	No	Don't know
☐	☐	☐	☐	☐

46 **Which of the following integrated gaming social networks do you or any other members of your household use? (Tick all that apply)**

Facebook Mobile for games	☐	Other (please specify below)	☐
Game Center (iOS)	☐	None	☐
Google Play Games (Android)	☐	Don't know	☐

47 **What are your or any other members of your households favourite games?**

1.	2.	3.	Don't know
			☐

48 **What are the three last games played in your house?**

1.	2.	3.	Don't know
			☐

49 **Do you or any other members of your household have an account on the following social networks? (Tick all that apply)**

Facebook	Twitter	Google+	Instagram	Other (please specify below)	Don't know	None
☐	☐	☐	☐	☐	☐	☐

If you answered "Don't know" or "None", go to Question 52.

50 **How often do you and any other members of your household use social networks?**

Several times a day	Once a day	Several times a week	Several times a month	Less than once a month	Don't know
☐	☐	☐	☐	☐	☐

51 **On average, how much time do you and any other members of your household spend on social networks each day?**

Hours	Minutes	Don't know
		☐

52 **How much do you agree or disagree with these statements? (Tick one answer for each statement)**

	Strongly agree	Tend to agree	Neither agree nor disagree	Tend to disagree	Strongly disagree	Not Applicable
I feel confident using a computer	☐	☐	☐	☐	☐	☐
I feel confident using the Internet	☐	☐	☐	☐	☐	☐

53 **Thinking about the design of a game to help households save energy, what would it have to include to make you want to play it?**

You and Your Household

IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

This section of the survey is to gather some basic information about you and other members of your household. This will help us to better understand the responses you have given in the survey so far.

54 **How old are you?**

Age	Prefer not to answer
	☐

55 **I am...**

Male	Female	Prefer not to answer
☐	☐	☐

56 **Who is living with you?**

	Adult (over 18 years)	Child (16-18 years)	Child (Under 16 years)	Male	Female
Person 1	☐	☐	☐	☐	☐
Person 2	☐	☐	☐	☐	☐
Person 3	☐	☐	☐	☐	☐
Person 4	☐	☐	☐	☐	☐
Person 5	☐	☐	☐	☐	☐

57 **What is your employment status?**

Employed	☐	Retired	☐
Unemployed	☐	Other (Please specify below)	☐
Seeking work	☐	Prefer not to answer	☐
Student	☐		

58 **How many people in your household are... (Insert number)**

Employed		Retired	
Unemployed		Other	
Seeking work		Prefer not to answer	
Student			

59 **Do you have any educational qualifications for which you received a certificate?**

Yes	No	Prefer not to answer
☐	☐	☐

60 **Do you have any professional, vocational or other work-related qualifications for which you received a certificate?**

Yes	No	Prefer not to answer
☐	☐	☐

61 **What is your highest qualification?**

O'level, GCSE, NVQ level 2 or equivalent	☐	Another kind of qualification	☐
A'Level, NVQ level 3 or equivalent	☐	Not applicable	☐
Degree level (e.g., BA, BSc) or above	☐	Prefer not to answer	☐

62 **Are you or other members of your household in receipt of welfare benefits, such as unemployment allowance, housing benefit?**

Yes	No	Prefer not to answer
☐	☐	☐

63 **How was your health in general in the last 12 months?**

Very good	Good	Fair	Bad	Very bad	Prefer not to answer
☐	☐	☐	☐	☐	☐

64 **How many times have you visited your GP surgery in the last 12 months?**

	Prefer not to answer
	☐

65 **Overall, how satisfied are you with life nowadays?**

0 Not at all satisfied	1	2	3	4	5	6	7	8	9	10 Completely satisfied
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

66 **Do you or other members of your household consider themselves to have a disability?**

Yes, I do	Yes, another member of the household	No	Prefer not to answer
☐	☐	☐	☐

67 **Is there anything else about your household that you would like to tell us?**

123456789

Future Activities

EnerGAware is a three year project that will involve a range of activities, from discussion groups, to learning about your home energy use and even designing and testing a computer game to help people save energy at home! You can get involved in as many or as few activities as you wish.

IN PARTNERSHIP WITH PLYMOUTH UNIVERSITY

There will also be many more opportunities to win prizes throughout the project, including family days out in Plymouth, Love2Shop vouchers, and tablets with Internet connections.

Are you interested in taking part in future activities?

Yes	No
☐	☐

If you would like to get involved in the project, please tell us how we can contact you. This page will be separated from your answers immediately when we receive it.

Telephone: _____

Mobile: _____

Email: _____

Thank you for completing the survey! Your support is vital to the success of the project. Sharing your views and experiences will make a difference.

The information you provide will be treated in strict confidence and held securely by DCH. Data given to Plymouth University will not contain your name or contact details unless you give your explicit permission as part of joining the project. No one will be identified in the results of the project. Your personal details will not be passed to other people or organisations. The project will be carried out in accordance with the Data Protection Act. Both DCH and Plymouth University have strict ethics procedures to control how the project is carried out and used.

Appendix D. EnerGAware Social Housing Survey Reminder Letter

<First> <Surname>
<Address1>
<Address2>
<Address3>
<PostCode>

29th May 2015

Dear <Title> <Surname>

We recently sent you a survey asking about your energy use at home, whether you are connected to the Internet and what digital devices you use. This is the first activity of a programme of activities which form part of the EnerGAware project. So far, we have had a great response, which is very encouraging as this is the first time that we have sent such a large survey to our residents.

If you have not returned your survey yet, it is not too late to do so and it would be wonderful if you could help us reach our target of a 100% response. We have also extended the deadline for the prize draw until the **25th June 2015** to make sure as many people as possible can be in with a chance to win. **There are ten prizes to be won, including family days out at Plymouth Aquarium and £50 Love2Shop Vouchers.**

The survey is quite straight forward and should take less than fifteen minutes to complete. Simply fill in the survey we sent you and return it in the pre-paid envelope provided as soon as you can. You can also choose to complete the survey online at **www.research.net/s/energaware2015**

If you have already returned your survey, thank you for taking the time to complete it and please ignore this letter. Should you have any questions, please contact us by telephone on 0300 123 8080 or by email at environment@dchgroup.com.

Thank you in anticipation. Your support is vital to the success of the project.

Yours sincerely

DCH Safety, Health and Environment Team

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