ICE PROJECT DELIVERABLE T5.1.1

COMSUMER ENGAGEMENT AT THE UEA

DECEMBER 2021

Phedeas Stephanides, Gina Kallis, Ian Bailey, Xin Li, Alexis Ioannidis, Fiona Lettice, Gwendal Vonk, Hélène Vente, Konstantinos J. Chalvatzis

About ICE

Supported by the Interreg VA France (Channel) England programme, the Intelligent Community Energy (ICE) project aims to further develop understanding as well as apply innovative and intelligent energy solutions for isolated areas in the Channel region. The surrounding islands and territories are confronted with specific energy challenges. Many islands are not connected to the European electricity grid and rely on imported fossil fuels, notably fuel-powered heat generators. The energy solutions they use tend to be less reliable, more costly and emit higher levels of greenhouse gases than the European continental grid.

In response to these issues, the ICE project considers the entire energy cycle, from production through to consumption, and integrates mature or new technologies so as to develop innovative energy solutions. These solutions will be trialled and tested on two pilot demonstration sites (the Island of Ushant and the University of East Anglia Campus), to prove their feasibility and to develop a general methodology which can be replicated on other isolated territories elsewhere. To transfer this methodology to other isolated territories, ICE is proposing a low-carbon commercial transition offer. This will include a complete assessment of resources and local energy conditions, a proposed bespoke energy transition model and a body of low-carbon skills and technologies available in a consortium of selected businesses. This ICE-certified consortium will promote the offer to other isolated territories both within and outside of the Channel region (initially 5 territories). The ICE partnership model brings together researchers and bodies providing support to SMEs and will be made up of members from both France and the UK in terms of skills, technological and commercial development.

The involvement of local and European SMEs will further boost competitivity and transnational cooperation.

ICE PROJECT DELIVERABLE T5.1.1

CONSUMER ENGAGEMENT AT THE UEA

DECEMBER 2021

Authors

Phedeas Stephanides [a]

Gina Kallis [b]

Ian Bailey [b]

Xin Li [a]

Alexis Ioannidis [a]

Fiona Lettice [a]

Gwendal Vonk [c]

Hélène Vente [c]

Konstantinos J. Chalvatzis [a]

[a] Norwich Business School, University of East Anglia, Norwich, NR4 7TJ, UK

[b] School of Geography, Earth and Environmental Sciences, University of Plymouth, B420, Portland Square, Drake Circus, PL4 8AA, UK

[d] Syndicat Départemental d'Énergie et d'Équipement du Finistère (SDEF), 9 All. Sully, 29000 Quimper, France

Corresponding Author:

Professor Konstantinos J. Chalvatzis

Norwich Business School, University of East Anglia, Norwich, NR4 7TJ, UK

Email: k.chalvatzis@uea.ac.uk

Tel.: +44 (0)1603 59 7241

Recommended Citation Format:

Stephanides, P., Kallis, G., Bailey, I., Li, X., Ioannidis, A., Lettice, F., Vonk, G., Vente, H., Chalvatzis, K. J. 2021. Consumer Engagement at the UEA. (ICE report T5.1.1), Intelligent Community Energy. https://www.ice-interreg.eu/public-deliverables

ICE DELIVERABLE T5.1.1:

Consumer engagement at the UEA

Executive Summary

In recent years, Higher Education Institutions (HEIs) such as the UEA have placed an increasing emphasis on sustainability and pro-environmental behaviour change. Initial efforts focused mainly on physical and/or technological improvements to buildings, while more recent activities have placed a greater emphasis on the role of human values, attitudes and behaviours.

The growing emphasis on staff/ student engagement with sustainability means that systematic social science research on public engagement around UEA's sustainable transition is timely and necessary. Although there are well-publicised and ambitious consumer engagement initiatives, there remains a deficit of empirical evidence to support the claim that UEA's staff and students can engage meaningfully with the sustainability agenda. This report draws on survey, focus group, and longitudinal data from a Smart Living Lab introduced at the UEA to provide a critical overview of the role of UEA's community in sustainable energy transitions.

Key findings:

On the one hand, UEA's community manifests itself as particularly energy literate and, thus, supportive of a sustainable energy transition. Energy users have: (1) sufficient knowledge and understanding about energy, its use and impacts on environment and society (i.e. *cognitive literacy*); (2) appropriate attitudes and values, for example, on the existence of global issues and the significance of personal decisions and actions (i.e. *affective literacy*); and (3) appropriate intentions and behaviours, as exemplified by participation in a number of "green" initiatives, and by broader practical engagements with the sustainability agenda (i.e. *conative literacy*)..

On the other hand, this research uncovers multiple evidence of a persistent and widespread 'value-action gap' defined by the inability of individuals to adopt additional sustainable practices in light of multiple institutional and structural factors undermining people's actual capacity and willingness to take action. Amongst the most prevalent barriers to action identified is the lack of easily accessible information on energy use and financial incentives, which mean that the amount of energy individuals consume is largely unknown and unaccountable despite its use for a range of everyday activities.

Moreover, the study points to the immense challenges of properly and fully domesticating new "green" energy technologies in student residences at the UEA. Against a backdrop of claims that smart heating technologies can result in significant energy gains whilst enhancing comfort, four core themes emerge from our engagement with students residing on the UEA campus: (1) smart heating technologies are technically and socially disruptive; (2) smart homes require forms of adaptation and familiarization from students that can limit their use; (3) learning to use smart home technologies is a demanding and time-consuming task; and (4) there is little evidence that smart home technologies will generate any energy savings and, indeed, there is a risk that they may generate forms of energy intensification in the longer-term. In simpler terms, given the inherent complexity of adopting and 'taming' new technologies, the process of engaging with new technologies to make everyday practices and behaviours on the UEA campus more sustainable is far from straightforward and, thus, UEA's community might be further limited in its ability to act upon pro-environmental attitudes to actively support the decarbonisation agenda.

Implications for future practice:

1	***Reconsider focus on consumer communication***	Sustainability Communication Plans figure prominently in the envisioned decarbonisation pathways of HEIs such as the UEA, with awareness-raising work expected to encourage the behaviour changes needed to meet decarbonisation targets. Key findings from this research programme challenge, however, these understandings; pro-environmental attitudes might be widespread, but significant barriers to action persist. There is, instead, a pressing need for ongoing and focused engagement with UEA's community to identify key areas of intervention to remove some of the persistent institutional and structural/ technological barriers to action.
2	***Properly scrutinise the potential of smart technologies***	It is vital that the claim that smart energy technologies can improve the experience of their users whilst resulting in significant energy savings is properly scrutinised to avoid over-relying on them to achieve ambitious decarbonisation targets. The future design and development of smart energy technologies at the UEA – and beyond – needs to better account for energy users, their needs, lifestyles, priorities, and interests, as well as the different meanings invested in otherwise similar smart technologies.
3	***Place less emphasis on behaviour change***	Given the complexities of trying to develop new interactions between energy users and smart technologies, alternative pathways should be prioritised. Technological solutions that do not depend on active user engagement and successful domestication might provide for a more straightforward pathway towards decarbonisation. Energy efficiency improvements and upgrades of the existing building stock, replacement of old appliances with more efficient models, investment in micro-renewable technologies, and simple retrofits throughout are among the favoured alternatives as their success does not depend on energy users.
4	***Tap into existing pro-environmental behaviours***	Given the challenges of promoting the adoption of new pro-environmental behaviours and the usage of new technologies, significant focus should, instead, be placed on supporting already-existing pro-environmental behaviours. This could be achieved by either equipping staff and students with additional resources that would make existing behaviours more effective (e.g. in the form of targeted financial or other support), or by promoting and actively supporting communities-of-practice through which individuals will share their experiences or tacit know-how, will cooperate on collaborative projects, and will inspire commitment to act sustainably.
5	***Adopt new models of thinking***	The persistent 'value-action gap' uncovered through this research highlights the need to adopt new, whole-systems understandings that avoid the pitfalls of oversimplified models of behavioural change. Specifically, this involves focusing not only on individuals, their attitudes and behaviours, or on technologies. Rather, the focus should be on the complex inter-relations between energy users, technologies and institutional modes of governance (see Figure 1).

Novel paradigm for the governance of energy transitions:

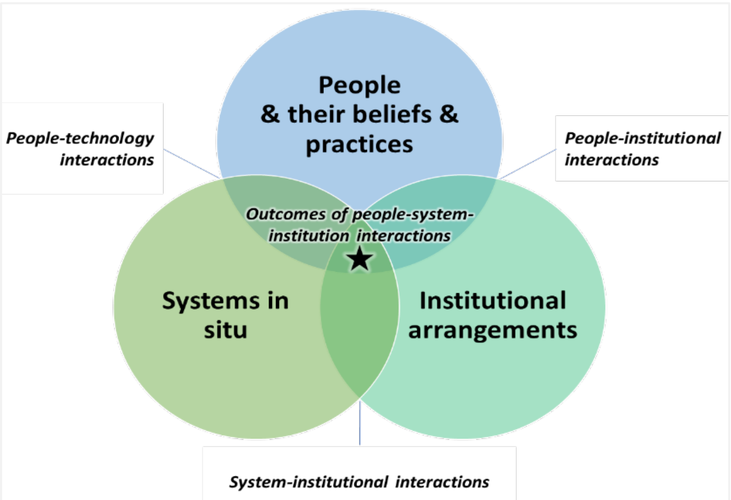

Figure 0.1: Novel model of thinking about the interactions between people, technologies & institutions

The research challenges the dominant *individualist* and *systemic* paradigms informing the governance of energy transitions. Alternative paradigms that recognize interactions between *systems*, *people*, and *institutions* are needed.

Practically, this involves: (1) more decision-making input from the UEA community to ensure the introduction of contextually appropriate technologies; and (2) in-depth explorations of how people, systems and institutional forms interact around specific activities, with the Living Lab methodology of the ICE project becoming a guiding model for future interventions.

Table of Contents

1. Introduction

Higher education institutions have become major consumers of resources such as energy, and their significance is further underlined by their influence on students as future business leaders, decision-makers and innovators (Marcell et al., 2004; Amutenya et al., 2009; Altan, 2010). With the recognition of their environmental impacts, many higher education institutions (HEIs) have attempted to promote pro-environmental behaviour among campus users (Lozano et al., 2013; 2015). In recent years, HEIs have placed an increasing emphasis on sustainability, prompted by rising energy costs, targets to reduce greenhouse gas emissions (Horhota et al., 2014), commitments to education for sustainability, and the impacts of student behaviours on the environment and society (Jones-White et al., 2010). In the UK, sustainability league tables and awards have contributed to this trend (Jones, 2017). For example, the People and Planet 'Green League' for environmental performance has grown in popularity since its implementation in 2005 and has encouraged universities to strive to become 'exemplary' organisations on sustainability issues (Ferrer-Balas et al., 2008; Winter and Cotton, 2012). Similarly in the USA, over 700 universities now participate in the American College and University Presidents' Climate Commitment by submitting greenhouse gas inventories and campus-wide climate action plans (Wisecup et al., 2017).

On a practical level, universities have worked in a variety of ways to integrate sustainable practices into their campuses and cultures. Initial efforts focused mainly on physical and/or technological improvements to buildings, while more recent activities have placed a greater emphasis on the role of human values, attitudes and behaviour, in particular, how to promote behavioural changes (Sovacool, 2014; Timm and Deal, 2016).

Indicatively, the UEA recognises its global impact and contributes to the United Nations Sustainable Development Goals through its work with the Aurora Universities Network and as a signatory to the SDG Accord. As a leader in environmental research and improving understanding and action on climate change and environmental sustainability challenges, the UEA has the ambition to extend its involvement in managing complex environmental problems. A climate and biodiversity emergency was declared in June 2019, and its corporate plan outlines the commitment to becoming an exemplar of good environmental practice in the HEI sector, as exemplified by the net-zero carbon emissions by 2045 target[1]. As part of its sustainable environmental management agenda[2], the UEA is working to:

---

[1] See, for example: https://www.uea.ac.uk/about/university-information/sustainability

[2] See, for example: https://www.uea.ac.uk/web/about/university-information/sustainability/strategy-policy-and-compliance

a) Integrate environmental management into its day-to-day operations by maintaining an Environmental Management System (EMS) certified to ISO 14001 for all operations on campus.
b) Comply with and, where possible and affordable, exceed all relevant environmental compliance obligations applicable to the University.
c) Minimise consumption of non-renewable energy and emissions of greenhouse gases.
d) Embed sustainability into teaching, learning and research.
e) Openly engage with University stakeholders by sharing knowledge and regularly publishing reports on environmental commitments, action and performance.
f) Motivate and empower staff, students, members of the local community and other stakeholders to support the ongoing development, implementation and evaluation of this policy.

Alongside infrastructural innovations, students and members of staff are envisioned as a key component of UEA's sustainability transition under the Sustainable Ways banner[3]:

a) The university is home to numerous green-minded student societies that contribute to the student collective of the sustainability network by running projects and campaigns to make UEA greener.
b) With Estates support, members of staff become part of an active Sustainability Champions network, which shares knowledge and best practice and provides a local focus for environmental and energy issues and help encourage friends and colleagues to make small changes to everyday practices that will collectively make a difference across the campus.
c) As part of the Green Impact initiative, staff teams take up challenges to win awards at the end of the year and improve the sustainability of their local area.

1.1. Report aims and objectives

The growing emphasis on staff/student engagement with sustainability and UEA's decarbonisation targets mean that systematic social science research on public participation in UEA's sustainable transition is timely and necessary. Although there are well-publicised and ambitious consumer engagement initiatives across UEA, there remains a deficit of empirical evidence to support the claim that UEA's staff and students can engage meaningfully with the sustainability agenda.

Instead of framing sustainable energy transitions as solely a question of finding the right energy mix and encouraging new energy technologies, the research undertaken in this report focuses on socio-technical understandings of energy transitions and the importance of society in delivering more sustainable energy systems. It explores the relationships between energy consumers and energy issues, and aims to shed light on

[3] See, for example: https://www.uea.ac.uk/web/about/university-information/sustainability/about-us

energy consumers, their views on sustainable energy behaviours and transitions, and the ways in which they engage with energy use, energy-related infrastructures, and innovative energy technologies. As part of the ICE project, this report provides a critical overview of the role of staff and students in sustainability transition processes. We focus especially on consumer attitudes and engagement with smart grid technologies. In doing so, we address two main research questions:

a) In what ways are members of staff and students across the UEA (i.e. not just individuals who are involved in sustainability initiatives) willing to support a sustainable energy transition?
b) How can members of the UEA community engage effectively with innovative smart grid technologies to make their everyday practices and behaviours more sustainable?

1.1 Events and activities informing this report

In addressing these research questions, this report draws on primary evidence collated through a series of events and other research activities organised as part of the ICE project:

Table 1.1: Project events and activities informing this report

	Event/ activity	Date(s)	People involved	Aims
1.	Questionnaire survey	September 2018 – May 2019	1480 students – staff members	To explore the energy-related attitudes, knowledge and behaviours of the UEA community.
2.	Series of student focus groups	February – November 2019	51 students (11 meetings)	To provide a more in-depth understanding of the above as well as insights to contextual constraints which influence energy-related behaviours.
3.	Public event introducing project and research activities	September 2019	75 students	To provide background information on the ICE project and research activities at the UEA - To raise awareness of the project and recruit interested participants
4.	Smart heating retrofit induction event	October 2019	40 first-year undergraduate students residing on the UEA Campus (University Village)	Information provision event designed to provide details around the research process and practical guidelines on the use of the smart heating technologies.
5.	Longitudinal studies of student engagement with smart heating controls	October 2019 – June 2020	20 first-year undergraduate students residing on the UEA Campus (University Village)	Research activities involving a series of focus groups, interactive workshops, interviews, energy diaries, and evaluation surveys.
6.	Distributed evaluation-feedback process	September – November 2021	Key stakeholders and energy experts, including, inter alia: members of UEA's Sustainability, Utilities and Engineering Department, students and staff participating in various sustainability initiatives and societies, and individuals involved in the smart heating trial	Inspired by participatory evaluation processes, informal evaluations of ICE project activities were encouraged over a period of several months using a variety of means. A diverse range of stakeholders from across the UEA were involved in this process to: (a) reflect on and evaluate key research outputs, and (b) consider the implication of this research vis-a-vis the ambitious decarbonisation targets of the UEA.

1.2 Report structure

This report is structured as follows:

1. Section 2 documents the findings from a large-scale questionnaire survey distributed across the UEA examining energy-related attitudes and behaviours that can both support and undermine a sustainable energy transition.
2. Section 3 focuses specifically on UEA's student body and explores findings from a series of focus groups conducted at UEA in February-November 2019 to explore the energy-related behaviours, attitudes and knowledge of students living in university halls of residence. In doing so, it uncovers multiple barriers to, and opportunities for, energy-saving on the UEA campus.
3. Section 4 draws on longitudinal data on student engagement with the smart heating technologies introduced in university halls of residence as part of the ICE project. This section provides more detailed insights into whether and how students bring new technologies into their existing routines and explores the processes and challenges of engaging with, and 'domesticating', such technologies.
4. The report concludes with reflections on the study's key findings on consumer engagement with sustainable energy at the UEA. In so doing, we also draw on data from a distributed evaluation process involving key stakeholders from across the University, and conclude by outlining the implications of the work for future research and practice.

References

Altan, H. (2010). Energy efficiency interventions in UK higher education institutions. *Energy Policy*, *38* (12): 7722-7731.

Amutenya, N., Shackleton, C. M., & Whittington-Jones, K. (2009). Paper recycling patterns and potential interventions in the education sector: A case study of paper streams at Rhodes University, South Africa. *Resources, Conservation and Recycling*, *53 (5)*: 237-242.

Ferrer-Balas, Didac & Adachi, Jun & Banas, S. & Davidson, C.I. & Hoshikoshi, A. & Mishra, Arabinda & Motodoa, Y. & Onga, M. & Ostwald, Madelene. (2008). An international comparative analysis of sustainability transformation across seven universities. *International Journal of Sustainability in Higher Education, 9*: 295-316. 10.1108/14676370810885907.

Horhota, M., Asman, J., Stratton, J. P., & Halfacre, A. C. (2014). Identifying behavioral barriers to campus sustainability: A multi-method approach. *International Journal of Sustainability in Higher Education*.

Jones, D. R. (2017). Opening up the Pandora's box of sustainability league tables of universities: a Kafkaesque perspective. *Studies in Higher Education*, *42* (3): 480-503.

Jones-White, D. R., Radcliffe, P. M., Huesman, R. L., & Kellogg, J. P. (2010). Redefining student success: Applying different multinomial regression techniques for the study of student graduation across institutions of higher education. *Research in Higher Education*, *51* (2): 154-174.

Lozano, R., Ceulemans, K., Alonso-Almeida, M., Huisingh, D., Lozano, F. J., Waas, T., ... & Hugé, J. (2015). A review of commitment and implementation of sustainable development in higher education: results from a worldwide survey. *Journal of cleaner production*, *108*: 1-18.

Lozano, R., Lukman, R., Lozano, F. J., Huisingh, D., & Lambrechts, W. (2013). Declarations for sustainability in higher education: becoming better leaders, through addressing the university system. *Journal of Cleaner Production*, *48*: 10-19.

Marcell, K., Agyeman, J., & Rappaport, A. (2004) Cooling the campus: experiences from a pilot study to reduce electricity use at Tufts University, USA, using social marketing methods, International *Journal of Sustainability in Higher Education*, 5 (2): 169-189.

Sovacool, B. K. (2014). What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. *Energy Research & Social Science*, *1*: 1-29.

Timm, S. N., & Deal, B. M. (2016). Effective or ephemeral? The role of energy information dashboards in changing occupant energy behaviors. *Energy Research & Social Science*, *19*: 11-20.

Winter, J., & Cotton, D. (2012). Making the hidden curriculum visible: sustainability literacy in higher education. *Environmental Education Research*, *18* (6): 783-796.

Wisecup, A. K., Grady, D., Roth, R. A., & Stephens, J. (2017). A comparative study of the efficacy of intervention strategies on student electricity use in campus residence halls. *International Journal of Sustainability in Higher Education*.

2. Energy-related attitudes and behaviours of UEA's staff and student community

2.1 Introduction

The role of civil society in energy systems and sustainable energy transitions is now widely acknowledged by policy makers, environmental practitioners and researchers. Attitudes and behavioural patterns are seen as playing an important role in reducing environmental pressures (Poortinga, Steg, and Vlek, 2004; Steg and Vlek, 2009; Steg et al., 2014). For the most part, social change is thought to depend upon the values and attitudes of individuals which are believed to drive the kinds of behaviour that individuals choose to adopt. This model of social change, derived from a strand of psychological literature grounded in theories of planned behaviour (Ajzen, 1991) and rational concepts of need (Gatersleben and Vlek, 1999), resonates with widely shared ideas about media influence and individual agency.

In line with the aforementioned understandings, research on the energy-related attitudes, knowledge and behaviours of university energy users has increasingly utilised the concept of energy literacy as a framework for assessing students' knowledge about energy, their attitudes towards energy conservation, and their intended and actual behaviours (Cotton et al., 2021). According to DeWaters and Powers (2011) and Cotton et al. (2015, p.457), energy literate students have:

a) Sufficient knowledge and understanding about energy, its use and impacts on environment and society (i.e. *cognitive literacy*);
b) Appropriate attitudes and values, for example, on the existence of global issues and the significance of personal decisions and actions (i.e. *affective literacy*); and
c) Appropriate intentions/behaviours, for example, to promote energy conservation, make thoughtful decisions and advocate change (i.e. *conative literacy*).

The relationship between environmental knowledge, attitudes, and behaviour is, however, complex, and uncertainty remains about the strength and direction of causal links between the three (Bamberg and Möser, 2007). A number of models have been developed to test the mediating influence of particular variables on the attitude-behaviour link, and to explore the conditions under which an attitude may impact upon behaviour (see, for instance, Bamberg and Moser (2007) and Barr (2007)). However, results have been mixed. For instance, Cleveland et al. (2005) argue that general environmental attitudes tend to be poor predictors of behaviour. In contrast, Chen and Chai (2010) concluded that individuals who had a positive attitude towards the environment were more likely to purchase and consume green products. In terms of the link between knowledge and behaviour, studies of university students (e.g. DeWaters and Powers, 2011) suggest that high levels of knowledge about sustainability do not necessarily lead to more sustainable behavioural choices, although a lack of knowledge may make it more difficult for individuals to select the most appropriate behaviour.

This research with university students shares an important feature with many other studies within and beyond university campuses – that of the 'gap' between attitudes, knowledge and action. People frequently express strong support for environmentally sustainable policies, but display limited commitment to altering their own behaviour. This 'value-action gap' has been defined by the Sustainable Development Commission (2006, p.63) as 'the observed disparity between people's reported concerns about key environmental, social, economic or ethical concerns and the lifestyle or purchasing decisions that they make in practice'.

The 'value-action gap' has been attributed to numerous contextual and other factors shaping human behaviours, with Darnton (2006; see also Darnton et al., 2006) observing in a systematic literature review that the 'value-action gap' approach must be supplemented by models which reflect the complexity and multiplicity of factors influencing pro-environmental behaviour. Indicatively:

a) Past research suggests that there are many types of 'environmentally significant behaviour' and causal factors, many of which are associated with different patterns of beliefs, norms and values. Stern (2000) refers to the 'Value-Belief-Norm Theory' and suggests that personal moral norms are an important basis for individuals' predisposition to pro-environmental action. However, he also acknowledges that personal habits and household routines, along with infrastructural constraints, may affect people's decisions. Stern's conclusion is that 'environmentally significant behaviour is dauntingly complex, both in its variety and in the cultural influences on it' (Stern, 2000, p.421).
b) Barr and Gilg (2006) examined the value-action gap among citizens adopting sustainable lifestyles (energy saving, waste recycling, water conservation, 'green' consumption). Their findings showed important differences not only between separate groups (committed environmentalists; mainstream environmentalists; occasional environmentalists; and non-environmentalists) but also in their level of commitment, which was affected by deeper social values. They also point out that people's preparedness to take environmental action is embedded in, and constrained by, their existing domestic lifestyle and everyday experience.

c) Poortinga et al. (2004) studied household domestic energy use and transport, and found that pro-environmental behaviour was associated more with socio-demographic variables (e.g., age, income, household size) than with attitudinal variables. Environmental behaviour, they argued, was determined by contextual factors rather than motivational factors alone. This links with the ABC framework – an account where social change is dependent on values and attitudes (A), which drive the kinds of behaviour (B) that individuals choose (C) to adopt (Shove, 2010). The policy version of the ABC discusses the 'C' as contextual factors (Stern, 2000), highlighting context as an 'external cause variable' which combines with other factors 'including habit, routine and personal capability' to encourage, enable or deter and constrain behaviours (Shove, 2020, p.1275).

d) Similarly, Blake (1999, p.275) notes that purely cognitive or social-psychological theories of decisions fail to take account of cultural, institutional and structural constraints on people's capacity and willingness to take action.

Summing up, the link between energy-related knowledge, attitudes and behaviour is complex and affected by a range of personal and contextual factors. The aim of this section is to help bridge gaps in current understandings of energy-related attitudes and behaviours in the context of a university campus. Building on research on the energy-related attitudes and knowledge of university students as predictors of energy-related behaviours, the section presents survey evidence that explores:

a) The energy-related attitudes and knowledge of the UEA community – including students and members of staff;
b) How these relate to energy-related behaviours; and
c) Contextual or other constraints that might influence energy-related behaviours and underpin a 'value-action gap'.

2.2 Survey research methodology

The online questionnaire survey was distributed among the UEA community from September 2018 until May 2019. It was publicised via a range of channels including, inter alia, School-specific and university wide mailing lists, newsletters, and daily bulletins, via social media, and via promotional posters and leaflets that were distributed across the UEA campus. During this period, a total of 1480 students and staff members completed the survey in full.

The survey contained 22 questions (most of which comprised of multiple question units) which aimed to explore both the energy-related attitudes, knowledge and behaviours of participants, as well as their experiences as energy users on the UEA campus. Questions consisted of a mix of Likert-type scale, closed- and open-ended questions (see Appendix A). Specifically:

a) A series of questions (see Questions 1.1, 1.2, 5.1, 5.2, 5.3, and 5.4) asked for demographic and basic background information about the research sample.
b) The next set of questions (see Section 2, Questions 2.1, 2.2) covered the energy-related behaviours and practices of participants at the UEA campus and aimed to build a profile of individuals as energy users.

c) Following these, a series of questions loosely incorporated the widely used New Ecological Paradigm (NEP) scale (Dunlap & van Liere, 1978), as well as some of our own, to investigate the potential pro-environmental and energy-related attitudes of participants (see Section 3, Question 3.1, 3.2, and 3.3).

d) The final set of questions (see Section 4, Questions 4.1-4.5) explored the energy experiences of individuals at the UEA campus, including their views on the UEA's management of its energy supply and any potential barriers to an efficient and fair energy system.

Responses were subsequently analysed using standard descriptive statistics methods. These helped in quantitatively describing and summarising key findings through a series of simple-to-understand graphs that subsequently informed a broader discussion around the ways, and the extent to which, members of staff and students across the UEA are capable of supporting a sustainable energy transition.

2.3 Overview of research sample

The survey was completed by both UEA students and staff members (see Figure 2.1). Both academic (19%) and admin/other staff members (30%) participated. Student participants included undergraduates living on campus (22%) and off campus (13%), as well as postgraduates living on campus (7%) and off campus (4%). This enabled views to be collected from those who live, study and work at the UEA.

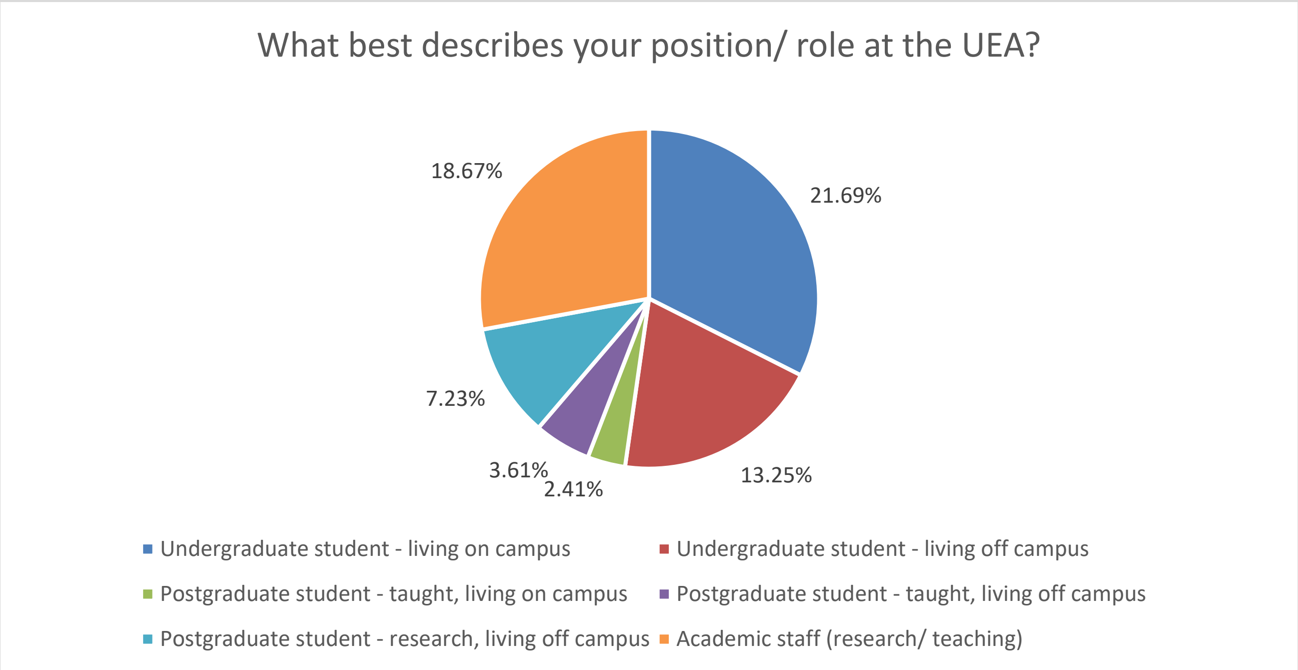

Figure 2.1: Overview of the positions/ roles of the research sample

The majority of respondents (62.50%) were female, 35% were male, 0.62% identified as non-binary, and 1.88% chose not to disclose any information on their gender.

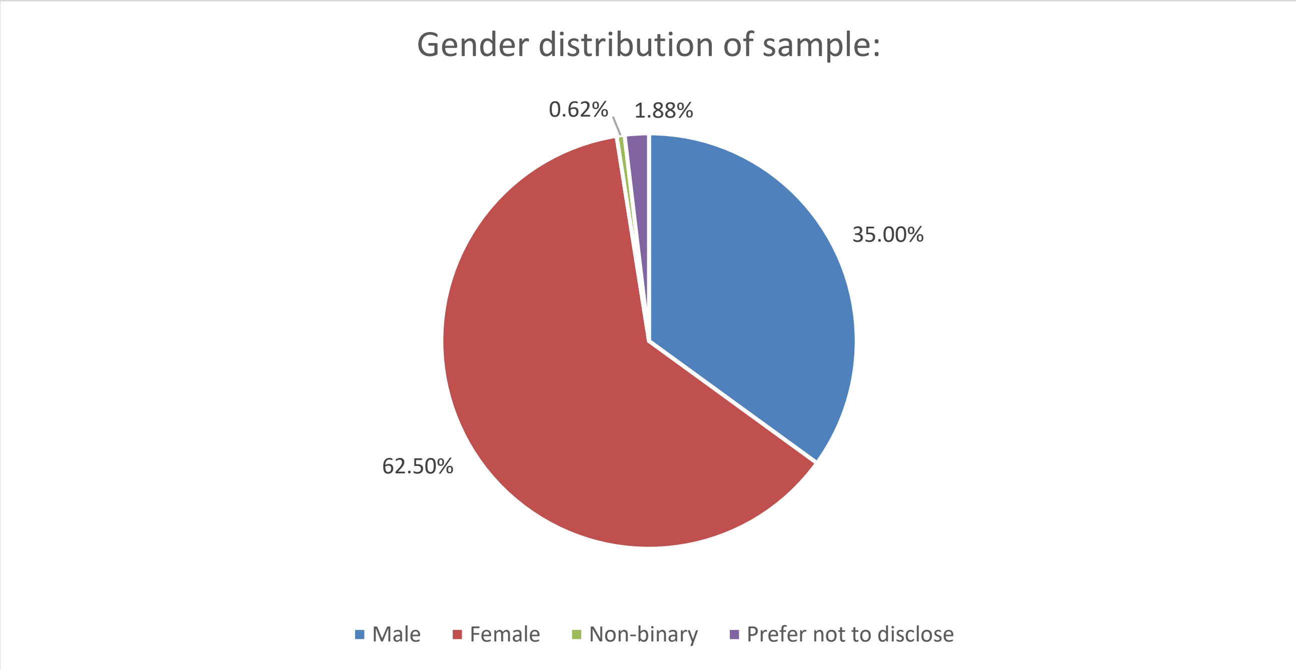

Figure 2.2: Overview of sample gender distribution

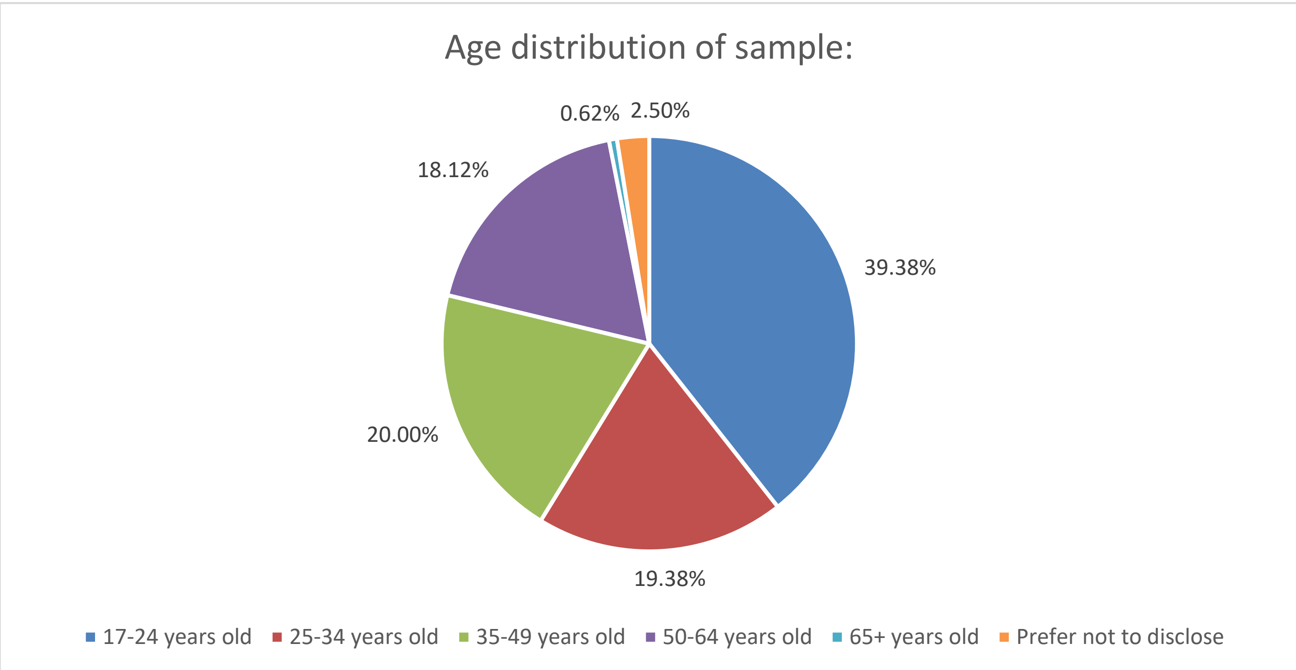

Figure 2.3: Overview of sample age distribution

There was a broad age distribution in the sample, representative of the UEA's total population (see Figure 2.3 above). The vast majority of participants, i.e. 39.38% of participants, were 17-24 years old. 19.38% of participants were between 25-34 year old, 20% between 35-49 years old, 18.12% between 50-64 years old, and 0.62% over 65 years old. An additional 2.5% chose not to provide any information on their age.

The vast majority (77.50%) of respondents identified as English, Welsh, Scottish, Northern Irish, or British, whilst all other ethnic groups, including the large Chinese and Japanese community of the UEA, were significantly under-represented in the survey sample (see Figure 2.4).

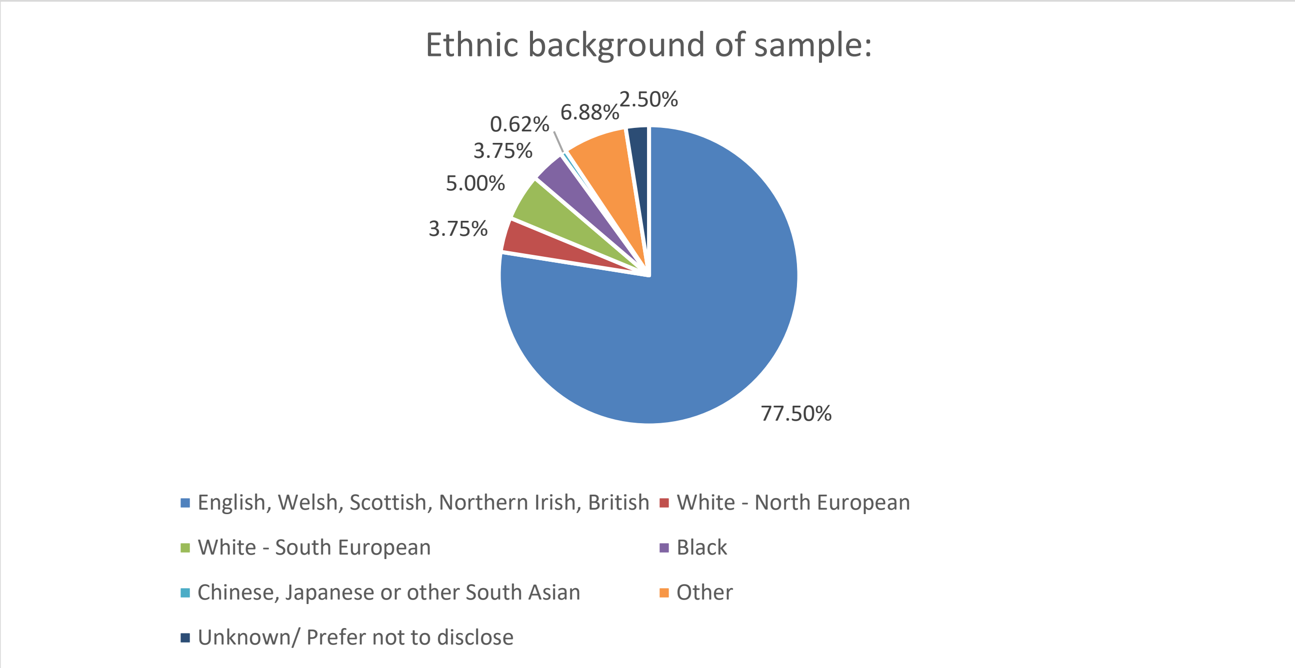

Figure 2.4: Ethnic background of sample

2.4 Findings

2.4.1 Overview of energy-related attitudes

Survey participants showed widespread environmental concern and eco-centric values, as well as acceptance that climate change is happening. Participants felt that action could be taken at the household level and there was also a sense of shared responsibility with scientists and institutions. Participants expressed high levels of willing to reduce their energy consumption, however; while they were taking action at the individual level, they felt they had limited influence over institutional action.

When asked about the importance individuals placed on environmental issues, results showed widespread environmental concern, with the majority of participants citing a range of environmental issues as either 'important' or 'very important' to them (see Figure 2.5). 59% of participants felt 'sustainability' was a 'very important' environmental issue and 47% said the same for 'energy efficiency/conservation'. Slightly higher levels of concern were shown for the issues of 'recycling/waste reduction' and the 'protection of wildlife'. 68% stated that recycling/waste reduction was very important and 63% said the same for wildlife protection. The focus on these environmental issues could be due to recent media attention placed on waste management and its impacts on wildlife, particularly following David Attenborough's 'Blue Planet II' documentary (see also Hynes et al., 2021). Less importance was placed on 'decarbonisation of the energy supply', with only 43% viewing this as a very important environmental issue. However, it is possible that not all participants fully understood the meaning or significance of this.

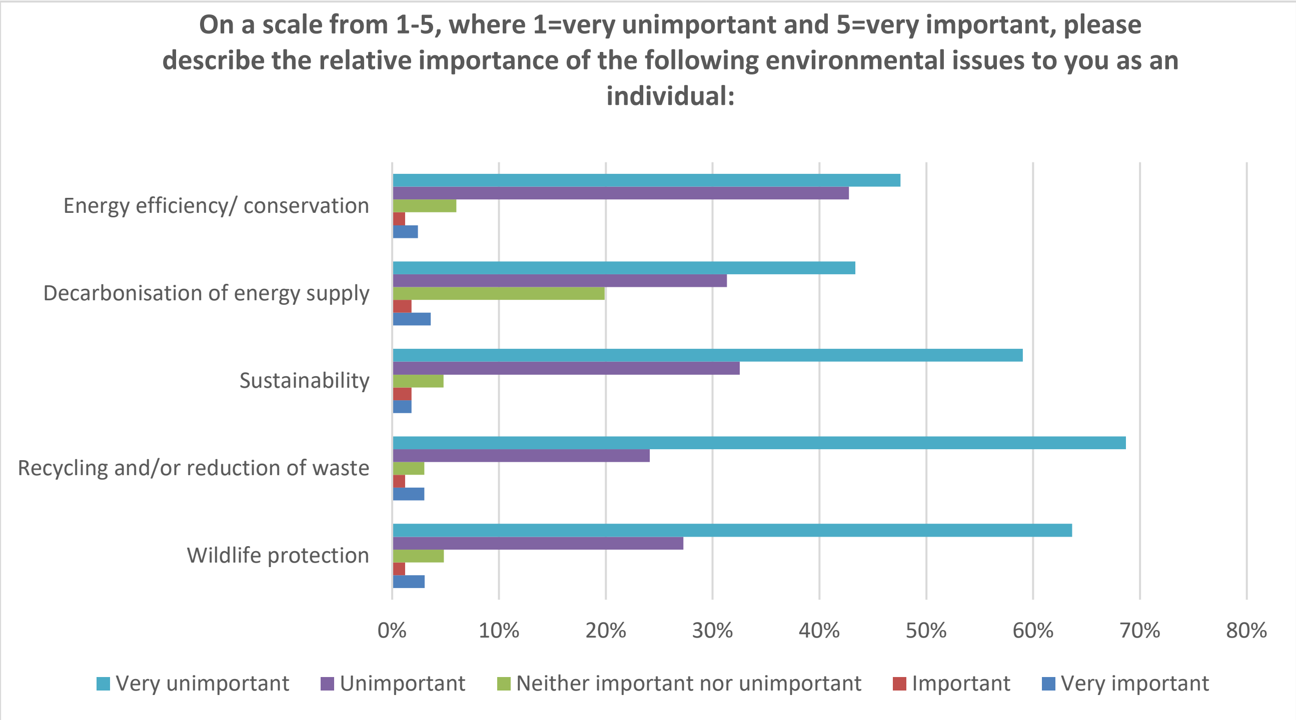

Figure 2.5: Responses to question on the importance placed on various environmental issues

Participants were then asked questions investigating whether they viewed climate change as a pressing issue and the extent to which they felt responsible for addressing the issue. Questions were informed by the New Environmental Paradigm (NEP) scale developed by Dunlap and van Liere in the 1970s (see Dunlap & van Liere, 1978), which attempts to measure the 'ecological consciousness' of individuals, although more recent research has shown that environmental attitudes are more complex than was originally supposed (Lalonde & Jackson, 2002).

Overall, there were high eco-centric values within the sample population (see Figure 2.6). 93% of participants agreed that 'climate change is caused by human activities' and 94% agreed that 'climate change requires immediate action'. This shows there was acceptance that climate change is occurring, that humans are largely responsible, and that immediate action needs to be taken (see Cotton *et al.* (2021) for similar findings among UK higher education students). In terms of locus of control – 'the extent to which participants felt that they could influence events around them' (Cotton et al., 2016a:889) – participants felt that action taken both at the household and the university level to conserve energy could be effective in reducing energy consumption and emissions. 92% of participants disagreed with the statement 'a private household cannot do much to conserve energy' and 89% disagreed that 'the UEA cannot do much to help address the national energy situation'. As with other studies, a fairly large proportion of the sample expressed faith in the ability of scientific/technological innovation to provide solutions to energy-related problems (Cotton et al., 2016a; 2021). Approximately 50% of participants agreed that science/technology will solve challenges related to climate change and energy consumption. These findings demonstrate that participants felt a sense of shared responsibility with scientists and institutions (see also Cotton et al., 2021). Interestingly, only 6% of respondents felt that high levels of energy consumption were required to achieve comfort and wellbeing. As the next question illustrates, this suggests that participants felt they could reduce their consumption levels without hampering their levels of comfort and wellbeing.

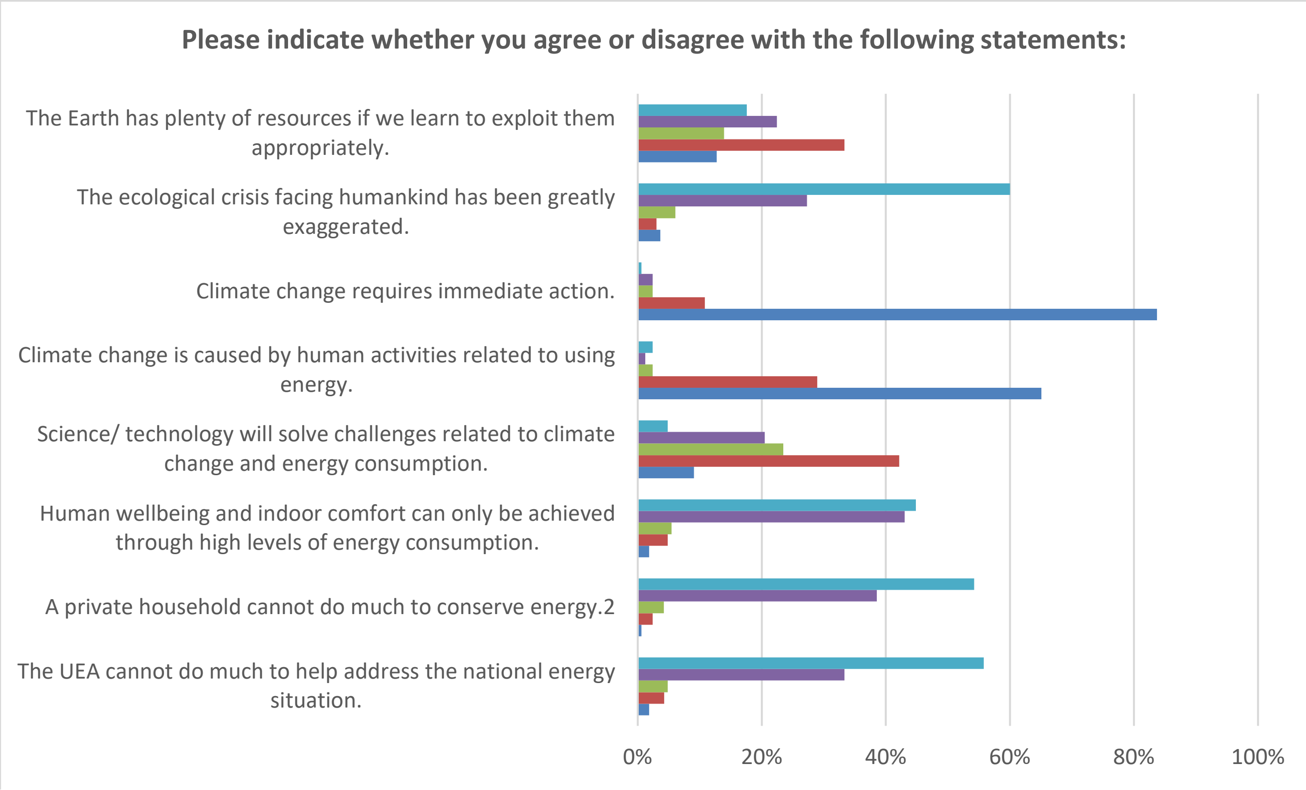

Figure 2.6: Responses to question on views around the extent of climate change as an environmental challenge and locus of control

Building on the previous questions, participants were then asked about their ability and willingness to reduce their energy consumption both at the personal and the institutional level. Respondents expressed high levels of willingness to reduce their energy consumption (see Figure 2.7). 91% stated they were willing to reduce their energy consumption to help the UEA meet its emission reduction targets and 58% stated they were already taking steps to do so (see following section). There was also general support for the argument that efficient energy use is simple, convenient, and does not negatively impact personal wellbeing and comfort. This does contrast with some focus group findings, however, where some individuals felt that restrictions on energy consumption could affect personal wellbeing (see Section 3.4.5). These findings, combined with those from the previous question, indicate that individuals do not require persuading that climate change is occurring and that humans must take action to prevent it. As the following sections show, the main priorities are now to provide appropriate infrastructures and information to encourage and enable individuals to behave more sustainably.

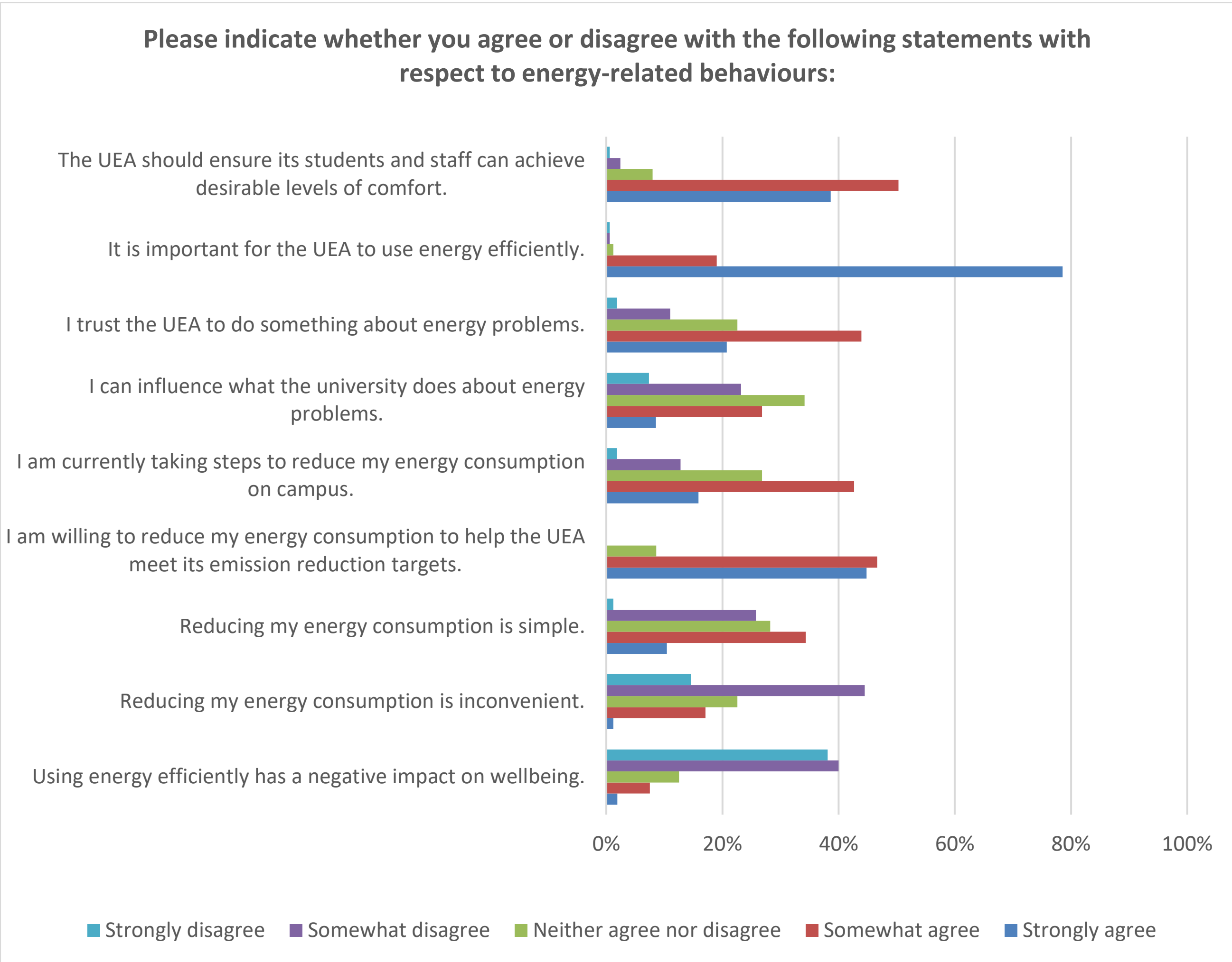

Figure 2.7: Responses to questions on personal and institutional responsibility to tackle sustainability challenges

Looking at institutional responsibility, 97% of participants felt it was important for the UEA to use energy efficiently, with 64% trusting the university to do this (see Figure 2.7). Responses were more mixed on personal influence and the ability of individuals to influence institutional action. Only 35% of participants agreed that they can influence what the university does about energy problems. In their research on sphere of influence, Cotton et al. (2016b) found individuals could take action at the individual level by adjusting their personal behaviours, i.e. by adopting 'curtailment behaviours' like turning off the lights, or 'investment behaviours' such as buying energy-efficient technologies. They also identified a third kind of activity – 'democratic or collaborative behaviour' – where groups and individuals utilise their agency to influence change through government and other institutions. Their research found that university students in other European countries were more focused on utilising their collective agency to influence what government and companies do about energy problems, while UK university students were more focused on individual agency and their ability to achieve change through their personal behaviours. Similarly, participants in the current study felt able to make individual behavioural changes, but the majority felt they had less ability to influence decisions at the institutional level.

2.4.2 Overview of energy-related behaviours and practices

The majority of participants described themselves as 'average' energy users overall. Most participants claimed to undertake energy-saving activities on most days of the week, with switching off the lights when not in use being the most commonly cited energy-saving behaviour.

Participants were asked to rate their personal energy consumption on the UEA campus (see Figure 2.8). 53% of participants described themselves as 'average' energy users overall. The majority described themselves as 'average' or 'low' energy users across a number of different energy-related activities. Slightly higher numbers described themselves as 'low' or 'very low' users of energy for space heating/cooling, hot water, cooking/refrigerating and laundering. While it is unlikely that many participants had access to air conditioning units for space cooling, many still classed themselves as 'low' energy users for this category despite likely having the option for heating. The results suggest that participants attempted to avoid using/did not feel the need to use heating too frequently. Alternatively, they may have been unable to control heating in campus buildings and one could surmise that individuals rated themselves as 'low' users of hot water as they felt they did not take long hot showers or use large amounts of hot water for washing dishes. It is also possible that they did not cook or do laundry frequently (see later discussion on laundering on campus).

Perhaps surprisingly, 35% of participants described themselves as 'very low' users of energy for entertainment. In contrast, 47% of participants described themselves as 'high' or 'moderately high' users of energy for computing. It is possible that individuals used personal laptops for entertainment and included this in the computing category. Beyond entertainment, computers and laptops are integrated into the daily lives of both students and staff in modern university contexts and the majority rely on these devices for work and assignments and to organise daily life (Anshari, 2017; Bodford et al., 2017). It is not clear, however, whether participant understanding of energy consumption was strong enough for them to make accurate judgements about their personal use (see also Cotton et al., 2015).

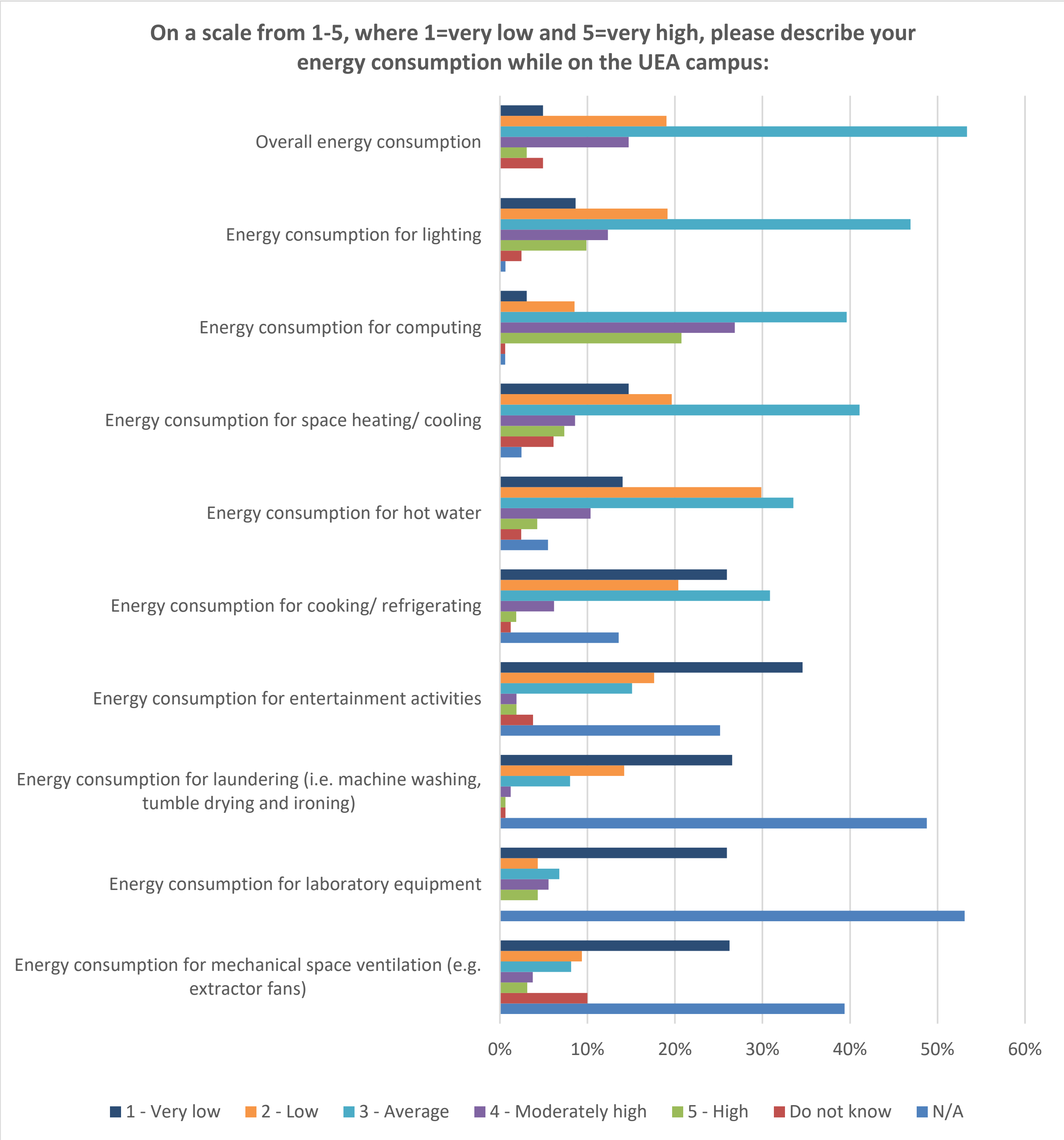

Figure 2.8: Responses to questions on personal energy consumption while on the UEA campus

Participants were asked about their involvement in a range of energy-saving activities related to lighting, heating, hot water and device usage (see Figure 2.9).

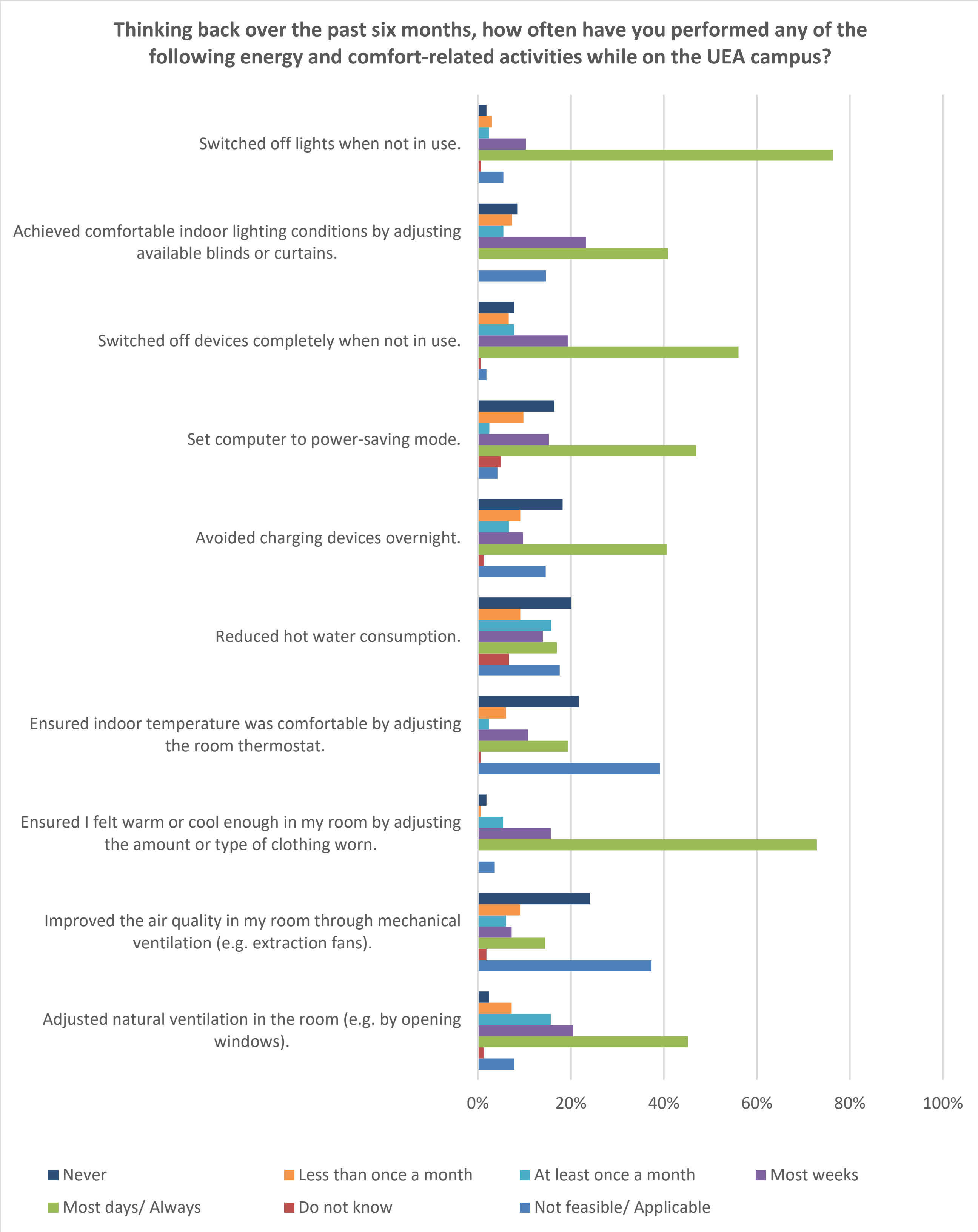

Figure 2.9: Responses to questions on participation in energy-saving behaviours while on the UEA campus

When asked about participation in energy-saving activities (see Figure 2.9), most participants claimed to undertake these on most days of the week and 58% of participants either somewhat or strongly agreed with the statement ‘I am currently taking steps to reduce my energy consumption on campus.’ Switching off the lights when not in use was the most commonly cited behaviour, with 78% of participants claiming to do this on most days/always. This finding correlates with research in the US (see Attari et al., 2010 and Lundberg et al., 2019), where participants preferred turning off the lights to many other environmental actions because it was convenient and something they had been taught to do when growing up. The second highest ranking activity was adjusting clothing to reach a comfortable temperature (72% did this most days/always), followed by switching off devices completely when not in use (56% did this most days/always). Again, these are routine actions which are likely to have become embedded behaviours over time and something participants do without thinking as part of their everyday routines.

Participants were less likely to reduce hot water consumption; however, as the majority of participants claimed to be very low to average users of hot water, it is possible they felt they could not reduce this further. Alternatively, it could indicate a hygiene effect, whereby hot water usage is an aspect of a ‘home system of practice’ (Eon et al., 2019) that people view as too important to personal wellbeing and social acceptance to compromise.

When asked about comfort-related activities, 21% of participants claimed they never adjusted thermostats to ensure indoor temperatures were comfortable, while 24% claimed they never used mechanical ventilation to improve indoor air quality. Individuals would not have had access to these functions in all buildings on campus, however, so they would have been relatively ‘locked-in’ to certain thermal comfort behaviours and conditions.

2.4.3 Identified opportunities for sustainable energy behaviours

The majority of participants trusted the UEA to manage energy problems and expressed their support for the university’s sustainability targets. There were also high levels of involvement in sustainability groups and initiatives. However, there did appear to be a need for improved communication on the UEA’s energy targets and policies.

Research has shown that the wider higher education environment offers many opportunities for connecting and enhancing the cognitive, affective and conative dimensions of energy literacy (Cotton et al., 2015). The UEA has a suite of policies, targets and plans to reduce energy use and, generally, participants expressed trust in the university’s sustainability leadership and commitment (see Figure 2.10). Around 65% said that they trusted the UEA to manage energy problems. The majority of participants also expressed their support for the university’s sustainability targets, with over 50% of survey respondents agreeing that they felt satisfied with the UEA’s targets to reduce energy and carbon usage. However, over 30% of respondents 'neither agreed nor disagreed' with these statements on the UEA's sustainability targets, which could point to a lack of knowledge/awareness of the targets that have been adopted. This supports previous research which suggests that opportunities for sustainability learning are often over-looked in university campuses and energy-saving initiatives go unseen (Cotton et al., 2015). Cotton et al. (2015) emphasise that clear and consistent messaging and action in this area is vital in promoting energy literacy on campus.

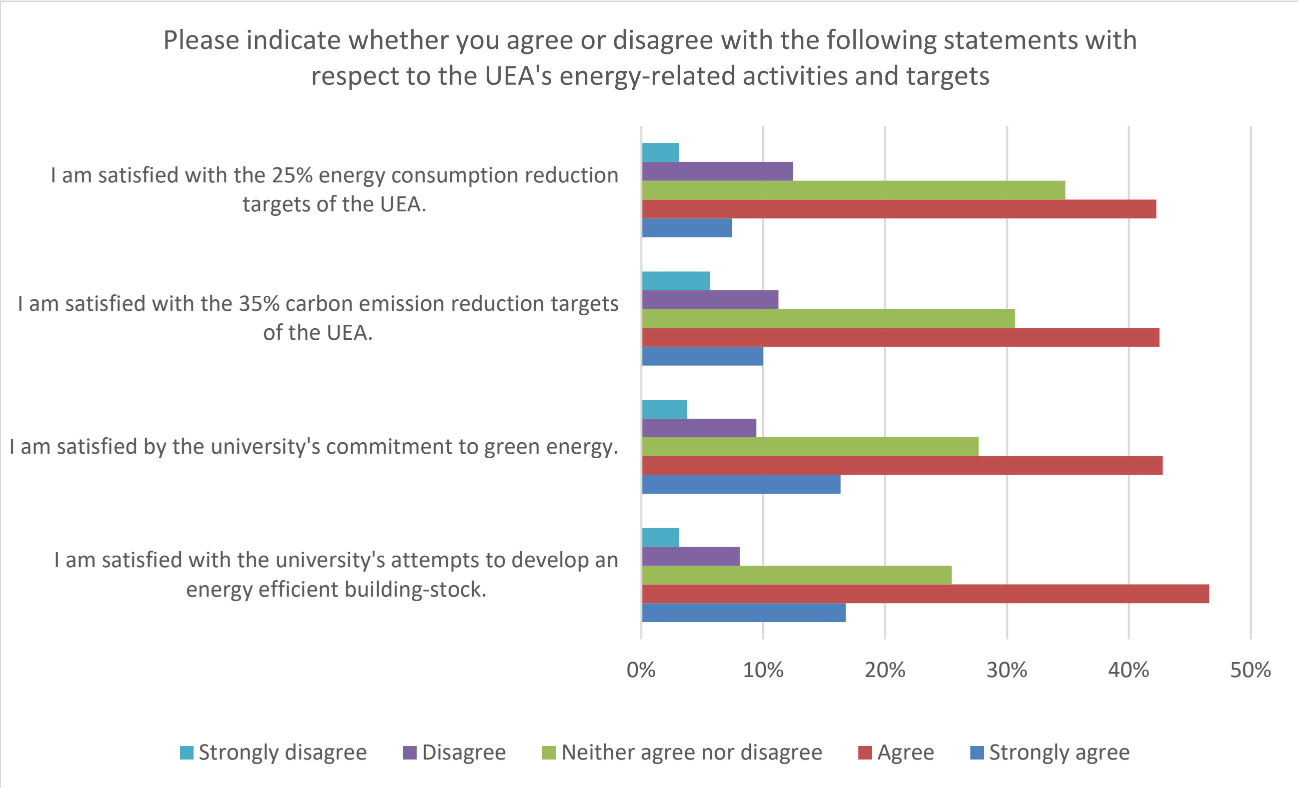

Figure 2.10: Responses to questions on the UEA's energy-related activities and targets

As one survey respondent characteristically commented:

> *"I am aware and sincerely appreciate that the university has a sustainability policy and goals, but believe more should be done to engage the entire UEA student community in eco-efficiency and conservation on campus".*

This echoed other comments, where participants suggested the need for improved communication on the UEA's energy targets and policies. Several participants also commented that information campaigns would be helpful in sharing these targets and policies with campus users.

A slightly higher number of respondents (63%) felt satisfied with the UEA's attempts to develop energy efficient buildings on campus. This could be because these attempts are more visible, as students routinely use and experience these buildings and their infrastructures when on campus. This contrasts with the setting of institutional targets which are more abstract.

Beyond the built environment, friendship groups also play an important part in influencing individual behaviour (Peschiera et al., 2010; Peshiera & Taylor, 2012; Senbel et al., 2014) and survey results showed evidence of social network pressure to be sustainable. 52% of participants agreed with the statement: 'The people whose opinions I value are concerned about their energy use'. Previous research indicates that informal interactions with friends, housemates and partners can positively influence individual attitudes and behaviours. For example, Nolan et al. (2008) found that the action of peers had a stronger influence on individual behaviour than information sharing. Therefore, being part of a social network where others are concerned about their energy use is important in encouraging reduced consumption (Senbel et al., 2014; Cotton et al., 2015).

41% of participants stated that they had participated in one or more of these activities. Figure 2.11 below shows the range of activities with which participants had engaged. Previous research has highlighted the value of extra-curricular clubs and activities in the development of personal commitment to act sustainably (Hopkinson *et al*., 2008; Lipscombe, 2008). However, individuals who engage with such initiatives may be more likely to participate in a survey on energy issues, so this figure may not be representative of the wider population of UEA staff and students.

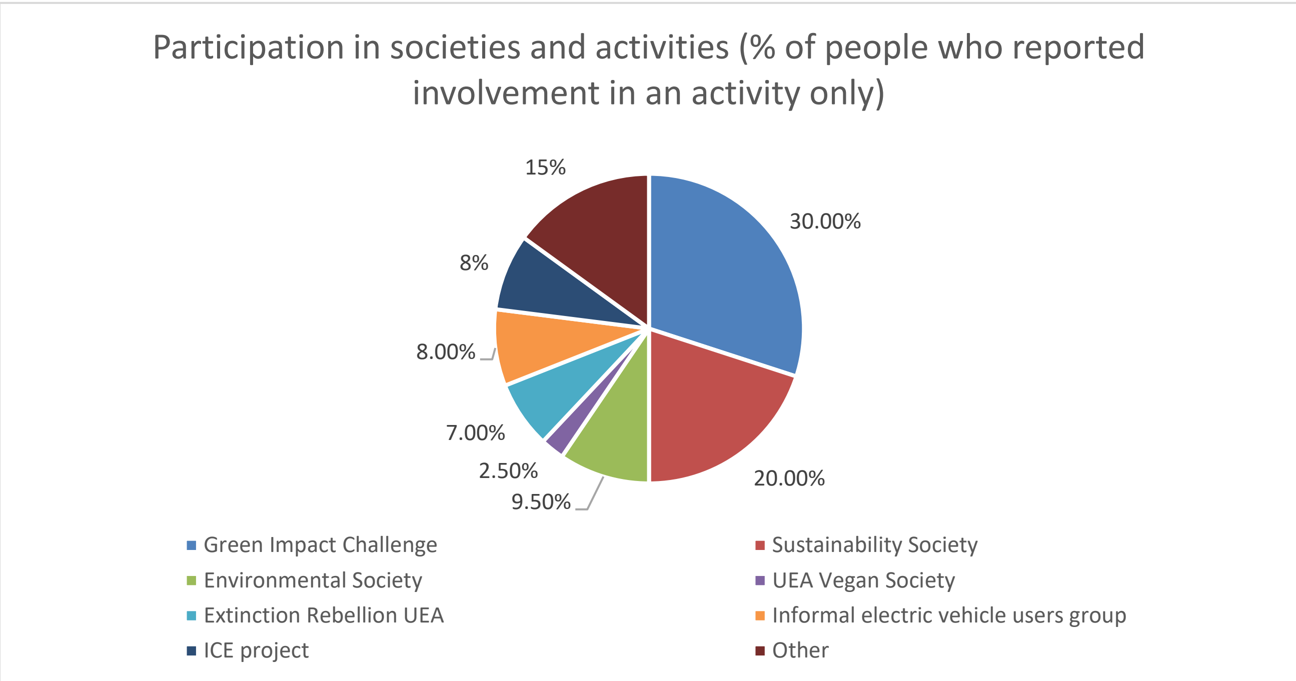

Figure 2.11: Participation in sustainability societies and activities at the UEA

As Figure 2.11 shows, the most popular initiative was the UEA's Green Impact programme, with which 140 participants stated they had been involved. This is an initiative where staff teams take up challenges to win awards at the end of the academic year and improve the sustainability of their local area. Several survey respondents did, however, comment on the need for greater institutional support and investment in this initiative, however:

> *"As part of the Green Impact team in my School for the past two years, I have been frustrated by the lack of engagement from other colleagues and by the reducing support from the UEA towards this initiative. The Sustainability Manager who ran the Green Impact scheme left in 2018 and has not been replaced, and the teams are struggling without the support of this role. Other universities employ many more Sustainability staff* […] *UEA is at the forefront of environmental science and climate change research, and should be taking the lead."*

2.4.4 Identified challenges for sustainable energy behaviours

Participants felt that they had limited influence over the UEA's energy-related decision-making and only a small number of participants were aware of the university's energy supply, however; there was higher awareness of the university's actions to promote sustainability. Pro-environmental attitudes appeared to lead to pro-environmental behaviours, however a number of barriers were identified that undermined the ability of individuals to act sustainably. These barriers included: inefficient buildings; systematic lock-in; disengaged staff/ students; and lack of information on energy consumption. This supports research which points to the importance of considering contextual factors when examining the value-action gap.

Although many participants expressed their trust in the UEA to address sustainability issues, the survey results revealed a general feeling among respondents that they had limited influence on decision-making. Only 23% of participants agreed that the UEA ensures student/staff views and needs inform its energy-related plans (see Figure 2.12). This represents an important challenge for UEA, as research suggests that universities have an important role in enabling and exemplifying sustainable behaviour, and in actively encouraging and engaging staff and students in sustainability issues (Cotton et al., 2015). As mentioned previously, it would also widen individuals' sphere of influence and by giving them the opportunity to play a greater role in decision-making, the UEA could offer the staff and student community more potential to utilise their collective agency to make a change (Cotton et al., 2016b).

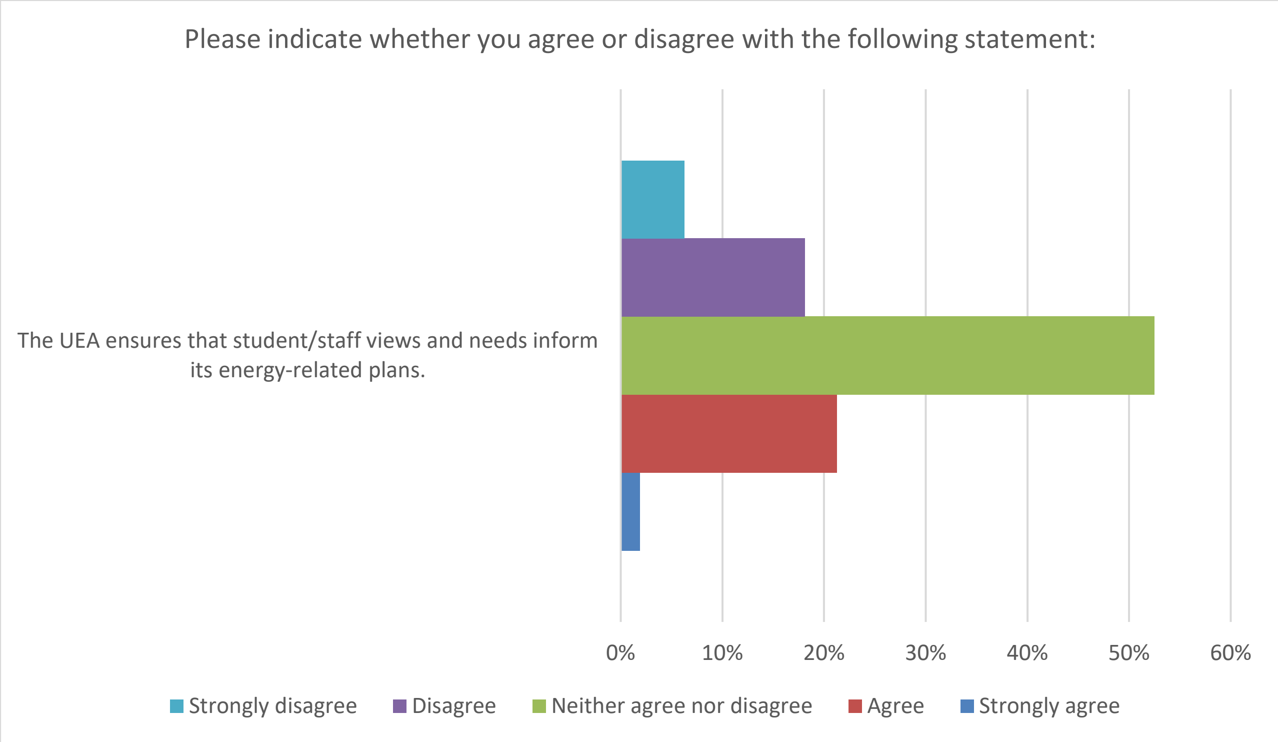

Figure 2.12: Response to question on the UEA's engagement with staff/students in formation of energy plans

Participants were also asked about energy-related information provision on the UEA campus. Responses to this question highlighted, however, that participants felt unable to track how much energy they used on campus. 50% of respondents felt there was not enough information on energy use on the UEA campus (see Figure 2.13). The focus group data also revealed this to be a major challenge for students in campus accommodation (see Section 3.4.3), as residents do not receive a monthly bill or other forms of feedback. This lack of information and financial incentives means that the amount of energy individuals consume is largely unknown and unaccountable despite its use for a range of everyday activities (Maréchal, 2009; Devine-Wright et al., 2010).

One resident observed:

> *"I am very unaware of my energy usage habits due to the lack of responsibility for my utilities and energy consumption habits. It is very nice that I do not have to pay for my utilities, and I am not advocating to place this burden on students; however, I do feel that providing students with some type of gauge or report that makes them aware of how much they are using would encourage reduced usage of energy. Offering incentives to those students living in university housing for lowering their energy usage levels may provide UEA with ample opportunities to save money on utility costs while promoting sustainability and energy-efficient habits among their students that could be carried for years to come".*

As Blake (1999) observes, it is important to consider such institutional and structural constraints when investigating individuals' capacity and willingness to behave sustainably.

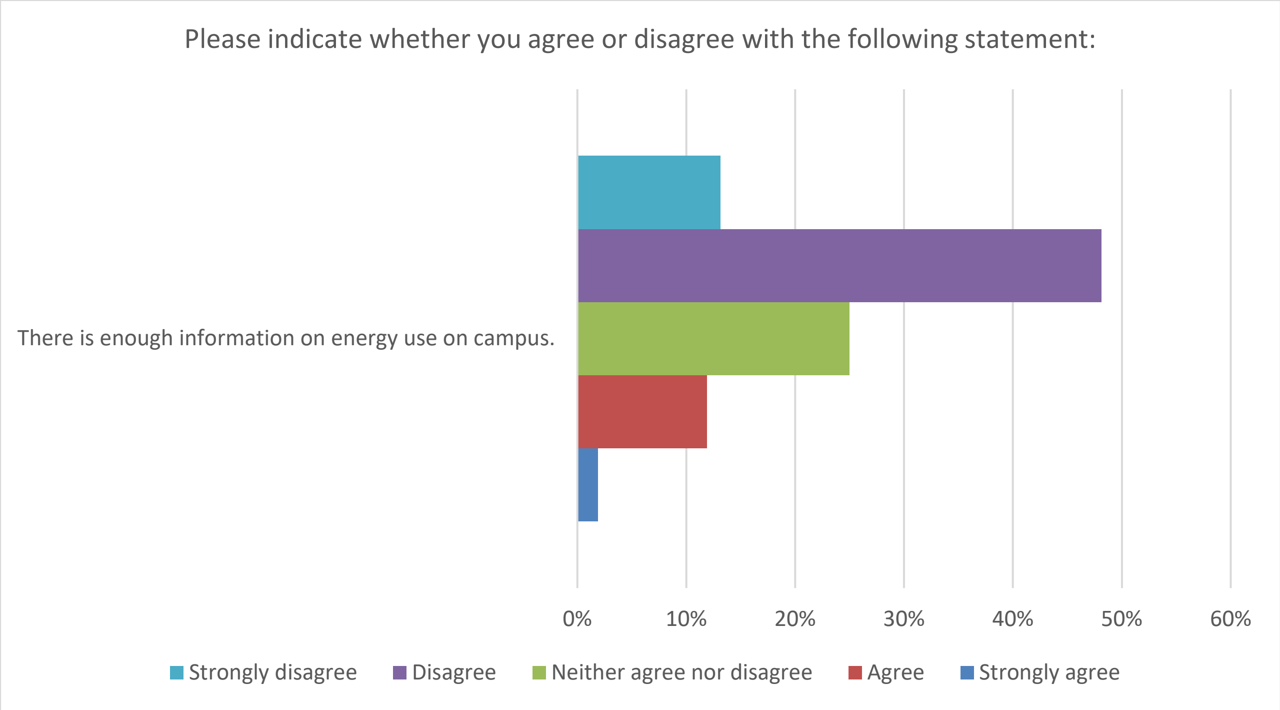

Figure 2.13: Response to question on energy-related information provision on the UEA campus

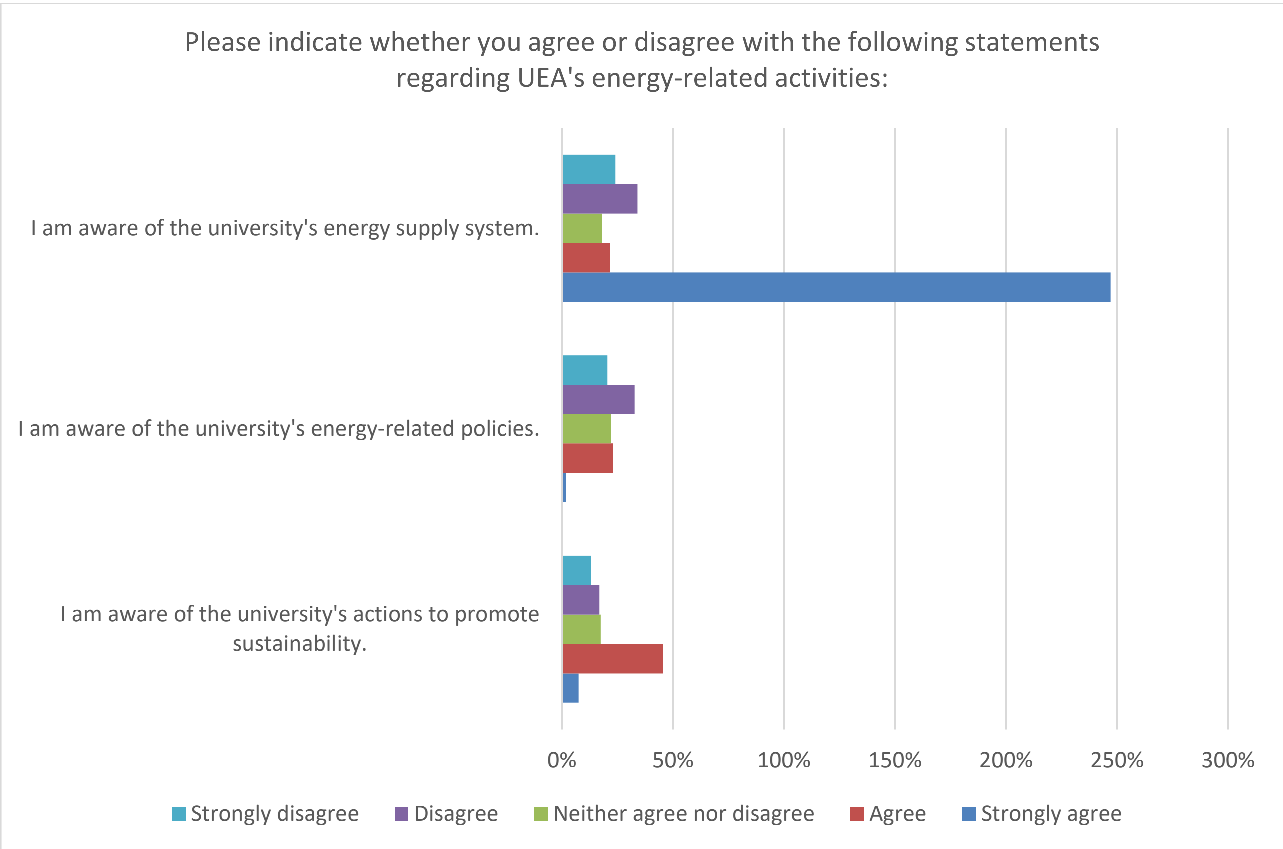

Figure 2.14: Responses to questions about awareness of the UEA's energy supply system, policies and actions

Participants were also asked about their awareness of the university's energy supply as the UEA generates most of its own energy and goes 'off-grid' at times in the year. Only 24% of participants stated that they were aware of this (see Figure 2.14). Similarly, only 24% of participants said they were aware of the UEA's energy-related policies. However, there was higher awareness of the university's actions to promote sustainability, where 52% of participants stated that they were aware of these. This suggests that the UEA is achieving a reasonable level of outreach, but that there is scope for more effective communication of institutional values, strategies and actions to students and staff on sustainability issues. This would help to ensure the university reaches its potential in exemplifying desired behaviours and demonstrating that the UEA has a sustainable energy supply, as well as strong policies, which would send a clear signal to campus users of the university's commitment in this area (Cotton et al., 2015).

The UEA also has an important role to play in encouraging and enabling energy efficient behaviours. However, only 22% of participants agreed that there is sufficient support for those seeking to be more sustainable (Figure 2.15). When given the opportunity to expand on their viewpoints, some survey respondents noted that the UEA does little to encourage individuals to behave sustainably on campus or to take 'responsibility' for their energy consumption, and links to the lack of energy-related information and incentives to behave sustainably mentioned previously. As Barr and Gilg (2006) note, people's preparedness to take environmental action is embedded in their existing everyday experiences and the UEA plays an important role in this.

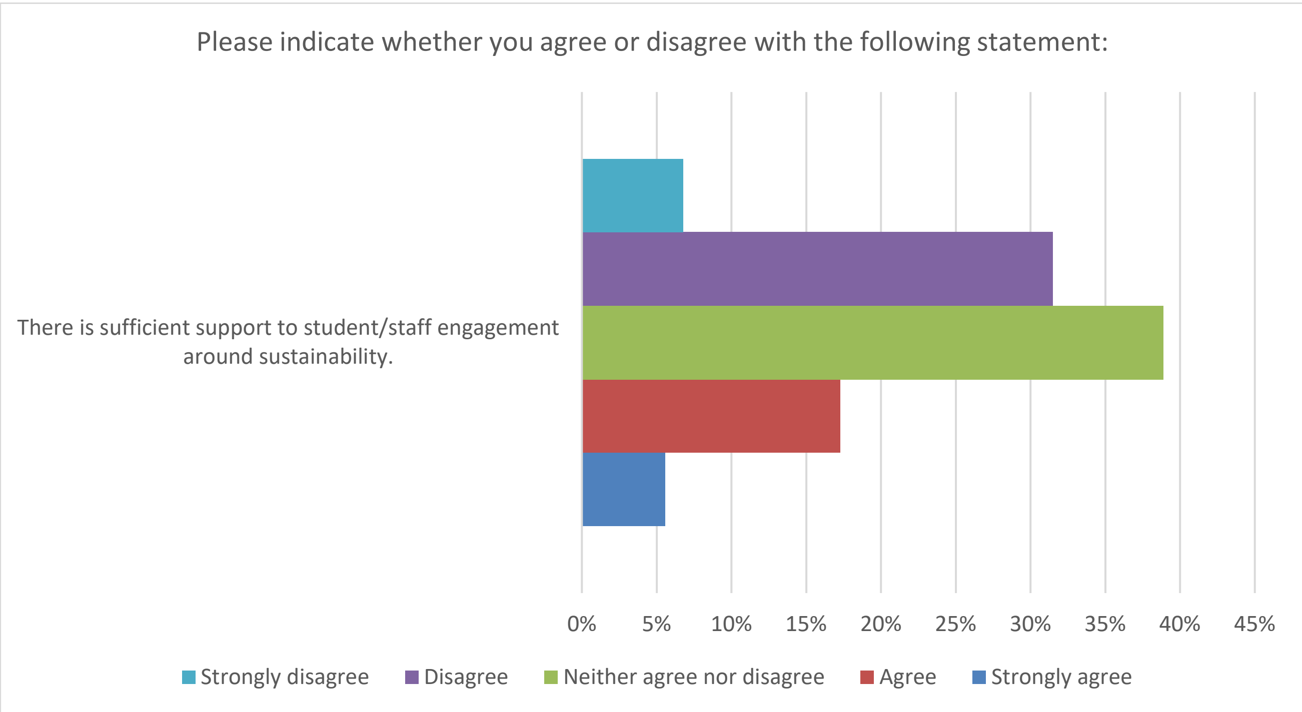

Figure 2.15: Response to question about the level of support provided by the UEA to engage staff/students on sustainability

Additionally, the survey results suggested that campus users felt 'locked-in' into certain patterns of energy use, due to an inability to adjust room conditions (see Figure 2.16). This was particularly the case with adjusting indoor temperatures and, to a lesser extent, lighting. As the focus group data shows (see Section 3), many individuals living in campus accommodation were unable to adjust indoor temperatures as they were centrally controlled. Some also raised concerns about the use of sensors for building lighting, which often caused lights to come on unnecessarily.

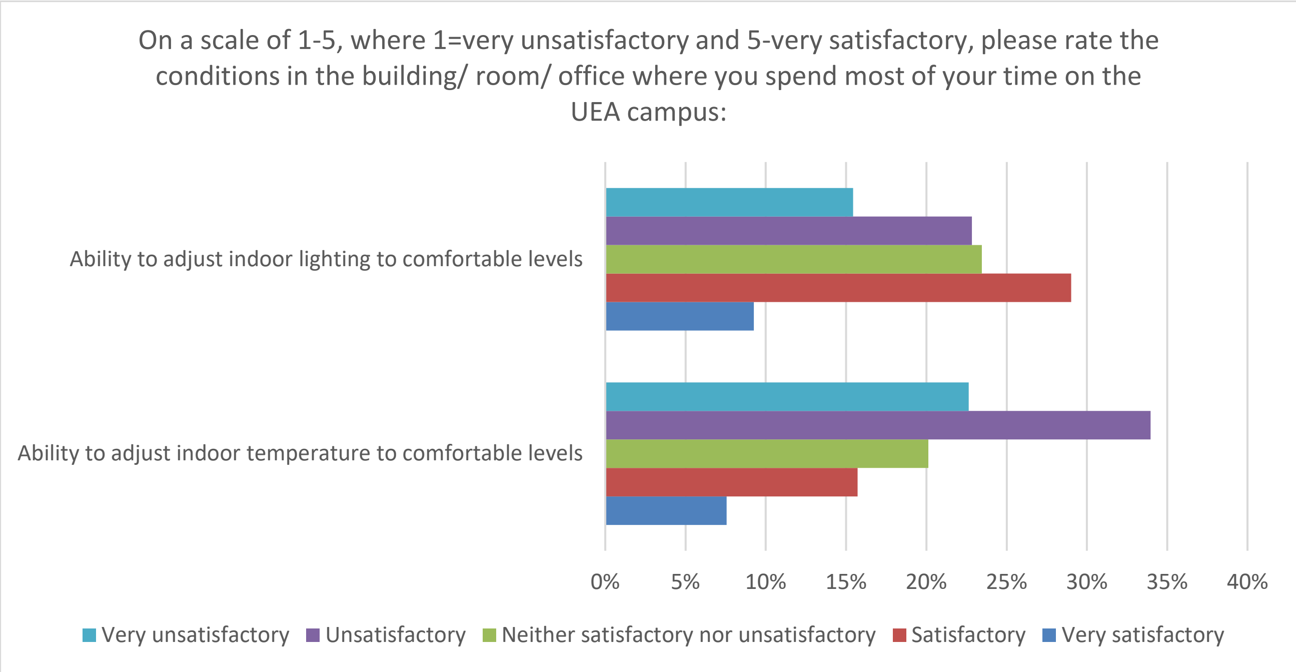

Figure 2.16: Responses to questions about the ability to control energy use patterns on the UEA campus

These issues were also raised by some survey respondents with comments such as:

> "*We have far too many lights on in the buildings*".
>
> *"Turn the heating down in Arts 2* [building] *when the day isn't cold. It's February, but it's 11 degrees outside today and the heating is pumping out heat - I have had to open the window to let the heat out!"*
>
> *"Make heating/cooling more controllable in the main teaching wall at an office level"*.

As a result, participants felt that some of the infrastructures on campus actively *prevented* energy-saving behaviours.

When asked about the main barriers to an efficient and fair energy system at the UEA, the most common answer was 'inefficient buildings' (55%) (see Figure 2.17). This is interesting, as in a previous question 63% of respondents had stated they felt satisfied with the UEA's attempts to develop energy efficient buildings on campus. This answer was closely followed by a 'limited ability to adjust the living/working environment in ways that would ensure personal comfort/ convenience' (49%); 'lack of information on energy consumption' (48%); and 'disengaged staff/ students' (46%). Once again, the systematic lock-in is revealed as a barrier to energy-saving behaviour, as is lack of feedback and the subsequent inability of staff and students to track their energy usage on campus. It appears that participants view others (or possibly themselves) as disengaged with energy issues and further work is needed by the UEA to develop engaging initiatives for promoting sustainability issues.

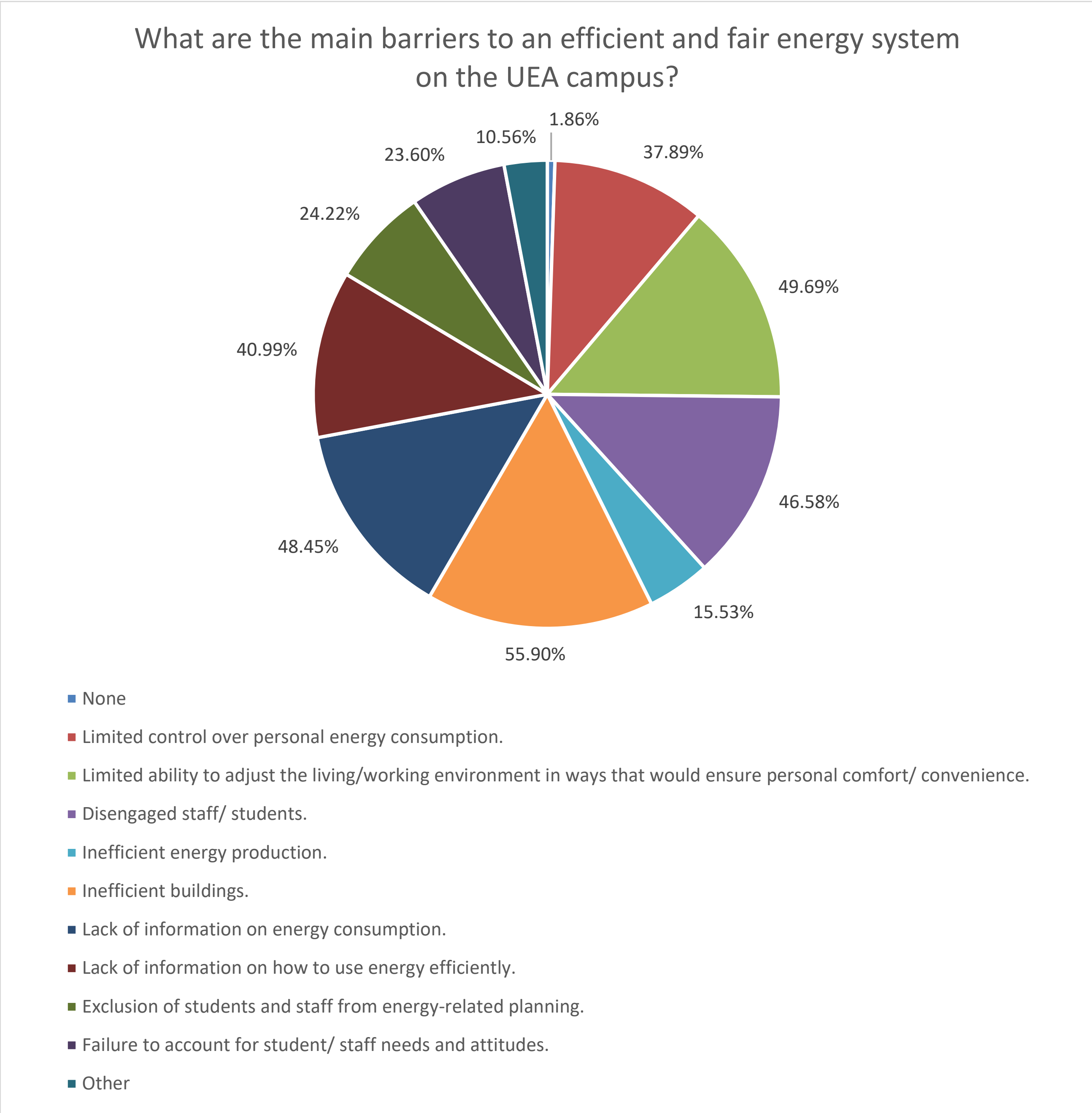

Figure 2.17: Response to question about the main barriers to an efficient and fair energy system on the UEA campus

This latter point was supported by comments made by some survey respondents about the need for more campaigns and information provision on energy issues at the UEA:

> *"I have noticed that a lot of students don't care or take actions to help, such as switching off the lights in the kitchen when they're not being used. Some of the maintenance staff do this as well. It might be simply because they don't know. An informative campaign or seminars for staff and students informing them why it's important could help a lot."*

> *"More information oriented towards students on how they can help [is required]."*

As the points illustrate, individuals felt it would be helpful to know both *why* energy efficiency is important and *how* they can achieve this through their own behaviours. The UEA's current strategy focuses more on provisioning energy efficiency through its building and infrastructures and subsequently making choices on people's behalf, rather than more active engagement with staff and students on energy issues. Research suggests that, to address the value-action gap, the complexity and multiplicity of factors influencing pro-environmental behaviours must be considered (Darnton, 2004). An integrated approach which combines both people-centred and technological elements has potential benefits in both encouraging and enabling more environmentally friendly behaviours.

2.5. Recommendations from survey participants

The survey asked participants to list any high-priority actions the UEA could implement to improve its energy-related infrastructures. As discussed in the previous section, these suggestions centred on: changing physical infrastructures and buildings on campus to make them more energy efficient; and changes to improve energy literacy at the individual level.

2.5.1 Infrastructural changes

There were many suggestions of ways to make campus buildings more energy efficient, particularly related to improving lighting and insulation conditions. For example:

> *"Improve window sizes in The Village to maximise natural light,* [users are] *reduced to using artificial light most days in winter, even at midday."*

> *"Double glazing on the teaching wall. Get it delisted if needs be, it's a working building- not a monument."*

The comments illustrate that individuals were keen for alterations that reduced the need to use lighting and heating throughout the year, and for more efficient forms to be used i.e. energy-efficient lightbulbs. Several participants also drew attention to the fact that some buildings were listed, which prevented certain changes from being made. These individuals felt that improving the energy efficiency of buildings was more important than maintaining their listed status and should be prioritised. Additionally, a number of participants suggested that more renewable/low carbon energy generation should be developed to supply UEA buildings, despite the fact that the university already does this. This suggests that UEA could do more to inform staff and students about its energy supply as an exemplar of its approach to sustainability and as a means of encouraging sustainable behaviours through leading by example (Cotton et al., 2015). Participants also proposed infrastructural changes that would provide building users more control and overcome systematic 'lock-ins' that they experienced. These related again to lighting, but also to computing and kitchen and recycling facilities:

> *"Enable and insist on switch-off for: lights not in use (in my accommodation, the corridor light is always on and cannot be switched off);* [and] *public computers not in use (to my knowledge, it is currently impossible to do by regular users)."*

> "*"Sustainability" projects rarely target the simple, practical, and cheap things that could be done. E.g. we have numerous reminders about "switching off your computers"; but we have boiling-water dispensers left on 24/7 for want of a timer switch and kitchens with no recycling facilities."*

These changes would subsequently both *encourage* and *enable* more energy efficient behaviours.

2.5.2 Improving energy literacy

A number of recommendations were made that could potentially enhance the cognitive, affective and conative dimensions of energy literacy. Several participants stated that more information would be helpful on energy-saving practices and why this is important, and could be delivered using talks, meetings and posters:

> *"Have community living meetings (i.e., all Nelson Court residents) to go over basic sustainability things, like what the bins in our rooms are for and where the food waste goes/how it helps. So many people just don't know how much they can help; it needs to be told and made clear".*

Previous research has shown how difficult it is to change behaviour when individuals' understanding is only partial (Cotton et al., 2015). Providing more opportunities for formal and informal learning is therefore crucial in encouraging behaviour changes. Additionally, many respondents felt that some form of energy feedback was needed so that residents of campus accommodation could track their usage. Some individuals suggested that this information be shared on flat notice boards, which could potentially encourage a more shared sense of responsibility to sustainability.

Participants also suggested a number of mechanisms focusing on behavioural changes to encourage energy efficiency:

> *"Make it compulsory for staff to be energy efficient e.g. turn off PCs and monitors."*

> *"Time limit on showers."*

Whilst making certain behaviours compulsory or setting time limits may be viewed as extreme for some campus users, it is important that the university makes attempts to encourage sustainable behaviours and that these are consistently applied across the university (Cotton et al., 2015).

2.6. Key themes emerging from the survey analysis

a) Members of the UEA community accept that climate change is happening and that human behaviours have contributed to this. Subsequently, they agree that immediate action needs to be taken to prevent further damage. Most individuals are already taking steps to reduce their energy consumption and believe this is simple and convenient to do.
b) Many individuals feel accountable at the personal level, but there is also a shared sense of responsibility with science and institutions- including the UEA.
c) There are several sustainability initiatives taking place at the UEA and there were high levels of involvement among survey respondents; however, many feel more could be done to support these initiatives and events.
d) Pro-environmental attitudes appeared to lead to pro-environmental behaviours, however a number of barriers were identified that undermined the ability of individuals to act sustainably. These barriers included: inefficient buildings; systematic lock-in; disengaged staff/ students; and lack of information on energy consumption. This supports points to the importance of considering contextual factors when examining the value-action gap.
e) While most individuals trust the UEA to manage energy problems, it appears that the UEA's current approach is more focussed on technological solutions and provisioning energy efficiency, rather than actively engaging staff and students and facilitating greater involvement in decision-making. An integrated approach which combines these two elements has scope to encourage and enable more sustainable behaviours.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50* (2): 179-211.

Anshari, M., Almunawar, M.N., Shahrill, M., Wicaksono, D.K., Huda, M. (2017) Smartphones usage in the classrooms: Learning aid or interference? *Education and Information Technologies*, 22: 3063-3079.

Attari, S.Z., DeKay, M.L., Davidson, C.I., & de Bruin, W. (2010) Public perceptions of energy consumption and savings, *Proceedings of the National Academy of Sciences of the United States of America*, 107 (37): 16054-16059.

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of environmental psychology*, *27* (1): 14-25.

Barr, S. (2007). Factors influencing environmental attitudes and behaviors: A UK case study of household waste management. *Environment and behavior*, *39* (4): 435-473.

Barr, S., & Gilg, A. (2006). Sustainable lifestyles: Framing environmental action in and around the home. *Geoforum*, *37* (6): 906-920.

Blake, J. (1999). Overcoming the 'value-action gap' in environmental policy: Tensions between national policy and local experience. *Local environment*, *4* (3): 257-278.

Bodford, J.E., Kwan, V.S.Y., & Sobota, D.S. (2017) Fatal attractions: Attachment to smartphones predicts anthropomorphic beliefs and dangerous behaviors, *Cyberpsychology, Behavior, and Social Networking*, 20 (5): 320-326.

Chen, T. B., & Chai, L. T. (2010). Attitude towards the environment and green products: Consumers' perspective. *Management science and engineering*, *4* (2): 27-39.

Cleveland, M., Kalamas, M., & Laroche, M. (2005). Shades of green: linking environmental locus of control and pro-environmental behaviors. *Journal of consumer marketing*.

Cotton, D.R.E., Miller, W., Winter, J., Bailey, I., & Sterling, S. (2015) Developing students' energy literacy in higher education, *International Journal of Sustainability in Higher Education*, 16 (4): 456-473.

Cotton, D.R.E., Miller, W., Winter, J., Bailey, I., & Sterling, S. (2016a) Knowledge, agency and collective action as barriers to energy-saving behaviour, *Local Environment*, 21 (7): 883-897.

Cotton, D.R.E., Shiel, C., & Paço, A. (2016b) Energy saving on campus: a comparison of students' attitudes and reported behaviours in the UK and Portugal, *Journal of Cleaner Production*, 129, 586-595.

Cotton, D.R.E., Zhai, J., Miller, W., Dalla Valle, L., Winter, J. (2021) Reducing energy demand in China and the United Kingdom: The importance of energy literacy, *Journal of Cleaner Production*, 278, 123876.

Darnton, A. (2006). *Influencing changes in behaviour: existing evidence to inform environmental leadership—review of theories and models (SD14002)*. Defra, London. http:// www2.defra.gov.uk/research/project_data/ More.asp?I=SD14002&M=KWS&V=ex.

Darnton, A., Elster Jones, J., Lucas, K., Brooks, M. (2006). *Influencing changes in behaviour: existing evidence to inform environmental leadership (SD14002)*. Defra, London. http://www2.defra.gov.uk/research/project_data/ More.asp?I=SD14002&M=KWS&V=ex.

Devine-Wright, P., Devine-Wright, H., & Sherry-Brennan, F. (2010) Visible technologies, invisible organisations: An empirical study of public beliefs about electricity supply networks, *Energy Policy*, 38 (8): 4127-4134.

DeWaters, J. E., & Powers, S. E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy policy*, *39* (3): 1699-1710.

Dunlap, R. E., & van Liere, K. D. (1978). The "New Environmental Paradigm": A proposed measuring instrument and preliminary results. *The Journal of Environmental Education*, 9 (4): 10-19.

Eon, C., Breadsell, J., Morrison, G., Byrne, J. (2019) Shifting Home Energy Consumption Through a Holistic Understanding of the Home System of Practice. In: Newton P., Prasad D., Sproul A., White S. (eds) *Decarbonising the Built Environment*. Palgrave Macmillan, Singapore.

Gatersleben, B., & Vlek, C. (1998). Household consumption, quality of life, and environmental impacts: A psychological perspective and empirical study. *Green households? Domestic consumers, environment, and sustainability*: 141-183.

Hopkinson, P., Hughes, P., & Layer, G. (2008) Sustainable graduates: linking formal, informal and campus curricula to embed education for sustainable development in the student learning experience. *Environmental Education Research*, 14 (4): 435-454.

Hynes, S., Ankamah-Yeboah, I., O'Neill, S., Needham, K. Xuan, B., & Armstrong, C. (2021) The impact of nature documentaries on public environmental preferences and willingness to pay: entropy balancing and the blue planet II effect. *Journal of Environmental Planning and Management*, 64 (8): 1428-1456.

Lalonde, R., & Jackson, E.L. (2002) The new environmental paradigm scale: Has it outlived its usefulness? *The Journal of Environmental Education*, 33 (4): 28-36.

Lipscombe, B.P. (2008) Exploring the role of the extra-curricular sphere in higher education for sustainable development in the United Kingdom. *Environmental Education Research*, 14 (4): 455-468.

Lundberg, D.C., Tang, J.A., & Attari, S.Z. (2019) Easy but not effective: Why "turning off the lights" remains a salient energy conserving behaviour in the United States, *Energy Research & Social Science*, 58, 101257.

Maréchal, K. (2009) An evolutionary perspective on the economics of energy consumption: The crucial role of habits, *Journal of Economic Issues*, 43 (1): 69-88.

Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008) Normative social influence is underdetected. Personality and Social Psychology Bulletin, 34 (7), 913e923.

Peshiera, G., & Taylor, J. E. (2012) The impact of peer network position on electricity consumption in building occupant networks utilizing energy feedback systems, *Energy and Buildings*, 49, pp 584-590.

Peschiera, G., Taylor, J. E., & Siegel, J. (2010) Response-relapse patterns of building occupant electricity consumption following exposure to personal, contextualised and occupant peer network utilisation data, *Energy and Buildings,* 42 (8): 1329-1336.

Poortinga, W., Steg, L., & Vlek, C. (2004). Values, environmental concern, and environmental behaviour: A study into household energy use. *Environment and Behaviour*, *36* (1): 70-93.

Senbel, M., Ngo, V. D., & Blair, E. (2014) Social mobilisation of climate change: university students conserving energy through multiple pathways for peer engagement, *Journal of Environmental Psychology*, 38, pp 84-93.

Shove, E. (2010). Beyond the ABC: climate change policy and theories of social change. *Environment and planning A*, *42* (6): 1273-1285.

Steg, L., Bolderdijk, J. W., Keizer, K., & Perlaviciute, G. (2014). An integrated framework for encouraging pro-environmental behaviour: The role of values, situational factors and goals. *Journal of Environmental psychology*, *38*: 104-115.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of environmental psychology*, *29* (3): 309-317.

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. Journal of *Social Issues, 56*: 407-424.

Sustainable Development Commission (2006). I will if you will: towards sustainable consumption, Report by the Sustainable Development Round Table, 1 May 2006, from: http://www.sd-commssion.org.uk/publications.php?id=367.

3. Student energy-related attitudes and behaviours

3.1 Introduction

This section explores findings from focus groups conducted at UEA in February and November 2019 to explore the energy behaviours, attitudes and knowledge of students living in university halls of residence. The focus groups allowed for deeper probing of some of the issues that emerged from the survey data, particularly the energy experiences of those living in campus accommodation. They provided an opportunity to further explore contextual factors surrounding the value-action gap discussed in the previous section and some of the barriers that students faced when trying to reduce their energy consumption, as well as how energy interventions might be implemented to help overcome some of these challenges. In particular, the focus groups explored how individuals might respond to interventions that aim to promote knowledge/attitude/behaviour change, as opposed solely to technological/infrastructural changes to buildings.

Sections 3.4.1 and 3.4.2 examine participants' self-identified energy-saving behaviours and their motivations for these behaviours. The barriers to, and opportunities for, energy-saving on the UEA campus are then discussed in 3.4.3 and 3.4.4. Section 3.4.5 examines the relationship between students' energy use, comfort and wellbeing. A number of potential energy-saving interventions are then explored in 3.4.6 and their advantages and disadvantages examined. Section 3.5 provides recommendations for the design and implementation of energy interventions with student populations.

3.2 Focus group research methodology

11 focus groups were held with 51 students in February and November, 2019. The aim of the focus groups was to build on the survey findings around participants' energy knowledge, behaviours and attitudes, and to also investigate participants' views on a variety of energy interventions for reducing energy use. The focus groups involved a series of questions and interactive activities (see Appendix B). Specifically, they asked questions surrounding participants' pro-environmental and energy-related attitudes and behaviours, their daily routines and energy use, the opportunities and barriers to reducing energy consumption on campus and their views on potential future energy interventions. Additionally, the first round of focus groups in February 2019 included more detailed questions about links between student's comfort, wellbeing and energy consumption.

3.3 Focus group participants

Most participants were in their first year of study, although some were international exchange students or postgraduates. Students were enrolled on a range of courses, from the humanities to science and mathematics. Some participants' degree courses were closely linked to the topic of discussion, for example, Environmental Science. The majority of students were from the UK, but there were international students from Zimbabwe, South Africa, Nigeria, Japan, Hong Kong, San Francisco and Canada. Most participants lived in the University Village in the following buildings: Hawthorn House, Courtyard A, Hickling, Ash House, Beech House, Barton House, Britten House, Paston House, and Colman House.

3.4 Findings

3.4.1 Energy-saving behaviours

Participants stated that they undertook a variety of energy-saving activities. However, turning off the lights was the most commonly cited energy-saving behaviour. Many participants prioritised alternative actions such as recycling and reducing waste over reducing electricity consumption, which were seen as more visible and tangible behaviours. Participants were willing to make further changes to their behaviour as long as these were not inconvenient and did not hamper their comfort and wellbeing.

The majority of (but not all) participants claimed to engage in some form of energy-saving behaviour. The most commonly cited energy-saving behaviour was turning off lights. This was perceived to be the most obvious and convenient way to save energy:

> *"I think the most important thing is just turning off the lights, like a lot, that's always something I'm looking for." (Focus group 4)*
>
> *"Just turning lights off when you leave is sort of more of a common sense sort of thing and that-it's not taking time out of my day just to switch off a light." (Focus group 9)*

This finding correlates with research in the US, where participants claimed to prefer 'turning off the lights' to many other environmental actions in a series of surveys conducted since 1985 (Attari et al., 2010; Lundberg et al., 2019). Participants in Lundberg et al.'s (2019) study claimed this was because it is easy, and because they were taught to do this. This perspective was echoed by focus group participants, who observed that this action was quick and simple (see also Niemeyer, 2010) and many of them had been encouraged to do this by their parents.

Energy-saving was generally viewed as something to be performed independently and most participants claimed they did not feel comfortable instructing their flatmates to practice energy-saving behaviours. However, some claimed they would turn the lights off in communal areas after their flatmates:

> *"Lights, I'm always turning lights off. If people leave them on, I go behind them and turn them off." (Focus group 7)*

> *"Because I know a few people in my flat, when they leave the kitchen they make sure they turn the lights off and they'll tell everyone else to do it." (Focus group 9)*

Participants felt that telling their flatmates to save energy could become confrontational. However, turning the lights off after them was seen as a more diplomatic way of saving energy in communal spaces.

In addition to turning off lights, participants claimed to take part in other energy-saving behaviours, including: ensuring devices were not left charging overnight; turning switches off; not doing laundry too often; limiting use of the heating/reducing room temperatures; limiting time in the shower; and only filling the kettle with the amount of water needed. Many participants also prioritised recycling over energy-saving and claimed they thought about this more, or felt there was a closer/more obvious connection between recycling and environmental issues:

> *"I think, me personally, I have more of a thing about recycling and things like that, so I've got the metal straws and stuff, I've had those for years and then I'm always filtering out anything that's recycling [from communal bins] but I think energy consumption, I'm not as aware of, you're not thinking about it as much. Although recently, when leaving my light on, I have thought to myself 'I need to stop doing that', but I think that's my only bad habit at the moment. I think otherwise, everything I do, usually I do have that in my mind, thinking about energy." (Focus group 11)*

Recycling was viewed as a more visible or tangible action, and was facilitated by the provision of recycling bins in student halls to make the behaviour convenient (see also Kelly et al., 2006; DiGiacomo et al., 2018). The visibility of recycling contrasted with the invisibility of energy consumption (Maréchal, 2009). Changing diets and limiting plastic and water use were also seen as important environmentally beneficial behaviours, whereas energy saving was seen as marginal in comparison. Participants also felt they had more choice and control over these other behaviours (see 'barriers' section, where participants discuss feeling locked-in to certain energy-consumption behaviours).

Several participants felt they would be willing to engage in more energy-saving practices if this did not cause major inconvenience in their daily lives:

> *"If it's just little things that I can do to make it better then obviously I will do it, but if it's actively avoiding things that will make my life a little bit more convenient or significantly more convenient, I wouldn't." (Focus group 2)*

Reference was sometimes made to individuals who took sustainability very seriously or tried to achieve zero waste. Some participants felt that this could be become 'all-consuming' and that living sustainably often became a key part of those individuals' identities. Several participants said they would be willing to make some compromises, but not to go to such extreme lengths. They also said they would limit themselves to actions that did not reduce their comfort and wellbeing (see also Kollmuss & Agyeman, 2002; Sweeney et al., 2013). This was particularly pertinent to their use of building heating systems and the desire to maintain a comfortable temperature, showering, and device use. The latter was seen by many participants as important for their personal wellbeing. Kollmuss & Agyeman (2002) argue that non-environmental motivations which revolve around personal needs (e.g. being comfortable) are often more intense than altruistic and social values as motivations for pro-environmental behaviours.

The general consensus among participants was that individual actions could make an impact and help to reduce environmental damage, although a minority disagreed. Participants often discussed this at length and the quotation below encapsulates two mind-sets that individuals adopted:

> *"It won't be just only you trying to make steps to reduce it, there'll be other people as well, so I think that if I'm doing it maybe someone else is doing it, so collectively it is making a change. But I guess if you think about it as only I'm doing it, then you might think that it might be a little bit pointless because it might not have that much- it just depends on your view on it, if you do think you're having an effect, but then I guess if you think that you're not having an effect then you won't do it."(Focus group 2)*

The two main perspectives were that: a) there was little point reducing energy consumption if nobody else did, as individual actions would have little impact; or b) everyone should take individual action because collective actions could then make worthwhile savings. The concept of 'locus of control' has been used widely by researchers to explain participation in environmentally responsible behaviours. An Internal-External (I-E) locus of control construct was developed by Rotter (1966) to ascertain the degree to which individuals perceive events in their lives resulted from their own actions (internal locus of control) or were beyond their personal control (external locus of control) (Huebner & Lipsey, 1981). Some research has shown that individuals who feel their personal actions can be effective in addressing environmental issues are more likely to engage in pro-environmental behaviours than those who do not.

Some participants questioned whether their personal actions could have a genuine positive effect on the environment, but others hoped they would.

The concept of 'powerlessness' has also been used to describe the perception that 'no one has power to affect an outcome by taking action and people think that taking action will make no difference to the outcome' (Aitken et al., 2011:752). Although there is evidence that powerlessness influences pro-environmental intentions and actions, where people judge that changing their behaviour cannot influence the occurrence or magnitude of climate change (Haller & Hadler, 2008), norms may also be a basis for inaction. Specifically, where conflict exist between an individual's norms (e.g. a desire to be pro-environmental and to keep warm during the winter), invoking powerlessness may help to justify inaction (Schwartz & Howard, 1981; Aitken et al., 2011). Some participants who did express a level of powerlessness may have done so because of conflicts with their norms.

3.4.2 Motivations for energy-saving

Attitudinal factors and habits and routines were important motivations for energy-saving – more so than environmental concern. Energy-saving was often a coincidental effect of behaviours driven by other contextual factors. A significant de-motivator was a lack of financial incentive to save energy in accommodation where energy bills were included in rent. This resulted in some participants using more energy than they would in their family home.

As with all behaviour, influences on energy conservation behaviour are multi-faceted and explaining the motivations and reasons for energy behaviours can be challenging (McMakin et al., 2002). Stern (2000) identifies four categories of variables which affect environmental behaviour: (1) *Personal capabilities* (e.g. knowledge and skills to perform an action, sociodemographic variables); (2) *Attitudinal factors* (e.g. norms, values, and beliefs); (3) *Contextual factors* (e.g. impediments to specified actions, institutional factors, physical environment constraints, policy or monetary incentives); and (4) *Habits and routine* (e.g. conditions to break existing behaviours) (cited in Azar & Ansari, 2017).

Participants cited a range of motivations for their energy-saving practices, which fell into all four categories. The most commonly mentioned were *attitudinal factors* and *habits and routine*, as participants described how they had been taught certain behaviours by their parents that had become habitual:

> *"I definitely do what I used to at home because we were quite energy conscious at home so then I barely have the lights on and if no one is in the kitchen I always turn the lights of. So I think*

maybe not so much cultural, but definitely your past habits and what your parents taught you is an important factor." (Focus group 3)

Some participants did cite concern for the environment as a motivating factor, but this was not the case for the majority. Often, this motivation was only discussed when prompted by the researchers and, even then, participants would describe how they associated environmental issues more with practices such as recycling or limiting plastic pollution:

"I think I've always associated environmental problems and climate change with pollution and recycling and stuff rather than energy use, so I know using a lot of energy is bad, but I never really thought it was because of climate change." (Focus group 5)

As mentioned previously, some individuals felt other practices were prioritised over reducing energy use because they were more visible. For example, it is possible to see waste going to landfill and plastic pollution, whereas energy use itself is invisible (Maréchal, 2009). A couple participants also mentioned that the media had created moral panic about plastic pollution, particularly in response to David Attenborough's 'Blue Planet II' documentary.

Energy-saving was also often coincidental where individuals were driven by *contextual factors* such as time-saving and the weather. In the case of personal devices, many were worried that excessive charging would damage battery life:

Participant: I never leave my devices charging overnight, I always do it to [fully charged] because I heard that messes up your battery life, I don't know whether that's true

Researcher: OK, yeh I was just going to ask why you do that, I was thinking is it to save energy or- but yeh, your battery, but yeh, I've heard the same

Participant: And to save energy just because…yeh…with the small matter (laughing) (Focus group 3)

Energy-saving was therefore often an afterthought. Another significant contextual factor was the lack of any monetary incentive to save energy, as participants did not pay energy bills when living in halls of residence. This made some likely to use *more* energy than they would in the family home:

"I think with the heating, when I was back at home, we'd hardly ever have the heating on and I think now because it's just there at no extra cost to me then I'm like 'oh well, I'll use it' instead of going to get a hot water bottle or something." (Focus group 10)

"I think in this sense, no matter how long you've got the lights on, you don't really get a bill, especially here. I remember my dad saying 'just keep the heating on throughout the day because you won't get a bill.' Obviously I don't, but like he said, the cost won't matter because we don't

> *get a heating bill or electricity bill so in that sense, things like that, I don't really think about it." (Focus group 11)*

Research has shown that economic reasons play an important role in motivating environmental behaviours, and that financial incentives or penalties can both influence behaviour (Kelly et al., 2006; Gadenne et al., 2011; Sweeney et al., 2013). Although some researchers suggest that the relationship between economic factors and energy use should be viewed with caution, as economic factors do not always explain energy use behaviour (Kollmuss & Agyeman, 2002), the lack of economic incentives played a significant role in the energy use of focus group participants. In the case of their laundering and drying – which they had to pay for – many individuals claimed they would wash clothes less frequently or take laundry home to their parents to save money:

> *"I think with laundry, where it's quite expensive here as well, so I save it up as long as possible which means I kind of shove lots into one load which the- they say isn't as good for the washer- but I guess it only pays for one." (Focus group 1)*

> *"I don't dry clothes in my room either because I always go home at the weekend so I think the washing on campus is so expensive, I just take it all home." (Focus group 10)*

Thus, both a lack of financial incentive (for energy use in halls of residence generally) and the existence of incentives (having to pay for laundering and drying) influences the energy behaviours of the student population.

3.4.3 Barriers to action

A number of barriers were identified including: lack of financial incentive; the inability to track or measure energy consumption; and a lack of education and knowledge about how to save energy. Additionally, participants felt they were 'locked-in' to energy use in their halls of residence and on campus. This was due to the provision of infrastructure by the university and also reflected the demands of university courses and lifestyles.

In addition to the lack of a financial incentive (except for laundering/drying), participants cited several barriers which they felt prevented them from reducing their energy use. Lack of education/knowledge was cited most frequently and many participants said they did not know *how* to save energy in practical terms:

> *"I think people want to help but they don't know how and you say with that kind of thing, it's difficult for people to find out because there's not that- the information's not out there unless*

you're looking for it at the moment and a lot of people wouldn't think to look for it." (Focus group 6)

"I think it is down to the individual, but also people need to be made aware how to reduce energy consumption because if you didn't know then you wouldn't be able to so you wouldn't think about it because there is no way." (Focus group 7)

Some participants felt that information was available, but that they needed expressly to look for it. The general consensus was also that more focus had been placed on recycling than energy use where they had been taught about environmental and sustainability issues in school. This partly explains why participants often focused more on recycling than reducing energy consumption.

Previous work suggests that the 'information deficit' model, which proposes that 'increasing knowledge and awareness alters consumers' attitudes towards the behaviour, which in turn translates to behavioural change' (Sweeney et al., 2013:372), is not always reliable. Research has shown that increases in knowledge and awareness do not necessarily translate to behaviour change (McKenzie-Mohr, 2000; Kollmuss & Agyeman, 2002). The gap between knowledge, values and attitudes and actions has been termed the 'value-action' or 'attitude-behaviour' gap. Several participants question how effective information provision would be, however (see Section 3.4.6).

Another barrier was that participants felt 'locked-in' into certain patterns of energy use on the UEA campus. Some energy-saving behaviours can only take place if the necessary infrastructure is provided. However, participants felt that some of the infrastructures on campus actually *prevented* energy-saving behaviours. In halls of residence, the heating was controlled by a centrally-controlled thermostat in most buildings and residents were only able to adjust temperature settings on radiators in their bedrooms:

"I actually can't control my heating, I don't know if I'm doing it wrong, but sometimes it's on and it's boiling and there's nothing I can do and sometimes it's off. I don't know, but I have the window open 24/7 just to make it colder." (Focus group 5)

Lack of control over whether the heating was turned on led many residents to feel like energy was being wasted at times. It also affected their comfort and wellbeing (see Section 3.4.5).

In many communal areas, including hallways and some kitchens, lights were activated by sensors and many residents felt that lights often came on unnecessarily because the sensors were too sensitive. Another issue was lighting in bedrooms. Some residents felt their rooms received little natural light or, for those living in lower floor flats, they had their blinds or curtains shut constantly for privacy and relied on artificial lighting:

"I feel like because we're on the ground floor and our windows face the courtyard, if you have the blind all the way up people literally stop and look into your room- I've literally walked past

people just standing and staring into my room so I always have the blind half-shut at eye level so I always need some kind of light on." (Focus group 6)

The majority of residents also had a fan connected to their bathroom light, which came on automatically when the light was turned on and stayed on for a time after the light was switched off. Many residents felt this was unnecessary, especially when they only used the bathroom briefly. Some residents, however, described how they kept the light switched on after taking a shower to allow the fan to help ventilate the bathroom, because bathrooms lacked an external window):

"I have to leave the light on to turn the extractor fan on so that it [bathroom] dries out because otherwise I'll go in there and will just get wet feet, and no one wants to get wet feet with socks on." (Focus group 5)

Residents also observed that the bathrooms stayed wet and that sometimes damp and/or mould developed if the fan was not left on. Although residents were able to open bedroom windows (although the extent to which they opened varied by building), there was not always sufficient ventilation to dry clothes in their bedrooms. They therefore paid to use the tumble dryers rather than air-drying laundry. This provides one illustration of the way infrastructure affected comfort and wellbeing (for further discussion, see Section 3.4.5).

Some participants also commented on the amount of electricity used to run other buildings on campus:

"And there's a lot of public spaces on campus that are always, for example, lit up and heated like that corridor no one's using right now [indicates corridor outside the room] and as much as the lights do go off in some of them, not all of them just turn off." (Focus group 1)

A common perception was that lights and heating were often left on unnecessarily. However, some students referred to specific buildings, particularly the Enterprise Centre, which they felt were more sustainable than the 'average'. Despite having some awareness that it was more 'environmentally friendly', participants weren't always aware how or why. Participants felt this lack of knowledge was caused by unsatisfactory information sharing and lack of awareness-raising by UEA.

In addition to feeling locked into certain patterns of energy use by the physical features of buildings and infrastructure, several participants felt their behaviour was determined by course requirements and lifestyles. In particular, individuals mentioned a heavy reliance on laptops to complete assignments and course-related work, and smartphones organising daily life:

"It's very hard to function without a phone, all of your socialising's on your phone, all your emails are on your phone. I find out if my lecture has been changed room on my phone, like everything, you need a phone for. […] There's the whole thing about people saying 'oh, but young people are always on their phones.' It's just because our lives have been conditioned to

be like that, I would constantly be lost and not know what room I was going to if I didn't have a phone." (Focus group 1)

The presence of technology in daily life is widely recognised and devices such as laptops and smartphones are now seen an integral part of many societies (Anshari, 2017; Bodford et al., 2017). This is the case for much of the student population, who rely on these devices for both their social lives and their studies.

Another barrier identified by participants was their inability to track how much energy they used. They did not receive a monthly bill or other forms of feedback, and struggled to gauge whether their use was above or below average:

"I think if I was aware of how much I was using it might make me stop because we don't actually know, we don't have any access to the bills or anything." (Focus group 5)

This once again links back to the invisibility of electricity consumption (Devine-Wright et al., 2010). Participants used electricity for a range of everyday activities. However, it is 'not consumed for its own sake but is 'derived demand', which remains hidden for most consumers' (Grønhøj & Thøgersen, 2011, p.138). As a result, many students favoured receiving some form of smart feedback to track their usage (see Section 3.4.5).

3.4.4 Opportunities for action

Education provision and technological/infrastructural changes were identified as opportunities to encourage more sustainable behaviours. Participants felt it was important that UEA send a clear message to its community that sustainability was an important priority.

In addition to identifying a lack of educational provision about energy saving, many participants saw this as an important opportunity. They felt it was particularly important to provide students with awareness-raising information about energy use, its impacts on the environment, and ways to reduce it when they begin university:

"I think re-education is really important, so, so important and I think that's why people aren't really aware what they do." (Focus group 3)

"I think they [UEA] could have presentations maybe telling people- showing the effects of how much their energy's sort of having, even if they don't realise and showing them- they could give

tips and simple ways that they could reduce their energy consumption that won't sort of affect them too much, yeh sort of education." (Focus group 8)

The timing of education was seen as important and participants felt that providing information early during students' degree would allow time for new behaviours to be integrated into the habits and routines students formed on campus. Certain energy-saving activities were habitual, and although developing new habits can be challenging (Kollmuss & Agyeman, 2002), working to change habits when students move to new residences may be a good time to encourage changes in behaviour. Additionally, participants felt that making information sessions compulsory and integrating them into existing sessions would be the most effective approach (e.g. accommodation induction meetings). This would ensure high attendance and highlight that UEA took the issue seriously.

Although providing education on energy could potentially motivate behaviour change (although, as noted previously, increasing environmental knowledge does not guarantee behaviour change (McKnezie-Mohr, 2000)), respondents also identified opportunities to make technological and infrastructural changes to campus buildings. A range of options were identified, including: installing better insulation; expanding the use of light sensors in kitchens and bathrooms; installing more LED bulbs; and implementing time limits on showers. The use of renewable energy was also identified as an option. The majority of students were surprised to learn that UEA generates most of its own energy and goes 'off-grid' at times in the year. This focus on energy efficiency to tackle environmental issues is linked to the prevalence of '"technology optimism"- the perspective that technologies will provide consumers with more efficient ways of using energy (Maréchal, 2009).

Responses were mixed on whether UEA should focus more on changing behaviours or infrastructural changes. Some viewed infrastructure changes as a good standalone response, while others felt that students might rely on energy efficient technologies and develop 'bad' habits. These technologies would then be counter-productive if they sustained unsustainable energy-consumption patterns. Several participants felt that a combination of the two would be preferable:

"If the infrastructure is in place then people will have to use it, but the buildings that are already in place, they might never get fitted or if they're going to retro-fit the buildings it might be 10 years before that's done. So in the meantime, actually getting people to make little changes is going to make a difference and then when the infrastructure came into place you could combine that and hopefully then the practice will be sort of normal to people and that just be how it is, I think it needs a combination of the two." (Focus group 7)

Some participants also felt that UEA would be sending a clear message that it is a sustainable campus if it provided technologies and infrastructures that enabled consumers to make pro-environmental choices, and that this could motivate individuals to adjust behaviours to feel part of that ethos.

3.4.5 Comfort and wellbeing

The infrastructure of buildings and their residents were not always well aligned. This resulted in many residents not achieving optimum comfort, particularly in respect of thermal and visual comfort and indoor air quality. Control and choice were important factors in achieving comfort and wellbeing. However, personal preferences meant that achieving desired comfort levels was often difficult in communal living spaces.

The inability to fully control some technologies in halls of residence affected residents' levels of comfort. The comfort conditions in buildings are determined by three main factors: thermal comfort, visual comfort, and indoor air quality (Dounis & Caraiscos, 2009). It appeared that discrepancies between building design and residents' preferences resulted in residents struggling to achieve their desired levels of comfort. In terms of thermal comfort, the inability to control whether the heating was turned on meant that residents often felt too cold or too hot:

> *"Our kitchen window is always open because it's unbearably hot in the kitchen and you can't turn the radiator off in there so if lots of people are in there and you're cooking, it's so hot that you have to have the windows open which seems counter-intuitive." (Focus group 7)*

As the quotation illustrates, not all residents were aware that the heating system was controlled by a centrally-controlled thermostat. This meant that the heating often turned on unnecessarily in some flats and temperatures were too high. Residents would often open the windows and waste energy to cool down. Alternatively, residents in other flats frequently felt too cold even when the heating turned on. Temperatures seemed to vary by building and depending on the floor-level and orientation of each flat. Those on higher floors were more likely to feel too hot.

Temperature preference also varied by individual. Some people preferred to feel cooler and were happy to wear multiple layers of clothing, while others preferred to feel warm. Previous research has shown that achieving thermal comfort is an individualised process and can be influenced by factors like long-term thermal history, previous experience of indoor environments, and cultural practices (Amin et al., 2016). Amin et al. (2016) suggest that occupants are more likely to achieve comfort when they have control over their environment. Many UEA residents did not have full control over their heating and this caused discomfort for some.

Visual comfort was also raised as a challenge by some residents. Visual comfort is usually determined by illumination levels. However, there were divergent viewpoints about how to achieve a comfortable level of illumination:

"I feel like when they build new buildings they try to counteract the dim lighting by putting in the brightest lights ever, but if I have the ceiling light on it gives me a headache and I would rather just work somewhere else with more subtle lighting." (Focus group 1)

"I think the lights in my room aren't LEDs so they're not very powerful and it does make your room feel dark and dingy and not very light and airy, but I do try and keep the window and the curtains open as long as possible to not have the lights on, but it can be quite difficult because it's quite- it feels very dark and gloomy in there and you want the light on just so you can see." (Focus group 7)

Preferences over illumination levels again appeared to be personal and there were those who preferred brighter lighting, while others preferred gentler lighting.

The third factor affecting comfort in buildings identified by Dounis & Caraiscos (2009) is indoor air quality. Ventilation is an important means for controlling indoor-air quality. However, many participants claimed to have issues with the ventilation in their en-suite bathrooms:

"My flat is also really bad with ventilation, I don't know if it's just how it's set up, but I'm in the very corner and when I do open my window, even then it doesn't get super dry in my room. So my clothes will be wet for a few days if I'm not really careful about it, so I have to do that twice [dry clothes in the dryer] *which I feel is bad but I don't want to have mildewy clothes. And I think the same thing with the bathrooms, I have a hard time keeping my bathroom dry and from getting mouldy because the ventilation isn't really good." (Focus group 3)*

Several participants felt their bedrooms and bathrooms were not ventilated sufficiently, so activities such as showering and drying clothes caused problems and some individuals claimed to have mould or damp in their rooms. Participants described how they left their bathroom light on to ensure the fan stayed activated after showering to encourage ventilation. In addition, some flat windows were located near trees and other vegetation and insects sometimes entered flats when they were open.

Several participants identified choice as a significant factor in achieving comfort and wellbeing. When asked how they would describe these concepts participants replied:

"It's like being able to control it and adapt it to what feels best for you I guess." (Focus group 1)

"I see that as just sort of being able to just sort of keep your environment suited to what you do and stuff like that." (Focus group 2)

The relationship between energy use and wellbeing was less than clear for the majority of participants. However, links were identified between device use and wellbeing. In particular, it was felt that not being able to use devices to contact friends and family or to watch films or television would affect their mental wellbeing.

3.4.6 Interventions favoured by students

Participants were asked to rank a selection of interventions in order of preference. The main interventions discussed were: education/information provision; smart feedback; new policies; financial incentives; social incentives (e.g. competitions); prompts (e.g. email reminders, posters); energy delegates; personal goal-setting; and new technologies. The following sections outline participants' perspectives on each type of intervention, including their advantages and disadvantaged and key themes relevant to understanding different energy interventions.

Financial incentives

Financial incentives were the most popular of the intervention types discussed. Participants suggested various forms these could take, including: energy bills for students in halls of residence; fines for excessive energy use; and receiving cash repayments from rent for reducing energy consumption. Early studies assessing the effects of converting energy savings into monetary savings for individual households found that this resulted in significant reductions in energy use (Hayes & Cone, 1977; Winett et al., 1978). Participants also observed that rewards did not necessarily have to be monetary and other rewards were suggested, including: cups of coffee, reusable mugs, televisions and pizzas. The main reason financial incentives were seen favourably was that saving money was a high priority for students living on a limited income:

> *"The financial incentives, obviously students are sort of cash-stripped and I think any sort of monetary penalty or anything will make them think twice about using their energy." (Focus group 7)*

> *"I put financial incentives as number one because I feel like, personally, that would be the number one reason as to why I might want to be more energy efficient and I feel like a lot of students struggle financially- that would definitely be a very effective method." (Focus group 6)*

Several participants also referred to the success of other financial incentives, such as plastic bag charges and the London congestion charge (see Poortinga et al. (2016) and Leape (2006)). They felt that individuals had changed their behaviour in response to the initiatives and, therefore, that financial incentives would have a similar effect on energy use.

A few participants viewed financial penalties more negatively and felt they would not be effective for people who had less need to budget:

> *"I think penalties is a really bad idea [...] because the issue with having penalties for things is if it was a scheme people wouldn't get involved in it and schemes which involve penalties usually tend to target people who have less money anyway, so it would just cause more of a class issue because people who have a lot of money wouldn't care about their energy use because they'd just be like 'it's a little bit more money to pay at the end.' But it would really, really target people who didn't have very much and it just causes a whole class issue which isn't really needed." (Focus group 6)*

Overall, though, financial incentives and penalties were viewed positively by participants.

Education/information provision

Lack of education about energy use, its environmental impacts, and how to reduce energy consumption were frequently cited as barriers to reducing energy consumption. The provision of education in these areas was identified as an important opportunity by participants, even before the focus groups discussed interventions. During discussions on potential interventions, education provision was explored further and highlighted a range of issues.

Some individuals were concerned that lessons could easily be forgotten or not acted upon even when educational opportunities were provided, a point also emphasised in research on the value-action gap in pro-environmental behaviour (McKenzie-Mohr, 2000; Kollmuss & Agyeman, 2002). However, it was suggested that the way information is communicated is important and could help to overcome shortfalls in behaviour change. Specifically, it was felt that people should not just be told what they should and should not do, and that energy education should be interactive and engaging:

> *"Something interactive because anything that engages people will get them to pay attention and to listen and they'll enjoy it at the same time, which is a huge motivator if they're both enjoying it and they're engaged, it will stay in their minds which is what you want." (Focus group 4)*

In addition to receiving information about the electricity consumed by individuals and appliances (see next section), participants generally felt it would be helpful to know the impact of their electricity use in terms that they could relate to easily:

> *"Something that has a practical element to it where you can see [...] the impact of your energy usage, for example, like the proportion of trees that there were once in Norwich, for example,*

before and how many there are now based on deforestation, needing to cut down trees for paper and stuff like that. So I think physical examples, that would be useful." (Focus group 8)

This supports findings by Emeakaroha et al. (2014), where participants wanted to see the environmental impacts of their energy use and how it contributed to problems such as climate change, habitat degradation and the depletion of renewable and non-renewable resources. There were mixed views about the use of traumatic images of the impacts of energy use as a way of encouraging behaviour change. Some participants thought this would be effective, but others felt that this was a form of scaremongering and was inappropriate.

"Smart" feedback

The majority of participants were very positive about the use of smart feedback. The lack of ability to track their energy use was identified as a key barrier to saving energy, and many felt that being able to see energy consumption in real time would encourage behaviour changes:

"In a personal sense, it's just the accountability- you're more aware of things when you're held accountable to them, but we aren't held accountable for energy use because we never see the end result of it, it's like in exams, if you never found out the result of your exam you would never try. (Laughing, agreement). Yeh, so it's like almost if there is an end result and something to aim for you're more likely to aim for it, like aiming for the health of the planet is a bit of a vague goal for most people, so maybe a number or a value that you can put on it would give people more motivation?" (Focus group 1)

Several participants referred to the way feedback is presented and felt that it was important to be clear and attention-grabbing. For example, some mentioned the use of colour-coding systems to show how residents were performing in energy saving. Karp et al. (2016) similarly suggest that students usually carry high cognitive loads, and that providing feedback which 'does not require effortful cognitive processing' is beneficial (p.474).

The general consensus was that feedback should be provided on a personal-level rather than at the flat-level due to differences in lifestyles, so that individuals could track their personal usage. However, some liked the idea of sharing personal feedback with others to boost a sense of competition or common purpose (see also Peshiera & Taylor (2012) and Alberts *et al*. (2016)). Others commented that providing constant real-time feedback would help make energy-saving part of daily routines and help to educate people about the energy consumption of different appliances. A number of studies have shown the positive effects of real-time feedback (Bekker et al., 2010; Emeakaroha et al., 2012). Karp et al. (2016) suggest that reason real-time feedback can be effective partly because it increases awareness of the connection between an individual's actions and energy consumption. Participants felt that this knowledge would help them prepare for life in private accommodation when they would start paying separate bills for energy use.

Social incentives

There were mixed views towards the use of social incentives, such as competitions, to encourage pro-environmental behaviours. Some participants ranked this as their preferred incentive and thought that it could be a fun activity that the wider student population would be keen to participate in. However, others ranked this as their least preferred intervention type and thought that people would not like to get involved. There were also concerns about the longevity of any impacts achieved by competitions once they ended. As one participant observed, it could be *'just a phase'*. Previous research shows mixed results on the longevity of impacts of energy-saving competitions (Petersen et al., 2007; Emeakaroha et al., 2014b) and further research is needed to improve understanding of how to ensure the durability of behaviour changes created by this type of intervention.

Prompts

The provision of prompts via email was generally ranked less favourably by participants. They felt they already received high levels of emails from the university and the accommodation office, and that emails about energy use would be overlooked (see also Marcell et al., 2004):

> *"With the prompts again, people are just going to put the emails in their spam folder and never look at it so that's not really going to do anything." (Focus group 6)*

> *"I put the same- prompts, email reminders, if people don't want to read it they won't read it, depending on what the title is people will just delete it so it ends up being less spread throughout the university." (Focus group 9)*

Some participants observed that email prompts could be more effective if they were personalised or had attention-grabbing subject lines.

Prompts to turn switches off were generally seen more positively. They were not often a priority when participants ranked different interventions, but they were mentioned earlier in several focus groups as a useful strategy to encourage energy savings.

New technologies

As with education provision, the installation of new technologies was identified as an opportunity to make energy savings before interventions were discussed. In earlier discussions participants expressed concerns that new technologies could be counter-productive if they encouraged unsustainable consumption patterns, but participants generally ranked them highly as an intervention and felt that a focus was on making energy savings (with less concern about how the savings were made) would be productive.

Energy delegates

Opinions were divided about the use of energy delegates. Some participants thought they could become a nuisance and to lead to energy shaming. A small number of participants, however, felt that energy delegates could be helpful if they communicated in balanced, informative and supportive ways. The continued presence of energy delegates was nevertheless thought to be a way of providing regular reminders to save energy that would then become ingrained habits. One participant compared the role of the energy delegate to his mother's monitoring of his energy use.

New policies

New policies were generally ranked less unfavourably because they were likely to have low visibility unless people specifically searched for information about them. Some participants also argued that many people would not necessarily pay attention to new policies or see their relevance to their everyday lives even they knew about them.

Personal goal-setting

Personal goal-setting was viewed as the least effective type of intervention. Participants felt that personal goals were easy to forget and difficult to remain committed to even when they were adopted with good intentions. A few participants felt that goal-setting would be more productive if combined with smart feedback or financial incentives:

> *"I've got personal goal-setting [last in the rankings] because it's not an easy- certainly with things like energy, it's not an easy thing to say […] if you've got a Fitbit app on your phone and you're saying 'right, I want to burn this many calories on this day' it's a lot easier than trying to say 'I want to reduce my energy consumption by 25 percent'. It's just at the moment with what we've currently got here, it's just very hard to measure our energy consumption." (Focus group 7)*

Suggested combinations:

Many respondents felt that interventions would achieve better results if implemented in combination with each other. In particular, there was consensus that social interventions would work better when combined with financial incentives:

> *"A competition is likely to bring more individuals, people like to be a bit competitive and the prize, whether it's a financial monetary prize, it intrigues people." (Focus group 8)*
>
> *"I put social incentives first and then financial and then the only thing is I'd say they're- the most effective would be linking those two together, having a social incentive and financial incentive too. For example, a competition and then you win money from it or you win vouchers or something like that." (Focus group 8)*

Participants observed that interventions which were enjoyable or gave opportunities to work in teams with peers would not be sufficient to motivate participation and would be more appealing if they were combined with a financial incentive. Education was also viewed as a complement to most other forms of intervention, in particular, smart feedback and social and financial incentives.

3.5 Key themes emerging from the focus group analysis

a) Participants felt they needed ways to track their energy use. Many felt that energy use is an abstract concept and that energy was easily taken for granted in their everyday lives. Participants generally felt they would benefit from more education on energy use and greater feedback on their energy usage through energy bills or smart feedback.
b) Participants felt it was important to be held accountable for their energy use. Intrinsic motivations were seen as insufficient to maintain involvement in energy interventions (or pro-environmental behaviours generally) and incentives or penalties were seen as necessary for maintaining behaviours.
c) Many participants thought that energy interventions would help them to prepare for living in private accommodation where they paid energy bills. The living arrangements in halls of residence were not seen as conducive to managing energy usage.
d) Participants generally felt that culture shifts at the institutional level and among would help to encourage behaviour change. Previous research also indicates the importance of social motivations and that peer actions have a strong influence on individual behaviour (Peschiera et al., 2010; Peshiera & Taylor, 2012). Senbel et al. similarly argue that 'proximity to a community of action

towards reduced consumption' presents individuals with a new social norm, which then informs their own behaviour (2014:92).

e) Interventions that encouraged participation at an individual level were generally regarded more positively than those that required group participation. Individuals thought they would struggle to persuade others participate, and there was a potential for activities to cause conflict between flatmates.
f) Several participants mentioned that the UEA's Enlightened App could be utilised as an energy intervention to provide feedback or information on energy consumption.
g) Some participants felt that interventions needed to run regularly and over a period of time to make energy-saving behaviours habitual. Some also felt that interventions should be implemented at the start of the academic year to ensure new behaviours became part of routines and habits on campus.
h) There were mixed views about who should implement interventions, ranging from the university taking a more directive approach, to student bodies and Senior Student Residents (SSRs) that involved greater peer-to-peer interaction.

References

Aitken, C., Chapman, R., & McClure, J. (2011) Climate change, powerlessness and the commons dilemma: Assessing New Zealanders' preparedness to act, *Global Environmental Change*, 21, 752-760.

Alberts, G., Gurguc, Z., Koutroumpis, P., Martin, R., Muûls, M., & Napp, T. (2016) Competition and norms: A self-defeating combination? *Energy Policy*, 96, 504-523.

Amin, R., Teli, D., James, P., & Bourikas, L. (2016) The influence of a student's 'home' climate on room temperature and indoor environmental controls use in a modern halls of residence, *Energy and Buildings,* 119, 331-339.

Anshari, M., Almunawar, M.N., Shahrill, M., Wicaksono, D.K., Huda, M. (2017) Smartphones usage in the classrooms: Learning aid or interference? *Education and Information Technologies*, 22, 3063-3079.

Attari, S.Z., DeKay, M.L., Davidson, C.I., & de Bruin, W. (2010) Public perceptions of energy consumption and savings, *Proceedings of the National Academy of Sciences of the United States of America*, 107 (37): 16054-16059.

Azar, E., & Ansari, H.A. (2017) Framework to investigate energy conservation motivation and actions of building occupants: The case of a green campus in Abu Dhabi, UAE, *Applied Energy*, 190, 563-573.

Bekker, M. J., Cumming, T. D., Osborne, N. K. P., Bruining, A. M., McClean, J. I., & Leland, L. S., Jr (2010) Encouraging electricity savings in a university residential hall through a combination of feedback, visual prompts, and incentives, *Journal of Applied Behaviour Analysis*, 43 (2): 327-331.

Bodford, J.E., Kwan, V.S.Y., & Sobota, D.S. (2017) Fatal attractions: Attachment to smartphones predicts anthropomorphic beliefs and dangerous behaviors, *Cyberpsychology, Behavior, and Social Networking*, 20 (5): 320-326.

Devine-Wright, P., Devine-Wright, H., & Sherry-Brennan, F. (2010) Visible technologies, invisible organisations: An empirical study of public beliefs about electricity supply networks, *Energy Policy*, 38 (8): 4127-4134.

DiGiacomo, A., Wu, D., Lenkic, P., Fraser, B., Zhao, J., & Kingstone, A. (2018) Convenience improves composting and recycling rates in high-density residential buildings, *Journal of Environmental Planning and Management*, 61 (2): 309-331

Dounis, A.I., & Caraiscos, C. (2009) Advanced control systems engineering for energy and comfort management in a building environment—A review, *Renewable and Sustainable Energy Reviews*, 13, 1246-1261.

Emeakaroha, A., Ang, C. S., & Yan, Y. (2012) Challenges in improving energy efficiency in a university campus through the application of persuasive technology and smart sensors, *Challenges*, 3 (2): 290-318.

Emeakaroha, A., Ang, C. S., Yan, Y., & Hopthrow, T. (2014) A persuasive feedback support system for energy conservation and carbon emission reduction in campus residential buildings, *Energy and Buildings,* 82, pp 719-732.

Emeakaroha, A., Ang, C. S., Yan, Y., & Hopthrow, T. (2014b) Integrating persuasive technology with energy delegates for energy conservation and carbon emission reduction in a university campus, *Energy*, 76, pp 357-374.

Gadenne, D., Sharma, B., Kerr, D., & Smith, T. (2011) The influence of consumers' environmental beliefs and attitudes on energy saving behaviours, *Energy Policy*, 39, 7684-7694.

Grønhøj, A., & Thøgersen, J. (2011) Feedback on household electricity consumption: learning and social influence processes, *International Journal of Consumer Studies*, 35, 138-145.

Haller, M., & Hadler, M. (2008) Dispositions to act in favor of the environment: fatalism and readiness to make sacrifices in a cross-national perspective, *Sociological Forum*, 23, 281–311.

Huebner, R.B., & Lipsey, M.W. (1981) The relationship of three measures of locus of control to environment activism, *Basic and Applied Social Psychology*, 2 (1): 45-58.

Karp, A., McCauley, M., & Byrne, J. (2016) The value of adding ambient energy feedback to conservation tips and goal-setting in a dormitory, *International Journal of Sustainability in Higher Education*, 17 (4): 471-488.

Kelly, T.C., Mason, I.G., Leiss, M.W., & Ganesh, S. (2006) University community responses to on-campus resource recycling, *Resources, Conservation and Recycling*, 47 (1): 42-55.

Kollmuss, A., & Agyeman, J. (2002) Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behaviour? *Environmental Education Research*, 8 (3): 239-260.

Leape, J. (2006) The London Congestion Charge, *Journal of Economic Perspectives*, 20 (4): 157-176.

Lundberg, D.C., Tang, J.A., & Attari, S.Z. (2019) Easy but not effective: Why "turning off the lights" remains a salient energy conserving behaviour in the United States, *Energy Research & Social Science*, 58, 101257.

Marcell, K., Agyeman, J., & Rappaport, A. (2004) Cooling the campus: experiences from a pilot study to reduce electricity use at Tufts University, USA, using social marketing methods, *International Journal of Sustainability in Higher Education,* 5 (2): 169-189.

Maréchal, K. (2009) An evolutionary perspective on the economics of energy consumption: The crucial role of habits, *Journal of Economic Issues*, 43 (1): 69-88.

McKenzie-Mohr, D. (2000) New ways to promote proenvironmental behavior: promoting sustainable behavior: An introduction to community-based social marketing, *Journal of Social Issues*, 56 (3): 543-554.

McMakin, A.H., Malone, E.L., & Lundgren, R. (2002) Motivating residents to conserve energy without financial incentives, *Environment and Behavior*, 34 (6): 848-863.

Niemeyer, S. (2010) Consumer voices: Adoption of residential energy-efficient practices. *International Journal of Consumer Studies*, 34 (2): 140–145.

Peshiera, G., & Taylor, J. E. (2012) The impact of peer network position on electricity consumption in building occupant networks utilizing energy feedback systems, *Energy and Buildings*, 49, pp 584-590.

Peschiera, G., Taylor, J. E., & Siegel, J. (2010) Response-relapse patterns of building occupant electricity consumption following exposure to personal, contextualised and occupant peer network utilisation data, *Energy and Buildings,* 42 (8): 1329-1336.

Petersen, J. E., Shunturov, V., Janda, K., Platt, G., & Weinberger, K. (2007) Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives, *International Journal of Sustainability in Higher Education,* 8 (1): 16-33.

Poortinga, W., Sautkina, E., Thomas, G.O., Wolstenholme, E. (2016) *The English plastic bag charge: Changes in attitudes and behaviour.* Available from: http://orca.cf.ac.uk/94652/1/Cardiff_University_Plastic_Bag_Report_A4%20(final%20proof).pdf [Accessed 9th March 2021]

Rotter, J. B. (1966) Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs*, 80 (1): Whole No. 609.

Senbel, M., Ngo, V. D., & Blair, E. (2014) Social mobilisation of climate change: university students conserving energy through multiple pathways for peer engagement, *Journal of Environmental Psychology*, 38, pp 84-93.

Stern, P.C. (2000) Toward a coherent theory of significant environmental behaviour, *Journal of Social Issues,* 56 (3): 407–424.

Sweeney, J.C., Kresling, J., Webb, D., Soutar, G.N., & Mazzarol, T. (2013) Energy saving behaviours: Development of a practice-based model, *Energy Policy*, 61, 371-381.

Winett, R. A., Kagel, J. H., Battalio, R. C., & Winkler, R. C. (1978) Effects of monetary rebates, feedback, and information on residential electricity conservation, *Journal of Applied Psychology*, 63 (1): 73-80.

4. Student engagement with smart grid technologies: A longitudinal field trial

4.1. Introduction

Smart Home Technologies (SHTs) figure prominently in future energy visions. Proponents of such visions contend that extending and integrating the functionality already provided in homes by a range of information and communication technologies will contribute to ‘‘better living’’ (e.g. Friedewald et al., 2005; Park et al., 2003). Their alleged benefits for end-users are manifold: comfort, security, scheduling tasks, convenience through automation, energy management and efficiency; and for specific end-users, health and assisted living (Balta et al., 2013; Cook, 2012; Rashidi, 2009). This functional view points to a wide variety of tasks and activities that smart homes could help people achieve: remotely controlling specific appliances, improving memory and recall through automated reminders, enhancing security, and so on (Park et al., 2003). A more clearly instrumental view of smart homes emphasises their potential to help achieve energy demand reduction goals. The smart home is seen as an important technological solution in delivering an affordable low-carbon energy transition (e.g. Martiskainen and Coburn, 2011; Lewis 2012) or sustainability more generally (Chetty, Tran, and Grinter 2008). Firms such as Honeywell Home[4] claim that smart home technologies (SHTs) can save up to 40% of energy costs without compromising comfort.

Given these anticipated benefits, it is hardly surprising that the smart home market is forecast to grow dramatically by 2030 (International Energy Agency, 2013), or that SHTs are seen as a key part of ambitious decarbonisation visions (e.g. Department of Energy and Climate Change, 2009; European Commission, 2015). It is, however, far from clear that SHTs will generate the level of energy savings claimed, with emerging research casting significant doubts on their energy-saving potential. For instance, Balta-Ozkan et al. (2013) detail three key social barriers to the adoption and effective use of SHTs: a) their potential misfit with the current and ever-changing lifestyles of energy users, b) issues relating to the ease with which SHTs can be administered (e.g. installation and maintenance), and c) concerns over privacy, security, interoperability between systems, and their reliability. Mennicken and Huang (2012) thus conclude that ‘living in and with an actual smart home today remains an imperfect experience’. Moreover, alluring smart home visions may conceal numerous ‘hidden energy costs’ that could even result in increased energy consumption (Nyborg and Røpke, 2011; Strengers et al., 2016).

Ultimately, the success or failure of SHTs, and what impacts, if any, they have on energy demand, depends on whether and how they are used by residents. The use and meaning of technologies will be

[4] See for instance: https://getconnected.honeywellhome.com/en/evohome

socially constructed and iteratively negotiated, rather than being the inevitable outcome of assumed functional benefits (Strengers 2013). Households in particular are complex places in which multiple household members with different roles and relationships with technology (Mennicken & Huang, 2012; Nyborg, 2015) may interact and negotiate their wants and needs (Baillie & Benyon, 2008). Furthermore, effective SHTs must be able to cope with routine and oftentimes competing everyday practices and improvised user behaviours (Mennicken et al., 2014). Finally, as individual energy users are typically focused on addressing pressing everyday needs and may have little interest in or sufficient time to understand everything a smart home can do, SHTs must not leave their users feeling out of control by overpowering with too many options or hard-to-use controls (Park, Won, Lee, & Kim, 2003; Mennicken et al., 2014).

Unfortunately, and in spite of growing interest in encouraging consumer adoption of SHTs, surprisingly little is known about the aforementioned interactions between people and SHTs (e.g. Balta-Ozkan et al., 2013; Hargreaves, Wilson, and Hauxwell-Baldwin, 2018). The few studies that have explored these interactions have focused on early adopter and special-interest groups (e.g. Bernheim Brush et al., 2011; Mennicken & Huang, 2012; Mozer, 2005; Woodruff, Augustin, & Foucault, 2007), or on small clusters of householders with pro-environmental and energy-saving attitudes (Hargreaves, Wilson, and Hauxwell-Baldwin, 2018). Further, and with the notable exception of Hargreaves, Wilson and Hauxwell-Baldwin (2018), these studies have typically been quite short-term, thus neglecting longer-term trajectories and learning processes of technology integration into everyday routines.

This gap is especially prominent in research on residential campuses. Halls of residence have, undoubtedly, attracted attention as a setting for research on the implementation of pro-environmental behaviours and there is now an extensive literature on the effects of different types of interventions on students' energy consumption and the factors promoting and hindering energy efficient behaviours (e.g. Marcell et al., 2004; Petersen et al., 2007; Marans & Edelstein, 2010; Parece et al., 2013; Savageau, 2013; Alberts et al., 2016; Bulunga & Thondhlana, 2018). A range of interventions have been employed and critically researched in halls of residence, including: education (e.g. Marcell et al., 2004; Mosher & Desrochers, 2014; Senbel et al., 2014), competitions and incentives (e.g. Petersen et al., 2007; Alberts et al., 2016; Schultz et al., 2017), feedback (e.g. Petersen, et al., 2007; Bekker et al., 2010; Wisecup et al., 2017), energy delegates/leaders (e.g. Parece et al., 2013; Emeakaroha et al., 2014a; 2014b), prompts (e.g. Parece et al., 2013; Bulunga & Thondhlana, 2018), and self-management (e.g. Karp et al., 2016; Schultz et al., 2017). Given, however, that the abovementioned research has uncovered a plethora of challenges in promoting pro-environmental behavioural change, it is critically important to consider whether technological retrofits might be better suited in supporting sustainable energy behaviours amongst university students living on campus.

With SHTs figuring prominently in the portfolio of energy solutions put forth by the Intelligent Community Energy (ICE) consortium (see Work Package 3 Deliverables), a core aim of this chapter is, therefore, to explore how UEA residents learn about, use and adapt to SHTs. Against a backdrop of survey and focus group data presented in the previous two sections and demonstrating that the UEA community (staff and students) are highly likely to actively support a sustainable energy transition in light of their pro-environmental attitudes and existing engagements with sustainable behaviours, the analysis presented in this chapter seeks to shed light to the ‘value-action gap’, i.e.: ‘the observed disparity between people's reported concerns about key environmental, social, economic or ethical concerns and the lifestyle or purchasing decisions that they make in practice’ (Sustainable Development Commission, 2006: 63). In doing so, this section provides one means of casting greater scrutiny over optimistic claims about the energy-saving potential of SHTs.

We address this critical gap by drawing on original data from UEA’s residential campus, where two flats of residence (incorporating 20 individual student rooms) have trialled smart heating controls over the course of two years. By drawing on in-depth qualitative findings of a field trial of SHTs installed in two Living Labs, we aim to develop existing understandings of how student residents learn about, use and adapt to SHTs in their own residences over the longer-term to help assess the potential role and value of SHTs in future energy transitions. In doing so, we move significantly beyond both a functionalist and instrumental view of smart technologies (e.g. Martiskainen and Coburn, 2011; Lewis 2012). Rather than focusing on presenting their benefits for end-users as both obvious and manifold, or on the potential of such technological solutions to help achieve energy-demand reduction goals, with associated benefits for households, utilities and policymakers, we take a socio-technical view. Following this socio-technical view, we seek to emphasize how the use and meaning of technologies will be socially constructed and iteratively negotiated, rather than being the inevitable outcome of assumed functional benefits (Strengers 2013).

We respond to Mennicken et al’s (2014) calls for more ‘in-the-wild’ research exploring how SHTs are integrated into existing residential settings. We especially draw on ‘domestication theory’ to provide insights into the active work involved in ‘taming’ ‘wild’ new technologies when integrating them within households (Berker, Hartmann, Punie, & Ward, 2005). From this point of view, the adoption of new technologies is seen as successful when ‘new technologies are not regarded as cold, lifeless and problematic, but as comfortable, useful tools […] that are reliable and trustworthy’ (Juntunen, 2014, p.2).

These conceptual understandings move significantly beyond both the ‘adoption curve’ theory (Rogers, 1983) implying a passive role for individual consumers who simply adapt to what is offered to them, and theories of planned behaviour introduced in the first main chapter of this report and envisioning consumers as very active individuals who exercise their agency by simply acting upon their beliefs and values. Instead, 'domestication theory' emphasizes:

a) How technologies and individuals co-evolve as technologies enable new routines and identities and are thus given particular functions and meanings in everyday life (Haddon, 2006; Oudshoorn and Pinch, 2003).
b) How the domestication of new technologies involves negotiations and conflicts between individual householders – as they become main users or non-users, or as some features come to be seen as useful whilst others are disregarded ((Sørensen, 1994; Wyatt, 2003; Isaksson, 2014).
c) How technologies and their usefulness are ultimately negotiated as faults emerge, newer technologies are acquired, or as the life circumstances and lifestyles of users change (Sørensen, 1994).

Following Lehtonen (2003) and Sørensen (1994; 1996), it can be argued that the domestication of new technologies unfolds over four distinct stages (see Figure 4.1).

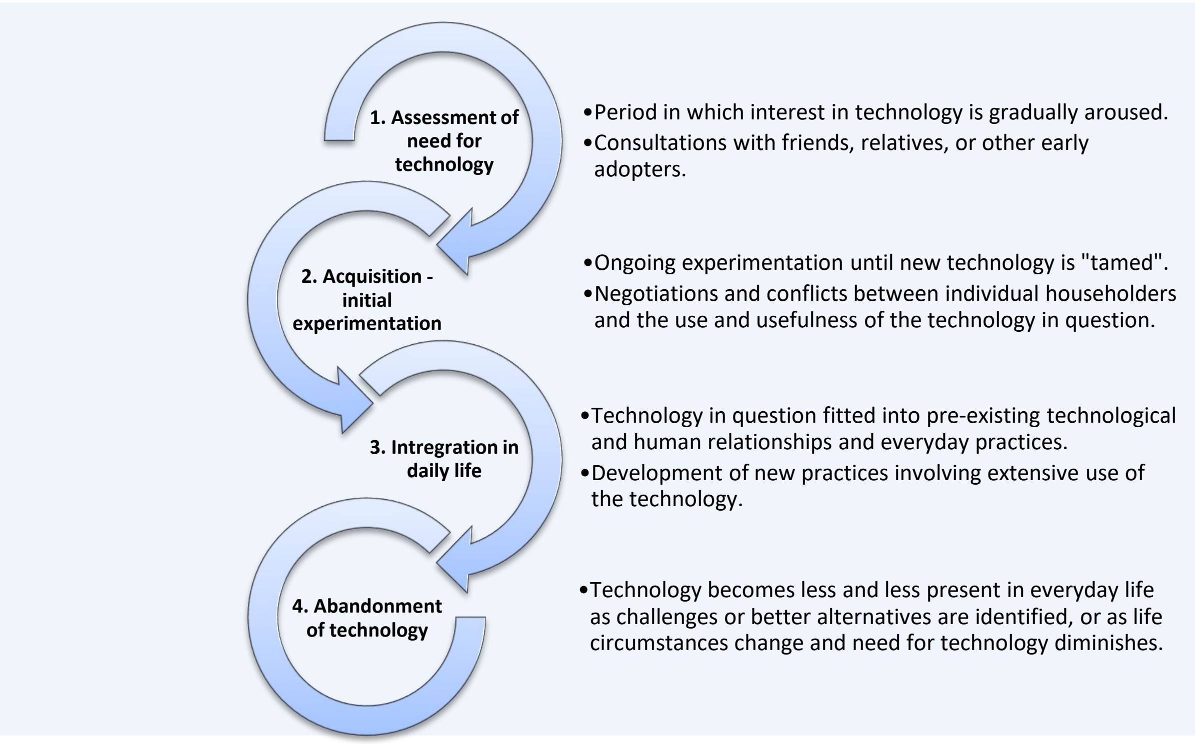

Figure 4.1: Stylised model of technology domestication processes

As part of our research on the UEA campus, we focus on the domestication process following the initial acquisition of smart home technologies (i.e., Stages 2-4 in the domestication model above). In doing so, we pay special attention to three distinct, yet interrelated types of work individuals undertake at the initial stages of 'taming' new technologies (Sørensen, 1996):

a) *Cognitive work* – i.e., learning about the new technology and its capabilities;
b) *Practical work* – i.e., developing practical know-how to be able to use the new technologies;
c) *Symbolic work* – i.e., learning about and constructing the meanings of new technology, and incorporating these in pre-existing user identities.

4.2. Methods

The central research design for this study is a fully operational Living Laboratory. A Living Laboratory refers to a user-centred sort of social experiment with the objective of testing a novel technology or intervention in a real-world and real-time environment (Korsnes et al., 2018, Voytenko et al., 2016). Claude et al. (2017) note that Living Laboratories have emerged as a useful research design for helping treat potential adopters or consumers as active agents in the creation or innovation process, rather than merely passive agents. Canzler et al. (2017) add that Living Laboratories enable "experimentation" spaces where inventions can be co-created, tested, and even validated by possible users. Living Laboratories have also become an essential feature in various literatures discussing "transition experiments " as well as "sustainability experiments" (Korsnes et al., 2018; Sengers et al., 2018).

Specifically, in September 2019 the ICE (Intelligent Community Energy) project recruited 40 students residing on UEA's campus. Recruitment materials including posters and communications via university-wide newsletters, bulletins and mailing lists, and presented the trial as: (a) an opportunity to experience new SHTs related to energy management, security and convenience, and (b) an opportunity to evaluate such systems and their effectiveness on the UEA campus and, subsequently, inform UEAs future energy policies. The final sample of 40 students were shortlisted on the basis of technical convenience: they had to reside in close proximity to each other to enable easy and cost-efficient installation and management of the SHTs. Furthermore, the students were divided into two groups of 20. Half the sample were assigned to one of two Living Labs (University Village, Courtyards A and B) and participated in the technological intervention and all qualitative and quantitative research activities; the other half were assigned to Control Flats and their energy use and energy-related behaviours were only monitored to enable comparisons with the Living Labs and their inhabitants.

The Living Lab trial sought to explore how student residents engaged with SHTs. Accordingly, we focused on delivering a system that was reliable and functional – offering a range of services including energy management, home monitoring, automated and remote control of devices, and easy access to data, and that they offered a range of smart home services.

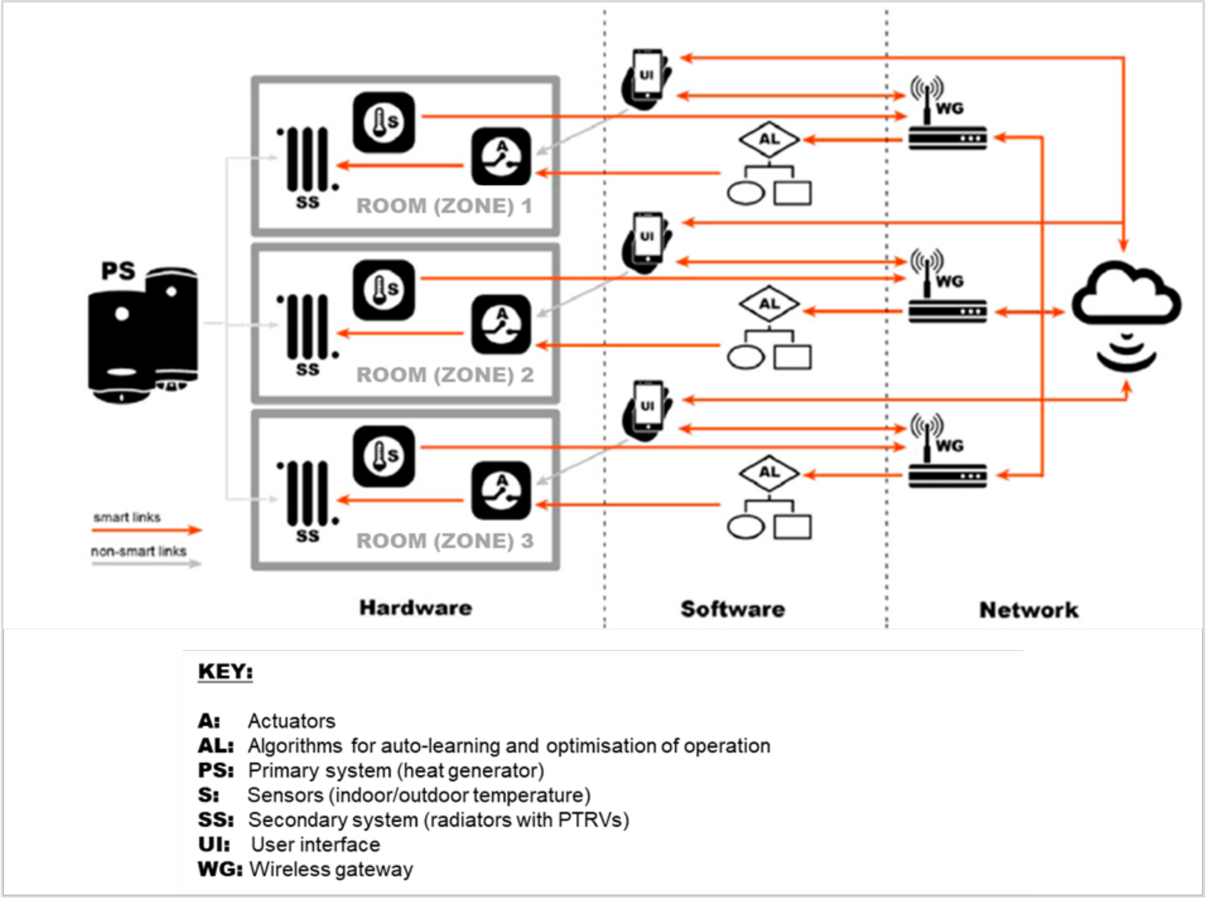

Figure 4.2: Schematic representation of all the components and connections of the smart heating system designed and delivered in multi-zonal residential units on the UEA campus. (NB – Whilst student flats at the UEA typically comprise of 8-10 individual rooms, the diagram includes only 3 rooms/zones in the interest of simplicity.)

Specifically, the smart heating system designed and developed within residential buildings on the UEA campus was based on Honeywell's EvoHome and includes 7 key components, including hardware, software and network components (see Fig.4.2 above for a simplified schematic representation of the system):

a) A zoning control system that enables the independent operation of radiators in individual student room (previously managed centrally at the flat level).
b) Programmable Thermostatic Radiator Valves (PTRVs) installed in individual rooms/radiators. These are battery-operated and have motorised valves and temperature sensors to control the flow of hot water to the radiators according to a target temperature schedule assigned for the room where the radiator is located. (NB – In contrast to conventional TRVs that are only adjustable to 5-6 different levels and, thus, leave householders without a clear understanding of what temperature each level is representing, exact temperatures can be adjusted using these PTRVs).

c) A central controller which communicates wirelessly with the PTRVs and through which the schedules for the target temperatures can be set remotely. (NB – Temperature settings can be manually overridden by the occupants if/when needed).

d) Sensors for monitoring the outdoor conditions and indoor (ambient) temperature – connected, through actuators, to the heating units/system to control their operation based on instructions received by the control algorithm. These enable on/off automatic control of heating units based on: (a) the outdoor weather conditions, (b) indoor temperature, and/or (c) whether windows are open (i.e. auto-window function that closes the radiator valve when ventilating the room).

e) A wireless user interface (mobile/tablet app and online platform) allowing users to set up and plan the heating profiles/ set-point temperatures and receive feedback about outdoor and indoor conditions and energy consumption. Up to six set points per day and three different set point temperatures can be set, and users can also choose from three pre-set operation modes – namely 'Eco', 'Holiday' and 'Day-Off' modes depending on their occupancy and specific needs.

f) Auxiliary clamp-on energy (gas) meters recording energy use data accessible through a dedicated online interface.

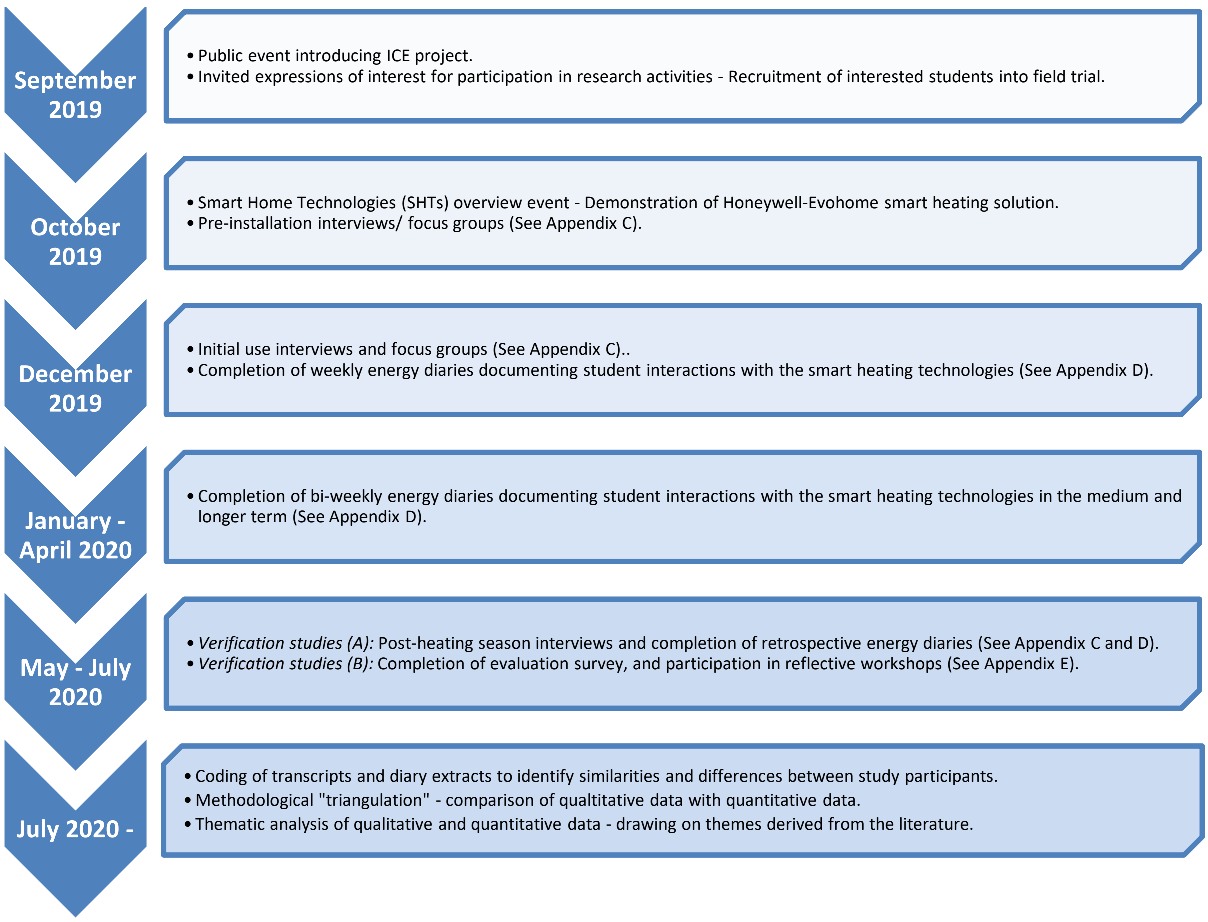

Figure 4.3: Timeline of qualitative research methods employed in longitudinal study of study engagement with smart home technologies

Alongside collecting a series of quantitative data on energy use and temperature settings, a large amount of qualitative data was collected at four key points (see Figure 4.3). Specifically:

a) An initial interview and a series of focus groups were conducted with all students before the installation of SHTs. Lasting two to three hours, Activity 1 explored how participants used their rooms/ flats, and decision-making around new technologies.
b) As part of Activity 2, further interviews and focus groups were conducted and students were invited to complete energy diaries over a two-week period. These tasks aimed to explore initial uses and responses to the SHTs.
c) As part of Activity 3, fifteen students completed reflective energy/ heating-use diaries detailing their medium-term use of the system.
d) Finally, at the end of the heating season/ academic year, students participated in a series of interviews and focus groups and were invited to complete retrospective energy diaries detailing their longer-term usage of the SHTs, and an evaluation survey.

4.3. Findings

Analysis of data collated by the SHTs confirmed our concerns that the system would not generate the level of energy savings we had initially hoped for. On the one hand, participation in the SHTs trial was principally driven by either an interest in protecting the environment or a desire to save energy (16 participants), with only a minority of participants (n=4) participating solely because of their interest in exploring new technologies and their ability to provide improved control and comfort. On the other hand, however, there was a sharp discrepancy between an initially expressed interest in the technologies and actual user engagement with them to either reduce energy consumption or improve heating control and experienced comfort.

As Figures 4.4 and 4.5 demonstrate, energy savings for both Living Labs were generally short-lived and, after around 14 weeks of residing in a Living Lab, students reverted to more energy-demanding heating behaviours. In particular, following an initial phase of familiarisation with the new technologies (weeks 1-4) where students living in the two Living Labs only consumed marginally less energy than those residing in control flats (-5.67% and -5.52% for Courtyards A and B respectively, we recorded extensive energy savings; between weeks 4 and 14, students residing in the Living Labs in Courtyards A and B, consumed -30.73% and -39.99% less energy respectively when compared against their peers residing in control flats. However, as highlighted by Figure 4.6, these savings were only short-lived. Between weeks 14 and 26, these students consumed considerably more energy when compared against students living in control flats (11.08% and 17.11% more energy used in Living Labs in Courtyard A and B respectively).

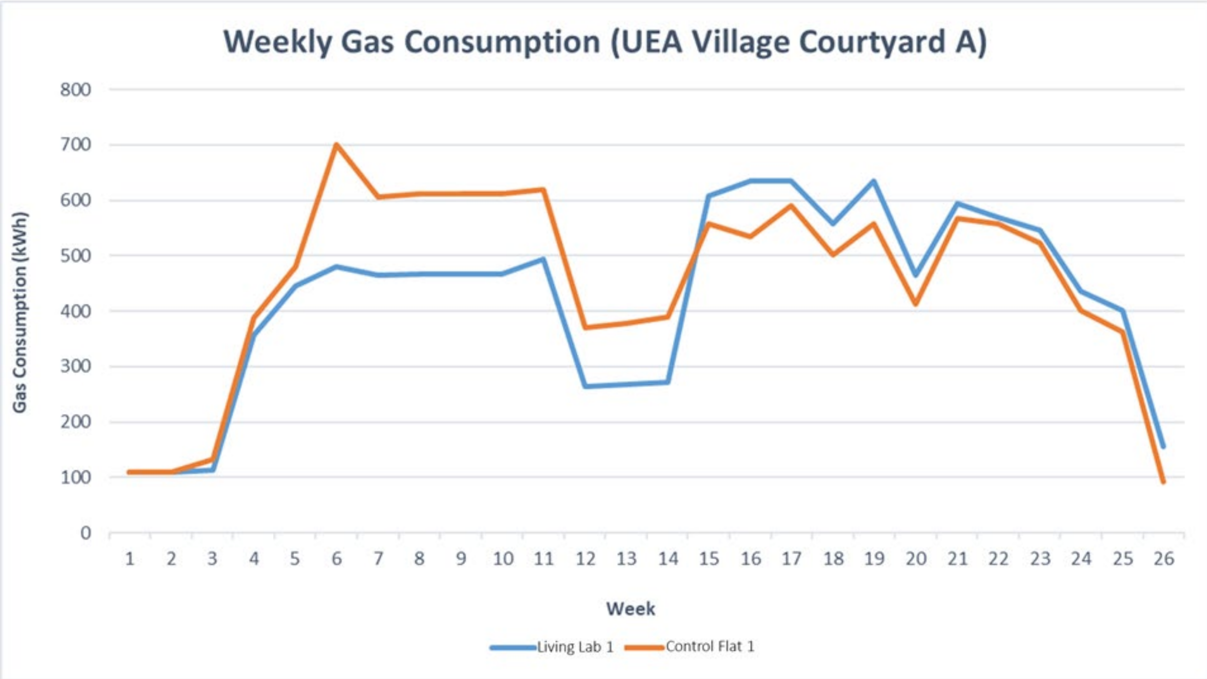

Figure 4.4: Weekly gas consumption (heating) in Living Lab and Control Flats 1 (UEA Village, Courtyard A).

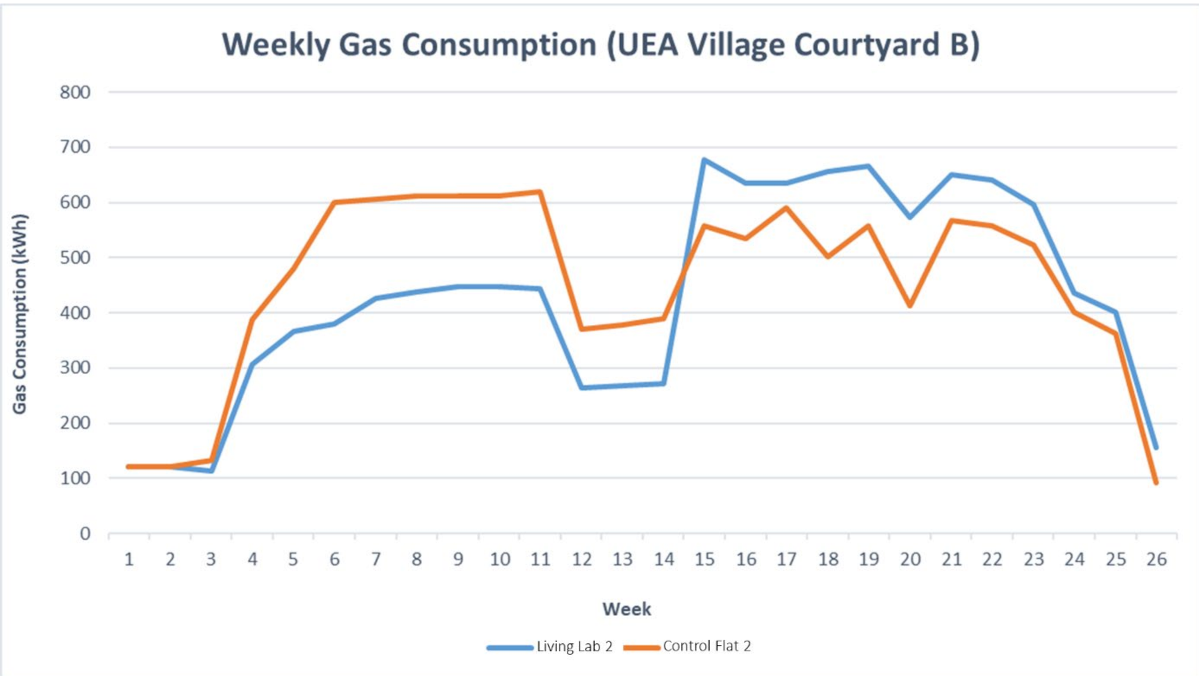

Figure 4.5: Weekly gas consumption (heating) in Living Lab and Control Flats 2 (UEA Village, Courtyard B). NB: Dip in energy use between weeks 12 and 14 is attributed to the winter holiday period when the majority of students were away from their rooms on campus for several days/ weeks.

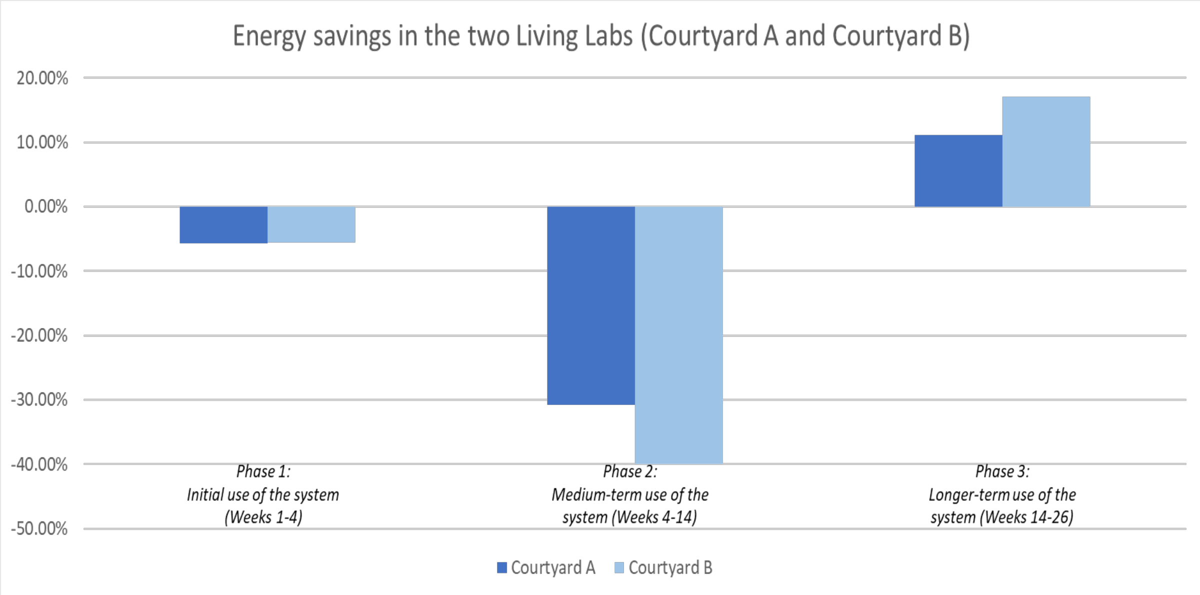

Figure 4.6: Energy savings in UEA's two Living Labs (compared against control flats)

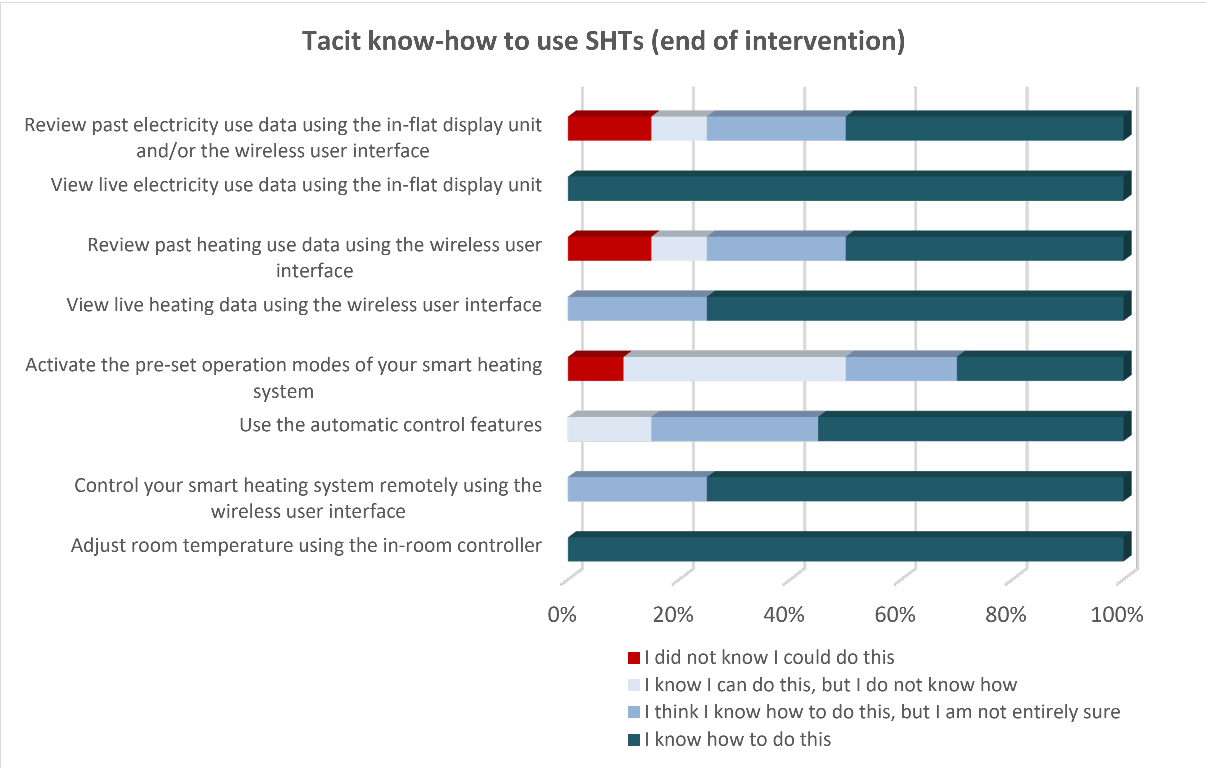

Figure 4.7: Tacit know-how to use specific features of the SHTs – as recorded at the end of the field trial

In parallel, rather than recording ever increasing levels of familiarity with the various features of the smart home system, by the end of intervention most students had only "tamed" successfully the most basic features of the system such as viewing live energy use data and adjusting room temperatures using the in-room controllers (see Figure 4.7).

This comes as no big surprise given the levels of student engagement with the smart home technologies. Rather than recording ever increasing levels of engagement with the various features of the smart system over time, we recorded an eventual fade-off of interest in using all features of the smart heating thermostats (see Figures 4.8 - 4.13).

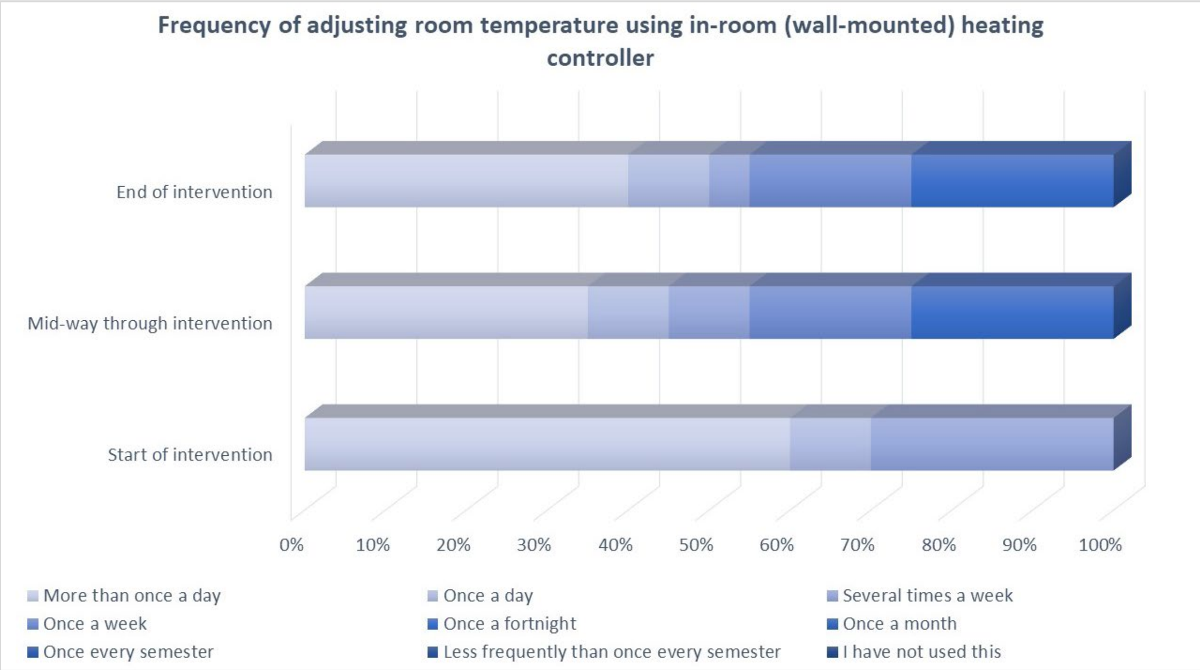

Figure 4.8: Reported frequency of adjusting room temperature using in-room heating controller

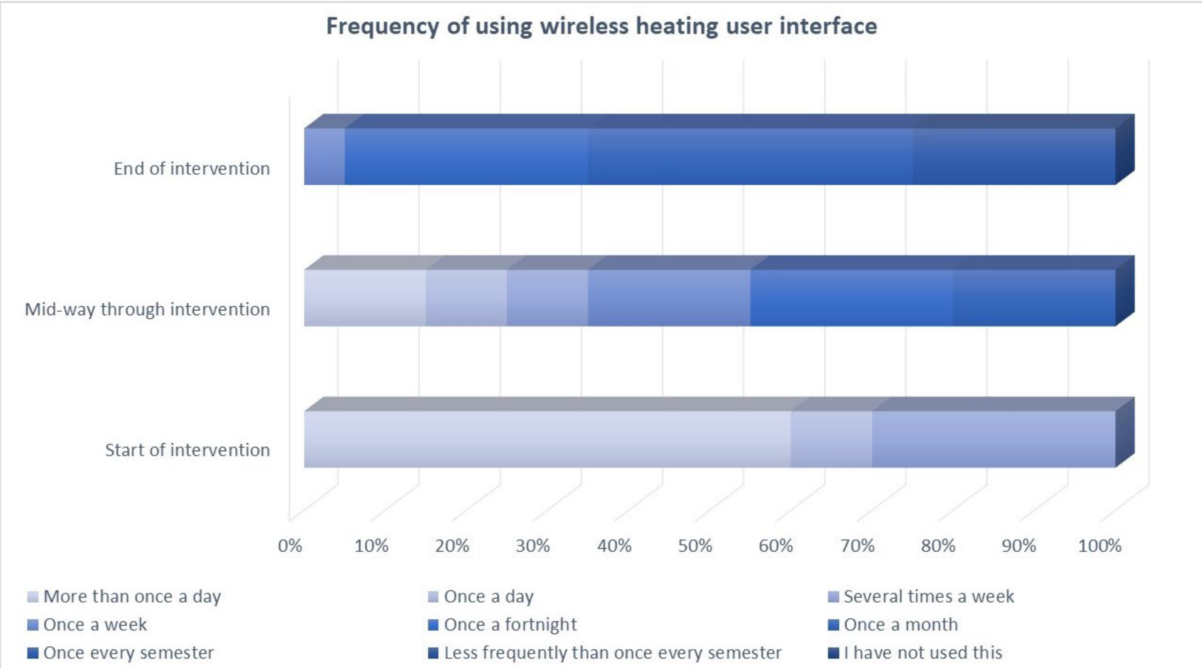

Figure 4.9: Reported frequency of using wireless heating user interface

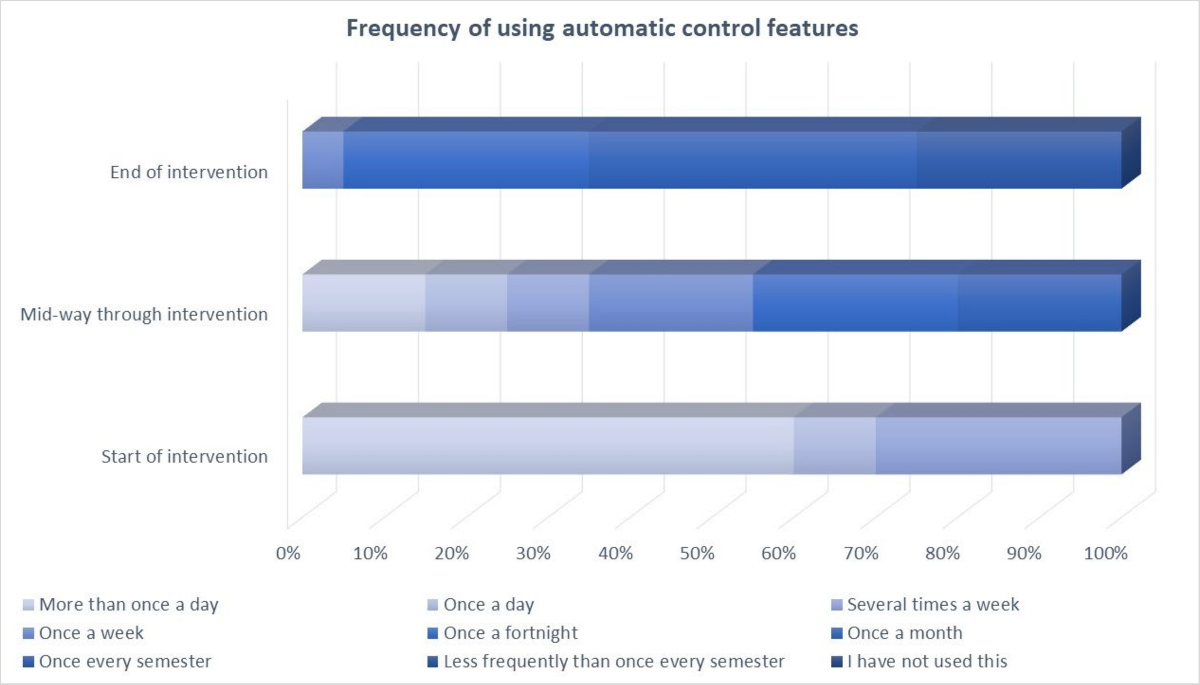

Figure 4.10: Reported frequency of using automatic control features

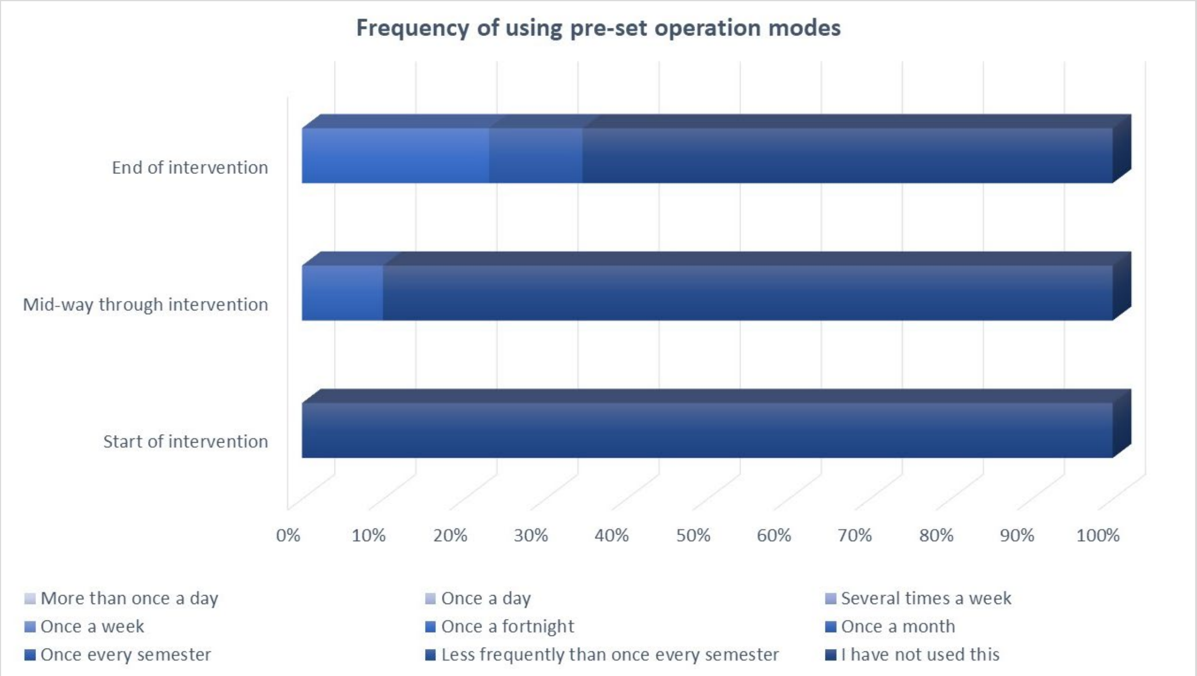

Figure 4.11: Reported frequency of using pre-set operation modes of the Honeywell-Evohome system

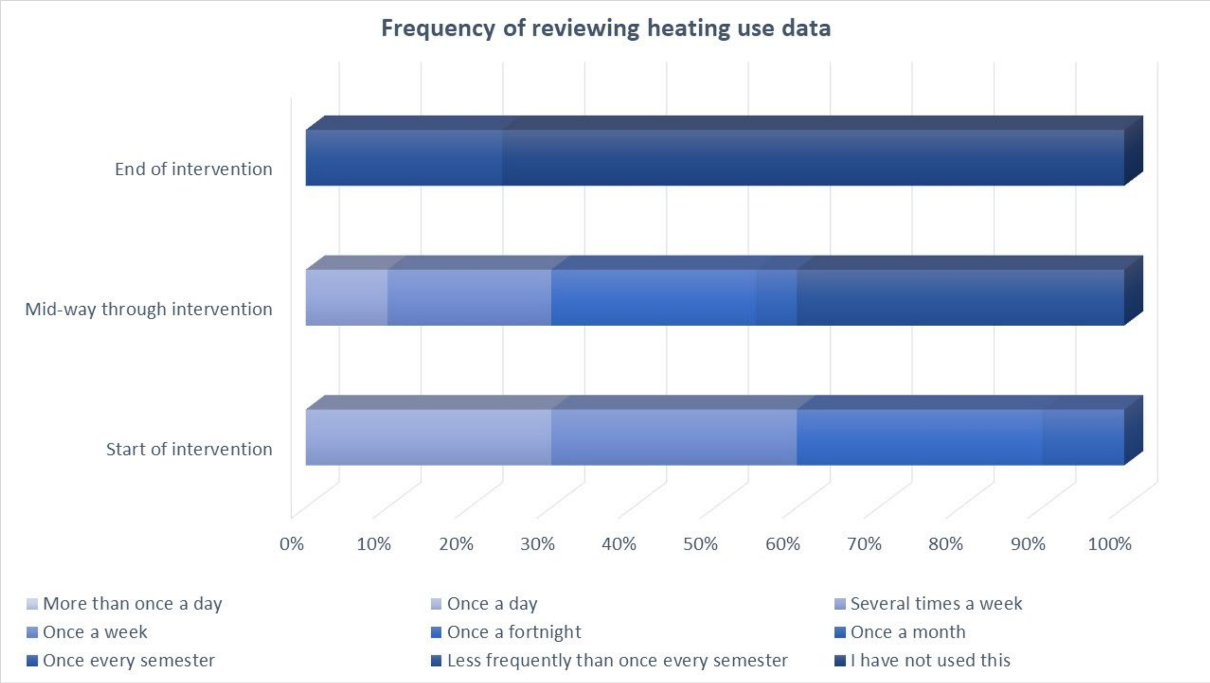

Figure 4.12: Reported frequency of reviewing data on individual energy demands for heating

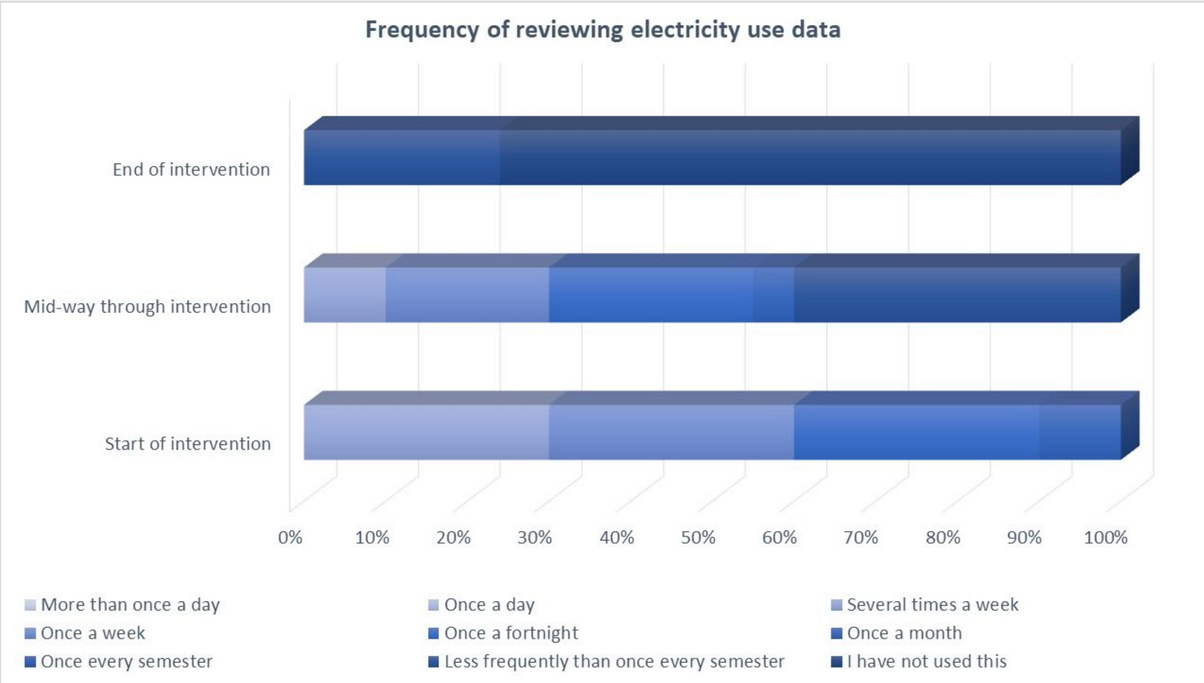

Figure 4.13: Reported frequency of reviewing data on individual electricity consumption

Specifically:

a) Whilst 65% of participants used the wall-mounted heating controllers on a daily basis on average at the start of the trial, usage gradually declined. Only 35% of participants used these controllers on daily basis towards the end of the study, and up to 28% of participants only used the controls once a month (see Figure 4.8).

b) Whilst wireless controls were used once a day by the majority of participants at the start of the trial, this number gradually decreased over the course of the intervention. By the end of the trial, the vast majority (95%) of participants used such wireless controls between once every fortnight and once per semester on average (see Figure 4.9).

c) Similarly, while most participants experiments with automatic control features on a daily basis at the start of the intervention, by the end of the trial the vast majority (95%) of participants only used such features between once every fortnight and once per semester on average (see Figure 4.10).

d) Pre-set operational modes were consistently under-used by all participants, with up to 70% of participants stating that they had never used these features by the end of the trial (see Figure 4.11).

e) Finally, while there was some interest to review heating and electricity use data at the start of the intervention (e.g. 25% of participant reviewed such data once a week on average), interest gradually declined. Up to 80% of participants in the trial rarely reviewed their energy data (i.e. stating that, on average, they reviewed such data less frequently that once per semester) (Figures 4.12 and 4.13).

Student engagement with the SHTs is, therefore, best understood by reference to three distinct phases of interaction defined by overall declining extends of engagement:

a) An initial phase where, following a short period of unease and uncertainty, participants experimented broadly with the various features of the smart system (See Section 4.3.1);

b) A second phase marked by comparatively lower levels of engagement and usage of the system in strikingly different ways by participants (see Section 4.3.2); and

c) A final phase (long-term usage) marked by declining interest in the system by even the most motivated individuals (see Section 4.3.3).

4.3.1. Initial use of the system

Whilst some configuration of the smart control system was completed during installation, several students involved in the intervention mentioned that they then largely ignored the technologies, sometimes for several weeks. Different reasons were given for this. For some, installation in early autumn meant they were waiting for the right time, either waiting for the heating season before automating or scheduling heating, or developing a sense of what living on campus entails in practice before starting to experiment with different settings of energy-saving behaviours:

'There was no much point experimenting with the system and learning to use the system as soon as I moved to the flat. There simply wasn't any need for heating at the time, so why bother familiarising yourself with the system when you'll end up forgetting how to use different functions before the start of the heating season?' (Participant 3, focus group, December 2019)

'Moving to the campus, having to live on your own for the first time, sharing facilities with several other flatmates, takes getting used to; developing new routines, learning how to do different things and use the equipment available, learning how to live with and respect each other… It's a challenging time and, during this period of adaptation, you inevitably just focus on that: adapting to the new circumstances. So using the system comes at a later stage; you first learn how to live on campus, and then start exploring ways of making your energy use more efficient, of using some of the advanced functionalities of the system, etc.' (Participant 11, interview, December 2019)

For others, including individuals who desired heating at an earlier stage in the autumn semester, the delay primarily occurred because they were unsure of the uses and usefulness of the smart heating system:

'It's taken several to use it and understand where it's useful. ... It wasn't entirely clear what parts of it you can do straight away, especially given restrictions put in place by the Estates Department' (Participant 7, interview, December 2019).

'I just wasn't sure how to use the different features, or even what to make of the energy usage information provided.' (Participant 19, focus group, December 2019).

The induction event that demonstrated the use of the system and the installation process itself also made some students realize that the systems would take time to configure fully and properly; time they could not always find as other aspects of their busy university lives prevented them from adequately engaging in the demanding work of technology domestication:

'The problem is trying to find the time to experiment with the software […] learning how to use it I think, because it is quite demanding.' (Participant 13, reflective energy diary, December 2019).

'You can pretty much get your job done by simply adjusting the thermostat on you wall. Why waste time familiarising yourself with other features of the smart heating system? Time you could instead spend hanging out with your friends, finding your way around the campus and the city, studying for your classes…' (Participant 5, focus group, December 2019).

The multiple different functions the systems provided arguably aggravated the situation. The students involved in the trial initially had to work hard to identify exactly how they could the system could be of any use to them. Only upon identifying useful practical applications for them could they start the demanding task of making use of the system. In other words, the participating students found the initial cognitive and practical work of domestication very challenging.

Nonetheless, once participants did start using the smart home systems, six distinct types of use were identified:

a) Setting heating schedules (*n* = 9);

b) Remote control of heating (*n* = 4);

c) Setting rule profiles for radiator use (*n = 2)*;

d) Activating/deactivating automatic heating controls (*n* = 5);

e) Manual use of heating via wall-mounted or radiator thermostats (n = 20; NB: although most students combined automated and manual control, 9 students did this exclusively);

f) Review of energy (electricity and gas) use data and subsequent experimentation with energy saving behaviours (*n = 13*).

Some of the more technically proficient student participants stated a desire to *'play'* with advanced, features of the Evohome system, such as setting automated rule profiles (e.g. to switch radiators off whenever a door or a room window was open). Once technically proficient participants started using the systems, however, they generally reverted to more basic system uses, e.g. manual control, or using the system as if it were a programmable thermostat,.

Nine students self-described as *'technophobes'*, and saw themselves as particularly technologically inept, resulting in exclusive manual use of the Evohome system. In two of these cases this even led non-users to resist the smart home systems as a whole and, ultimately, to their abandonment. Three further students who were unwilling to use the system also expressed a feeling of loss of control. In particular, these three individuals expressed unease about feeling watched or monitored when the systems were first installed. This was not helped by: (a) the small noises made by the radiators when they automatically turned on or adjusted themselves, and (b) the bi-weekly visits by members of the Estates Department who wanted to collect system performance and energy use data and, thus, inadvertently, reaffirmed the sense of being constantly monitored by the University. These examples of resistance and feeling out of control reveal the significant challenges participants faced in conducting the symbolic work of constructing the meaning of the Evohome system and incorporating it into individual identities.

In summary, during these initial stages of the smart heating trial, the cognitive, practical and symbolic work of domestication was particularly challenging for the students. Importantly, these different forms of domestication work were not always undertaken by the same students, nor were all students living in a flat evenly engaged in the domestication process. Whilst technically proficient participants enjoyed the practical and cognitive work of learning to use the Evohome system, this was easily thwarted by their flatmates who found the symbolic work too demanding and thus resisted the incorporation of the system in their heating practices. This uncovers the critical importance of treating the flat as a whole system and not just as a collection of student rooms when analysing new technologies, and of understanding the many potential roles of both users and non-users in smart technology domestication processes. (cf. Nyborg, 2015).

4.3.2. Medium-term use of the system

Over the medium-term, the students involved in the trial generally made less rather than more use of the advanced features of the system. Rather than progressively using advanced functions as the systems became more familiar, simpler forms of use tended to emerge. Nine students reverted to exclusively manual control, avoiding computers or smartphones altogether. Most stopped checking door/window sensors regularly and using timer schedules whilst away from their rooms.

Whilst some automated functions remained in use throughout the trial, the experience for most was that it *'just pottles along in the background and [they] don't tend ... to do so much with it' (Participant 9, reflective energy diary, February 2020).* Several participants mentioned that they now simply manually adjusted their heating settings whenever needed. For the more advanced capabilities of the systems had *'complicated [their] lives, [because] before [they] would blissfully set everything and leave it running for several months' (Participant 2, reflective energy diary, March 2020).* Most participants, however, saw little need to engage with the systems. As Participant 14 *(reflective energy diary, March 2020)* indicatively asserted: *'if it's working decently, then nobody will go into all the trouble of using high-tech features that only marginally – if at all – improve things'.*

A dominant theme in the interviews, energy diaries and evaluation surveys was that using the smart home technologies demanded a significant amount of learning without much benefit. Three types of learning were described. The first form related to the practical work of learning to configure and use the smart heating systems. Here, almost all participants were somewhat negative about their design, with devices almost universally described as rather complicated, tricky, confusing, or even potentially easy to break. Furthermore, where participants experienced operational problems, they mentioned that there was a general lack of sufficient instructions, or because the in-house maintenance team of the

Estates Department lacked the necessary skills and technical know-how to repair the systems. The challenge of learning to use and maintain the smart systems was thus considerable.

The second form of learning involved the cognitive work of identifying what the smart heating systems could be used for. Several participants mentioned that, beyond controlling heating temperatures, they could not identify additional meaningful uses. For example, as one student indicatively asserted: *'I get this feeling that there's probably some more that I can get from it' (Participant 3, reflective energy diary, April 2020).* Specifically, the occupants of UEA's Living Labs often felt they were not using the smart heating systems to their full potential and called for more help. Several students felt it would be useful for the systems themselves to make suggestions, such as providing advice on energy saving, or templates that demonstrated their potential functionality.

The third form of learning focused on the symbolic work of incorporating the smart systems into their identities and working out how to adapt to get more out of the smart systems. Multiple students described how they felt that smart technologies would increasingly become the norm and that there was therefore a need *'to get to grips with using this stuff' (Participant 1, reflective energy diary, March 2020).* One research informant, for example, suggested that realizing the full benefits of smart technologies may require *'that you have to look at the other things that they link into' (Participant 11, reflective energy diary, April 2020)*, and thus to acquire still other smart home technologies that could be connected into a wider home network. Indeed, the introduction of the smart home technologies served to disrupt and unsettle the status of some older technologies in the respective flats. Indicatively, multiple students came to perceive their existing radiators and boilers as *'old'*, somehow insufficient and in need of replacement, or potentially unable to cope with the additional demands they perceived the smart control systems would place on them. Finally, two students commented that the Honeywell-Evohome system could not be used fully to switch on their devices because they were unable to override specific thresholds set by the Estates Department. In short, the symbolic work of domesticating new smart home technologies called into question and reopened the meaning and symbolism of other, older domestic appliances that were now seen to need replacement.

In spite of these examples, the general feeling among participants was that *'the system should learn to react to our needs and desires rather than relying on our reactions' (Participant 10, reflective energy diary, April 2020)*. Rather than adapting themselves to the systems, most students had instead symbolically adapted their understanding and use of the smart home technologies so they came to resemble familiar technologies, such as a *'traditional heating system found in everyone's home' (Participant 9, reflective energy diary, April 2020).*

4.3.2.1. Medium-term use of the system. temperature preferences and trade-offs between comfort, convenience and pro-environmental values

Given that the students involved in the research ultimately focused on incorporating the new systems into their own realities in a way that preserved their pre-existing identities, it came as no big surprise that different students prioritised different things whilst using the system in the medium-term.

Specifically, drawing from the extensive qualitative data collected, occupants of UEA's two Living Labs were found to hold very different preferences that could be summarized as either prioritizing: (a) comfort, (b) convenience, or (c) pro-environmental value. These three rationales were categorized based on a number of criteria demonstrated in interviews and segmentation responses.

Comfort-focused individuals discussed valuing the enhanced control they received and the extra reassurance they could stay comfortable. Comfort was therefore a significant feature emphasized by multiple students, irrespective of their levels of environmental concern:

> *'The room has never been so warm… I've noticed a massive difference... Because now, you know, we can actually control our own radiators […] My room was always so cold because I couldn't adjust the temperature – I just had no way of overriding the default temperature set by Estates… But with these new thermostats, I can always ensure it's nice and warm, irrespective of time or how cold it is outside… It's nice to keep it that way!' (Participant 10, reflective energy diary, April 2020).*

> *'You cannot simply sacrifice your comfort for the sake of saving energy. You need to feel cosy in your room – not having to wear layers upon layers. And if that means adjusting the thermostat by a couple of degrees every now and then, you just do that. Anyway, I doubt it makes much of a difference.' (Participant 8, reflective energy diary, April 2020).*

Convenience-focused individuals were most likely to avoid forms of engagement with the smart heating system that challenged the inconspicuous nature of energy consumption. In their view, constantly monitoring their heating use and settings constituted an unnecessary inconvenience they avoided at all costs, especially in light of the perceived limited impact of these devices in terms of either energy use, sustainability, or physiological comfort:

> *'I rarely adjust my heating. I'm perfectly fine with a temperature between 18 and 20°C. Why would I go into all that trouble of making constant adjustments when it doesn't make much of a difference?' (Participant 4, reflective energy diary, April 2020).*

'I just turn the radiator on and off and try to make sure it's only warm when I'm in. There's no much point in overcomplicating things with all those smart features – automatic controls, pre-set programmes, remote temperature, etc. – when, at the end of day, it's just a small radiator in a small room that keeps relatively warm most of the time.' (Participant 12, reflective energy diary, March 2020).

'I'm not the savviest of energy users if I'm being honest. I love feeling cosy in my room, and I tend to like it much hotter than others in my flat. […] It's not that I don't care at all about the environment; I just don't think my small radiator will make much of difference and, rather than worrying whether I've set the temperature high enough for the evening or when it's too cold outside, I tend to keep it at a relatively constant high.' (Participant 14, reflective energy diary, April 2020).

Individuals with high levels of environmental concern liked knowing how much heating they were using, valued sustainability, altruistic action, and energy conservation and, contrary to convenience-seekers, felt that the newly installed smart thermostats were especially easy and convenient to use:

'We all need to do our part to help the planet. Adjusting the thermostat, putting on some extra clothes when it's a bit too cold… It's really small things like these that matter – they all add up…' (Participant 14, reflective energy diary, April 2020).

'The thermostat has given me the power to adjust the temperature in my room as often as I want – without having to consult my flatmates or ask from the Estates Department to do it. […] It has given me the ability to try and conserve some energy in a simple and effective way, without really making any major changes in my life and daily routine.' (Participant 15, reflective energy diary, April 2020).

Tellingly, engagement with the study participants revealed the tensions and trade-offs between these three priorities of comfort, convenience, and pro-environmental value. Whilst these different motives and understandings explain why students with near identical occupancy patterns can make different decisions, the study participants frequently highlighted how their heating preferences were not always driven by a single concern. Hence, the aforementioned three heating priorities and preferences, crystalized over time into five distinct heating patterns of use, grouped together based on temperature profiles and further defined by trends driving this behaviour.

These patterns – which we treated as mutually exclusive – are outlined in Figure 4.14 overleaf (A and B) with labels created by the research team and validated with the students (i.e., they each identified with one of the distinct profiles during our follow-up interviews and data collection).

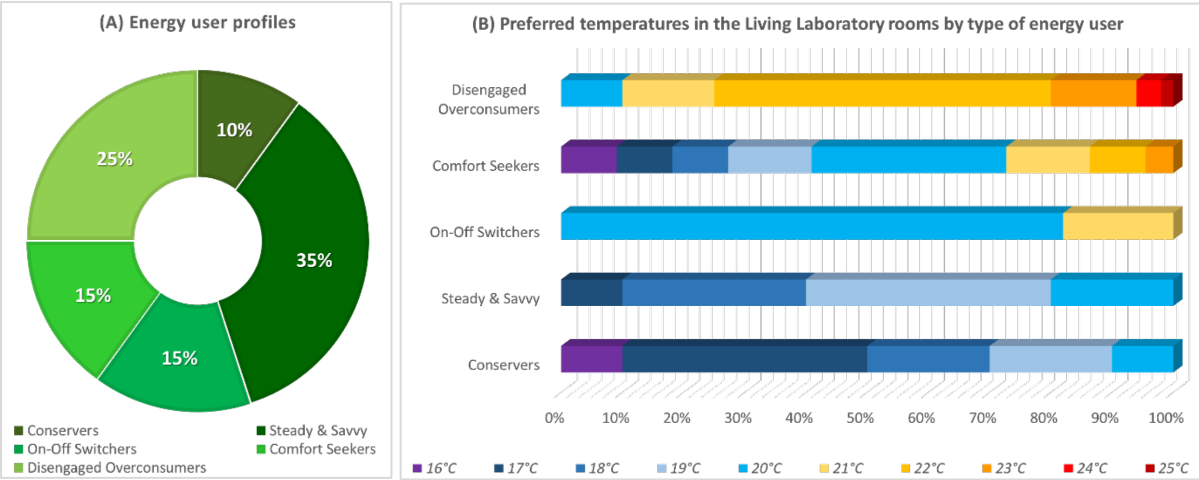

Figure 4.14 (A) and (B): Five heating patterns and profiles with the preferred temperature for smart rooms in UEA's Living Laboratory. (Source: Based on data collated by the research team and UEA's Estates Department).

Specifically:

a. "Conservers" made up 10% of our study participants. These individuals adjusted the temperatures in their rooms frequently – though never above 20°C – and actively focused on keeping cooler temperatures to promote sustainability.
b. "Steady and Savvy" individuals were the most prominent group (35% of students involved in the study). These students rarely adjusted their heating as they were fine with 18-20°C and felt that constant adjustment of temperatures was an unnecessary inconvenience.
c. "On-off Switchers" (15% of individuals involved in the study) were driven by both pro-environmental attitudes and concerns over convenience and, thus, both turned the heating on and off frequently to make sure their rooms were only warm when occupied (or activated auto on-off functions), and varied their target temperature the least to avoid the perceived added inconvenience of adjusting the thermostat settings.
d. "Comfort Seekers" (approximately 15% of students residing in the two Living Labs) used the smart heating system on a more frequent basis, almost constantly adjusting temperature targets in response to changing weather or other conditions in order to address their priority for thermal comfort.
e. Finally, "Disengaged Overconsumers" (25% of study participants) represent the other end of the spectrum to "Conservers". In valuing convenience and comfort above all else, they prefer almost constant room temperatures of around 22°C, and never went below 20 °C.

4.3.2.2. Diverse technology domestication pathways

In the medium-term, three different domestication pathways were identified in the trial that shaped how the smart home technologies were (or were not) used in the medium-term.

First, a mere three student residents could be described as having successfully domesticated the Evohome technologies. Here, the smart heating system had come to be seen as a helpful and convenient part of living on campus. Further, these individuals expressed interest in using such technologies in the future beyond the university campus to reduce their future energy bills without sacrificing comfort. Although each individual encountered some difficulties – such as finding the Evohome system fiddly – they also described how they checked the smart home technologies regularly and, as such, had come to depend upon them. For example, when their Honeywell-Evohome system had a minor malfunction, one student commented that *'I was a bit lost without it. I didn't realize how dependent on it I was' (Participant 4, reflective energy diary, April 2020)*.

Importantly, even within this group of successful domesticators there was little interest in making use of the more advanced and automated features of the systems. Instead, these individuals had mostly made use of heating schedules on the heating system, and the ability to monitor remotely the status of windows or radiators, and of their energy use as a whole. In these ways, they had made the systems fit around them: *'I haven't actually gone in the trouble of working out other features. […] I feel it's working for me as it is, without overcomplicating things unnecessarily' (Participant 6, reflective energy diary, April 2020).* Subsequently, successful domestication depended on the abandonment of the more advanced features of the smart technologies to make them function effectively within a particular room. Hence, the cognitive work involved in learning what to use smart technologies for was not principally shaped by the actual capabilities of the system but, rather, by broader apprehensions relating to the uninterrupted experience of everyday life on the UEA campus.

Fourteen students ultimately followed a second pathway that could be described as 'precarious' domestication. Here, the smart home technologies were being used, but not regularly, and their use was often perceived quite negatively. For this group, such smart technologies had potential but were excessively complicated and, thus, the practical work of learning how to use them was perceived as too challenging. Hence, despite awareness of their potential, the basic ways the SHTs were being used made them seem to be *'little more than expensive radiator valves or timer switches' (Participant 17, reflective energy diary, April 2020).*

Some also suggested that such systems might be useful for other student households beyond the UEA campus, but not them. Appropriate households were seen as those were individuals had collective control of significantly more than just their own room:

> *'Some friends share their own house outside the [UEA] campus. They always have to negotiate when to turn the heating on, at what temperature, for how long… And there's always this concern around wasting money by heating communal areas or each other's bedrooms when not in use. Having this system there would be super useful for them; it would help ensure that everyone in the house is comfortable and satisfied. But here, you don't really need to worry about these things as much; you don't really share the responsibility, you don't share any bills and everyone can pretty much do whatever they want without affecting others.' (Participant 19, reflective energy diary, March 2020)*.

Given, however, that these students could perceive potential benefits, they persevered with the systems, albeit in a basic way. As one student explained: *'there might be some technical issues with the system, it might be rather limited in terms of what can be achieved on campus, but it still allows us to do the basics – that is set comfortable temperatures' (Participant 19, reflective energy diary, April 2020)*. But for this group of students, *'if this started to go wrong, the systems would be abandoned altogether without second thought' (Participant 19, reflective energy diary, April 2020).*

The third domestication pathway was observed in three cases and resulted in complete rejection of the smart heating technologies. In these cases, participants expressed little interest in technology and the smart systems were as a waste of time that risked making things worse rather than better. Common in these cases were stories of being *'overruled'* by the technologies, which generated a sense of losing control over the home. Two students, for example, mentioned occasions when their attempts at manual control were frustrated by the smart heating technologies. For example, they complained that *'the computer would override what you wanted to be happening in the room' (Participant 16, reflective energy diary, March 2020*), or that *'the system would be overriding my own judgement about what I think is the best thing to do' (Participant 17, reflective energy diary, March 2020*). As a result, this group came to thoroughly resist the SHTs as excessively complicated and unnecessary:

> *'It's too bloody complicated and there's no point in it and it's doing me no benefit, not worth having' (Participant 16, reflective energy diary, April 2020).*

Some individuals even rejected smart home technologies as a whole as they could, allegedly, make things worse either for the environment or society. In other words, the symbolic work of domestication had led to forms of resistance against smart home technologies, rather than to their adoption and use. Indicatively, one student was concerned that the ability to 'pre-warm' their room before arrival could result in higher energy consumption *(Participant 17, reflective energy diary, March 2020*). Whilst others also suggested that smart technologies would become increasingly common, for this group this was perceived in a potentially negative technological development. As asserted by one student, this risked raising expectations about technological requirements, without their potential impacts or benefits being clearly known:

> *'New houses are already starting to have a lot of these technologies by default. We will, inevitably, get more of these, but we don't know really know what they actually do, whether they are an effective means of curtailing energy consumption, whether they can actually deliver on their promise for instant wellbeing and comfort. More work – along the lines of what you are doing on this project – should have informed the seemingly widespread rollout of such technologies, But, unfortunately, it might be too late to change things now…' (Participant 16, reflective energy diary, April 2020*),

In summary, the smart home technologies followed very different domestication pathways. Some students came to see them as a positive development that made life easier. For others, they had potential but were excessively complicated to use, whilst for still others they became an elaborate, and potentially dangerous, waste of effort. Crucially, these different pathways reveal the importance of all three types of work involved in domestication. Whilst different individuals appeared to find different kinds of work more or less challenging, at various points all three kinds of work threatened to derail the domestication process.

4.3 Longer-term engagement with the technologies

Whilst individual inhabitants of UEA's two Living Labs were able to make increased use of select system features in the medium-term, usage of the smart home technologies was exceptionally limited over the last few weeks of the intervention. Consequently, whilst significant energy savings were made prior to the Christmas break (when comparing the Living Labs against Control Flats), energy use over the end of the heating season increased significantly.

Specifically, rather than making increased use of the system following a period of familiarisation, this period was marked by near universal criticism of the system in place. First, once individuals had made the range of *'small changes'* they felt they could realise in terms of more efficient energy use, they came to resist the individualization of responsibility for energy problems. In short, they started asking not what they can or should do to reduce their energy use, but rather what the University, and other more powerful system actors as a whole, are or should be doing. In this way they come to question and challenge what Marres (2011) refers to as the 'distribution of the problem' created by conventional approaches to energy end-use management which places the agency and responsibility for energy savings onto energy consumers whilst leaving other system actors and their practices out of the picture and unchallenged.

Second, in line with past research on smart home technologies, we recorder diminishing levels of interest in the system. After an initial period of intrigue, almost all students lost interest as the novelty of the intervention wore off, with the new technologies fading into the background of everyday life (an effect that is sometimes referred to as the "fallback effect"(Wilhite and Ling 1995). Indeed, as one student involved in the study reported:

> *'The impacts of such systems seem to be rather short-lived; once you play with it a bit, you just lose interest and, inevitably, return to your past behaviours and heating practices' (Participant 4, reflective workshop, June 2020*).

Third, a number of students reported a series of *'rebound effects'* (see Buchanan et al. 2015). Upon realisation that they were using significantly less energy for heating than their peers during the first phase of the intervention, numerous students felt entitled to return to more energy intensive heating patterns. Several students residing in the two Living Labs even felt they had put in too much effort to heat their rooms more responsibly without achieving as much energy savings as they had hoped for and, subsequently, felt *'it was all of waste of time and effort' (Participant 1, reflective energy diary, July 2020*). For still others, the growing ability to control conditions in their rooms meant that they ultimately prioritised convenience and comfort, permanently setting thermostats at relatively high temperatures rather than prioritising energy conservation, with the smart heating systems thus serving to legitimize excessive energy use as normal, necessary or even *'good'* as it helped improve levels of comfort and perceived wellbeing.

Fourth, whilst we anticipated that the small changes in everyday heating practices that were made possible following the introduction of the system would convince students to participate more actively and use energy more sustainably, the majority of students involved in the research ultimately became too critical of this 'change of no change' (see Marres 2011, p. 523). In their view, not much could be achieved by using the system and its advanced features.

Fifth, at least five students involved in the study had arrived to the conclusion that past positive trends could be attributed to so-called 'Hawthorne effects' (see Buchanan et al. 2015). Specifically, in this view, several participants were perceived to have only changed their behaviours as a result of being monitored by the research team and UEA's Estates Department. As part of this discourse, what we label as precarious users of the system are believed to have marginally persevered with the technologies because they were part of a field trial and that, without this research context, they may have abandoned the technologies altogether. But given that: (i) the second phase of research did not involve as much direct interaction with students, (ii) it was becoming increasingly clear that the research team was not collating any data that could name-and-shame specific individuals, it could be argued that they ultimately reverted to more naturalistic behaviours.

Sixth, and more broadly, a number of eco-conscious participants felt that the smart system unwittingly locks users in existing patterns and trajectories of unsustainable energy consumption. In their view, rather than inspiring further pro-environmental lifestyle choices and behaviours, the intervention created the sense that they were doing their part to help with energy and climate-related problems and, thus, several students were no longer interested in actively supporting or engaging in other forms of sustainable consumption.

Finally, the majority of students involved in the study felt that the technological intervention failed to inspire and incentivise new behaviours. They could not reap any direct economic or other benefits from their engagement. As such, participation in the study was seen by many as *'a mere inconvenience'*.

Not surprisingly, then, when asked to indicate their levels of satisfaction with the technological intervention, most participants indicated that they were not particularly satisfied. For instance, as shown in Figure 4.15 below, up to 60% of participants were either 'very' or 'fairly' dissatisfied with the smart heating system. Similarly, the majority of respondent felt unable to provide any comments regarding their levels of satisfaction with either advanced smart heating features or with the smart meters provided as, ultimately, they did not use them much. The only notable exception to the recorded overall dissatisfaction with the smart heating system concerns the newly found ability to adjust room temperature setting using the in-room heating controllers.

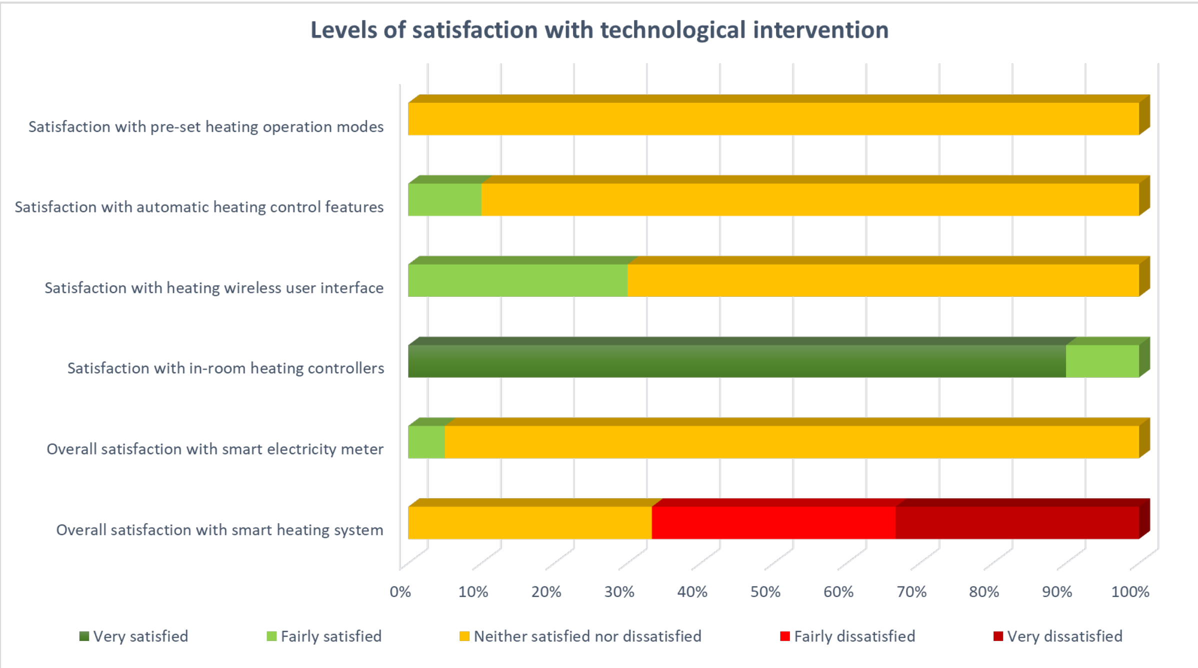

Figure 4.15: Recorded levels of satisfaction with smart home technologies introduced on the UEA campus

Consequently, when asked to indicate their favoured means of delivering a sustainable energy transition for the UEA campus (see Figure 4.16), the vast majority of students (up to 80% of participants filling-in the final evaluation survey) indicated overwhelming support for alternative technological solutions. As they subsequently explained, such technological solutions should involve no or minimal active user engagement. Drawing on their own experiences from the two Living Labs, they collectively asserted that such technological solutions should instead improve UEA's energy system in a less visible way – e.g. through energy efficiency retrofits, through the introduction of more efficient energy production processes on campus, or through the automation of services.

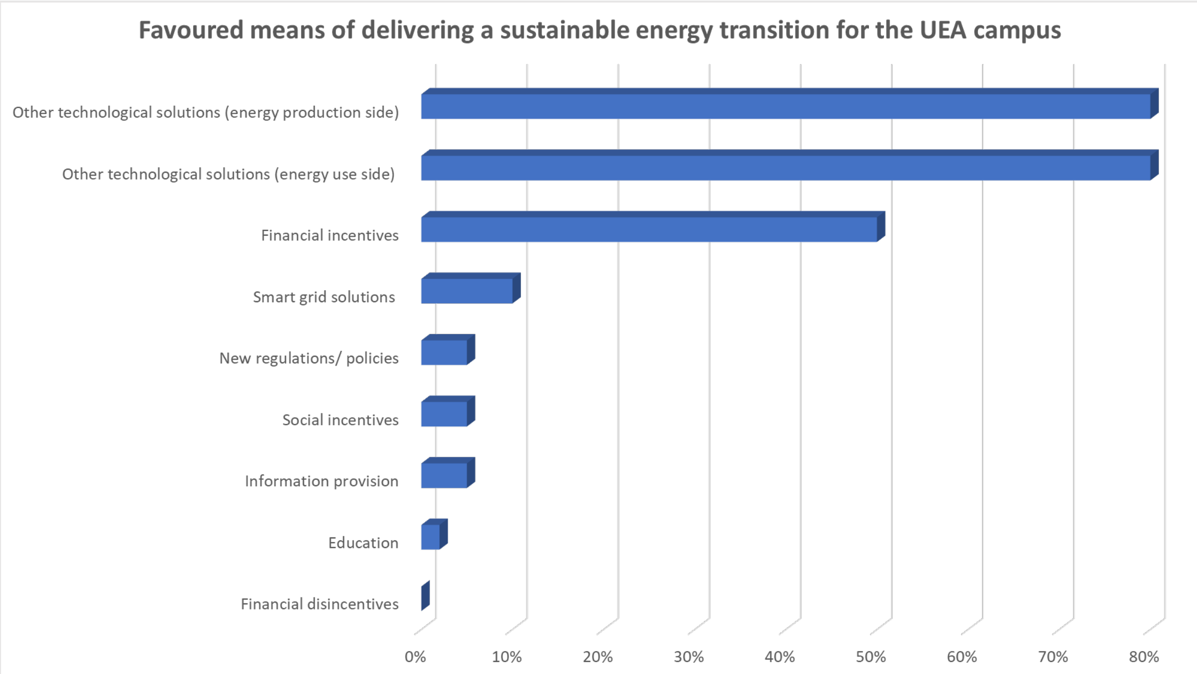

Figure 4.16: Favoured means of delivering a sustainable energy transitions for the UEA campus (students residing in Living Labs; post trial)

4.4. Key themes emerging from the analysis of the field trial data

The analysis presented in this chapter represents the first in-depth, qualitative study on how university students use SHTs over the longer-term. Its core aim was to explore how students residing on the UEA campus in Norwich learn about, use and adapt to SHTs in their own dormitories as one means of scrutinizing claims around SHTs' energy-saving potential. This concluding sub-section distils four core findings from the study:

a) The SHTs introduced at the UEA represent disruptive technologies for students residing on the campus. In spite of student motivation to use these technologies to further their pro-environmental and energy-saving interests, domestication of the technologies proved especially demanding and, even when the system was successfully domesticated, this was far from smooth. Rather than making energy management easier, the new layer of control functionality added an extra layer of complexity, and many other aspects of the domestic environment required re-domestication into the new 'smarter' dormitories.

b) Students adopt a range of adaptation strategies to cope with SHTs. Alongside forms of non-use and rejection, these strategies include using only some of SHTs' potential functionality to make them more familiar and less disruptive. One of the key trends observed was for participants to use the SHTs in less rather than more sophisticated ways as the trial evolved.

c) Whilst disruptive, SHTs are not capable of reconfiguring the priorities and interests of students to promote the sustainability agenda. As demonstrated by the diverse meanings invested in these technologies by students themselves, the use of the technologies was socially constructed and iteratively negotiated, rather than being the inevitable outcome of assumed functional benefits.

d) Finally, a core aim of this chapter was to understand how students use SHTs in order to scrutinize claims that they can or will lead to significant energy savings. Unfortunately, the trial did not result in energy savings of the order predicted by many SHT advocates. As participating students made limited or no use of the SHTs to manage their energy use, the trial generated no evidence of substantial energy savings. Conversely, and in line with concerns raised by some students themselves, overall energy use increased in the long-run, with new forms of energy demand emerging.

References

Alberts, G., Gurguc, Z., Koutroumpis, P., Martin, R., Muuls, M., & Napp, T. (2016) Competition and norms: a self-defeating combination? *Energy Policy, 96*: 504-523.

Baillie, L., & Benyon, D. (2008). Place and technology in the home. *Computer Supported Cooperative Work, 17*: 227– 256. doi:10.1007/s10606-007-9063-2.

Bulunga, A., & Thondhlana, G. (2018) Action for increasing energy-saving behaviour in student residences at Rhodes University, South Africa, *International Journal of Sustainability in Higher Education,* 19 (4): 773-789.

Balta-Ozkan N, Davidson R, Bicket M, Whitmarsh L (2013) Social barriers to the adoption of smart homes. *Energy Policy*. doi:10.1016/j.enpol.2013.08.043.

Berker, T., Hartmann, M., Punie, Y., & Ward, K. J. (2005). Introduction. In T. Berker, M. Hartmann, Y. Punie & K. J. Ward (Eds.), *Domestication of media and technology* (pp. 1–17). Maidenhead: Open University Press.

Bernheim Brush, A. J., Lee, B., Mahajan, R., Agarwal, S., Saroiu, S., & Dixon, C. (2011). Home automation in the wild: Challenges and opportunities. Paper presented at the *ACM CHI Conference on Human Factors in Computing Systems*. May 7–12, 2011. Vancouver, Canada.

Buchanan, K., Russo, R., & Anderson, B. (2015). The question of energy reduction: The problem (s) with feedback. *Energy Policy*, *77*: 89-96.

Bull R, Fleming P, Irvine K, Rieser M (2013) *Are people the problem or the solution? A critical look at the rise of the smart/ intelligent building and the role of ICT enabled engagement*. ECEEE Summer Study (European Council for an Energy Efficient Economy). Toulon, France.

Bulunga, A., & Thondhlana, G. (2018) Action for increasing energy-saving behaviour in student residences at Rhodes University, South Africa, *International Journal of Sustainability in Higher Education,* 19 (4): 773-789.

Canzler, W., Engels, F., Rogge, J. C., Simon, D., & Wentland, A. (2017). From "living lab" to strategic action field: Bringing together energy, mobility, and Information Technology in Germany. *Energy Research & Social Science*, *27*: 25-35.

Chetty M, Tran D, Grinter RE (2008) Getting to green: understanding resource consumption in the home. In: *10th International Conference on Ubiquitous Computing* (UbiComp 2008). Seoul, South Korea, pp.242–251.

Claude, S., Ginestet, S., Bonhomme, M., Moulène, N., & Escadeillas, G. (2017). The Living Lab methodology for complex environments: Insights from the thermal refurbishment of a historical district in the city of Cahors, France. *Energy Research & Social Science*, *32*: 121-130.

Cook DJ (2012) How smart is your home? *Science, 335* (6076): 1579–1581.

Department of Energy and Climate Change. (2009). *Smarter grids: The opportunity*. London: Department of Energy and Climate Change.

Emeakaroha, A., Ang, C. S., Yan, Y., & Hopthrow, T. (2014a) A persuasive feedback support system for energy conservation and carbon emission reduction in campus residential buildings, *Energy and Buildings, 82*: 719-732.

Emeakaroha, A., Ang, C. S., Yan, Y., & Hopthrow, T. (2014b) Integrating persuasive technology with energy delegates for energy conservation and carbon emission reduction in a university campus, *Energy*, *76*: 357-374.

European Commission. (2015). *Towards and integrated Strategic Energy Technology (SET) Plan.* Accelerating the European energy system transformation. Brussels: European Commission.

Friedewald M, Da Costa O, Punie Y, Alahuhta P, Heinonen S (2005) Perspectives of ambient intelligence in the home environment. *Telematics Inform, 22:* 221–238.

Haddon, L. (2006). The contribution of domestication research to in-home computing and media consumption. *The Information Society, 22*: 195–203. doi:10.1080/ 01972240600791325,

Hargreaves, T., Wilson, C. and Hauxwell-Baldwin, R. (2018) Learning to live in a smart home. *Building Research & Information*, *46* (1): 127-139.

International Energy Agency. (2013). *Energy efficiency market report: Market trends and medium-term prospects.* Paris: International Energy Agency.

Isaksson, C. (2014). Learning for lower energy consumption. International *Journal of Consumer Studies, 38:* 12–17. doi:10.1111/ijcs.12045.

Juntunen, J. K. (2014). Domestication pathways of small-scale renewable energy technologies. Sustainability, *Science, Practice & Policy, 10* (2): 28–42.

Karp, A., McCauley, M., & Byrne, J. (2016) The value of adding ambient energy feedback to conservation tips and goal-setting in a dormitory, *International Journal of Sustainability in Higher Education, 17* (4): 471-488.

Korsnes, M., Berker, T., & Woods, R. (2018). Domestication, acceptance and zero emission ambitions: Insights from a mixed method, experimental research design in a Norwegian Living Lab. *Energy Research & Social Science*, *39*: 226-233.

Lehtonen, T. K. (2003). The domestication of new technologies as a set of trials. *Journal of Consumer Culture*, *3* (3): 363-385.

Lewis SCR (2012) Energy in the smart home. In: Harper R (ed) *The connected home: The future of domestic life.* Springer, London, pp 281–300.

Marans, R. W., & Edelstein, J. Y. (2010) The human dimension of energy conservation and sustainability: a case study of the University of Michigan's energy conservation program, *International Journal of Sustainability in Higher Education, 11* (1): 6-1.

Marcell, K., Agyeman, J., & Rappaport, A. (2004) Cooling the campus: experiences from a pilot study to reduce electricity use at Tufts University, USA, using social marketing methods, *International Journal of Sustainability in Higher Education*, 5 (2): 169-189.

Marres, N. (2011). The costs of public involvement: everyday devices of carbon accounting and the materialization of participation. *Economy and Society*, *40* (4): 510-533.

Martiskainen M, Coburn J (2011) The role of information and communication technologies (ICTs) in household energy consumption—prospects for the UK. *Energy Efficiency, 4*: 209–221.

Mennicken, S., & Huang, E. M. (2012). Hacking the natural habitat: An in-the-wild study of smart homes, their development, and the people who live in them. *Lecture Notes in Computer Science, 7319*, 143–160. doi:10.1007/978-3-642- 31205-2_10.

Mennicken, S., Vermeulen, J., & Huang, E. M. (2014). From today's augmented houses to tomorrow's smart homes: new directions for home automation research. Paper presented at *UbiComp 2014. 13–17 September 2014*. Seattle, WA, US.

Mosher, H. R., & Desrochers, M. (2014) The effects of information regarding sustainability issues and behavioural self-management instruction on college students' energy conservation, *International Journal of Sustainability in Higher Education, 15* (3): 359-370.

Mozer, M. C. (2005). Lessons from an adaptive house. In D. Cook & R. Das (Eds.), *Smart environments: Technologies, protocols and applications* (pp. 273–294). Hoboken, NJ: Wiley.

Nyborg, S., & Røpke, I. (2011). Energy impacts of the smart home – conflicting visions. Paper presented at the *ECEEE 2011 Summer Stud*y, Toulon, France. 6–11 June 2011.

Oudshoorn, N., & Pinch, T. (2003). Introduction: How users and non-users matter. In N. Oudshoorn & T. Pinch (Eds.), *How users matter: The co-construction of users and technology* (pp. 1–25). Cambridge, MA: MIT Press

Parece, T. E., Younos, T., Grossman, L. S., & Geller, E. S. (2013) A study of environmentally relevant behavior in university residence halls, *International Journal of Sustainability in Higher Education, 14* (4): 466-481.

Park SH, Won SH, Lee JB, Kim SW (2003) Smart home—digitally engineered domestic life*. Pers Ubiquit Comput, 7:* 189–196.

Petersen, J. E., Shunturov, V., Janda, K., Platt, G., & Weinberger, K. (2007) Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives, *International Journal of Sustainability in Higher Education, 8* (1): 16-33.

Rashidi P, Cook DJ (2009) Keeping the resident in the loop: adapting the smart home to the user. *Syst Man Cybern A Syst Hum IEEE Trans, 39* (5): 949–959.

Savageau, A. E. (2013) Let's get personal: making sustainability tangible to students, *International Journal of Sustainability in Higher Education, 14* (1): 15-24.

Schultz, N. R., Kohn, C. S. & Musto, A. (2017) Examination of a multi-element intervention on college students' electricity consumption in on-campus housing, *Behavioural Interventions, 32* (1): 79-90.

Senbel, M., Ngo, V. D., & Blair, E. (2014) Social mobilisation of climate change: university students conserving energy through multiple pathways for peer engagement, *Journal of Environmental Psychology*, *38*: 84-93.

Sengers, F., Späth, P., & Raven, R. (2018). Smart city construction: Towards an analytical framework for smart urban living labs. In *Urban Living Labs* (pp. 74-88). Routledge.

Sørensen, K. H. (1994). Technology in use: two essays on the domestication of artefacts. *Centre for Technology and Society Working Paper 2/94.* Trondheim, Norway.

Sørensen, K. H. (1996). Learning technology, constructing technology. *Centre for Technology and Society Working Paper 18/96*. Trondheim, Norway.

Strengers, Y. (2013). *Smart energy technologies in everyday life: Smart utopia?* Basingstoke: Palgrave Macmillan.

Strengers, Y., Morley, J., Nicholls, L., & Hazas, M. (2016). *The hidden energy costs of smart homes. The Conversation (12 June 2016).* Online at: https://theconversation.com/ the-hidden-energy-cost-of-smart-homes-60306.

Sustainable Development Commission , (2006), *I will if you will: towards sustainable consumption, Report by the Sustainable Development Round Table,* 1 May 2006, from: http://www.sd-commssion.org.uk/publications.php?id=367.

Voytenko, Y., McCormick, K., Evans, J., & Schliwa, G. (2016). Urban living labs for sustainability and low carbon cities in Europe: Towards a research agenda. *Journal of cleaner production*, *123*: 45-54.

Wilhite, H., & Ling, R. (1995). Measured energy savings from a more informative energy bill. *Energy and buildings*, *22* (2): 145-155.

Wisecup, K., Grady, D., Roth, R. A. & Stephens, J. (2017) A comparative study of the efficacy of intervention strategies on student electricity use in campus residence halls, *International Journal of Sustainability in Higher Education, 18* (4): 503-519.

Woodruff, A., Augustin, S., & Foucault, B. (2007). Sabbath day home automation: 'It's like mixing technology and religion'. Paper presented *at CHI 2007*, April 28–May 3, 2007. San Jose, CA, US.

Wyatt, S. (2003). Non-users also matter: The construction of users and non-users of the internet. In N. Oudshoorn & T. Pinch (Eds.), *How users matter: The co-construction of users and technology* (pp. 67–79). Cambridge, MA: MIT Press.

5. Conclusion

As part of research on energy users for the ICE project, this report sought to provide a critical overview of the role of UEA's staff and student community in sustainable energy transition processes. We focused especially on consumer attitudes and engagement with smart grid technologies. In doing so, the three main empirical chapters of this report explored two main research questions:

a) In what ways (and to what extent) are members of staff and students across the UEA willing to support a sustainable energy transition?
b) How can members of the UEA community engage effectively with innovative smart grid technologies to make their everyday practices and behaviours more sustainable?

In dealing with the first research question, Sections 2 and 3 presented a largely positive narrative. Individual members of the UEA community overwhelmingly share a concern about environmental problems and overconsumption of energy, and engage in a number of sustainable energy practices. Hence, and in line with work by DeWaters and Powers (2011) and Cotton et al. (2015, p.457), UEA's community of staff and students manifests itself as particularly energy literate. Energy users on the UEA campus generally have: (1) sufficient knowledge and understanding about energy, its use and impacts on environment and society (i.e. *cognitive literacy*); (2) appropriate attitudes and values, for example, on the existence of global issues and the significance of personal decisions and actions (i.e. *affective literacy*); and (3) appropriate intentions and behaviours, as exemplified by multiple energy conservation behaviours, participation in a number of "green" societies and initiatives, and by broader practical engagements with the sustainability agenda (i.e. *conative literacy*). Moreover, and in line with past research (Cotton et al., 2015), the wider higher education environment of the UEA offered a number of opportunities for connecting and enhancing the *cognitive, affective* and *conative* dimensions of energy. In simpler terms, this research uncovered multiple ways through which a very large number of students and members of staff, and the UEA as an institution, already support a sustainable energy transition.

Simultaneously, though, the research echoes past calls to move significantly beyond oversimplified models of consumer behaviour positing that behaviours are the direct outcome of consumer attitudes and values (see Shove, 2010). Specifically, this research uncovers multiple evidence of a persistent and widespread 'value-action gap' (e.g. see Sustainable Development Commission, 2006, p.63). This is defined by the inability of individuals to adopt additional sustainable practices in light of multiple barriers to action that is reflective of Blake's (1999) assertions that institutional and structural factors oftentimes undermine people's capacity and willingness to take action. Indeed, in line with past research in the US (see Attari et al., 2010; Lundberg et al., 2019), the research participants almost exclusively engaged in relatively simple energy-saving behaviours, such as turning off the lights when not in use, as these actions tended to be far more convenient and did not rely on any institutional or technological support. Amongst the most prevalent barriers to action identified was the lack of easily accessible information on energy use and financial incentives, which meant that the amount of energy individuals consume is largely unknown and unaccountable despite its use for a range of everyday activities (see also Maréchal, 2009; Devine-Wright et al., 2010). Hence, given the multiple challenges experienced and documented in Sections 2 and 3 of this report, it appears unlikely that UEA's community will adopt further sustainable energy behaviours without any organisational support.

The idea that UEA's community might be incapable of further supporting the ambitious decarbonisation plans of the UEA is further supported by the results presented in Section 4 of this report. In addressing the second key research question around means of effective student engagement with smart heating technologies, we have found that 'Domestication Theory' (e.g. Lehtonen, 2003; Sørensen, 1996) is extremely valuable in identifying and distinguishing between the different types of work different students perform when domesticating smart home technologies. At the same time, however, the study points to the immense challenges of properly and fully domesticating new technologies. As such, our results provide further support to Shove's (2010) and Hargreaves et al.'s (2018) calls to move beyond simplistic models of behaviour change. Rather, an understanding of domestication must not be limited solely to new technologies. Domestication depends just as much on the properties of SHTs themselves as it does on the wider personal biographies and everyday lives of their users. Domestication theory should therefore pay more attention to the longer-term domestication biographies of different users in order to encompass the wider influences on everyday lives and practices (cf. Nyborg, 2015) that ultimately shape the impacts – positive or negative – that SHTs will come to have

Specifically, against a backdrop of claims that smart heating technologies can result in significant energy gains whilst enhancing comfort, four core themes emerged from our engagement with students residing on the UEA campus: (1) smart heating technologies are technically and socially disruptive; (2) smart homes require forms of adaptation and familiarization from householders that can limit their use; (3) learning to use smart home technologies is a demanding and time-consuming task; and (4) there is little evidence that smart home technologies will generate any energy savings and, indeed, there is a risk that they may generate forms of energy intensification in the longer-term. In simpler terms, given the inherent complexity of adopting and 'taming' new technologies, the process of engaging with new technologies to make everyday practices and behaviours on the UEA campus more sustainable is far from straightforward and, thus, UEA's community might be further limited in its ability to act upon pro-environmental attitudes to actively support the decarbonisation agenda.

The findings of this research are, of course, limited in their generalisability. The research team only engaged with a relatively small part of UEA's community at a specific moment in time. Given the nature and focus of our survey and focus group meetings it is highly likely that we attracted participants who are especially interested in issues relating to sustainability and energy. Similarly, our longitudinal studies only involved 20 students, so it is clear that more research is required with more students, with different configurations of smart home technologies, with interventions involving both new technologies and other "soft" methods (e.g., financial or other incentives for energy saving, using social support networks, etc.), in different contexts, and over longer time periods before firm conclusions can be made.

Yet albeit limited in its empirical generalisability, the research speaks to an emerging body of scholarship challenging the dominant paradigms informing the governance of energy transitions and environmental change in general (see Table 5.1 for a succinct overview).

Table 5.1: Dominant paradigms for the governance of energy transitions (Based on Spaargaren, 2011, p.814)

Individualist Paradigm	Systemic (Technological) Paradigm
Individuals and their values/ attitudes are key units of analysis and (policy) intervention	Organisations/ states and their strategies are key units of analysis and (policy) intervention
Behaviours of individuals is decisive for environmental change	Technological innovation is decisive for environmental change
Individual choices are the key intervention targets (micro-level)	Technical systems are the key intervention targets (macro-level)
Key policy approaches: social ("soft") instruments directed at changing values and attitudes – e.g. information provision campaigns	Key policy approaches: direct regulation to promote technological innovation and the extensive roll-out of novel (smart) energy technologies

First, the findings challenge the individualist paradigm by suggesting than an exclusive focus on individuals is sociologically naïve while neglecting the profound influences of the wider chains of interaction that serve as systems of provision shaping and sometimes pre-configuring the choices and behaviours of individual citizen-consumers to a considerable extent. Second, the findings provide fresh empirical insights to the core criticism that an exclusive focus on new technologies as tools for social change overlooks the crucial role of human agents in processes of change (see Spaargaren, 2011; Shove, 2010). Indeed, as studies on failed technological innovations (e.g. Schot, 2001; Heiskanen et al., 2005) show, it is near impossible to realize the environmental benefits of eco-designed products, technologies and infrastructures when they are designed without reference to the user-practices they help constitute.

5.1. Implications for future practice

As demonstrated by informal discussions during the participatory evaluation process conducted in September – November 2021 and involving stakeholders from across the UEA, each of these findings has implications for future regulation-making and design and development of smart energy technologies on the UEA campus and beyond. This final section distils the five key implications of this work for future practice

a. **Given a persistent value-action gap, UEA should reconsider its focus on consumer communication.**

The UEA has recently set in motion ambitious decarbonisation targets. A comprehensive Sustainability Communications Plan figures prominently in the envisioned decarbonisation pathways, with sustainability engagement campaigns and awareness-raising work expected to encourage the behaviour changes needed to meet decarbonisation targets and deadlines. Key findings from this research programme challenge, however, these understandings. Survey and focus group findings consistently demonstrate that pro-environmental attitudes are already widespread, but significant barriers to action persist – including, amongst others, the fact that living arrangements in halls of residence are not conducive to managing energy usage. There is, instead, a pressing need for ongoing and focused engagement with UEA's community to identify key areas of intervention to remove some of the persistent barriers to action identified in this report.

b. **Claims concerning smart energy technologies and their impacts should be properly scrutinised.**

Bearing in mind the findings presented in Section 4, it is vital that the claim that smart energy technologies can improve the experience of their users whilst resulting in significant energy savings is properly scrutinised to avoid over-relying on them to achieve ambitious decarbonisation targets. It is clear that the future design and development of smart energy technologies at the UEA – and beyond – needs to better account for energy users, their needs, lifestyles, priorities, and interests, as well as the different meanings invested in otherwise similar smart technologies. The findings highlight three core ways this could be done. First, greater attention should be paid to the cognitive work involved in identifying what smart technologies could or should be used for. Second, to ease the practical work that users engage in, multiple different types of user must be acknowledged, and multiple entry points should be explored to account for different levels of technological proficiency. Third, to support the symbolic work of domestication, designers and developers should be fully aware that the meaning of smart technologies is not clear-cut. They must account for different types of user to minimize potential tensions between the energy saving and other services offered by smart energy technologies.

c. **UEA's decarbonisation targets should be revised to place less emphasis on individual actions and behaviours for sustainability.**

Evidence from the longitudinal field trial documented in this report also points to the difficulties of changing behaviours and everyday routines, even when the necessary technological means are provided to students. Given the complexities and occasional unintended outcomes of trying to develop new interactions between energy users and new technologies, alternative pathways should be prioritised instead. Indicatively, technological solutions that do not depend on active user engagement and successful domestication might provide for a more straightforward pathway towards decarbonisation. Energy efficiency improvements and upgrades of the existing building stock, replacement of old electrical appliances with more efficient models, large-scale investment in micro-renewable technologies, and simple retrofits throughout the campus (e.g. extensive rollout of sensor-operated light fixtures) are among the favoured technological alternatives as their success does not depend on energy users themselves.

d. **New ways of tapping into existing pro-environmental behaviours should be considered.**

Given the abovementioned challenges of promoting the adoption of new pro-environmental behaviours and the usage of new technologies, significant focus should, instead, be placed on supporting already-existing pro-environmental behaviours. This could be achieved by either equipping staff and students with additional resources that would make existing behaviours more effective (e.g. in the form of targeted financial or other support), or by promoting and actively supporting communities-of-practice through which individuals will share their experiences or tacit know-how, will cooperate on collaborative projects, and will inspire commitment to act sustainably.

e. **New models of thinking about the interactions between energy users, technologies and institutions should be adopted.**

The persistent 'value-action gap' uncovered through this research also highlights the need to adopt new, whole-systems understandings that avoid the pitfalls of oversimplified models of behavioural change. Specifically, this involves focusing not only on individuals, their attitudes and behaviours, or on technologies. Rather, the focus should be on the complex inter-relations between energy users, technologies and institutional modes of governance (see Figure 5.1 below).

Practically, this could involve, inter alia:

- More in-depth explorations of how people, systems and institutional forms interact around specific activities;

- More decision-making input from the broader UEA community to ensure the introduction of contextually appropriate and desired technologies; and
- The adoption of new governance models that embrace experimentation to explore people-technology interactions in situ, with the Living Lab methodology of the ICE project becoming a guiding model for future interventions.

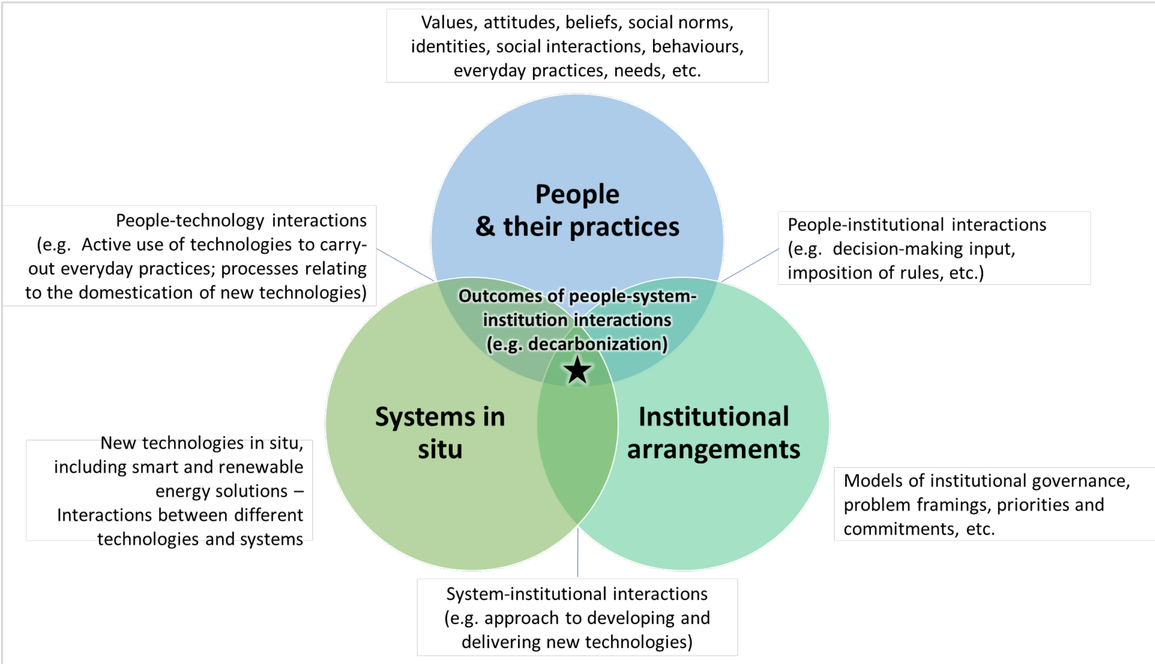

Figure 5.1: A novel model of thinking about the interactions between energy users, technologies and institutions

Collectively, these recommendations for the future governance of sustainable energy transitions at the UEA and beyond point to a third-way alternative to the two dominant paradigms of energy governance outlined in Table 5.1. Bearing in mind the limitations of both the individualist and systemic or structuralist approaches in explaining necessary breakthroughs towards sustainability, our findings and subsequent recommendations emerging form the participatory evaluation workshop highlight the importance of finding an alternative approach which pays attention to both agency and structure, and which recognizes the mutual influencing and co-shaping of human actors on the one hand and objects and technological infrastructures on the other (cf. Spaargaren, 2011; Shove, 2003; 2006; Southerton et al., 2004).

We are not alone in pushing for better-informed governance paradigms. Indeed, in the aftermath of the 2013 Green Campus Summit that invited the exchange of ideas around campus greening and sustainable energy solutions (Némoz 2015), university campuses are increasingly (re-)envisioned as "Living Labs" in which a university uses its integrated organizational, technological and other assets and facilities to investigate, test or demonstrate innovative technologies or services by, with and for their community (Verhoef et al., 2019). The University of Applied Sciences (HFT) Stuttgart's EnSign real-world lab is an exemplary case-study, employing transdisciplinary research methods to find transferable solutions for the transition to a climate neutral inner-city campus. EnSign's approach includes the development of an iterative, optimization-based, knowledge capture process that is inclusive of both external and internal stakeholders. Goals are to catalyse the campus transition, adjust user behaviour, and increase energy efficiency by developing new building operating concepts, public building renovation financing models, stakeholder integration methods, and institutional management structures (Botero et al. 2016).

As Némoz (2016, p.314) asserts: 'this is an opportune time to examine the areas of [university] campuses as privileged territories for socio-technical learning and collective intelligence'. This is precisely what was attempted through this research project on the UEA campus. The ICE project played a pivotal role is furthering collective socio-technical learning and laid the groundwork for a novel model for the governance of UEA's sustainable energy transition.

References

Attari, S.Z., DeKay, M.L., Davidson, C.I., & de Bruin, W. (2010) Public perceptions of energy consumption and savings, *Proceedings of the National Academy of Sciences of the United States of America*, 107 (37): 16054-16059.

Blake, J. (1999). Overcoming the 'value-action gap' in environmental policy: Tensions between national policy and local experience. *Local environment*, *4* (3): 257-278.

Botero, L., Bossert, M., Eicker, U., Cremers, J., Palla, N., & Schoch, C. (2017). A real-world lab approach to the carbon neutral campus transition: a case study. In *Handbook of theory and practice of sustainable development in higher education* (pp. 73-88). Springer, Cham.

Cotton, D.R.E., Miller, W., Winter, J., Bailey, I., & Sterling, S. (2015) Developing students' energy literacy in higher education, *International Journal of Sustainability in Higher Education*, 16 (4): 456-473.

Devine-Wright, P., Devine-Wright, H., & Sherry-Brennan, F. (2010) Visible technologies, invisible organisations: An empirical study of public beliefs about electricity supply networks, *Energy Policy*, *38* (8): 4127-4134.

DeWaters, J. E., & Powers, S. E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy policy*, *39* (3): 1699-1710.

Hargreaves, T., Wilson, C. and Hauxwell-Baldwin, R. (2018) Learning to live in a smart home. *Building Research & Information*, *46* (1): 127-139.

Heiskanen, E., Kasanen, P., & Timonen, P. (2005). Consumer participation in sustainable technology development. *International Journal of Consumer Studies*, *29* (2): 98-107.

Lehtonen, T. K. (2003). The domestication of new technologies as a set of trials. *Journal of Consumer Culture*, *3* (3): 363-385.

Lundberg, D.C., Tang, J.A., & Attari, S.Z. (2019) Easy but not effective: Why "turning off the lights" remains a salient energy conserving behaviour in the United States, *Energy Research & Social Science*, 58, 101257.

Maréchal, K. (2009) An evolutionary perspective on the economics of energy consumption: The crucial role of habits, *Journal of Economic Issues*, 43 (1): 69-88.

Némoz, S. (2015). Smart Campus: Recent advances and future challenges for action research on territorial sustainability. *Implementing Campus Greening Initiatives*, 313-323.

Nyborg, S. (2015). Pilot users and their families: Inventing flexible practices in the smart grid. *Science & Technology Studies*, *28* (3): 54-80.

Schot, J. (2001). Towards new forms of participatory technology development. *Technology Analysis & Strategic Management*, *13* (1): 39-52.

Shove, E. A. (2003). *Comfort, Cleanliness and Convenience: The Social Organization of Normality*. Berg.

Shove, E. (2004). Efficiency and consumption: technology and practice. *Energy & Environment*, *15* (6): 1053-1065.

Shove, E. (2010). Beyond the ABC: climate change policy and theories of social change. *Environment and planning A*, *42* (6): 1273-1285.

Sørensen, K. H. (1996). Learning technology, constructing technology. *Centre for Technology and Society Working Paper 18/96*. Trondheim, Norway.

Southerton, D., Chappells, H., & Van Vliet, B. (Eds.). (2004). *Sustainable consumption: The implications of changing infrastructures of provision*. Edward Elgar Publishing.

Spaargaren, G. (2011). Theories of practices: Agency, technology, and culture: Exploring the relevance of practice theories for the governance of sustainable consumption practices in the new world-order. *Global Environmental Change*, *21* (3): 813-822.

Sustainable Development Commission , (2006), *I will if you will: towards sustainable consumption, Report by the Sustainable Development Round Table,* 1 May 2006, from: http://www.sd-commssion.org.uk/publications.php?id=367.

Verhoef, L., Graamans, L., Gioutsos, D., van Wijk, A., Geraedts, J., & Hellinga, C. (2017). ShowHow: a flexible, structured approach to commit university stakeholders to sustainable development. In *Handbook of theory and practice of sustainable development in higher education* (pp. 491-508). Springer, Cham.

Appendix A – Online Questionnaire Survey

- This questionnaire comprises of 22 questions.
- Filling in the questionnaire should take around 15-20 minutes.
- The purpose of this survey is to: a) contribute ideas to the Intelligent Community Energy (ICE) research project, and b) inform the development of energy and sustainability-related policies on the UEA campus.
- This survey has been sent to all students and staff at the UEA. Please send on to your colleagues as we would like to reach out to the people we do not know.
- Participants are requested to answer the questions as honestly as possible.
- Participation in this survey is voluntary.
- We will not identify any individuals when reporting the results and will use our best efforts to ensure that no individuals can be identified by implication. However, your contact details are requested should you wish to participate in the gift voucher draw.
- For full details on the research project, data processing and retention please refer to our Privacy Statement for Research Participants.
- For further information, please contact Prof Konstantinos Chalvatzis (k.chalvatzis@uea.ac.uk) and/or Dr Phedeas Stephanides (p.stephanides@uea.ac.uk), Norwich Business School, University of East Anglia.

Do you wish to participate in this questionnaire survey? *

☐ I DO NOT wish to participate in this survey.

☐ I WISH to participate in this survey.

---

1. Background Information

This section invites you to provide some background information about yourself. This information will help us direct you to a series of questions that best correspond to your profile as a member of the UEA community.

1.1. What best describes your position/ole at the UEA?

☐ Undergraduate student - living on campus

☐ Undergraduate student - living off campus

☐ Postgraduate student - taught, living on campus

☐ Postgraduate student - taught, living off campus

☐ Postgraduate student - research, living on campus

☐ Postgraduate student - research, living off campus

☐ Academic staff (research/ teaching)

☐ Admin or other staff

☐ Other (please specify):

1.2. In which building are your based or spend most of your time on the UEA campus?

2. Energy-related Behaviours at the UEA

This section invites you to share information with respect to the energy-related activities in the building/room/office where you spend most of your time while on the UEA campus.

2.1. How many energy consuming devices or appliances do you currently use on the UEA campus?

	0	1	2	3	4	5 or more
Privately-owned devices (e.g. laptop, mobile phone, etc.)						
Public devices (e.g. public printer, communal fridge, etc.)						

2.2. On a scale from 1-5, where 1=very low and 5=very high, please describe your energy consumption while on the UEA campus:

	1 - Very low	2 - Low	3 - Average	4 - Moderately high	5 – High	Do not know	N/A
Overall energy consumption							
Energy consumption for lighting							
Energy consumption for computing							
Energy consumption for space heating/ cooling							
Energy consumption for hot water							
Energy consumption for cooking/ refrigerating							
Energy consumption for entertainment activities							
Energy consumption for laundering (i.e. machine washing, tumble drying and ironing)							
Energy consumption for laboratory equipment							
Energy consumption for mechanical space ventilation (e.g. extractor fans)							

2.3. Thinking back over the past six months, how often have you performed any of the following energy and comfort-related activities while on the UEA campus?

	Never	Less than once a month	At least once a month	Most weeks	Most days/ Always	Do not know	Not feasible/ Applicable
Switched off lights when not in use.							
Achieved comfortable indoor lighting conditions by adjusting available blinds or curtains.							
Switched off devices completely when not in use.							
Set computer to power-saving mode.							
Avoided charging devices overnight.							
Reduced hot water consumption.							
Ensured indoor temperature was comfortable by adjusting the room thermostat.							
Ensured I felt warm or cool enough in my room by adjusting the amount or type of clothing worn.							
Improved the air quality in my room through mechanical ventilation (e.g. extraction fans).							
Adjusted natural ventilation in the room (e.g. by opening windows).							

3. Pro-environmental and Energy-related Attitudes

This section asks some general questions with respect to pro-environmental and energy-related attitudes that might influence your behaviours. Please respond to these questions as honestly as possibly.

3.1. On a scale from 1-5, where 1=very unimportant and 5=very important, please describe the relative On importance of the following environmental issues to you as an individual:

	1 - Very unimportant	2 - Unimportant	3 - Neither important nor unimportant	4 - Important	5 - Very important
Energy efficiency/ conservation					
Decarbonisation of energy supply					
Sustainability					
Recycling and/or reduction of waste					
Wildlife protection					

3.2. Please indicate whether you agree or disagree with the following statements:

	1 - Strongly disagree	2 - Somewhat disagree	3 - Neither agree nor disagree	4 - Somewhat agree	5 - Strongly agree
The Earth has plenty of resources if we learn to exploit them appropriately.					
The ecological crisis facing humankind has been greatly exaggerated.					
Climate change requires immediate action.					
Climate change is caused by human activities related to using energy.					
Science/ technology will solve challenges related to climate change and energy consumption.					
Human wellbeing and indoor comfort can only be achieved through high levels of energy consumption.					
A private household cannot do much to conserve energy.					
The UEA cannot do much to help address the national energy situation.					

3.3. Please indicate whether you agree or disagree with the following statements with respect to energy-related behaviours:

	1 - Strongly disagree	2 - Somewhat disagree	3 - Neither agree nor disagree	4 - Somewhat agree	5 - Strongly agree
The UEA should ensure its students and staff can achieve desirable levels of comfort.					
It is important for the UEA to use energy efficiently.					
I trust the UEA to do something about energy problems.					
I can influence what the university does about energy problems.					
I am aware of my energy consumption on campus.					
I am currently taking steps to reduce my energy consumption on campus.					
I am willing to reduce my energy consumption to help the UEA meet its emission reduction targets.					
Reducing my energy consumption is simple.					
Reducing my energy consumption is inconvenient.					
Using energy efficiently has a negative impact on wellbeing.					
The people whose opinions I value are concerned about their energy use.					

4. Energy User Experiences at the UEA

This section invites you to reflect on UEA's energy related activities. Please respond to these questions as honestly as possible.

4.1. Please indicate whether you agree or disagree with the following statements regarding UEA's energy-related activities:

	1 - Strongly disagree	2 - Disagree	3 - Neither agree nor disagree	4 - Agree	5 - Strongly agree
I am aware of the university's energy supply system.	☐	☐	☐	☐	☐
I am aware of the university's energy-related policies.	☐	☐	☐	☐	☐
I am aware of the university's actions to promote sustainability.	☐	☐	☐	☐	☐
I am satisfied with the electricity supply system of the UEA.	☐	☐	☐	☐	☐
I am satisfied with the 25% energy consumption reduction targets of the UEA.	☐	☐	☐	☐	☐
I am satisfied with the 35% carbon emission reduction targets of the UEA.	☐	☐	☐	☐	☐
I am satisfied by the university's commitment to green energy.	☐	☐	☐	☐	☐
I am satisfied with the university's attempts to develop an energy efficient building-stock.	☐	☐	☐	☐	☐
There is sufficient support to student/staff engagement around sustainability.	☐	☐	☐	☐	☐
There is enough information on energy use on campus.	☐	☐	☐	☐	☐
The UEA does enough to ensure a comfortable user experience of its building stock.	☐	☐	☐	☐	☐
The UEA ensures that student/staff views and needs inform its energy-related plans.	☐	☐	☐	☐	☐

4.2. On a scale of 1-5, where 1=very unsatisfactory and 5-very satisfactory, please rate the conditions in the building/ room/ office where you spend most of your time on the UEA campus:

	1 - Very unsatisfactory	2 - Unsatisfactory	3 - Neither satisfactory nor unsatisfactory	4 - Satisfactory	5 - Very satisfactory
Indoor temperature in winter	☐	☐	☐	☐	☐
Indoor temperature in summer	☐	☐	☐	☐	☐
Indoor air quality	☐	☐	☐	☐	☐
Lighting (natural and artificial)	☐	☐	☐	☐	☐
Hot water availability	☐	☐	☐	☐	☐
Kitchen/ cooking infrastructure	☐	☐	☐	☐	☐

	1 - Very unsatisfactory	2 - Unsatisfactory	3 - Neither satisfactory nor unsatisfactory	4 - Satisfactory	5 - Very satisfactory
Ability to adjust indoor temperature to comfortable levels	☐	☐	☐	☐	☐
Ability to adjust indoor lighting to comfortable levels	☐	☐	☐	☐	☐
Overall ability to address basic everyday needs	☐	☐	☐	☐	☐
Overall feelings of health because of conditions in the room	☐	☐	☐	☐	☐
Overall ability to work productively	☐	☐	☐	☐	☐
Overall ability to experience comfort	☐	☐	☐	☐	☐
Overall ability to flourish and have an enjoyable lifestyle	☐	☐	☐	☐	☐

4.3. What are the main barriers to an efficient and fair energy system on the UEA campus? (Please select all that apply)

☐ None

☐ Limited control over personal energy consumption.

☐ Limited ability to adjust the living/working environment in ways that would ensure personal comfort/ convenience.

☐ Disengaged staff/ students.

☐ Inefficient energy production.

☐ Inefficient buildings.

☐ Lack of information on energy consumption.

☐ Lack of information on how to use energy efficiently.

☐ Exclusion of students and staff from energy-related planning.

☐ Failure to account for student/ staff needs and attitudes.

☐ Other (please specify):

(Optional) Please list any high priority actions the UEA can implement to improve its energy-related infrastructures and services:

Action 1

Action 2

Action 3

Action 4

(Optional) Is there anything else about energy use, experience or conservation on the UEA campus you believe we should know?

5. Respondent Profile

This final section invites you to provide some general demographic information about yourself.

Your Gender:

- ☐ Male
- ☐ Female
- ☐ Trans
- ☐ Non-binary
- ☐ Other
- ☐ Prefer not to disclose

Your Age:

- ☐ 17-24
- ☐ 25-34
- ☐ 35-49
- ☐ 50-64
- ☐ 65+
- ☐ Prefer not to disclose

Your Ethnic Background:

- ☐ English, Welsh, Scottish, Northern Irish, British
- ☐ White - North European
- ☐ White - South European
- ☐ Black
- ☐ Asian
- ☐ Chinese, Japanese or other South Asian
- ☐ Arabic
- ☐ North African

☐ Unknown/ Prefer not to disclose

☐ Other (please specify):

Are you involved in any sustainability groups/ initiatives/ events at the UEA?
(Please specify and/or exemplify)

Would you be interested in participating in a focus group where you can further detail, exemplify and validate your energy-related perceptions, opinions, beliefs, and attitudes in an interactive setting?

☐ Yes

☐ No

Please provide us with your contact details. A member of the research team will subsequently contact and invite you to one of a number of focus groups that will be organised over the coming months:

Name

Email

Appendix B – Student Focus Group Protocol

1. Icebreaker – Initial introductions (5 minutes)
   Brief introductions (name, cultural background, place of residence in the past)

Prompt question: Tell us something interesting about yourself

2. Discussion around pro-environmental and energy-related attitudes (20 minutes)
   Prompt questions:
   a. *How important are environmental issues for you? Are you concerned about climate change?*
   b. *Do you feel that your personal behaviours can have an impact? Responsible at the personal level, or the responsibility of the university and/or government? Might science/technology solve our problems without much need for personal level change?*
   c. *Are you concerned about your energy use levels?*
   d. *Can comfort / wellbeing only be maintained through high levels of energy?*

3. Discussion around energy-related behaviours and wellbeing – energy use profile (10 minutes)
   Prompt questions:
   a. *Are you aware of your energy consumption?*
   b. *How would you describe yourself as an energy user, and why? (Low/ below average? Medium/ average? High/ above average)?*
   c. *Do you take any steps to improve your consumption? What kind of steps do you take?*
   d. *What factors influence your energy consumption? (E.g. social, economic, cultural, habits, physical/physiological, control/ autonomy, access to/ affordability of "green" products/services, etc.)*
   e. *How might energy consumption and energy-related infrastructures on campus influence your perceived wellbeing/ quality of life? How do you understand wellbeing in relation to energy use?*

4. Interactive activity: Ranking of perceived energy use whilst performing a range everyday practices (e.g. cooking, showering, laundering, studying/ computing, heating, leisure activities, etc.) (20 minutes)
   Participants invited to describe how much energy they (believe) they use when performing routine everyday practices.
   Marking their perceived energy use on a scale (low-medium-high) using coloured stickers – one colour per participant – justification of responses.

   Group discussion and individual reflections

5. Discussion around opportunities and barriers to "greening" energy consumption (30 minutes)
   Prompt questions:
   a. *Does the UEA do enough to improve its energy consumption? Does it do enough to enable energy users to improve their personal consumption?*
   b. *Are there any barriers to you improving your consumption? (e.g. lack of financial incentives, convenience, lack of awareness, missing impacts)*
   c. *Do you feel you have a sufficient level of control over your energy use?*
   d. *Does the provision of energy and/or energy services on campus allow you to maintain a high level of wellbeing? (physiological and subjective)*
   e. *What impact(s) might reducing your energy consumption on campus have to you as an individual? Does reducing energy consumption undermine or improve your personal wellbeing/ quality of life? (E.g. 'eudaimonic' life satisfaction of goal attainment, positive emotions, feeling of contentment, <u>or</u> negative feelings, requiring personal sacrifice, challenging existing routines, undermining comfort, physical wellbeing and convenience, difficult, aggravating, etc.)*

6. Break - Refreshments (10 minutes)

7. Discussion around potential future interventions to promote sustainable energy use on the UEA campus (30 minutes)
   a. *Opening question: What would motivate you to conserve energy/ use energy more efficiently?*
   b. *Interactive activity: design your own intervention – in pairs – to improve energy use on campus.*
   c. *Consideration of alternative approaches – ranking of intervention types (8) based on preference or effectiveness*

(Types of intervention: education – information provision; energy use feedback (smart); social incentives (competitions, energy delegates); financial (incentives or penalties); prompts (email reminders); personal management strategies (goal-setting); technical (e.g. RES, efficiency improvements); policies (e.g. binding targets)).

8. Concluding remarks, comments, questions (5 minutes)
   Prompt questions:
   Have you learned anything new? Take home messages?

Additional Information:

- Participants:
  - 5-6 students living on campus per focus group
  - Ideally a mix of different ethnicities, genders, ages, levels of environmental concern (identified through questionnaire survey), and living in different halls of residence from across the campus
  - Separate different stages of study (masters/ undergraduates)

- Venue: on campus, at a "neutral" seminar room (e.g. Union House)

- Food-refreshments: Arranged through the Catering Services of the UEA

- Key roles: facilitator, note taker

- Key things to note during focus group:
  - Any cultural differences (e.g. culturally induced thresholds between a comfortable and an uncomfortable temperature)
  - Past experiences and 'energy biographies' of participants
  - Socio-demographic factors shaping behaviours and attitudes
  - Changing personal circumstances influencing behaviours (e.g. living on your own for the first time)

- Materials/ equipment needed:
  - Audio recording (Phedeas to bring recording equipment)
  - Card printouts with different practices
  - A1 ranking sheets
  - Coloured stickers
  - Name tags
  - Markers
  - Flip chart paper
  - Consent forms
  - Focus group payment receipt forms
  - Information sheets

Appendix C – Longitudinal research protocol

Key research aims:

To evaluate the impact of the technological intervention on energy-related knowledge/ awareness, attitudes, behaviour and well being

Methods:

Focus groups, semi-structured interviews, and online energy-activity diaries

---

STAGE 1: Pre-installation focus groups and informal personal interviews (with students)

Aims: To develop an (initial) understanding of the energy user profiles of the students

Prompt questions:

a. *How important are environmental issues for you? Are you concerned about climate change?*
b. *Do you feel that your personal behaviours can have an impact? Responsible at the personal level, or the responsibility of the university and/or government? Might science/technology solve our problems without much need for personal level change?*
c. *Are you concerned about your energy use levels?*
d. *Can comfort / wellbeing only be maintained by using high levels of energy?*
e. *Are you aware of your energy consumption?*
f. *How would you describe yourself as an energy user? Low? Medium? High?*
g. *Do you take any steps to improve your consumption? What kind of steps do you take?*
h. *What factors influence your energy consumption? (social, economic, cultural, habits, physical/physiological, control, access to/ affordability of "green" products/services, etc.)*
i. *What motivates you to conserve energy?*
j. *Are you aware of smart home technologies? Have you used a smart heating thermostat or a smart meter before?*

STAGE 2: Initial use focus groups and informal personal interviews (conducted in parallel with completion of personal energy diaries – See Appendix D)

Aims: To develop an (initial) understanding of student engagement with the smart home technologies introduced

Prompt questions:

i. *What are your initial impressions and experiences of using the system?*
ii. *Have you used the system, and to what extent or in what ways?*
iii. *What specific features have you used or experimented with?*
iv. *Is the smart heating system easy to use? What challenges, if any, have you faced whilst using the system?*
v. *Have you noticed any changes (e.g. in your energy use, in your experienced levels of comfort) since using the system?*

vi. Do you have any concerns about the system and its use?

STAGE 3: Completion of bi-weekly personal energy diaries (See Appendix D)

STAGE 4: Post-heating season interviews and reflective workshops (conducted in parallel with completion of personal energy diaries – See Appendix D)

Prompt questions:

i. How did you go about using your smart home technologies? Have you used all features of the system?
ii. Have you managed to make the technologies an integral part of your heating practices?
iii. Have the technologies affected your routines, practices and quality of life? What activities/ practices have you adapted following the introduction of the smart home technologies?
iv. What do you think of such smart home technologies following your interaction with them over the past academic year?
v. What are your views and opinions of the intervention and its effectiveness as a whole: Was the intervention successful? In what ways?
vi. What impacts did the intervention have on you as an energy user? Have the devices affected your energy awareness and use? Any wider impacts? What have you learnt about your energy use, if anything?
vii. Have you enjoyed learning about your energy use and using the smart heating thermostats?
viii. What challenges have you faced, if any? Have you encountered any institutional or other barriers to action?
ix. Have you noticed any unanticipated changes?

Appendix D – Energy diary template

Please tell us about your weekly energy-related experiences in your flat by completing the following templates. Feel free to add any additional notes/ comments on your energy-related attitudes, motivations and on any (personal, contextual and/or environmental) factors that might have influenced your energy use on the UEA campus.

Task 0.1: Please use this space to detail your energy-related activities over a typical weekday at the UEA campus

	Activity	Electrical/ electronic appliances used	Approximate time spent	Comments/ notes
Morning (06:00-11:59)				
Lunch (12:00-13:59)				
Afternoon (14:00-17:59)				
Evening (18:00-24:00)				

Task 2: Please use this space to detail what devices were being used (either actively or on stand-by) in your room at the specified times

	Total number of devices used	Types of devices used actively	Types of devices on stand-by
Room inspection 1: 8:45			
Room inspection 2: 13:30			
Room inspection 3: 22:00			

How do you feel about your energy use this week?

___
___
___

Have you used your smart heating thermostat this week? How? Why?

___
___
___

How often, if at all, have you used the following features of your smart home system this week?

	More than once a day	**Once a day**	**Several times a week**	**Once a week**	**I have not used this**	**Notes/ comments/ reflections**
Adjusted room temperature using the in-room (wall-mounted) controller of your smart heating system.						
Controlled your smart heating system (adjust temperatures, turn on/off, and/or program) remotely using the wireless user interface (mobile/tablet app and online platform)						
Used the automatic control features (e.g. auto on/off in response to indoor/outdoor temperature thresholds; auto-window function) of your smart heating system						
Activated the pre-set operation modes of your smart heating system						
Viewed live heating data using the wireless user interface of your smart heating system						
Reviewed past heating use data using the wireless user interface of your smart heating system						
Viewed live electricity use data using the in-flat (wall-mounted) display unit						
Reviewed past electricity use data using the in-flat display unit and/or the wireless user interface						

What, if any, difficulties have you had with your smart heating system and smart electricity meter?

Further thoughts, comments, or reflections:

Appendix E - Smart Energy Retrofits in UEA's Halls of Residence – Student evaluation survey

Dear student

As you already know, your flat in UEA's halls of residence was selected for inclusion in a pilot study on smart energy retrofits. As part of this study, your room/flat was equipped with smart electricity meters and a smart heating system, and you were invited to participate in a series of focus groups through which we collected information around your engagement with these technologies.

In light of the current COVID-19 situation, we have been forced to cancel all planned face-to-face research activities. Instead, we would like to invite you to share your experiences of living in a room/flat with smart electricity meters and heating systems by completing this online survey.

The survey is very important as it will help us: a) complete our research activities, b) understand your experiences and energy-related needs; and c) influence UEA's energy and sustainability policies.

We realise that you might feel anxious about participating in a research project. We would, nonetheless, like to assure you that we will fully respect your opinions, we will protect your anonymity when reporting the research findings, and we will ensure that we handle all the information provided by you in an ethical and secure manner – following UEA's codes of research conduct and the GDPR (see Information Sheet for Research Participants for full information).

Would you be willing to take part in the survey?

☐ Yes
☐ No

Section 1: Your experience of using your smart heating system and smart electricity meter

	A great deal	A fair amount	Just a little	Heard of, but knew nothing about	Had never heard of them
1. How much, if anything, would you say you knew about smart heating systems before having one installed in your flat?					
2. How much, if anything, would you say you knew about smart meters before having one installed in your flat?					

3. Thinking about your smart heating system and smart electricity meter, which of the following best describes how you feel about doing each of the following?

	I know how to do this	I think I know how to do this, but I am not entirely sure	I know I can do this, but I do not know how	I did not know I could do this

Adjust room temperature using the in-room (wall-mounted) controller of your smart heating system.				
Control your smart heating system (adjust temperatures, turn on/off, and/or program) remotely using the wireless user interface (mobile/tablet app and online platform)				
Use the automatic control features (e.g. auto on/off in response to indoor/outdoor temperature thresholds; auto-window function) of your smart heating system				
Activate the pre-set operation modes of your smart heating system				
View live heating data using the wireless user interface of your smart heating system				
Review past heating use data using the wireless user interface of your smart heating system				
View live electricity use data using the in-flat (wall-mounted) display unit				
Review past electricity use data using the in-flat display unit and/or the wireless user interface				

4. How often, if at all, have you used the following features of your smart heating system and smart electricity meter during your time in UEA's halls of residence?

	More than once a day	Once a day	Several times a week	Once a week	Once a fortnight	Once a month	Once every semester	Less frequently than once a semester	I have not used this
Adjusted room temperature using the in-room (wall-mounted) controller of your smart heating system.									
Controlled your smart heating system (adjust temperatures, turn on/off, and/or program) remotely using the wireless user interface (mobile/tablet app and online platform)									
Used the automatic control features (e.g. auto on/off in response to									

indoor/outdoor temperature thresholds; auto-window function) of your smart heating system									
Activated the pre-set operation modes of your smart heating system									
Viewed live heating data using the wireless user interface of your smart heating system									
Reviewed past heating use data using the wireless user interface of your smart heating system									
Viewed live electricity use data using the in-flat (wall-mounted) display unit									
Reviewed past electricity use data using the in-flat display unit and/or the wireless user interface									

Section 2: Evaluation of your smart heating system and smart electricity meter

	Very satisfied	Fairly satisfied	Neither satisfied nor dissatisfied	Fairly dissatisfied	Very dissatisfied
Overall, how satisfied or dissatisfied are you with your smart electricity meter?					
How satisfied or dissatisfied are you with the in-flat display unit (wall-mounted) of your smart electricity meter?					
How satisfied or dissatisfied are you with the wireless user interface of your smart electricity meter?					
Overall, how satisfied or dissatisfied are you with your smart heating system?					
How satisfied or dissatisfied are you with the in-room (wall-mounted) controllers of your smart heating system?					
How satisfied or dissatisfied are you with the wireless user interface					

(mobile/tablet app and online platform) of your smart heating system?					
How satisfied or dissatisfied are you with the automatic control features (e.g. auto on/off in response to indoor/outdoor temperature thresholds; auto-window function) of your smart heating system?					
How satisfied or dissatisfied are you with the pre-set operation modes of your smart heating system?					

2. Which of these statements best describes your experience of your smart heating system?

☐ I would be critical of my smart heating system without being asked.
☐ I would be critical of my smart heating system if someone asked my opinion.
☐ I would be neutral about my smart heating system if someone asked my opinion.
☐ I would speak highly of my smart heating system if someone asked my opinion.
☐ I would speak highly of my smart heating system without being asked.

3. What, if any, difficulties have you had with your smart heating system and smart electricity meter?

____
____
____
____

4. What, if any, were the impacts of using your smart heating system and smart electricity meter? (e.g. ability to adjust temperature to comfortable levels; growing awareness of energy use; growing impetus to conserve energy; etc.)

____
____
____
____

5. A key aim of our technological intervention was to give end users greater control over their energy use and, subsequently, to promote more efficient/sustainable energy use in halls of residence. To what extent have we been able to address this aim, in your view?

☐ To a very great extent ☐ To a moderate extent ☐ To a small extent
☐ To a great extent ☐ To some extent ☐ Not at all

6. Which ***two*** of the following tools would you propose as the most effective means of promoting efficient/sustainable energy use on the UEA campus?

☐ Smart grid solutions (smart meters, smart heating systems, etc.)
☐ Other technological solutions (e.g. energy efficiency retrofits, automated controls, etc.)

- ☐ Education
- ☐ Information provision
- ☐ Social incentives (e.g. competitions, energy delegates, etc.)
- ☐ Financial incentives (e.g. discounts in accommodation bills)
- ☐ Financial disincentives (e.g. billing on energy use)
- ☐ New regulations/ policies (e.g. energy use quotas)
- ☐ Other (Please specify) _____________

i. Why do you think that these are the most effective means of promoting efficient/sustainable energy use on the UEA campus?

____
____
____
____

7. Are there any other comments/observations you would like to make with regard to your smart heating system and smart electricity meter?

____
____
____
____