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Dumber energy at home please: Perceptions of smart energy technologies are dependent on home, workplace, or policy context in the United Kingdom

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ABSTRACT

Smart energy technologies (SETs) are being developed around the world to support using energy more efficiently and to smooth our consumption over time, helping us to meet our carbon reduction targets. Notably, SETs will only be effective with support and engagement from the public. Previous literature has focused on evaluating SETs within a residential context, however, results here may differ from a workplace or policy context. We note that surrogate decision making (SDM [1]) theory indicates we make decisions differently for others than for the self. Study one (N = 213) comprises a survey using a UK population sample that examines public perceptions and support for SETs in different contexts. Study two (N = 12) utilises interviews to explore perceptions in more depth, probing the nature of support using socio-cognitive constructs relating to SDM. We find that people are more likely to support SETs in a workplace or policy context, compared to residential contexts. In addition, we note that support for SETs is related to different socio-cognitive constructs in different contexts, and also that impulsivity of decision making differs across contexts. Decision making within workplace and policy contexts is characterised by higher levels of impulsivity than in a residential context, as well as a sense of shared responsibility. Our results indicate that translational research is needed when considering evidence based on residential studies in making decisions within workplace and policy contexts.

1. Introduction

Given stringent carbon reduction targets in many countries around the world, including the UK, and the availability of natural resources, we need to change the way we use energy. Smart energy technologies (SETs) have been developed in order to improve energy efficiencies and shift energy use so that we use energy when it is plentiful and stop when it is not; SETs feature in many future energy scenarios (e.g. [2]). Examples of SETs include white goods that could be automatically, or externally, controlled to turn off at peak times, and energy storage batteries which could charge when energy is plentiful and be used at peak times. Note that the term SET is commonly used to refer to a range of services that are made possible with the increased availability of energy data, than has been available in the past, within a smarter grid, and often does not involve one specific piece of technology. For SETs to achieve reductions and shifts in energy use to the scale suggested by future energy scenarios, widespread engagement will be needed but the extent of actual likely uptake is uncertain. Previous research has indicated that a significant proportion of people may reject some forms of SETs [3] and recent research has indicated that many experts considered widespread implementation of SETs for domestic users as unviable, though developments within a workplace context were considered more positively [4].

Notably, the bulk of research on public acceptance of SETs has been carried out within a residential context, whilst less research has considered workplace contexts [3,5–8]. We additionally propose that policy support for SETs should be considered as a third context, a more abstract context which considers the national and local government

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rules that people would support (which may have impact on both residential and workplace contexts). Notably, despite previous assertions of the importance of context (e.g. [9]), there has been little consideration of the differences in public acceptance and support of SETs between residential, workplace and policy contexts. The little research that does exist is not systematic across contexts and is mixed as to whether people are likely to be consistent or divergent in their energy saving intentions and behaviour [10–15]. In keeping with the lack of integration of existing literature, some literature considers acceptance, some considers engagement with, and some considers support for SETs. These terms are different but overlapping with acceptance implying a more passive consideration, engagement implying that action is necessary, and support indicating a more general positive evaluation; in the interest of integrating perspectives across contexts, we will consider public support towards SETs here. We consider it important to distinguish public support of SETs between residential, workplace, and policy contexts and consider similarities and differences in socio-cognitive predictors of support of SETs between contexts. Taking a theoretical perspective, given that people have different roles and responsibilities between contexts, and that decisions within workplace and policy contexts would tend to impact a greater number of people, and people with quite different relationships to the decision maker, it makes sense that style of decision-making is also likely to be different between contexts. Here we consider Surrogate Decision Making (SDM) theory specifically in considering factors that impact decision making when decisions are being made on behalf of others [16]. SDM has previously been used, primarily in health contexts, to consider when people may be obliged to take important health decisions on behalf of others unable to do so and has observed key differences between the process of decision making for the self, compared to decision making for others, because this decision making considers the perspective of others. Here we use SDM in a different way, considering the potential theoretical implications for situations in which people make decisions for themselves and others combined, and how this may vary when the 'others' considered may differ. We use SDM to examine how people may take decisions relating to supporting SETs either primarily for the self and close family members at a residential level, or when considering colleagues in a workplace context, or a wider group of others in a policy context.

1.1. Public perceptions of smart energy technologies

Members of the public in many countries around the world are generally keen to reduce their energy use [3,17] which has positive implications for the development of SETs. The specific form of technology has an impact on acceptance of SETs however, with higher acceptance where benefits are perceived clearly, e.g. environmental and cost savings. Importantly, members of the public exhibit some scepticism around whether SETs will provide cost savings, as well as concerns about hidden costs and lengthy payback periods [5,18]. Interestingly people with concerns around energy affordability were found to be less accepting of SETs despite the framing of SETs in terms of reducing energy costs [3] possibly in part due to lower levels of trust around value and payback periods. There is also much lower acceptance of SETs where health and safety issues are perceived, as with food storage technologies such as freezers for example [5,19]. Concerns have particularly been expressed where current lifestyles and comfort are perceived to be compromised [20], with most people keen to retain autonomy and individual control; though note that increased control over energy has also been perceived as a benefit of many SETs [9]. In relation to ceding control, policy makers and academics often highlight potential problems around whether people will share their energy data and whether there are data privacy concerns, however in reality, evidence on public concerns on data privacy is mixed [3,5,19]. Members of the public also express mixed feelings towards automated operation of SETs; here perceived benefits have been found to be important, with compensation desired for potential inconveniences experienced [4].

In addition to the attributes of SETs themselves, it is theorised that environmental attitudes and symbolic attitudes of the perceiver impact the likelihood of support and adoption (ISE model [21,22]). Symbolic attitudes are the way in which adoption of products may impact someone's perceived self-identity or status [21]. For example, engaging in a community battery storage project may indicate to others that you are a person interested in innovation and new technology. Evidence supports these ideas [21,22] and additionally indicates the importance of adoption norms (i.e. the extent to which people think others would consider adoption of technologies) [23]. Environmental perceptions also indicate that SETs tend to be evaluated as a positive contribution to society [23]. Beyond this, people are quite aware of the value offered by SETs to stakeholders, in that by their participation with SETs, they are providing value to the grid, to network operators, and their energy suppliers [21]. In relation to this, the development of SETS is also associated with some mistrust around why they are being promoted and whether individuals are likely to see benefits at a personal level [9]. Indeed, scepticism may be well founded as some experts also indicate scepticism about whether SETs are worth the investment at a residential level [3]. It is noted that there is a lack of data and a great deal of uncertainty around domestic DSM, particularly in the UK [24]. It is clear that people often take other people's and organisations' perspectives and decisions into account when considering whether they are likely to engage with SETs.

1.2. Smart energy technologies (SETs) in different contexts

The bulk of research carried out on public perceptions of SETs has focused on acceptance, and engagement, at a residential level [3,5–7]. Research in the workplace context is limited [25–28], and that which focuses on support for government policy even more so.

It is observed that beyond individual preferences, support for SETs in the workplace is impacted by consideration of others, community, and organisational culture [29], and that energy management must negotiate, often competing, organisational goals [30]. Within the workplace, people are likely to consider how their decisions will affect their colleagues, they may consult others on their views, and consider these views when making decisions [31]. Individuals also usually comprise an organisational community through which energy practices can be negotiated and social and descriptive norms can be passed on [32]. The ability of people to make decisions about energy in their workplaces may also vary dramatically depending on the organisational structure, the scope of their position within it [29], and environmental goals within the organisation [33,34]. Energy goals within an organisation are negotiated alongside other competing goals (e.g. profitability) and are often not considered a priority, which impacts whether individuals within the organisation are motivated, and able, to address energy saving [35].

Energy use in a workplace context is also inherently linked to the physical and technical conditions of the buildings in which they are located [29,36], and this is likely to impact individuals' consideration of what is possible in terms of energy saving. Buildings that are perceived as difficult and overly complex to control could limit support for SETs but the potential for shared responsibility, and expertise within a workplace environment may expand perceptions of what is possible [31].

Another key difference between decision making around SETs in different contexts are the cost implications. Notably, in a workplace the cost implications of implementing SETs are not directly felt by individuals [31]. This does not necessarily mean that individuals do not care about the financial implications for their workplace, but the extent to which the individual prioritises cost implications is likely to be less [37].

Research considering government policy support for SETs is also limited and tends not to be distinguished clearly from individual level behaviour; indeed, individual level perceptions and behaviour in relation to SETS is often used to indicate likely policy support [26,38]. Here

we consider policy support in terms of government rules or legislation that individuals would be prepared to verbally defend or advocate to others; this need not imply activism.

In considering policy support it is useful to look to the broader literature on public perceptions which are highlighted as integral to policy formation by feeding into decision making at an early stage in policy development [39]. Again, there is little here that distinguishes between contexts in support for SETs however. Notably Demski and colleagues [40] identified a set of social values that are theorised to be drawn on when members of the public consider whole system energy change (including SETs). Values identified comprised Efficiency and Wastefulness, Environment and Nature, Security and Stability, Social Justice and Fairness, Autonomy and Power, and Processes and Change. These values are proposed to specifically focus on socially relevant criteria important for public support [40]. Interestingly, in formulating these values, Demski and colleagues [38,40] observe that the scale of what is being considered is important, and people may shift their perspective when considering individual circumstances compared to the more general situation [41].

We propose that for policy support, similarly to the workplace, people are likely to consider how their decisions will affect others, and in this case usually a large number of others, in their decision making. Descriptive norms and also particularly injunctive norms – regarding what others think that you ought to do – are also likely to impact policy support [42,43]. However, other individuals within a policy context may be more socially distant from one another than in other contexts, and therefore related norms may have a lesser impact (cf. psychological distance [44]). People may consult others in terms of their views but may be less likely to know those impacted by the policy, and to see the impacts of the policy, in comparison to a workplace situation.

It is likely that the cost implications of policies in relation to SETs will be less central to an individual's decision making, both because the impacts of that policy may not be felt personally, and because the scale of costs and benefits may be too abstract for individual comprehension [31]. Individuals may consider financial implications for wider society but may not have an accurate understanding of these and may lack a relevant frame of reference with which to evaluate these. In comparison to considering the use of SETs at a domestic level, considering broader energy system policy on SETs involves additional multiple complexities that may be unfamiliar and uncertain to most public(s) [45–47]. Integrating the research evidence in relation to acceptance, engagement, and support for SETs across residential, workplace and policy contexts indicates that there may be different factors that relate to support in different contexts. Notably the nature of cost and financial implications of decision making will differ between contexts, as will the consideration that people give to others' perspectives. These are likely to impact the perceived risks and benefits considered in a rational decision making process and may also impact the decision making process itself.

1.2.1. Theoretical reasons for contextual differences in decision making

Interestingly, theoretical research also indicates that decision making may differ in terms of process and in terms of which factors impact upon the process when considering the self or others [1,16]. SDM indicates that people making decisions for the benefit of others are less impulsive and less driven by affect in their decision making, the more distant those 'others' are socially from themselves [16]. It is theorised that when we have empathetic links with other people, the more likely that we will allow our affective responses to influence our decisions. It is theorised that the closer we are to others, the more likely we are to make decisions in line with decisions that we would make for ourselves, and the more likely these will be impulsive and affect driven.

This would imply that people's decision making in relation to SETs is likely to vary in terms of impulsivity for decisions that involve others. So workplace and policy contexts, which are likely to affect other people more socially distant from the individual than in a residential context, may prompt more calculated and less impulsive decision making; possibly even more calculated and less impulsive for policy contexts where social distance may be greater than in a workplace context. We propose that a calculated decision is more likely to rely on perceptions of risks and benefits, within that particular context, than impulsive decision making. Notably, decisions in relation to SETs in residential, workplace, or policy making contexts differ from those within standard SDM contexts in that decisions usually impact the self as well as others. However, it is interesting to extrapolate decision making for others to the situations in which decisions involve others, and the possibility that then the process of decision making may also differ from decision making solely for the self.

Accountability is also highlighted within SDM as a key factor that may influence decisions made for others. Where individuals expect to be held accountable for decisions, individuals are likely to spend longer considering all possible perspectives and options [1]. Where people are less likely to be held accountable for the decisions that they make, the personal intentions of the decision maker are likely to carry more weight. It is currently unclear as to which contexts individuals may consider themselves accountable for in relation to SETs. Within residential contexts, individuals may consider themselves accountable to their immediate family and closest friends, in which case it could be considered that their accountability is high. Alternatively, it could be considered that accountability within workplace or policy contexts could be higher than in a residential context, given that decisions in these contexts impact a much greater number of people.

It is also interesting to consider how individuals may act consistently or inconsistently across contexts with regards to SETs. Theory on cognitive consistency indicates that people seek consistency across their attitudes and behaviour and therefore should demonstrate consistency in their behaviour across contexts [48,49]. There is no known evidence here relating to support of SETs, however the evidence with regards to energy saving behaviour is mixed. Interestingly, some research indicates that individual's energy saving personal actions are positively associated with their support for energy policy [10–12], or that behaviour shaped by energy policies may become internalised and then enacted in different contexts [13]. However other research indicates that people are less supportive of energy policy if they already engage in personal energy-saving behaviour [14,15]; it is theorised that personal actions could be considered as a substitute for policy support or vice versa [15]. One possible explanation for differences observed in behaviour is that these may arise if behaviour in different contexts had differing aims, such as protecting the environment, or saving money [10,27]. To our knowledge, no previous research has examined the consistency of support for SETs across residential and workplace contexts; and we extend this further by also including a comparison with a policy context.

2. Study design

We used a mixed methods approach here, comprising an online survey (study 1) and structured interviews (study 2), to assess support for, and socio-cognitive constructs relating to SETs in different contexts. We used a survey approach in order to gain quantitative data examining support for SETs within residential, workplace and policy contexts. We additionally examined key socio-cognitive constructs relating to SDM theory comprising: impulsivity of decisions; perceived accountability; and perceived risks and benefits of supporting SETs. We examined how these socio-cognitive constructs related to differences in support between contexts. Subsequently, we conducted a series of interviews focusing on the same SETs and probing the same key socio-cognitive constructs in order to gain depth of understanding with regards to the basis for people's responses.

For study 1, we hypothesised that support for SETs would differ between residential, workplace, and policy contexts but did not predict direction of differences given lack of previous research. We also predicted differences in support for different forms of SETs. Considering previous research indicating that health and comfort are particular

concerns around engagement with SETS, we predicted that our scenario focused on remote control of white goods including fridge freezers would be least popular across contexts.

Socio-cognitive constructs examined (based on SDM) encompassed factors that were thought to impact rational calculated decision making (perceived risks and benefits, accountability), and a factor that related to the decision making process itself (impulsivity). We hypothesised that socio-cognitive constructs examined would differ both in terms of empirical levels, and in terms of their importance in relating to support expressed, across contexts. Based on previous research we predicted that empirical levels of perceived risks and benefits would differ across contexts. We also predicted (based on SDM theory) perceived risks and benefits would be more related to support for SETs with increasing social psychological distance of those impacted; stronger relationships between perceived risks and benefits and support were therefore expected within workplace and policy contexts compared to a residential context. Again, based on SDM, we hypothesised that the levels of impulsivity felt in decision making would be highest in residential scenarios, compared to workplace and policy contexts. We also predicted differences in levels of accountability felt across contexts but given previous mixed research, we did not predict direction. We further explicitly examined consistency of support between contexts but did not make a specific prediction here given previous mixed research.

3. Study 1 – Online survey

3.1. Method

3.1.1. Participants

We recruited 213 participants from a general British population sample using the recruitment website Prolific. Thirteen participants were excluded from the sample as they answered a filter question checking that they were paying attention, incorrectly. The final sample contained 200 participants comprising 69 men and 131 women. Ages ranged from 22 to 61, with a median age of 35. Within our sample, 190 reported being employed, with six stating that they were unemployed, and one stating that they were retired (three did not answer this question). Seventy-seven people indicated that they have supervisory or managerial responsibilities within the workplace and 122 people indicated they did not (one person did not answer this question).

3.1.2. Materials

The survey comprised questions examining demographics, participants' support for a series of scenarios about Smart Energy Technologies (SETs), measures of the Value Belief Norm Model which examines how values relate to behaviour [50], feelings about SETs using a standard scale assessing affect (the Positive And Negative Affect Schedule: PANAS [51]), measures of empathy and perspective taking [52], identification with colleagues and with the rest of the UK population [53], and measures of SDM [16]. The current analyses focus on demographics, participants' support for SETs and measures of socio-cognitive constructs relating to SDM only, see Appendix A for full question items.

Questions assessing SET scenarios were prefaced by a short text, describing what SETs are, and why they are being developed. This text was developed by the full research team comprising four academic researchers, who have expertise in the field of smart energy research with different academic backgrounds of Sociology, Psychology, and Business. The text described how smart energy technologies can enable a greater flexibility in, and support reductions in, energy demand, and highlighted both carbon and cost implications of reducing energy demand; see full text in Appendix B.

Altogether 15 scenarios regarding SETs were presented to participants, involving five different technologies across three different contexts: residential; workplace; and policy. Scenarios were developed by the project team in a series of meetings focused on scenario development, where project members considered current and likely future SETs that were currently being discussed within academic, policy, and industry literatures. Text was kept almost identical across scenarios for each context so that the only point of difference was the context in the scenario, and wording was chosen so that the meaning was understandable and relevant across contexts. Within the questionnaire, scenarios were grouped according to context, so participants would focus on that context and so as to facilitate the imagination of technologies within each context. Combined scales were formed for each context to provide an indicator of support of technologies for each context; scale reliabilities were acceptable for the Residential and Workplace contexts ($\propto = 0.65$ and $\propto = 0.69$ respectively) and slightly low for the Policy context scale ($\propto = 0.58$) [54]. The variability of responses between technologies within the Policy context should be borne in mind when considering the generalisability of analyses based on this scale; it is clear that support does vary according to the specific technology despite the consistencies across the contexts examined.

Questions were also included to assess socio-cognitive constructs of relevance for SDM including impulsivity of decisions, perceived accountability, and perceived risks and benefits of supporting SETs. Impulsivity was measured by asking participants to reflect on the decisions that they took within the previous scenarios involving SETs and the extent to which their responses were impulsive or planned within each of the contexts examined. Perceived accountability was examined by asking participants the extent to which they thought that they would be held accountable or not for their decisions within each context and perceived risks and benefits were assessed by asking participants directly to rate the extent of the risks and benefits that they perceive in relation to supporting SETs in each context. Items were based on previous SDM research [16] and adapted to focus on SETs and different contexts. A filter question was included to ensure that participants were reading the questions and paying attention. This asked participants to simply select 'Strongly disagree' as their response.

3.1.3. Procedure

Participants were recruited using the website Prolific on 2nd February 2017 using pre-screening criteria to restrict participation to people who lived in the UK, were 18 years old or older, non-students and those that were in full time or part time employment only. We note that not all participants reported being employed indicating that their status may have changed between completion of screening questions and completion of the current questionnaire or indicating false responding. Whilst Prolific maintains a diverse participation panel, it does not provide a representative sample of the UK, however we highlight that the empirical levels of the data are not the focus given that this study focuses on comparing scenario responses between different conditions. Completion time for the questionnaire was estimated as 20 min and participants were awarded points from the website for completion which were equivalent to £2.

Participants completed the full questionnaire online at a time and place of their choosing. At the end of the study, participants received a full debrief as to the aims of the study and intentions for analysis. No personal identifying information was gathered from participants; all data was stored anonymously.

3.2. Results

In order to examine the differences in levels of support of SETs between scenarios in terms of the context, and technology, we conducted a repeated-measures 5 (technology: data sharing; real time pricing; network control; energy storage; bulk purchase) × 3 (context: policy; work; home) ANOVA, with gender and age included as covariates, see Fig. 1, descriptive data is provided in Appendix C. Mauchly's test of sphericity was significant for differences between contexts ($x^2(2) = 18.10$, $p < 0.001$), differences between technologies ($x^2(9) = 60.34$, $p < 0.001$), and the interaction between the two ($x^2(35) = 75.33$, $p < 0.001$) indicating that the variance of the differences between groups

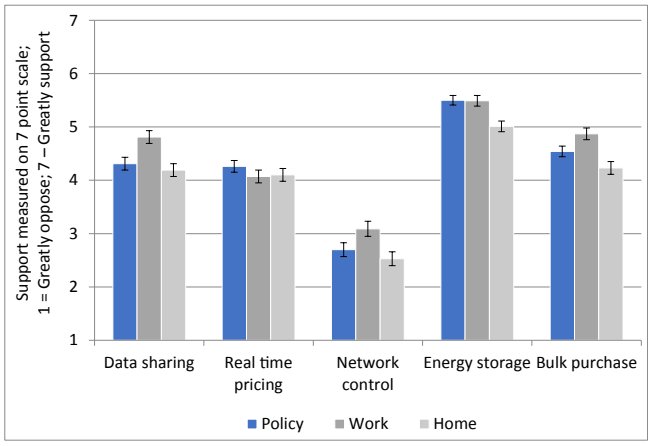

Fig. 1. Differences in support of SETs between technology and context. Support was measured on a 7-point scale where greater values indicated greater support and 4 was the midpoint, indicating neither opposing or supporting the technology. Significant differences in support (N = 198) were observed between technologies, and between contexts (with gender and age included as covariates in the analysis). Error bars indicate the standard error of the mean.

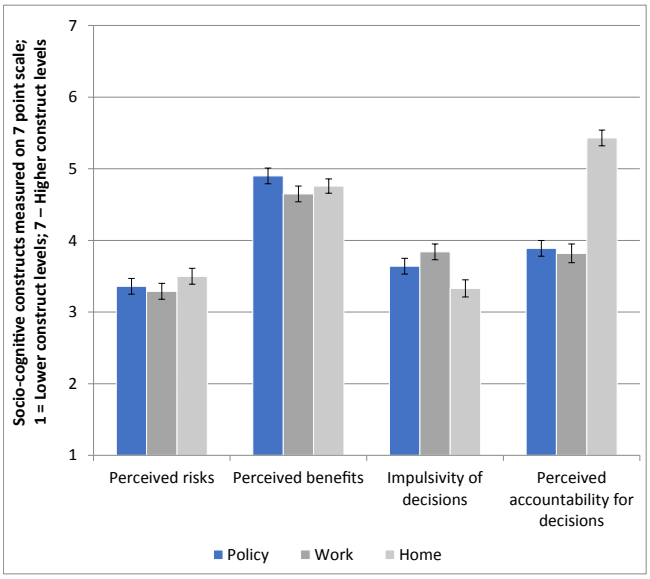

Fig. 2. Differences in socio-cognitive constructs relating to SETs between contexts. Socio-cognitive constructs were measured on 7-point scales where greater values indicated greater values of each construct. Analysis (N = 199) indicated that perceived benefits, impulsivity of decisions, and perceived accountability for decisions were significantly different between contexts. Error bars indicate the standard error of the mean.

examined were not equal, and thus Greenhouse-Gaisser corrected values were used for all tests here to reduce the chance of our data giving falsely positive results. Within subjects' effects showed that differences between technologies were significant ($F(3.48, 677.70) = 5.94$, $p < 0.01$, $\eta^2 = 0.03$), differences between contexts were marginally significant ($F(1.84. 358.11) = 2.98$, $p = 0.06$, $\eta^2 = 0.02$), and the interaction between technology and context was non-significant ($F(7.23. 1409.74) = 0.78$, $p = 0.61$, $\eta^2 = 0.00$).

Follow up pairwise comparisons of support in different contexts, indicated that technologies were most likely to be supported in the workplace context, which had significantly higher support than those in the policy context ($p < 0.01$) or the home context ($p < 0.01$). Support in the policy context was also higher than that in the home context ($p < 0.01$).

When examining the different energy technologies, energy storage was the most strongly supported technology, with significantly higher support than all other technologies (all ps < 0.01). Bulk purchasing of energy also received high levels of support, significantly higher than real time pricing or network control (ps both < 0.01). Data sharing was also mostly supported, with again significantly higher support than network control ($p < 0.01$). Real time pricing received lower support than other technologies, significantly lower than energy storage and bulk purchasing scenarios (ps both < 0.01), though most people did support rather than oppose this technology; support for real time pricing was also significantly higher than that for network control ($p < 0.01$). Most people opposed network control and support here was significantly lower than all other technologies examined (all ps < 0.01).

We examined how empirical levels of socio-cognitive constructs linked to SDM – perceptions of risks, benefits, impulsivity of associated decisions and perceived accountability for decisions - differed between contexts, see Fig. 2. A repeated measures 3 (Context: Policy; Work; Home) × 4 (Construct: Perceived risks; Perceived benefits; Impulsivity of decisions; Perceived accountability for decisions) ANOVA was used to examine the significance of differences between means. Gender and age were included as covariates.

Results indicated that overall there were significant differences between contexts ($F(8, 189) = 3.06$, $p < 0.01$, $\eta^2 = 0.12$). Gender was not a significant covariate ($F(4, 193) = 0.60$, $p = 0.66$, $\eta^2 = 0.01$) but age was ($F(4, 193) = 2.72$, $p = 0.03$, $\eta^2 = 0.05$). Mauchley's test of Sphericity was significant for benefits, impulsivity, and accountability ($x^2(2) = 17.86$, $p < 0.001$; $x^2(2) = 42.91$, $p < 0.001$; and $x^2(2) = 33.69$, $p < 0.001$ respectively) indicating that the variance of the differences between groups was not equal. Greenhouse-Geisser corrected values were thus considered for these variables.

Univariate follow up tests indicated a quadratic significant difference between context for impulsivity ($p = 0.04$, $\eta^2 = 0.02$) and a linear significant difference between contexts for accountability ($p = 0.02$, $\eta^2 = 0.02$). Follow up tests indicated impulsivity was highest for decisions made in the workplace ($M = 3.83$, $SD = 1.55$), significantly higher (both $p < 0.01$) than both decisions made relating to policy ($M = 3.64$, $SD = 1.50$) and those made in the home ($M = 3.32$, $SD = 1.69$). Decisions made at the policy level were also significantly more impulsive than those made at home ($p = 0.04$). Perceived accountability was highest at home ($M = 5.43$, $SD = 1.55$), significantly higher (both $p < 0.01$) than those made in the workplace ($M = 3.82$, $SD = 1.84$) or at the policy level ($M = 3.89$, $SD = 1.63$). Perceived accountability levels in the workplace or at the policy level did not significantly differ from one another.

No significant differences were observed in perceived risks between contexts ($p = 0.29$, $\eta^2 = 0.01$) with similar levels perceived for policy (Mean (M) = 3.36, Standard Deviation (SD) = 1.56), workplace ($M = 3.29$, $SD = 1.57$) and home ($M = 3.50$, $SD = 1.61$). No significant differences were observed between contexts for perceived benefits either ($p = 0.71$, $\eta^2 = 0.00$). However, follow up tests indicated that perceived benefits at the policy level ($M = 4.90$, $SD = 1.48$) were significantly higher than those perceived within the workplace ($M = 4.65$, $SD = 1.55$). No significant differences were observed between those perceived at home ($M = 4.75$, $SD = 1.55$), and in the workplace or at a policy level.

We also examined consistency of participants responses across contexts using correlations. Correlations were high between all contexts with the mean support in residential contexts correlating with mean support in workplace contexts and policy contexts with $rs = 0.69$ ($p < 0.01$) and 0.79 ($p < 0.01$) respectively, and mean support in workplace and policy contexts correlating with $r = 0.72$ ($p < 0.01$).

3.2.1. *Factors contributing to support of SETs*

A series of forced entry linear regressions were used in order to examine the relationships between socio-cognitive constructs relating to SDM, and support for SETs in each context (policy, work, and home), see Table 1. Perceived benefits consistently predicted support across contexts, even when other variables were included within analyses. When

Table 1
Correlations and linear regressions of socio-cognitive constructs on support for SETs in different contexts.

Factor	Policy		Workplace		Residential	
	r	B	r	B	r	B
Perceived risks	−0.07	−0.03	−0.15*	−0.08	−0.04	0.03
Perceived benefits	0.28**	0.14**	0.28**	0.19**	0.42**	0.30**
Perceived impulsivity	−0.20**	−0.11*	−0.08	−0.07	−0.13	−0.05
Perceived accountability	0.17*	0.06	0.02	−0.03	0.16*	−0.00
Age	−0.05	−0.01	−0.08	−0.01	−0.02	0.01
Gender	0.04	0.06	0.01	−0.06	0.00	0.12
R^2		0.12**		0.10**		0.19**

N.B. * = $p < 0.05$, ** = $p < 0.01$

examining zero-order correlations between constructs, perceived risks was a significant predictor of support in the workplace, in that lower perceived risks predicted greater support of SETs in the workplace, but this became non-significant in the regression when other factors were included. Impulsivity and perceived accountability also demonstrated significant zero-order correlations with support for SETs in the policy sphere and at home, but these also became non-significant within regressions when other variables were included. Notably, VIF levels were acceptable indicating that collinearity was not a significant issue within regressions conducted. Lower levels of impulsivity were associated with higher levels of support of SETS and greater levels of perceived accountability in relation to SETs were related to higher levels of support.

4. Interim discussion

Support for SETs was significantly different depending on the context in which they are proposed to be implemented; differences observed have a small effect size, but these translate to large numbers of the population when considering impacts across the UK, and potentially beyond. SETs were most likely to be supported in the workplace context and policy support was also higher than in the residential context. This is in line with opinions expressed by experts in the field who indicated that SETs may be more successful in a workplace context [4], though does not indicate that SETs do not have value within residential contexts. Despite clear contextual differences, there was consistency in how individuals responded across contexts supporting previous ideas of cognitive consistency [48,49] rather than ideas of substitution [15]. Note however that internal consistency of scales were slightly low, particularly for the policy context, indicating variability in support between technologies which should be acknowledged when considering generalisability.

Support for SETs also differed significantly across different technology scenarios with a small effect size that is nonetheless important when considering numbers of people needed to engage with the technologies. Energy storage was the most strongly supported technology and bulk purchasing of energy was also highly supported. In line with hypotheses, most people opposed network control, possibly reflecting the belief that this scenario might impact comfort or health [5,19].

Results indicated that socio-cognitive constructs relating to SETs significantly differed across contexts and were useful in predicting support in each context. Perceived benefits predicted support for SETs in all contexts. This contradicts the hypothesis that perceived risks and benefits would be particularly relevant for workplace and policy contexts where individuals are theorised to take more rational, careful decisions [16]. Interestingly perceived impulsivity was the only other factor which continued to predict support (in a policy) context once other variables had been accounted for in a regression. Unpartialled correlations indicated that higher impulsivity related to lower support in a policy context, and higher accountability related to higher support in policy and residential contexts (not workplace) but that these overlapped with other variables and did not significantly predict support when included in a regression. Empirical levels of perceived benefits of SETs were higher than the associated risks and whilst perceived risks did not differ between contexts, perceived benefits were significantly higher in the policy context compared to those perceived in the workplace, perhaps reflecting perceived benefits of a large-scale collective of people mitigating climate change.

Empirical levels of impulsivity of decision making about SETs reported also significantly differed across contexts, with decisions being made in the workplace being more impulsive than in other contexts and those being made at the policy level being more impulsive than those being made at home. Data contradicts predictions made based on SDM theory which indicate that decisions made for others are less impulsive and more rational than those made for the self [16]. It is possible that plurality is important here; whilst surrogate decision making considers decision making for a specific other, policy and workplace contexts considered here focus on a large number of others rather than one specific other individual.

Perceived accountability for decision making about SETs was significantly higher in the home context than in the workplace or policy context. It appears that individuals consider themselves most accountable to their immediate family and friends in a residential context, despite their decisions potentially impacting a greater number of people within a workplace or policy context. The current situation may differ from previous SDM research in health contexts in that here, it might be envisioned that other people would be involved in the decision-making situation in workplace and policy scenarios, which could lessen accountability or at least introduce some uncertainty into perceptions of accountability; in previous SDM scenarios, the participant was clearly the key person responsible for making a decision [1,16]. A fuller discussion of results alongside those from Study 2 will follow in Section 6.

5. Study 2 – Interviews

Given that several hypotheses from Study 1 were not supported, and in order to further examine reasons underlying differences found between socio-cognitive constructs relating to SETs between residential, workplace, and policy contexts, we undertook further in-depth qualitative research. We wanted to determine the nature of the socio-cognitive constructs outlined within SDM, as exhibited in the field of SETs, and observed to be of differential importance across contexts in Study 1. We proposed that this would help us both better define the constructs as perceived by participants, (e.g. what accountability means in terms of smart energy technologies), and would also identify subcategories of the constructs mentioned, (e.g. the types of benefits perceived). Based on previous research and findings in Study 1, we predicted that the types of risks and benefits perceived would differ across contexts. We also predicted that the spontaneity of decisions made would be greatest in workplace and policy contexts, and perceived accountability would be highest in a residential context, based on findings from Study 1. Following up reasoning as to why accountability might be lower in workplace and policy contexts despite decisions potentially impacting larger numbers of people, we also examined

perceptions of uncertainty across contexts.

5.1. Method

5.1.1. Participants

We recruited a sample of 12 participants; five women and seven men, all from the UK. Ages ranged between 18 and 64 years; six participants were aged 18–24, one aged 35–44, three aged 45–54 and two aged 55–64. Participants comprised six undergraduate students and the remainder had a range of occupations: a school secretary; an electrician; a sales and marketing director; a chartered surveyor; a university lecturer; and a clinical psychologist.

5.1.2. Materials

The questions used in the structured interviews comprised questions about participant's demographics, the extent to which participants supported SETs in different scenario contexts, and further questions primarily assessing the socio-cognitive constructs of SDM, again for each context. Scenarios examining SETs were the same as those used in Study 1. As with Study 1, these related to five technology types (Data sharing, real-time pricing, external control, energy storage, and collective purchasing) which were repeated within three different contexts (residential, workplace, and UK policy), see Appendix B for question wording. Internal reliability of scales used within each context was assessed to consider the potential of combining scales across contexts however these were too low to consider forming scales, likely due to the low sample sizes (residential $\alpha = 0.28$, workplace $\alpha = 0.43$, policy level $\alpha = 0.46$).

Further questions examined SDM constructs including: impulsivity of responses to previous scenarios, perceived accountability for decisions relating to SETs, and perceived risks and benefits from supporting SETs. Participants were asked to consider each construct for each context (residential, workplace and policy) and to give their responses verbally to the interviewer. We also included a further question about the participants certainty of their decision making about SETs, given reasoning on the data from Study 1 that accountability may be less clear in workplace and policy contexts. Participants were asked to what extent they felt certain or uncertain about making decisions regarding whether or not to accept SETs in each context and prompted to discuss why.

NVivo software was used to aid analytic coding.

5.1.3. Procedure

Participants were an opportunity sample, recruited through personal contact by the researchers and through a snowball technique. Contact was made in order to sample a range of different ages, occupations, and gender, so as to gain depth of understanding into different socio-cognitive constructs. Participants were told of the topic of study and were not offered any incentive to participate. Interviews were conducted either in person or using video conferencing software and lasted approximately 30 min. A structured interview technique was used in which a questionnaire containing the study questions was provided to the interview participant either in hard copy or by email. This enabled participants to read and re-read questions in order to establish meaning, considered particularly important for the scenario questions. When participants completed the quantitative items, they were asked to describe to the interviewer what they were considering when making their decision. On completion of the interviews, participants were debriefed as to the aims of the study, and the intended analysis of data. All interviews were audio recorded and subsequently transcribed for analysis. No personal details were recorded within the transcriptions and data was stored anonymously.

5.2. Results and discussion

5.2.1. Analytic approach

Two researchers initially coded two interview transcripts independently and then met to discuss and agree themes that had emerged. Transcripts were anonymised and initials used to refer to participants in discussions and noted where quotes are provided subsequently. Analyses comprised the identification of key themes that participants expressed in relation to support of SETs in different contexts and of the examination of the nature of socio-cognitive constructs relating to SDM that the participants were specifically questioned about. An inductive approach was used in developing themes emergent in both analyses. Despite using a SDM framework to create the interview structure, an inductive rather than deductive strategy was deemed appropriate in identifying themes given surprising results from study 1. Once the themes had been agreed, one researcher then used these to code the rest of the transcripts. Upon completion of thematic coding of the full dataset, emergent themes were again discussed with the initial researcher and a further researcher. Themes did not change following the initial thematic agreement but the ways in which they were expressed developed more fully with the further interviews coded.

5.2.2. Key themes emergent in SETs scenarios and differences between contexts

A range of themes emerged within descriptions of why participants expressed support or opposition to SETs including financial considerations, autonomy, environmental considerations, lack of knowledge, control, practical considerations, motives of energy companies, health and safety concerns, and privacy concerns, see Table 2. Whilst there were differences in themes highlighted in different SET scenarios, the current analysis focuses on differences in themes between contexts which is where our theorised differences lie.

Overall, financial considerations, autonomy concerns, practical considerations, and privacy concerns were expressed at a similar frequency across policy, workplace, and residential contexts. Notably, different financial considerations were considered when deciding whether to support SETs across contexts. In residential contexts people considered costs as a benefit but also expressed concern and uncertainty around potential increases in costs. In policy contexts participants also considered potential inequalities in cost burdens and people's abilities to take advantage of potential cost savings due to inflexibility of lifestyles. Within a workplace context, there were mixed opinions on cost. Some participants noted that they were indifferent to SETs that had the potential to lower costs, because they do not pay the bills personally (in line with previous research [55]). However, others indicated that it was important to them that their workplaces saved money.

Many people also raised privacy issues in relation to sharing energy data. However, responses were mixed as to whether sharing energy data actually concerned participants. It may be that privacy concerns are dependent on other motivations, e.g., only evident when there is concern about the motives of energy companies [56].

For residential contexts, a lack of knowledge, and health and safety concerns, were expressed more commonly than in other contexts, whilst environmental benefits and motives of energy companies were less likely to be mentioned. It is possible that an individual's lack of knowledge is less important for workplace and policy scenarios given that others are likely to collaborate around a technology's purchase, use, and maintenance. Similarly, within a residential context, there are less people able and likely to monitor health and safety concerns.

In workplace contexts, environmental benefits, and motives of energy companies were more likely to be expressed and a lack of knowledge and health and safety concerns were less likely to be expressed. For policy contexts, environmental benefits, motives of energy companies, and health and safety concerns were more likely to be expressed whilst a lack of knowledge was less likely to be expressed. It appears that participants may particularly have considered the support of others within workplace and policy contexts, which may relate to the increased focus on environmental benefits and lowered concern around a lack of knowledge. It is also possible that participants had a higher-level focus when considering policy and workplace contexts, which may help to explain why consideration of the motives of energy companies is more

Table 2
Themes emerging in relation to support for SETs across contexts.

Themes	Definition	Illustrative Quotes	R	W	P
Financial considerations	In residential contexts included participants indicating that SETs would reduce energy bills, or conversely that energy would end up costing more. Policy contexts additionally comprised discussions of potential for everybody to be able to benefit due to inflexibilities of lifestyles. Workplace contexts were mixed as to whether people were concerned about increased or decreased costs for their workplace.	"*It's a worthwhile thing to invest in because it would make it cheaper in general…*" [RL: residential] "*it kind of feels like it's unfair on people that don't have a choice but to use their energy at peak times, and they're being penalised for it*" [SA: policy] "*Yes I would strongly support because it wouldn't be me that's paying for it to start with and it would show that the company I'm working for is concerned with the environment*" [LP: workplace]	0	0	0
Autonomy	Comprised consideration of infringements of SETs on participants' day-to-day routines and activities across contexts. Also encompassed participants belief in energy as a human right. This was expressed similarly across contexts.	"*it's just again the issue of the employer being penalised for using energy during peak times whereas they might not have an option not to, and it's not really their responsibility to pay for that.*" [SA: workplace] "*if I wanted to keep things switched on, that's my right as a human*" [AJ: policy]	0	0	0
Environmental considerations	Decisions supporting SETs based on their potential to help reduce carbon emissions. Encompassed ideas of reducing waste and increasing energy efficiencies. This was particularly mentioned in relation to workplace and policy contexts; less so in residential contexts.	"*It's doing your bit for the environment isn't it*" *[JJ: residential]* "*Well, obviously it would encourage people to use energy less at peak times which has environmental benefits*" *[SA: policy]*	−	+	+
Lack of knowledge	Participants were often unsure about their decisions, indicating that they did not fully understand the technologies or have enough knowledge to make an informed decision. A lack of knowledge was predominantly expressed in residential contexts.	"*I think I'd need to know more ins and outs of it.*" *[GM: policy]* "*I just don't know if it's financially worthwhile. I just think it's often unclear how many years it would take to recoup the investment that you would have to make,*" *[LP: residential]*	+	−	−
Motives of energy companies	Participants were sceptical over company's motives for supporting SETs. Companies were perceived as making additional gains from SETs, to their advantage and at the consumer's costs. This was more likely to be mentioned in workplace or policy contexts.	"*The network operators would use the data in their favour to gain more money from the consumers.*" *[AA: policy]*	−	+	+
Practical considerations	Comprised the idea that participants perceived some technologies to be impractical. Many liked the theory of the idea but did not believe it would work so effectively in practice. These were expressed similarly across contexts.	"*I think it would be quite difficult to organise and I suppose that would be my main concern.*" *[RR: policy]* "*I do think this is a really good idea in theory. It is just whether it would work practically*" *[AA: residential]*	0	0	0
Health and Safety concerns	Health and safety was often considered in relation to how technologies might malfunction. This was most often mentioned in policy and residential contexts.	"*it is also not a practical policy for all establishments since it could be a health and safety issue*" *[AA: policy]* "*I would be very cross if someone turned off my fridge or freezer and ruined all my food*" *[RR: policy]*	+	−	+
Privacy concerns	Many, but not all, people mentioned privacy aspects of the technologies. It was mixed as to whether this aspect concerned people. This was expressed similarly across contexts.	"*Yeah it's all data protection but it's not… it's not personal data, it's just what you use. Like I don't know how that could affect a person in any way*" *[EM: policy]* "*I have no problem with sharing the data from my workplace, since most things are measured and shared anyway so I'd have nothing to hide as a workplace organisation*" *[AA: workplace]*	0	0	0

N.B. R = Residential context; W = Workplace context; P = Policy context; + = Expressed more than in other contexts; − = Expressed less than in other contexts; 0 = Expressed similarly to other contexts. Initials presented alongside quotes represent participants; they are not their real initials but allow comparison to other quotes from the same individual.

salient in these contexts, cf. construal level theory [44].

5.2.3. Key differences in surrogate decision making (SDM) constructs between contexts

Participants' responses indicated that SDM constructs were relevant for their consideration of SETs and were able to discern differences in these between contexts. In identifying themes, responses were grouped according to the SDM construct being investigated, and the way in which this was expressed is of primary interest, see Table 3. Analysis of each construct involved a consideration of the whole interview, although the most direct answers emerged, understandably, from the responses to probes about each individual socio cognitive construct. Here, quotes are only labelled according to context if they emerged within specific probes for context. Often participants responded to specific SDM constructs by comparing them directly across constructs rather than considering each context individually.

Risks and benefits were perceived to a similar degree across contexts.

Table 3
SDM constructs manifested in relation to SETs.

Themes	Scope	Illustrative Quotes	R	W	P
Accountability	Included comments that indicated that people felt accountable or not accountable to society, or also to other individuals. Accountability was felt to be highest for residential contexts, lower for workplace contexts, and lower again for policy contexts.	*"In your own home… it's 100% your fault, it's your house. If you… if you for example… even if you didn't back the policy for the bulk buying energy… if that majority say yes and that's gone through government, you have to work with it." (EM)* *"Uhm I don't think I would be particularly held accountable personally to the general society. Well um it's kind of like I was saying before, I'm just one person and there are millions of people in our country" (RR)*	+	−	−
Uncertainty	Primarily related to perceptions of a lack of knowledge. In residential contexts, people were uncertain of negative impacts around cost and control. In workplaces people were concerned about disruption to current work schedules. In policy contexts, people were uncertain about what other people thought, and were concerned about getting it right because of the magnitude of the impacts.	*"In my own home…I guess I feel pretty uncertain because I would want to make sure the decision is the right one… when it is affecting me so personally and closely… so I would want some more information." (AA)* *"In UK society in general… I would feel very uncertain because the decision would be so widespread, and the impact can be detrimental if there is the wrong decision." (AA)*	0	0	0
Impulsivity	Consideration of the impulsivity of responses and the extent of thought given to comments made. Most people indicated that their responses were more planned within residential scenarios than other contexts.	*"I think it's planned for your home because its you. And its impulsive for the other two because you would just hope that the next person up has planned" (EM)* *"I don't think I was impulsive on any of them. I understand the… criteria very well" (AJ)*	−	+	+
Risks	Included a variety of risks including lack of control, costs, health concerns, a lack of ability to engage because of lifestyle, political use, practicalities of implementation, and privacy. Several people indicated that they thought risks were minimal. These were perceived similarly across all contexts.	*"There are risks in terms of money, it might end up costing you more money to engage with smart energy technologies, but on the whole it's not too risky" (SA)* *"I'm very concerned that smart technology could go wrong and put people in danger at work."(AJ)*	0	0	0
Benefits	Participants mentioned a variety of benefits including becoming more energy efficient, benefiting the environment, and reducing costs. Benefits were considered to exist across all contexts though in policy contexts additional benefits of energy security and alleviating fuel poverty was mentioned. In relation to workplaces, the additional benefit of engaging people with SETs and energy saving was mentioned.	*",,.people will become more responsible in their use of energy and people would become more environmentally aware." (FM)* *"In the UK society in general, I think again it can only be a good thing because it could help bring prices down, especially for those people that are in… what do they call it…. something poverty… fuel poverty. Can't afford to put the heating on. If it's across the whole UK you're looking at, it would benefit all."(JJ)*	0	0	0

N.B. R = Residential context; W = Workplace context; P = Policy context; + = Expressed more than in other contexts; − = Expressed less than in other contexts; 0 = Expressed similarly to other contexts. Initials presented alongside quotes represent participants; they are not their real initials but allow comparison to other quotes from the same individual.

There were a range of risks identified by participants, with the majority relating to finance and lifestyle supporting previous research [5,18,20]. In particular, participants expressed concerns over the initial cost of investing in SETs as well as how long it would take to gain returns on their investments supporting concerns of some experts [4]. People also indicated some concerns around being controlled and losing autonomy, again in line with previous research [20]. The potential for malfunctions and health and safety concerns were also raised [see also [5,19]], particularly in relation to external control scenarios. In relation to policy contexts, participants also mentioned the risk that not everyone would engage, and that new systems could create societal problems, e.g., the abuse of power, and inequity. However, notably several people also indicated they did not perceive any significant risks. Benefits were particularly perceived in relation to environmental benefits and cost. In policy contexts, people additionally mentioned energy security benefits and the potential to tackle fuel poverty. In workplace contexts, participants also proposed that the use of SETs would engage people and make people more aware of environmental issues and energy use more broadly. The idea that saving energy was good for a sustainable company image was also noted.

5.2.3.1. Accountability. Perceived accountability appeared to follow a trend, in that participants felt least accountable for the impacts of SETs in policy contexts, more in workplace contexts, and most accountable in residential contexts. This appears to be due to higher levels of perceived responsibilities within the home, where impacts may be felt more directly:

> "I would feel the most accountable as it's a smaller scale and I'm responsible for what decisions I make in my house" (SA: Residential context)

Participants were highly concerned about making the best choices for the people closest to them. It was felt that making decisions to support SETs in their own homes would leave them liable to consequences such as financial losses if suggested benefits (e.g., energy efficiencies) were not apparent. Within workplace and policy contexts, participants indicated that accountability may be shared between lots of people, and unless you had specific responsibility for SETs in a workplace or policy context, you were unlikely to be held accountability. One person indicated that with increased monitoring in the workplace, accountability

might increase:

> "I think I would be held more accountable if the business I worked for was monitoring it and had to pay more, then they might start monitoring me in terms of how much energy I use, such as computer usage" (LP: Workplace)

5.2.3.2. Uncertainty. Uncertainty was apparent across all contexts, though reasons for uncertainty differed across contexts. Participants indicated that they would be more likely to engage with SETs if they were provided with further information about what they are, how they work and about related risks and benefits. For residential contexts, uncertainty was also indicated due to the potential for faults or increases in costs; people indicated that they would be particularly cautious because they would be affected personally. For work contexts, participants indicated that they were less responsible and there would be more information available, however, there was uncertainty over whether working practices and patterns would be disrupted. With regards to policy contexts, people were particularly uncertain because the decision would impact so many other people, because they did not know what others thought and because they were uncertain of who to trust. This extends previous research which has similarly highlighted multiple complexities that may be uncertain to public(s) within energy policy development [45–47].

5.2.3.3. Impulsivity. Participants indicated low levels of impulsivity in expressing support for SETs across all contexts. However, there were many indications that people would be most careful and least impulsive with decisions relating to their own homes given that they had most control here and that the impact of the decisions would be most immediate. There were also some limited expressions of impulsivity though. One participant indicated that, in the residential context, their decisions regarding support of SETs were impulsive due to "*ignorance*" and "*wanting to protect* [what they already had]". Here it seemed that impulsivity was associated with opposition and linked with the idea of lacking knowledge and maintaining the status quo.

It is possible that indications from participants that their responses were planned may partly be due to the nature of the study, in that participants were in an interview context and it may have been deemed rude to indicate that their responses were not considered. Furthermore, the range of questions surrounding SETs may have prompted participants to consider SETs in more depth than they might have otherwise:

> *"…I felt like I'd had a chance to process the questions in a lot of different scenarios." (LL)*

5.2.3.4. Overall differences by context. Risks, benefits, and uncertainty were perceived to a similar extent across contexts though with different themes apparent in different contexts. In home contexts participants indicated a greater focus on personal impacts, and cost. In the workplace context, people indicated that they were less responsible, and were liable to have more information. In both workplace and policy contexts influence between people was considered both in terms of people not engaging and in terms of people engaging more due to the influence from others. In policy contexts, people also considered power and equity balance, with the potential for each to develop positive or negatively. Levels of perceived accountability and impulsivity appeared to differ across contexts with participants indicating that they felt most accountable and least impulsive with decisions in their own homes in relation to higher felt responsibilities and immediacies of impacts potentially felt.

6. General discussion and conclusions

For the first time, we demonstrate significant differences in how people are likely to support SETs across home, workplace and policy contexts. We find that people are more likely to support SETs in a workplace or policy context in Study 1 supporting the views of experts in this field [4]. Notably, despite the focus on residential studies within this field, we find that support for SETs within workplace and policy contexts are related to different socio-cognitive factors from those in residential contexts. Furthermore, in both studies, we note that style of decision making within workplace and policy contexts is likely to differ from a residential context, in that it is more spontaneous in nature and characterised by a sense of shared accountability. We conclude that results from residential studies should not alone be used in the formation of policy at a workplace or national level. Research within these specific contexts is needed and results here contribute to understanding how results may systematically differ.

Study 1 data indicates that perceived benefits are particularly important in predicting support across contexts. Empirical levels of benefits were also found differ across contexts (Study 1) with the highest benefits being perceived within a policy context and lowest perceived benefits within a workplace context. However, Study 2 indicates that benefits perceived are qualitatively quite varied across contexts; differences which are masked when perceived benefits are examined as a single construct. Environmental benefits were mentioned across contexts in Study 2 but in a residential context often focused on personal impacts and financial benefits. In workplace contexts people also mentioned social benefits of introducing SETs, in particular the benefits of engaging a large number of people in tackling climate change. In policy contexts, social issues such as alleviating fuel poverty, or ensuring energy security were more likely to be mentioned. Study 1 observed that perceived risks were less relevant to predicting support of SETs and responses in Study 2 indicated different risks were considered across contexts, with more practical considerations being considered in residential contexts, and potential societal problems noted in relation to policy contexts.

We observe that people also tended to feel most accountable for decisions relating to SETs in a residential context compared to workplace or policy context where accountability may be shared. Style of decision making appears to differ in relation to SETs between contexts but in a different way to that predicted by SDM [1]. Decision making was reported to be least impulsive within a residential context, more in policy contexts, and most impulsive in workplace contexts in study 1. Exploring reasoning around these decisions further in Study 2, it appears that people feel more responsible at home where the immediacies of the decisions are salient and with respect to workplace and policy contexts, people appear to consider that the responsibilities are shared, and accountability diffused amongst others. Results here therefore do not support SDM [1] though we note differences in that decisions here are being taken for others and the self, rather than others excluding the self as in previous SDM research [1,16]. We propose that further theoretical development is required in considering how people make decisions for the self when others are impacted by those decisions. Notably, this is something that may differ across cultures both between countries, where there are differences in the extent to which people may feel accountable in society and between workplace organisational cultures [57,58]. Further studies could investigate the nature of perspective taking, and the consideration of others, that is involved in decision making in relation to SETs (and other fields) and how this differs in different contexts, and indeed across cultures.

We highlight that given the lack of existence of real-world examples of many of the SETs examined within this study, we asked people to imagine scenarios involving a range of different SETs. It is possible that people's responses to scenarios will not be the same as those that will be enacted in a real-world situation and when novel SETs are developed, real life trials and examination of related socio-cognitive constructs and engagement is advised. It would also be interesting to systematically examine different situations in which impulsivity, or perceived accountability, of decisions in relation to SETs varies or is manipulated;

this would allow the investigation of the causal nature of these factors, and better prediction of behaviour in different situations.

We highlight that we used general population samples which were not representative of the UK and we should therefore generalise our findings with caution. However, it is noted that the samples incorporated a range of genders, ages, and employment statuses indicating a diverse sample which should therefore have captured a diverse range of views. A more specific limitation with respect to our data relates to the low internal reliability of our scale of policy support, reflecting differing levels of support for the different technologies encompassed within the scale for the policy context; the variation between technologies should thus be heeded and generalisations across policy contexts taken with some caution. It is also possible that different participants may have considered policy opposition and policy support to mean different things. For example, one participant may have considered policy support as a voting preference and another whether they might have engaged in activism to support or oppose the issue; differences in interpretation could have added to variability noted within the data. However, given that that ambiguities were not raised or considered by interviewees in Study 2, we suggest that variation in the data is likely to be more reflective of differences between technologies. Furthermore, differences in support of SETs between contexts and between technologies, noted in our quantitative data, had only small effect sizes though we consider these important when considering these in terms of how many people are planned to be engaged with SETs. The current sample was limited to the UK but given the current developments of SETs across the world, we propose that the findings here are likely to be relevant to other cultures; however, as noted, given cross cultural differences in interpersonal relationships, results may differ in different cultural and organisational contexts.

In conclusion, we note that caution is needed when integrating SETs into the workplace or formulating policy based on residential information and trials as socio-cognitive factors relating to support, and the decision making process, are quite different between contexts. Factors identified here indicate how support and decision making may systematically differ between contexts. However, policy makers and those integrating SETs within a workplace environment should ensure translation research is conducted, and contextual issues are examined rigorously prior to implementation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Questionnaire items

Construct	Questionnaire item	Response scale
Support for SETs – residential questions	[Data sharing] There is a new mandate that all residential energy-use data (every 30 min) will be shared with energy suppliers and network operators. To what extent do you think you would support or oppose the sharing of your own home energy use? [Real time energy pricing] The Department for Business, Energy & Industrial Strategy (BEIS) is going to introduce the use of real time pricing where energy use tariffs reflect current demand more closely and thus, will be cheaper at off peak times but will be more expensive during peak times. To what extent do you think you would support or oppose that kind of tariff in your own home? [Remote control of appliances] The Department for Business, Energy & Industrial Strategy (BEIS) is going to introduce more network control where the network operator can remotely turn on or off appliances to reduce energy use during peak times (e.g., fridges, freezers, washing machines). To what extent do you think you would support or oppose the purchase of appliances that link to the network and allow external control in your own home? [Energy storage] The UK Government want to introduce a policy to encourage storage of energy to help smooth peaks in demand for energy. This involves subsidies for energy storage at a building level and would allow advantage to be taken of cheap energy from microgeneration excesses (e.g. when lots of energy is produced by turbines when it is very windy) and off peak pricing times (when energy is cheap because less people are using it). To what extent do you think you would support or oppose investing your own money in energy storage in your own house? [Collective energy purchasing] The UK Government wants to encourage local communities to purchase energy in bulk to takeadvantage of discounts available for bulk purchase and encourage responsible energy use. This would make energy purchased cheaper but amounts above that budgeted for would become more expensive. To what extent do you think you would support or oppose your household taking part in a collective energy purchasing scheme?	7-point Likert scale (Greatly oppose – Greatly support)
Support for SETs – workplace questions	[Data sharing] There is a new mandate that all workplace energy-use data (every 30 min) will be shared with energy suppliers and network operators. To what extent do you think you would support or oppose the sharing of your workplace energy use? [Real time energy pricing] The Department for Business, Energy & Industrial Strategy (BEIS) is going to introduce the use of real time pricing where energy use tariffs reflect current demand more closely and thus, will be cheaper at off peak times but more expensive during peak times. To what extent do you think you would support or oppose that kind of tariff for your employer in your own workplace? [Remote control of appliances] The Department for Business, Energy & Industrial Strategy (BEIS) is going to introduce more network control where the network operator can remotely turn on or off appliances to reduce energy use during peak times (e.g., fridges, freezers, washing machines). To what extent do you think you would support or oppose your company purchasing appliances that link to the network and allow external control? [Energy storage] The UK Government want to introduce a policy to encourage storage of energy to help smooth peaks in demand for energy. This involves subsidies for energy storage at a building level and would allow advantage to be taken of cheap energy from microgeneration excesses (e.g. when lots of energy is produced by turbines when it is very windy) and off peak pricing times (when energy is cheap because less people are using it). To what extent do you think you would support or oppose your workplace investing in energy storage? [Collective energy purchasing] The UK Government wants to encourage local communities to purchase energy in bulk to take advantage of discounts available for bulk purchase and encourage responsible energy use. This would make energy purchased cheaper but amounts above that budgeted	7-point Likert scale (Greatly oppose – Greatly support)

(continued on next page)

(*continued*)

Construct	Questionnaire item	Response scale
	for would become more expensive. To what extent do you think you would support or oppose your workplace taking part in a collective energy purchasing scheme?	
Support for SETs – policy questions	[Data sharing] A new mandate has been proposed that all residential and business energy-use data will be collected and shared with energy suppliers and network operators every 30 mins. To what extent do you think you would support or oppose the sharing of all residential and business energy use data with energy suppliers and network operators? [Real time energy pricing] The Department for Business, Energy & Industrial Strategy (BEIS) would like to introduce the use of real time pricing where energy use tariffs reflect current demand more closely, and thus, energy will be cheaper at off peak times but more expensive during peak times. To what extent do you think you would support or oppose that kind of policy in the UK? [Remote control of appliances] The Department for Business, Energy & Industrial Strategy (BEIS) would like to introduce more network control where the network operator can remotely turn on or off appliances (e.g., fridges, freezers, washing machines) to reduce energy use during peak times. To what extent do you think you would support or oppose that kind of policy in the UK? [Energy storage] The UK Government want to introduce a policy to encourage storage of energy to help smooth peaks in demand for energy. This involves subsidies for energy storage at a building level and would allow advantage to be taken of cheap energy from microgeneration excesses (e.g. when lots of energy is produced by turbines when it is very windy) and off peak pricing times (when energy is cheap because less people are using it). To what extent do you think you would support or oppose that kind of policy for the UK? [Collective energy purchasing] The UK Government wants to encourage local communities to collectively purchase energy in bulk to take advantage of discounts available for bulk purchase and encourage responsible energy use. This would make energy purchased cheaper but amounts above that budgeted for would become more expensive.To what extent do you think you would support or oppose your local community developing collective energy purchasing schemes?	7-point Likert scale (Greatly oppose – Greatly support)
Impulsivity	To what extent do you think the decisions you made for the following scenarios were impulsive or planned? …Scenarios about your own home? …Scenarios about the workplace? …Scenarios about the UK?	7-point Likert scale (Extremely impulsive – Extremely planned).
Accountability	If you choose to engage with smart energy technologies, to what extent do you think you will be held accountable or not for your decisions when choices affect people in: …Your own home? …Your workplace? …UK society in general?	7-point Likert scale (Not at all – Extremely). Not applicable option provided.
Perceived risks	[Residential] Please indicate on the scale below the risks you perceive regarding supporting SET in your own home. [Workplace] Please indicate on the scale below the risks you perceive regarding supporting SET in your workplace. [Policy] Please indicate on the scale below the risks you perceive regarding supporting SET in the UK.	7-point Likert scale (Very little risk – Very high risk)
Perceived benefits	[Residential] Please indicate on the scale below the benefits you perceive regarding supporting SET in your own home. [Workplace] Please indicate on the scale below the benefits you perceive regarding supporting SET in your workplace. [Policy] Please indicate on the scale below the benefits you perceive regarding supporting SET in the UK.	7-point Likert scale (Very little risk – Very high risk)

Appendix B – Text introducing Smart Energy Technologies (SETs)

In order to reduce carbon emissions from energy use, we could become more flexible about when and how we use energy, and make use of smart energy technologies and services. Being more flexible in our energy use helps us reduce the likelihood of periods of extreme demand which puts a strain on the electricity grid. Reducing these peaks of demand saves the UK money, lowers carbon emissions, and reduces the number of power plants we need to build. Here are some examples of how energy usage could be managed differently. Please indicate your view of how much you would support each of the following proposals.

Appendix C Descriptive statistics of levels of support between technologies and contexts

Technology type	Residential		Workplace		Policy	
	Mean	SD	Mean	SD	Mean	SD
Data sharing	4.18	1.74	4.79	1.61	4.28	1.72
Real time pricing	4.08	1.65	4.05	1.70	4.23	1.60
Network control	2.50	1.82	3.06	1.92	2.68	1.83
Energy storage	4.99	1.46	5.47	1.40	5.48	1.32
Bulk purchasing	4.21	1.64	4.85	1.50	4.53	1.45

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