Energy Research & Social Science 79 (2021) 102143

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Sustainability following adversity: Power outage experiences are related to greater energy saving intentions in the United Kingdom and Mexico

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ARTICLE INFO

Keywords:
Community
Flooding
Power outage
Energy saving intentions
Environmental experience

ABSTRACT

Concerns about climate change and energy security, and related behaviour may be impacted by experiences such as flooding and power outages and we consider that impacts may be different for individual and social actions. Our first study, using online survey data from a quota sample in the UK ($N = 1543$) found that concerns about climate change and energy security differed for people who had recent power outage experience compared to those who did not; with small but significant effects. A mediation model analysis found that people who had experienced power outages were more likely to intend to engage in social energy saving behaviours, partially mediated by concerns about climate change and energy security. Our second study used survey data from a convenience sample in Mexico City ($N = 661$). Here a further mediation analysis indicated that people who had experienced higher levels of power outages or flooding were more likely to intend to engage in social energy saving behaviours. In aggregate no significant impacts of experiences on individual energy saving behaviours were found. We conclude that shared adverse experiences may promote prosocial interactions around environmental issues and that there is a key role for communications around environmental experiences in order to promote sustainable behaviour.

1. Introduction

Meeting the ambitious greenhouse gas emissions targets being set in many countries around the world [1] will require major changes to the way that we manage and consume energy [2]. Significant behaviour changes, alongside structural changes to our energy system, are necessary in alleviating the pressure put on our energy resources. It is therefore useful to examine how behaviour may change with environmental experiences. Previous research has demonstrated that flooding experiences are related to higher levels of concern about climate change and preparedness to reduce energy use [3,4], however other research has found that differences in climate change concerns held by those who have experienced flooding do not translate into behaviour intentions [5,6].

It has been reasoned that environmental experiences, such as flooding, could act as a 'shock' to increase concern about the environment and sustainable behaviour. Significant environmental events have sometimes been considered as important 'windows of opportunity' [7,8] within which habits are disrupted and susceptible to change. Notably, previous research has not differentiated impacts of environmental experiences on individual and social behaviour. Where research has differentiated individual and social behaviour in environmental research, there tends to be an individual drive to consume more but a social (and moral) imperative to consume less [9–11] and resource constraints appear to increase these drives [12]. Research to date has focused on extreme weather events, e.g. flooding, but it is possible that events relating to energy specifically, e.g. power outages, could disrupt habits and provide opportunities for communication on social issues such as climate change and energy security.

1.1. Environmental shocks and public concerns

Events relating to energy such as price variability, fuel shortages, or power outages may have impacts on energy behaviour similar to environmental experiences such as flooding. Changes to our climate mean that we are experiencing increasingly extreme weather that result in a loss of electricity [13]. Extreme weather is considered to be one of the main causes of power outages [14–16] and often results in longer supply interruptions than other causes. Notably the frequency of weather-related power outages has increased in the last 30 years and is

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https://doi.org/10.1016/j.erss.2021.102143
Received 18 September 2020; Received in revised form 27 May 2021; Accepted 2 June 2021
Available online 16 June 2021

expected to continue to increase due to climate changes. These weather events include high temperatures, wildfires, high winds, increased amounts of ice and snow, and flooding [15]. Some people have also argued that increasing amounts of renewables being integrated into energy supplies in many countries to meet carbon reduction targets, may threaten electricity supplies and lead to power outages due to the intermittent nature of renewable supplies [17–19]. However, evidence is mixed here; others have argued that the integration of multiple energy sources strengthens the reliability of power systems [20,21]. In many cases countries have met reliability risks with additional measures including interconnectors, supplemental supply resources, and demand side balancing [22,23]. For example, in the UK the introduction of a Supplemental Balancing Reserve, which incentivises electricity providers to keep capacity on standby to meet needs, and a Demand Side Balancing Reserve, which incentivises large energy users to reduce their energy demand at peak times, means that risks of losing electricity supply due to a lack of capacity are low [22]. Aside from impacts from weather, and the possible impact of renewables on energy supply, in some countries, e.g. Pakistan, Nigeria, Mexico, inadequate investment means that energy supply is poorly managed and in many cases power outages are already frequent [24,25]. In Mexico, for example, insufficient investment in electricity infrastructure has led to extensive losses in electricity distribution and transmission which have contributed to power outages in some instances [26,27]. We observe, however, the main cause of power outages across countries around the world is the weather [15,16] and power outages due to extreme weather are likely to become more regular in the future due to climate change [13].

Power outages are one way in which energy security issues tend to be discussed amongst members of the public along with geopolitical issues, energy shortages, and unaffordable prices [28,29]. Notably, many energy security issues are abstract in nature [28], which may remove the individual from a more personal consideration of energy security issues, resulting in psychological distancing (cf. [30]) where an individual feels that the issue is abstract and unrelated to them. Power outages, as events that threaten personal energy use, may make energy security issues 'visible' [28] and relevant. Recent research has started to attend further to public concerns about energy security and has observed notable levels of public concern [31,32], and cross-country differences in concern [32,33].

The public response to a power outage plays a key role in the extent of the impacts of a loss of power. Studies have demonstrated that food poisoning and carbon monoxide poisoning increase during power outages because people consume food that is spoiled (given fridges and freezers do not work) or use alternative power sources improperly [34]. The use of back-up generators [35] also contributes to poor air quality and carbon emissions [36]. It is concluded that communications following power outages are important in order to reduce health and safety risks [34]; communications could also link experiences to consideration of wider societal issues, for example energy security and climate change.

To date, there is little research on the impact of experiencing power outages on public concerns about energy issues or climate change. However, a series of qualitative focus groups [37] examined people's responses to future potential energy (in)security scenarios and found that power outages were considered the most frightening of consequences considered with the biggest impacts on individuals. Following exposure to future energy security scenarios, participants indicated greater concerns about energy security, and around a quarter of participants indicated they intended to make sustainable behavioural changes. However, we note that these findings are based on small numbers from a UK sample that was not representative and based on scenarios rather than lived experiences. We suggest that it is unlikely that people commonly link their electricity usage to supply problems such as power outages given the availability of energy supplies and robust electricity grid in most areas. However, media sources do report instances of demand side response programs that ask people to limit their electricity usage in order to help keep the grid stable and resilient [38]. It is possible that some people may directly link the experience of power outages to weather events and climate change. We also propose that discussions arising from a power outage experience may include the discussion of the local and/or national energy system and thus indirectly link to the topics of energy security and climate change more broadly, increasing the salience of these issues.

We propose that sudden extreme events, such as flooding, or power outages may focus the individual on related issues. In the case of flooding or power outages, concerns about climate change or energy security or both may increase, and the increased concern may also translate into behaviour changes. Previous research has already demonstrated relationships between flooding experiences and concerns about climate change [3,4,41]. Furthermore, flooding experience has been related to increased intentions to save energy, and increased support for sustainable energy policies [3,4]. Similar studies have observed effects of a range of environmental experiences, including precipitation [40,44], air pollution [5] both hot and cold temperatures [39–44], droughts [40,41], wildfires [40,45], tornados [45] and hurricanes [41,46], on beliefs or concerns about climate change.

However there also appears to be clear individual differences in the interpretation of environmental experiences with people's pre-existing beliefs about climate change [43,44] and political affiliation [45–47] interacting with how experiences are interpreted. Importantly environmental experiences are only likely to impact people's concerns about climate change, and potentially pro environmental behaviour, when people relate these experiences to climate change and it is highlighted that pre-existing ideology will impact the way that people attribute their experiences [47,48].

Much less research has been carried out on the impact of environmental experiences on concerns about energy security. Notably, Larcom et al [6] examined the impacts of a heatwave in the UK on perceptions of energy security. They found that people who experienced extreme high temperatures were more likely to perceive future energy shortages, though there was no indication they would change the way they were using energy. We propose that experience of power outages link quite directly to considerations of energy security as people may think about the source of their electricity supply. Whilst there may be salient proximal attributions for a power outage, e.g., storms, network mismanagement, in many cases these attributions could also link to consideration of climate change. Increases in flooding and storms may be linked to changes in the climate, and consideration of changes in the energy system with the increasing integration of renewables onto the electricity grid, also bring in considerations of climate change (as the reason for introducing greater levels of renewables). The experience of disruptive events, such as power outages and flooding, may therefore increase concerns about energy security and climate change, and because of this increase both adaptive responses, e.g. flood defences, use of back-up generators, and mitigation responses, e.g. sustainable behaviour.

Across the literature, research examining the impacts of environmental experiences on behaviour – actually predominantly behaviour intentions – is mixed, with only some finding impacts [3–6]. Given that previous studies have not considered potential differential impacts on individual and social behaviour, we propose that some impacts may have been masked by combining these. If effects of environmental experiences predominantly impact social behaviour for example, the sole examination of individual behaviour would mask this impact, and the inclusion of individual behaviour measures in a scale would dilute their consideration.

1.2. Environmental experience impacts on individual and social behaviour

We propose that environmental experiences may have different impacts on individual and social community behaviours. Energy was historically considered as an example of a common resource where the

group interest is to conserve resources but an individual's self-interest, other motivations aside, is to consume excessively [49,50]. The classic 'tragedy of the commons' describes a situation in which individuals acting independently results in an outcome detrimental to the common good, because they act in a self-interested manner and deplete a shared resource [9]. In modern times and in developed countries, we suggest most people are likely to consider electricity as inexhaustible rather than as a finite resource (cf. common resources problems). Electricity supply is most often mediated through a complex socio-technical system comprising responsibilities from different stakeholders (e.g., government, local authorities, private companies). The likelihood of considering energy as a common good may therefore be reduced and the common resource problem useful only in theory, illustrating potential differences between individual and social motivations in relation to energy use. Though we note in instances in which electricity is locally generated and consumed, consideration of energy as a common resource could be possible.

Moreover, power outages and flood experiences often have financial impacts on victims [51], where personal resources are depleted and subsequently individuals may perceive that they have a greater need for resources than others. This may encourage individuals to act in accordance with their own self-interest to help restore lost resources and quality of life.

Little research distinguishes cooperative or social sustainable behaviour from individual sustainable behaviour despite important differences observed [52,53]. Indeed, sustainable behaviours can be identified at both an individual and social level, where individual behaviours focus on actions that involve and affect primarily the self, e.g., putting on layers of clothes rather than using additional heating, and social behaviours focus on actions that involve and affect more than one person, e.g., taking part in a campaign to reduce energy [54,55]. Cooperative behaviours are considered as a subset of social behaviours in which people behave purposefully in order to benefit others [56]. We assert that most energy behaviour carried out with others is not enacted because of their outcome for the other individual(s) engaging with the behaviour but rather for the outcome for the environment. Consideration of only cooperative behaviours in relation to energy use is therefore considered restrictive in terms of everyday behaviours. For this reason, we consider the more encompassing category of social behaviours as a contrasting category with individual behaviours (cf., [55]). Note that there has also been recent attention on collective environmental behaviour, but again we consider this as a narrower category of behaviour than social behaviour focusing on larger group, often civic, activity [57]. Individual behaviours are considered more likely to be driven by self-interest in comparison to social behaviours, which are more likely to be prosocial given the interaction with others involved and increased visibility [54,57].

Divisions between individual and social behaviour are similar to a dichotomy observed in social relationships across cultures. Cross cultural research observes that people within individualist cultures (e.g., the UK, the U.S.A.) are thought to be more focused on the individual compared to collectivist cultures (e.g., China, and to a lesser extent Mexico) in which people are more interdependent [58,59]. Indeed, there is some evidence that people within collectivist cultures may exhibit higher levels of cooperative behaviour in comparison to those in independent cultures [60,61]. It is possible therefore that people in collectivist cultures are less inclined to act in a self-interested manner at the individual level than people in individualist cultures. Any divergence observed between individual and social behaviour as a result of environmental or energy shocks may therefore also differ between countries.

2. Current research

We used two studies to explore the impact of power outages on related concerns about climate change, energy security, energy affordability, and behavioural intentions. One study was conducted in the UK, as a country with a stable energy system and little experience of power outages. A second study used an opportunistic sample in Mexico, a country with a more unstable energy system, frequent extreme weather (e.g., high temperatures, storms), and more extensive experience of power outages. In our Mexican study, we extended the study to also consider the impact of flooding on concerns and behaviour intentions. In both studies we hypothesised that:

1. experiences of power outages (and in Mexico, flooding) would be related to higher levels of concern about climate change and higher levels of concern about energy security, and energy affordability.
2. experience of power outages (and in Mexico, flooding) would be related to individual energy saving behaviour intentions.
3. experience of power outages (and in Mexico, flooding) would be positively related to social energy saving behaviour intentions.

Our second hypothesis was two tailed because we considered the potential for either a positive or negative effect of power outages on individual energy saving intentions. It is possible that power outages prompt increased concerns about climate change and energy issues and thus people intend to increase their energy saving behaviour. However, it also possible that power outages prompt self-interest in relation to regaining previous levels of the lost energy resource and reduce levels of energy saving intentions. With respect to social energy saving behaviour intentions (hypothesis 3), we considered that self-interest was less likely to influence behaviour intentions.

2.1. Analytic approach

For both studies, our initial analyses focused on examining differences in key demographic variables between participants who had and had not experienced power outages and flooding to consider the similarity of our samples. In study 2, we developed our measure of power outages into a scale which examined extent of experience to gain more granular data into the experience; we therefore used correlations rather than difference tests in order to examine the relationship of demographic variables with our key variables of interest (experience of power outages and flooding). Where we found significant differences in demographics between participant samples, these demographics were included as covariates in subsequent statistical examinations so as to examine differences above and beyond these demographic differences in samples.

We then examined the relationship between experience of power outages (and additionally flooding in Study 2) and our key socio-cognitive variables of interest – concern about climate change, energy security, and affordability, and intended future energy saving behaviour. In study 1, we used a mixed ANCOVA, with a between groups factor of power outage experience and a repeated measure of concern type, to examine the significance of differences between samples. A sensitivity power analysis indicated that this design was powered to detect effect sizes from $f = 0.05$ [62].

We further examined relationships between constructs in Study 1 using a regression-based mediation model [63] which examined how concerns about climate change, energy security, and affordability explained the relationships observed between power outage experience and energy saving behaviour intentions. A sensitivity power analysis indicated that a regression model with five predictors (power outage or flood experience, three concerns, and one covariate) would detect effect sizes from $f^2 = 0.01$ [62]. In study 2, given that our measure of power outage and flooding experience was a scale rather than dichotomous, we did not use difference tests and instead used similar regression-based mediation models to examine the relationships between measures of experience, concern, and future intended behaviour. For both mediation models, we used bootstrapping to resample the data 10,000 times which increases the reliability of our analysis by increasing the normality of the distribution of the indirect effect [64].

3. Study 1 – method

3.1. Participants

We recruited a national sample of participants in the UK to complete an online survey (Final $N = 1729$). The original sample size was 2570, however data from participants who took < 5 min ($N = 841$) to complete the survey were deleted as it was considered that these participants were likely to have responded simply to gain points and could not have read questions completely. The remaining sample consisted of 791 men and 890 women (3 did not specify) and had an age range from 18 to 99 ($M = 49.87$, $SD = 15.04$). We note that a proportion of the participants (7.9%) took over an hour to complete the study however these participants were retained if they had data on relevant variables for analysis (see Supplementary Materials 1 for further details).

3.1.1. Materials

Questions were carefully designed with input from a larger team of academics from multiple disciplines alongside careful consultation of existing literature. Note that the set of items used within the current analyses are a subset of items taken from a broader survey, which examined both participants' motivations to save energy at home and in the workplace, and participants' likely reactions in different scenarios involving interactions around energy use. Questions analysed here included measures of power outage experience, concern about climate change, energy security and energy affordability, and behavioural intentions, see Table 1. Measures of power outage experience were here measured with a single item that dichotomised the experience into whether someone had experienced a power outage or not. Concern about climate change was measured using a commonly used tracker item [65–67]. Energy security and affordability were measured using scales developed by Demski et al [28]. One item from this scale regarding concern about power outages was removed so as to conceptually focus on broader energy security issues, and to reduce potential collinearity in the model which would reduce its power [68].

Behavioural intentions were based on previous scales [69,70] and asked participants to report the extent to which they would consider adopting a range of energy saving behaviours. These were adapted to specifically incorporate a number of actions that were clearly individual or social in nature. Whilst the survey distinguished intentions to save energy at home and in the workplace for separate research aims, for the purpose of the current analyses these were combined to provide indices of intentions to save energy more broadly. All scales had good reliabilities, see Table 1. We also included questions asking participants whether they owned a prepayment meter, reasoning that cuts in power can be experienced due to running out of funds on prepayment meters, and considering that participants could consider a cut in power due to running out of funds as a power outage. Demographic questions also examined age, gender, and social grade. National Readership Survey (NRS) classification was used in order to examine social grade and participants were provided with the classification system and asked to classify themselves. This system asks people to consider the occupation of the main income earner in their house and classify themselves according to categories provided, see Table 1 for categories provided.

3.1.2. Procedure

We recruited a quota sample approximately representative of the UK in terms of age, gender, social grade, and location. Recruitment was from an online panel hosted by a social research company between 12 August and 20 August 2016 (see Supplementary Materials 1 for further information). Quotas for sampling were set according to data obtained from the Office of National Statistics [71]. At the point of recruitment, the study was described to participants as examining energy use in the workplace. Details of how long the study was estimated to take (15–20 min) and how many incentives points would be provided for participation were also given. We note that whilst participants were

Table 1
Survey questions included in analysis in Study 1.

Construct (Cronbach's alpha levels)	Question	Response Options
Power outage experience	Have you experienced a black out in your local area recently?	*Yes / No*
Climate Change Concern	How concerned, if at all, are you about climate change, sometimes referred to as 'global warming'?	4-point scale (Not at all concerned – *Very concerned*; *Don't know* option provided)
Energy security ($\alpha = 0.81$)	How concerned, if at all, are you that in the next 10–20 years… - …the UK will become too dependent on energy from other countries? - …there will be a national petrol shortage? - …the UK will have no alternatives in place (e.g., renewables) if fossil fuels (gas, oil) are no longer available?	4-point scale (*Not at all concerned – Very concerned*; *Don't know* option provided)
Energy affordability ($\alpha = 0.81$)	How concerned, if at all, are you that in the next 10–20 years… - …electricity and gas will become unaffordable for you? - …petrol will become unaffordable for you?	4-point scale (*Not at all concerned – Very concerned*; *Don't know* option provided)
Individual energy behavior intentions ($\alpha = 0.90$)	In the following months, to what extent would you consider adopting the following behaviours at home? - …turn off the lights before leaving a room - …turn off your computer when not being used - …turn off your monitor when not being used - …at home, turn off your printer when not being used - …turn off TV or other equipment rather than putting them on standby - …at home, put on layers of clothes rather than use additional heating - …consider energy efficiency of environmental factors when making a new purchase for the home In the following months, to what extent would you consider adopting the following behaviours at work? - Turn off the lights before leaving for the day - Turn off your computer before leaving for the day - Turn off your monitor before leaving for the day - Turn off your printer before leaving for the day - Put on layers of clothes rather than use additional heating - Turn off your computer/ monitor when you are away from the desk	6-point scale (*Very unlikely – Very likely*; *Not applicable* option provided)
Social energy saving behavior	In the following months, to what extent would you	

(*continued on next page*)

Table 1 (*continued*)

Construct (Cronbach's alpha levels)	Question	Response Options
intentions (α = 0.92)	consider adopting the following behaviours at home?	6 point scale (*Very unlikely – Very likely*; *Not applicable* option provided)
In the following months, to what extent would you consider adopting the following behaviours at work?	- Speak to your family/ housemates about energy issues - Take part in a campaign about an energy issue - Overtly disapprove (e.g. frowning, commenting on other people in the house wasting electricity - Suggest practical changes to save energy at home - Discuss energy saving measures with family/ housemates - Remind a family member/ housemate to switch something off to save energy	
- turn off communal office equipment (e.g. printer, copy machine, lab equipment) before leaving for the day. - Speak to key people in charge about energy issues - Take part in a campaign about an energy issue - Overtly disapprove (e.g. frowning, commenting) on other people wasting electricity - Suggest procedural changes to save energy - Discuss energy saving measures with colleagues - Consider energy efficiency or environmental factors when requesting a new purchase - Remind a colleague to switch something off to save energy		
Electricity payment method	In which of the following ways do you currently pay for your electricity?	*Direct Debit / Quarterly payment on receipt of bill / Pre payment meter (PPM, or card or key meter) / Other*
Social grade	Please consider the occupation of the main income earner in your household. How would you classify it according to the categories below? (Please answer based on the main income earners' most recent occupation if they are retired and/or widowed and receive a private/company pension or if they are in paid employment but have been out of work for less than 6 months.)	*A – Higher managerial administrative or professional*; *B – Intermediate managerial administrative or professional*; *C1 – Supervisory or clerical and junior managerial, administrative or professional*; *C2 – Skilled manual workers*; *D – Semi-skilled and unskilled manual*

incentivised to participate, it is possible that those who participated were those who had a particular interest in energy issues and this is a possible bias in our sample. This is a common problem with surveys focused on a particular topic and we think unlikely to affect the distribution of responses across those who reported having recently experienced power outages or not. The median time for completion of the survey tool was 12 min (slightly faster than estimated).

3.1.3. Results

182 people reported that they had recently experienced a power outage and 1,361 reported they had not (186 people did not respond to this question). Samples were similar in terms of gender, social grade, and whether households had prepayment meters or not, but those who had recent power outage experiences were significantly younger than the sample who had not (see Table 2).

We used an analysis of variance (ANCOVA) to examine differences in concern about climate change, energy security, and affordability between those who had, and had not, experienced a power outage recently, including age as a covariate so we know results found were not attributable to the age differences observed between samples. People who had experienced a power outage recently were more concerned about climate change than those who had not ($M = 2.99$, $SD = 0.87$ and $M = 2.79$, $SD = 0.87$ respectively, $F = 6.33$, $p < 0.01$, $\eta^2 = 0.01$), more concerned about energy security ($M = 3.25$, SD = 0.72 and $M = 2.99$, $SD = 0.74$, respectively, $F = 10.78$, $p < 0.001$, $\eta^2 = 0.01$), and more concerned about energy affordability ($M = 3.18$, $SD = 0.83$ and M = 2.96,

Table 2
Demographics of those who had and had not experienced a power outage[1] recently.

	Experienced power outage out recently	Not experienced power outage recently	Significance of Difference
Age	Mean = 45.10 years (SD = 15.12)	Mean = 49.64 years (SD = 14.56)	t (1540) = -3.931, $p < 0.001$, 95% CI = [2.27, 6.80])
Gender	Male = 44% Female = 56%	Male = 47.3% Female = 52.7%	Pearson Chi-Square = 0.872, $p = 0.647$ (N = 1,681)
Social grade[2]	A = 13.2% B = 21.4% C1 = 23.6% C2 = 17.6% D = 13.2% E = 10%	A = 5.1% B = 26.8% C1 = 28.4% C2 = 17.8% D = 12.2% E = 9.5%	Mann-Whitney U test: $p = 0.93$ (N = 1,684)
Prepayment meter	Pay electricity with prepayment meter = 8.8%	Pay electricity with prepayment meter = 9.7%	Pearson Chi-Square = 4.867, $p = 0.088$ (N = 1,562)

[1] Participants were asked about their experiences of *black outs*. We have adjusted terminology to *power outages* here to be in keeping with the most common used terminology in the literature.

[2] *Social grade* refers to National Readership Survey (NRS) classifications which relate to the occupation of a household's chief income earner: A – Higher managerial administrative or professional; B – Intermediate managerial administrative or professional; C1 – Supervisory or clerical and junior managerial, administrative or professional; C2 – Skilled manual workers; D – Semi-skilled and unskilled manual workers; E – State pensioners, casual and lowest grade workers, unemployed with state benefits only.

SD = 0.91, respectively, $F = 5.48$. $p < 0.01$, $\eta^2 = 0.01$) see Fig. 1.

We note that Box's *M* which examines the similarity of covariance matrices between samples, was significant (M (6, 539596.75) = 13.76, F = 2.28, p = 0.03), within the ANCOVA, perhaps unsurprising given sample size differences between those who had and had not experienced power outages. We therefore replicated the examination of these differences with t-tests which allowed for the possibility of assuming unequal sample variances, see Table 3. We conducted Levene's test of equality of variances for each independent *t*-test conducted observing that variances between samples were not significantly different for concerns about energy security, affordability, or climate change between samples when examined individually; it appears that variances in samples were magnified when differences were examined in an omnibus test. We therefore used *t*-test values assuming equal variances between samples. The pattern of results observed mostly replicate the ANCOVA however one key difference is that here differences between concerns about energy affordability were not significantly different for people who had or had not experienced power outages. We note that the significance of the difference in energy affordability concerns for those who had and had not experienced power outages is therefore not robust and we will not interpret this further.

We subsequently investigated whether power outage experiences were related to differences in behavioural intentions for both individual energy saving actions (e.g. turning off lights) and social energy saving actions (e.g. discussing energy saving actions with family or housemates). To consider the relationship between power outage experiences, concerns about climate change, energy security and affordability, and individual energy saving behavioural intentions, we constructed a mediation model using ordinary least squares path analysis using age as a covariate (given age was significantly different between samples), see Fig. 2. The relationship between power outage experiences and individual energy saving behaviour intentions was non-significant (total effect = -0.03, 95% *CI* = [-0.16, 0.10]). We note that literature on mediation has highlighted that mediation can exist when the total effect is not significant however [72] and thus we further examined indirect effects. We observed that when indirect effects of concerns about climate change and energy security were included in the model and held constant, the relationship between power outage experience and individual energy saving behavioural intentions was significantly negative (direct effect = -0.14, 95% *CI* = [-0.26, −0.01]). Indirect paths through climate change concern and energy security concern were both significant (*CI*s from 0.02 to 0.09 and from 0.02 to 0.08 respectively). The indirect path through energy affordability was non-significant (*CI* = -0.00, 0.02). A bias corrected bootstrap *CI* for the indirect effect (*ab* = 0.09) based on 10,000 bootstrap samples was entirely above zero (*CI* = 0.05 to 0.16). This is termed a suppression effect [63]; the mediators had a positive impact on individual behaviour intentions, and when these mediating concerns were held constant, the remaining direct effect between power outage experience and energy saving intentions was negative. Combined together, the total effect was non-significant.

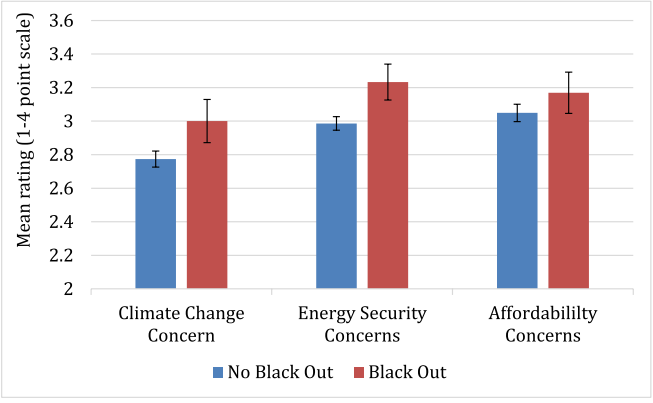

Fig. 1. Energy concerns between those who have and have not recently experienced power outages. Mean levels of concern between those who have and have not recently experienced power outages. Concern measured on a 4-point scale from 'Not at all concerned' to 'Very concerned' where high values indicate high concern and a 'Don't know' option was offered. Note that error bars represent 95% confidence intervals. Due to missing responses, data was deleted listwise from the model (Concern about climate change: N = 1469, concern about energy security: N = 1541, Concern about energy affordability: N = 1474.

We conducted a similar mediation model, again using ordinary least squares path analysis, in order to examine the relationship between power outages, concerns about climate change, energy security, and energy affordability, and social energy saving behavioural intentions, again using age as a covariate, see Fig. 3. Here, power outage experience was related to significantly greater levels of social energy saving behavioural intentions (total effect: 0.28, 95% *CI* = [0.10, 0.46). The direct relationship between power outage experience and social energy saving intentions (holding mediators constant) was non-significant (0.12, 95% *CI* = [-0.04, 0.29]). In this case, the significant indirect paths through climate change concern and energy security concern (*CI*s from 0.02 to 0.11 and from 0.05 to 0.14 respectively) increased the direct relationship between power outage experiences and social energy saving intentions, resulting in a positive total effect. The indirect path through energy affordability concern was non significant (*CI* = (-0.01, 0.03). A bias corrected bootstrap *CI* for the indirect effect (*ab* = 0.16) based on 10,000 bootstrap was entirely above zero (*CI* = 0.09 to 0.23).

4. Interim discussion

The first hypothesis was partially supported in that experience of power outages was related to greater levels of concern about climate change, and energy security, but not concern about energy affordability. This is the first evidence, to the authors knowledge, that finds a relationship between power outage experience and concerns about climate change. Previous literature has identified a relationship between flooding and climate change concerns however [3,4,41] and given that flooding is a frequent cause of power outages [15,16], this may partly explain our finding. Our findings also add to currently sparse literature examining impacts of experiences on concerns about energy security. Whilst previous research has linked heatwave experience to perceived future energy shortages [6], there has been no previous research linking power outage experiences to energy security concerns.

We had a two tailed hypothesis (hypothesis 2) regarding the relationships between power outage experience and individual energy saving intentions as previous research provided us with contrary predictions regarding whether relationships were likely to be positive or negative. We found that people who had recent power outage experience did not have significantly different individual energy saving intentions from those who did not have this experience. We observe that the relationship between power outage experience and individual energy saving intentions was mediated by greater levels of climate change and energy security concern following power outages. When mediators were controlled for, the relationship between power outage experience and individual energy saving intentions was negative. This appears to support both of our competing hypotheses. The negative relationship between power outage experience and energy saving intentions, when concerns are removed, gives credence to the idea that power outage experience may encourage self-interested behaviour [12]. However, the mediating impact of concerns supports the idea that energy experiences, like environmental experiences [3,4] will promote energy saving behaviour due to increases in concern for climate change and energy security. Results also provide support for our third hypothesis, finding a positive relationship between power outage experience and social energy saving intentions, partly explained by concerns about climate change and energy security.

In Study 2, we used a survey in Mexico, again to examine the

Table 3
Descriptive statistics and significance tests of differences in concerns between groups that had and had not experienced power outages recently.

	Power outage experience	*N*	Mean	*SD*	Levene's test		*t*-test	
					F	*p* value	*t*	*p* value
Concern about climate change	No	1291	2.77	0.87	3.10	0.08	−3.25	< 0.01
	Yes	178	3.00	0.87				
Concern about energy affordability	No	1360	3.05	0.98	3.33	0.07	−1.57	0.12
	Yes	181	3.17	0.84				
Concern about energy security	No	1293	2.99	0.74	0.00	1.00	−4.21	< 0.001
	Yes	181	3.23	0.73				

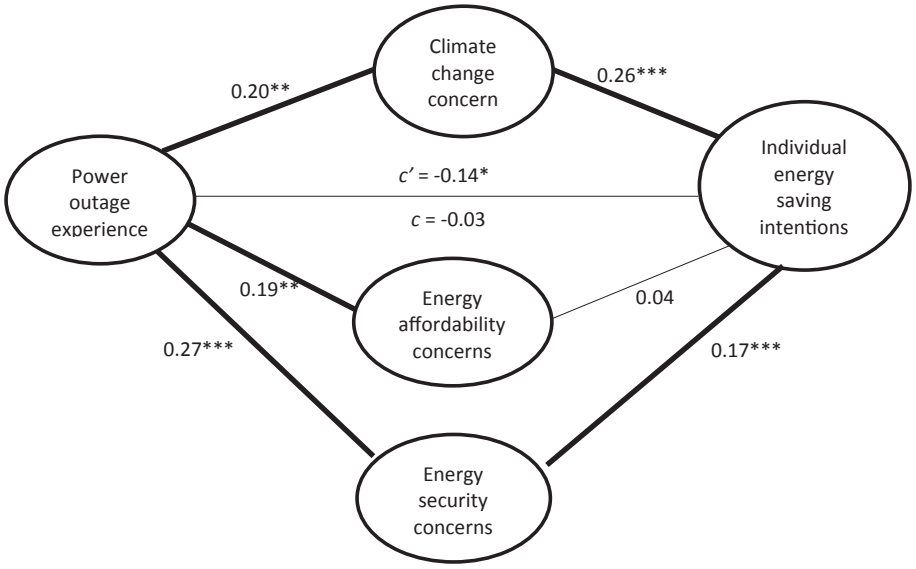

Fig. 2. Relationships between power outage experiences and individual energy saving intentions. Relationships between power outage experiences, concerns about energy issues and climate change, and intentions to undertake individual energy saving behaviour. Owing to missing data, 311 cases were deleted from the model leaving a sample size of 1418. Coefficients are unstandardized, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$; bold lines indicate significant relationships; *c*' represents the direct effect of power outage experience on individual energy saving behavioural intentions; *c* represents the total effect. A bias corrected bootstrap *CI* for the indirect effect (*ab* = 0.11) based on 10,000 bootstrap was entirely above zero (*CI* = 0.05 to 0.16).

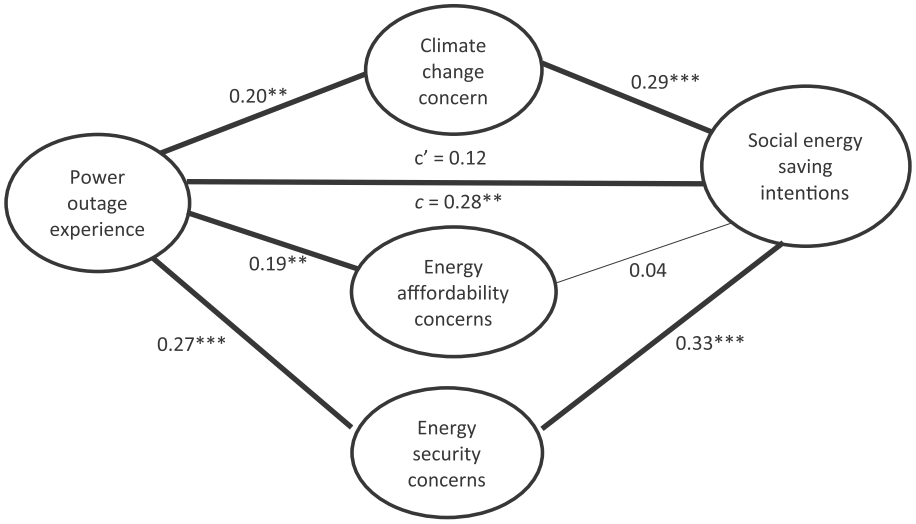

Fig. 3. Relationships between power outage experiences and social energy saving intentions. Relationships between power outage experiences, concerns about energy issues and climate change, and intentions to undertake social energy saving behaviour. Owing to missing data, 311 cases were deleted from the model leaving a sample size of 1418. Coefficients are unstandardized, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$; bold lines indicate significant relationships; *c*' represents the direct effect of power outage experience on individual energy saving behavioural intentions; *c* represents the total effect.

relationship between power outages and concerns about climate change, energy issues, and energy saving intentions. We were opportunistic in expanding an existing survey being developed in Mexico to test our hypotheses in an additional cultural setting. The contrasting energy context of Mexico also provided us with a different energy context in which frequency of power outages were greater. Hypotheses for Study 2 were the same as for Study 1 (noted in section 1.2). In Study 2, we examined whether relationships observed between power outages, concerns about climate change, energy security, energy affordability, and energy saving intentions were similar for the experience of flooding. The Mexican data set also provided an opportunity to consider whether experience effects increase with frequency; measures of power outage and flooding experiences were therefore changed from study 1 to measure *extent* of experience using a scale measure rather than a dichotomous measure.

4.1. Study 2 - method

4.1.1. Participants

A total of 661 (315 women, 343 men, 3 gender unreported) volunteers took part in the study. Calculations indicated that a total sample size of 650 would be required to detect an effect size of $\eta^2 = 0.005$ (based on results from study 1) using a mixed ANOVA with 95% probability [62]. Ages ranged from 18 to 80 ($M = 33.18$, SD = 11.47).

4.1.2. Materials

The survey instrument for Study 2 was developed from that used in Study 1 and examined motivations to save energy at home and in the workplace, alongside socio-cognitive variables relating to energy use, concern about energy issues, and energy behavioural intentions at home and in the workplace. Questions included in the analyses comprised measures of power outage and flooding experience, concern about climate change, energy security and energy affordability, and energy behaviour intentions, see Table 4. Measures of power outage and flooding experience were here measured with single items that examined frequency of experience. Measures of concern about climate change, energy security, and energy affordability were replicated from study 1. Self-reported behaviour was developed and expanded from Study 1 to clearly incorporate both individual and social items that could be conducted both at home and at work. Scale reliabilities were again good, see Table 4. Demographic variables of age, gender, and education level were also measured. We used education level instead of social grade measured in Study 1, given that the social grade measure was developed for the UK specifically. With respect to education level, participants were asked to report their highest level achieved; five response options were provided from primary level to postgraduate level of education with a 'no studies' option also included.

Questions were translated and back translated from English to Mexican Spanish by two bilingual native speakers of each language (of Spanish for the translation to Spanish, and of English for the back translation). Translators had previous experience in translating material for behavioural research. Additionally, the formulation of the questions and response scales was refined by a group of local academic experts in behavioural sciences within Mexico City to ensure local interpretation would remain accurate.

4.1.3. Procedure

Participants were recruited to take part in a hard copy survey by undergraduate student volunteers in Mexico City between April and May 2017. Students recruited participants through acquaintances using a snowball method. Participants were restricted to those who were currently employed in a full time or part time job given that many questions asked participants to consider activities relating to energy use at work.

Paper and pencil questionnaires were used to administer the study and it was introduced as examining people's attitudes and beliefs about the use of energy. This means that the sample obtained may be biased towards those who are particularly interested in energy use. Participants were also not incentivised for their participation; however, variance within the data was sufficient so as to enable the correlational and comparative analysis conducted. The survey had an approximate completion time of 15 min. After completion, participants were thanked and debriefed.

4.1.4. Results

Of our Mexican sample, 41 participants reported no experience of power outages and 620 participants reported experience. Mean frequency of power outage experience reported was 2.75 ($SD = 0.97$), on a 6-point scale where higher values indicated more experience. For flood experience, 331 participants reported no experience of floods and 330 participants reported experience with a mean frequency of 1.90 ($SD = 1.17$), again on a 6-point scale where higher values indicated more

Table 4
Survey questions included in analysis in Study 2 (translated from Spanish).

Construct (Cronbach's alpha)	Question	Response Options
Power outage experience	Have you experienced a black out in your local area?	6 point scale (*Never – Very frequently*)
Flooding experience	Have you experienced a flood in your local area?	6 point scale (*Never – Very frequently*)
Climate Change Concern	How concerned are you about climate change?	4 point scale (*Not at all concerned – Very concerned*; *Don't know* option provided)
Energy affordability concern ($\alpha = 0.77$)	Indicate your degree of concern about the following aspects of the environment in the next 10–20 years… - …electricity and gas will become too expensive? - …petrol will become unaffordable for you?	4 point scale (*Not concerned – Very concerned*; *Don't know* option provided)
Energy security concern ($\alpha = 0.78$)	Indicate your degree of concern about the following aspects of the environment in the next 10–20 years… - …Mexico will become too dependent on energy from other countries - …there will be a national petrol shortage? - …Mexico will have no alternatives if fossil fuels (e.g. gas, oil) are no longer available?	4 point scale (*Not concerned – Very concerned*; *Don't know* option provided)
Individual energy behavior intentions ($\alpha = 0.82$)	In the following months, how frequently would you consider adopting the following behaviours at work? - Turn off your printer before leaving for the day - Use light clothes rather than use air conditioning or fan - Turn off your monitor before leaving for the day - Turn off your computer before leaving for the day - Turn off your computer/ monitor when you are away from your desk for a period of time (e.g. lunch) - Turn off the lights before leaving for the day In the following months, how frequently would you consider adopting the following behaviours at home? - Use light clothes rather than use air conditioning or fan - Turn off your computer when not being used - Turn off the lights before leaving a room - Turn off TV or other equipment rather than putting them on stand-by - Consider energy efficiency or environmental factors when buying a new electrical product	6 point scale (*Not very frequently – Very frequently*; *Not applicable* option provided)
Social energy saving behavior intentions ($\alpha = 0.82$)	In the following months, how frequently would you consider adopting the following behaviours at work? - Take part in a campaign about an energy issue - Turn off communal office equipment (e.g. printer, copy	6 point scale (*Very unlikely – Very likely*; *Not applicable* option provided)

(*continued on next page*)

Table 4 (*continued*)

Construct (Cronbach's alpha)	Question	Response Options
	machine, lab equipment) after using them - Turn off communal office equipment (e.g. printer, copy machine) before leaving for the day - Overtly disapprove of other people wasting electricity - Suggest procedural changes (politics of the company) to save energy - Discuss energy saving measures with colleagues - Remind a colleague to switch something off to save energy - Speak to key people in change about energy issues - Consider energy efficient or environmental factors when requesting a new purchase In the following months, how frequently would you consider adopting the following behaviours at home? - Overtly disapprove of other people in the house wasting electricity - Suggest practical changes to save energy at home - Remind a family member to switch something off to save energy - Discuss energy saving measures with family - Take part in a campaign about an energy issue	

experience (see Supplementary Materials 2 for a comparison of UK and Mexican samples for experience, concern, and energy saving intentions).

To examine demographic differences in power outage and flood experience, measures of experience were correlated with age, gender and education level (Table 5). Lower education levels were related to greater levels of power outage experience reported (r = -0.10, 95% CI = [-0.18, −0.02]); no other significant relationships were observed.

To consider the relationship between power outage experiences and energy saving behavioural intentions, we conducted mediation analyses using ordinary least squares path analysis, see Figs. 4 and 5. We included education level as a covariate to examine relationships above and beyond the impact of education, given education was significantly related to experience of power outages. We found no relationship between power outage experiences and behavioural intentions for individual energy saving intentions (see Fig. 4, Total effect = -0.00, CI [-0.07, 0.07]). However, for social energy saving intentions we found that greater levels of power outage experience were associated with greater levels of social energy saving intentions (see Fig. 5, Total effect = 0.09, CI = [0.00, 0.17]. Notably power outage experiences were not related to climate change concerns, energy security concerns, or energy affordability concerns in either model. However, climate change concerns and energy security concerns were strongly related to intentions for both individual and social energy saving intentions; energy affordability concerns were not. In both models the indirect effects of power outages on intentions, were non significant (ab = 0.00, CI = [-0.02, 0.03] and ab = 0.00, CI = [-0.04, 0.04] respectively).

We again used mediation analyses using ordinary least squares path analysis in order to examine the relationship between flood experiences and energy saving behavioural intentions, including education level as a covariate, see Figs. 6 and 7. The total effect of the relationship between flood experiences and individual behavioural intentions was non significant (see Fig. 6: Total effect = -0.04, CI = [-0.10, 0.01]). However, when concerns were accounted for in the model the direct effect between flooding experience and individual energy saving intentions was significantly negative (Direct effect = -0.05, CI = [-0.10, −0.00]). Flooding experience was related to greater energy security concerns, and energy security concerns significantly mediated the relationship between flood experience and individual energy saving intentions (ab = 0.01, CI = [0.00, 0.02]). Flooding experience was not related to climate change concern or energy affordability concern, but climate change concern was related to greater individual energy saving intentions.

For social energy saving intentions, the greater the reported frequency of flood experience, the greater the reported intentions to undertake social energy saving intentions (see Fig. 7: Total effect = 0.11, CI = [0.03, 0.18]). Energy security concerns mediated the relationship between flood experience and social energy saving intentions (ab = 0.01, CI = [-0.02, 0.03]). Flood experience did not relate to climate change energy concerns, or energy affordability however but climate change concerns did relate to both individual energy saving behaviour intentions and social energy saving intentions; energy affordability concerns were unrelated. In both models, bias corrected bootstrapped Cis for the indirect effects of flooding experience on intentions, based on 10,000 bootstraps, were non significant (ab = 0.01, CI = [-0.01, 0.04] and ab = 0.00, CI = [-0.04, 0.04] respectively).

5. Discussion

This study is the first to link experiences of power outages and energy saving behavioural intentions. It adds to existing literature on the impacts of environmental experiences by examining impacts on energy security concerns, amongst other concerns, which have previously not been given much consideration. Our study also considers the experience of power outages, where research is also sparse though growing along with warnings that we could see increases in power outages in many countries in the future [15]. We found that experiences of power outages (Studies 1 and 2) and of flooding (Study 2) were positively related to social energy saving intentions in both the UK and Mexico, supporting hypothesis 3. Data indicated no significant differences in individual energy saving intentions as a result of power outage or flood experience. However, in two of our samples (power outage experience in the UK, flood experience in Mexico), direct relationships between experiences and individual energy saving intentions were negative when concerns were accounted for in the relationship. This partially supports hypothesis 2 indicating that when concerns are held constant, power outage (in the UK) and flood experiences (in Mexico) relate to lower levels of energy saving behaviour indicating that people with these experiences

Table 5
Relationships between measures of experience and demographics.

	Power outage experience	Flood experience	Age	Gender	Education level
Power outage experience	1 [1,1]	0.36** [0.26, 0.45]	−0.04 [-0.012, 0.04]	−0.01 [-0.04, 0.07]	−0.10** [-0.18, −0.02]
Flood experience	0.35** [0.26, 0.45]	1 [1,1]	−0.04 [-0.13, 0.06]	0.04 [-0.02, 0.10)	−0.08 [-0.26, −0.06]
Age	−0.04 [-0.012, 0.04]	−0.04 [-0.13, 0.06]	1 [1,1]	−0.05 [-0.10, 0.06]	0.29** [-0.02, 0.48]
Gender	−0.01 [-0.04, 0.07]	0.04 [-0.02, 0.10]	−0.05 [-0.10, 0.06]	1 [1,1]	−0.00 [-0.10, 0.05]
Education level	−0.10** [-0.18, −0.02]	−0.08 [-0.26, −0.06]	0.29** [-0.02, 0.48]	−0.00 [-0.10, 0.05]	1 [1,1]

Note: Figures are Pearson's correlations (r); ** = $p < 0.01$, * = $p < 0.05$. 95% confidence intervals are provided below correlation figures. N = 614 for all calculations.

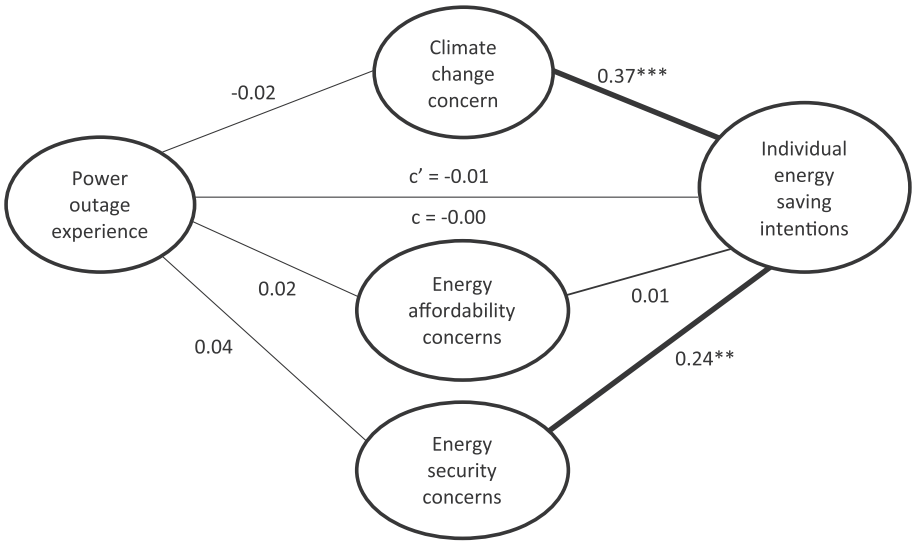

Fig. 4. Relationships between power outage experiences and individual energy saving intentions. Relationships between power outage experiences, concerns about energy issues and climate change, and intentions to undertake individual energy saving behaviour. Education level was included as a covariate. The analysis had a sample size of 613, due to deletion of 48 cases with missing data. Coefficients are unstandardized, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$; bold lines indicate significant relationships; *c*' represents the direct effect of power outage experience on social energy saving behavioural intentions; *c* represents the total effect.

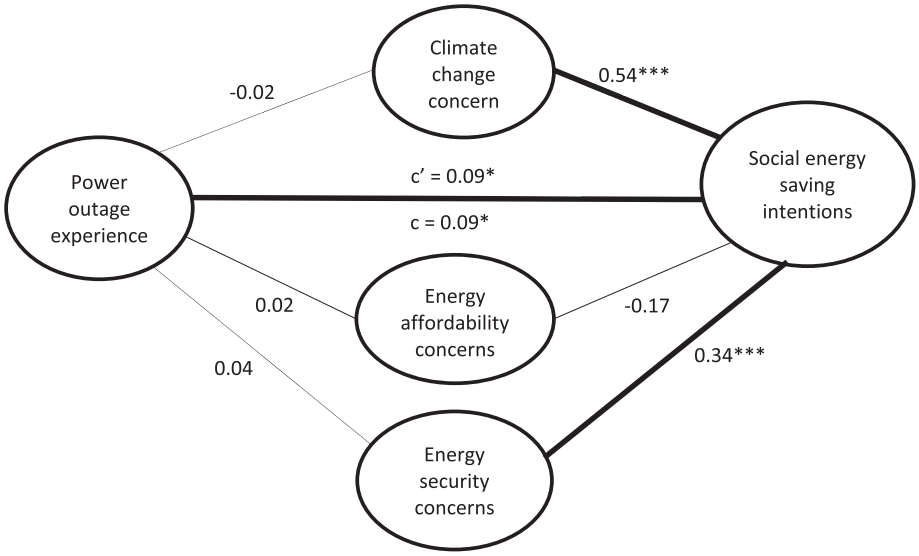

Fig. 5. Relationships between power outage experiences and social energy saving intentions. Relationships between power outage experiences, concerns about energy issues and climate change, and intentions to undertake social energy saving behaviour. Education level was included as a covariate. The analysis had a sample size of 613, due to deletion of 48 cases with missing data. Coefficients are unstandardized, * = p < 0.05, ** = p < 0.01, *** = p < 0.001; bold lines indicate significant relationships; c' represents the direct effect of power outage experience on social energy saving behavioural intentions; c represents the total effect.

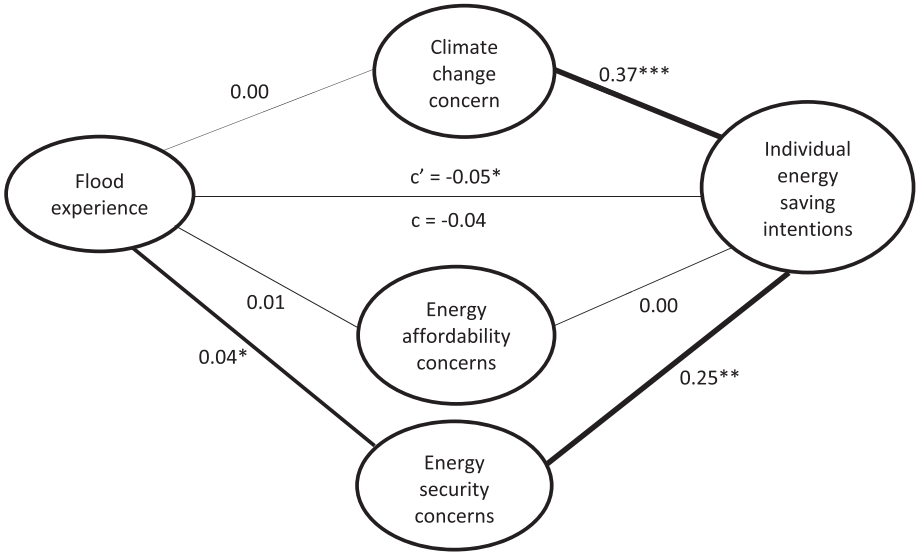

Fig. 6. Relationships between flood experiences and individual energy saving intentions. Relationships between flood experiences, concerns about energy issues and climate change, and intentions to undertake individual energy saving behaviour. Education level was included as a covariate. The analysis had a sample size of 613, due to deletion of 48 cases with missing data. Coefficients are unstandardized, * = p < 0.05, ** = p < 0.01, *** = p < 0.001; bold lines indicate significant relationships; c' represents the direct effect of flood experience on social energy saving behavioural intentions; c represents the total effect.

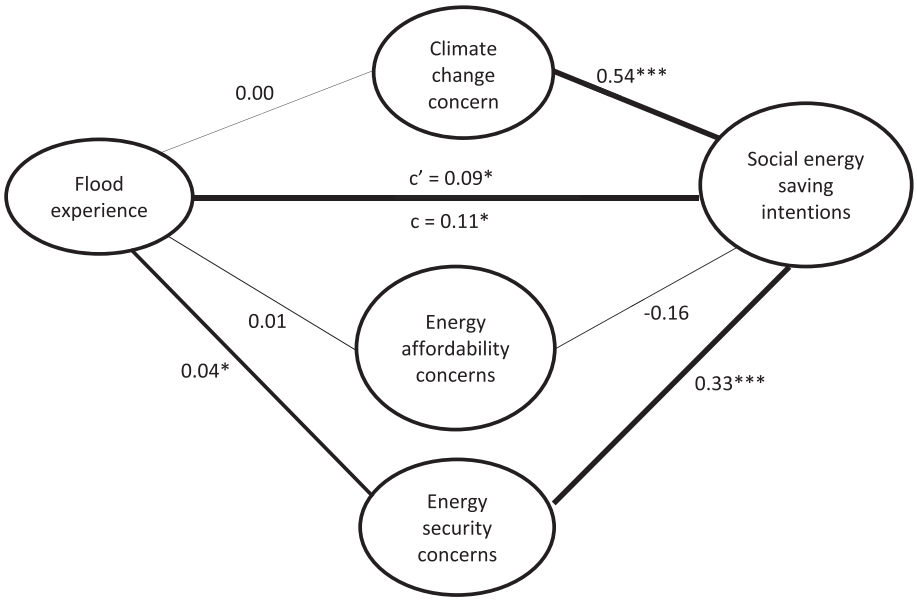

Fig. 7. Relationships between flood experiences and social energy saving intentions. Relationships between flood experiences, concerns about energy issues and climate change, and intentions to undertake social energy saving behaviour. Education level was included as a covariate. The analysis had a sample size of 613, due to deletion of 48 cases with missing data. Coefficients are unstandardized, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$; bold lines indicate significant relationships; *c'* represents the direct effect of flood experience on social energy saving behavioural intentions; *c* represents the total effect.

were subsequently less concerned about energy saving, possibly because they felt like they were striving to regain lost resources. Notably, concerns arising from the experiences related to higher levels of energy saving intentions resulted in net non significant relationships between power outage / flood experience and energy saving behaviour overall.

We propose that the different effects apparent for individual and social behavioural intentions may help to explain previous mixed findings in that combined measures of behaviour could have masked more nuanced impacts [3–6]. We found partial support for hypothesis 1 in that power outage experiences also related to differences in concern about climate change and energy security in the UK, with a small but significant effect, and that flood experience related to energy security concerns in Mexico. Where experiences did relate to concerns, both individual and social energy saving behavioural intentions were higher. Findings therefore support the use of communications highlighting the relationship between personal environmental experiences and current environmental and energy policy issues to encourage energy saving behaviour.

5.1. Relationships between power outage and flood experiences and concerns

The relationship between power outage experiences and higher levels of climate change concern observed in the UK had a small effect size but supports much literature that links environmental experiences and concerns about climate change [3–5,41,42,46] and adds to limited literature that has indicated a relationship between environmental experiences and energy security concerns [6]. We observe that our distinction of energy security and energy affordability concerns indicated that concerns about affordability did not appear to be related to experiences examined. Our analysis implies that power outage and flood experiences are more related to facets of energy security that consider geopolitical issues and energy shortages [28,29]. Results also underline the importance of energy security concerns [31,32] in the small but significant, relationships observed between energy security concerns with energy saving behaviour intentions, in both the UK and Mexican samples here.

5.2. Cross cultural differences in the nature and attribution of experiences

We examined Mexico, partly opportunistically given relationships with ongoing research in this country, but this also represented a different energy context as well as a different cultural context to the UK. Data indicate that frequency of experience of power outages in Mexico was not related to concerns about climate change, energy security, or energy affordability and we suggest that it is possible that the frequent nature of power outages in Mexico means that their impact on concerns may be lessened. Given the frequency of power outages in Mexico, we examined these using a scale measure of frequency of experience rather than a dichotomous measure of experience and the difference in measures between studies may help to explain differences observed between studies, though we would expect that a scale measure would offer more power to detect effects.

We observe that there is a greater number of salient proximal causes for both flooding and power outages in Mexico than the UK. Whilst weather remains the predominant cause of power outages around the world [15,16], in Mexico and in Mexico City the partly outdated electricity infrastructure might contribute to instability in supply and its vulnerability to extreme weather [26]. In addition, Mexico City contains many subterranean canals, and has poor drainage systems, which contribute to flooding events. People may therefore be more likely to feel powerless to affect the security of their supply in Mexico. There may also be less links made between power outages or flooding, and climate change because the level of discourse surrounding the relationship between climate change, and flooding and power outages, may be lower in Mexico than the UK. Further studies should examine whether perceptual and behavioural impacts vary depending on the perceived causes of power outages and flooding. An interesting extension of this research might be to examine perceptual and behavioural impacts of experiences of both flooding and power outages, or of other experiences of multiple environmental experiences (e.g., high temperature and power outages). Presumably the experience of multiple adverse experiences may increase the impact of these events whether these co-occur in time or not, but it may also impact the potential for people to relate events experienced to climate change.

5.3. Impact of experiences on individual and social behavioural intentions

Data obtained from both our Mexican and UK samples found that experience of power outages was related to greater levels of social energy saving intentions. The Mexican data also demonstrated that a similar relationship was observed in relation to the experience of flooding and social energy saving intentions. Our mediation models indicate that this relationship may partly be explained by higher levels

of climate change and energy security concerns, relating to environmental and energy experiences examined. Another potential explanation for higher levels of social behaviour in relation to environmental and energy experiences may be the shared nature of that experience strengthening interpersonal relationships. Previous research has highlighted that shared painful experiences has been found to promote trust and cooperation amongst strangers [73]. Within flood research specifically there have been mixed findings regarding levels of helping behaviour immediately following an incident [74,75] where differences are theorised to be due to differences in ability to help given levels of poverty in areas affected by flooding. This research extends these findings and implies that adverse shared experiences could promote pro social behaviour more generally. We acknowledge however that experiences of power outages and flooding may differ quite dramatically, between hazards, between severity of hazards experienced, and between communities with different levels of ability to cope. Our second study indicated that frequency of experience was related to behavioural intentions to act however the sample is likely to have included people with quite different experiences and severity of experiences. On one hand this makes the consistency in our results more remarkable but on the other means that reasons for findings are harder to disentangle and require further investigation.

Our results also provide some limited support for research which has demonstrated that increasing the perceived scarcity of a resource can increase self-interested behaviour [12]. Our data indicates that following a power outage or flooding experience, people might reduce their energy saving efforts were it not for the concern that they exhibit for climate change and energy security. The positive impact that increased concerns relating to power cut and flood experiences have on individual energy saving behaviour outweigh any tendency to behave selfishly, resulting in overall non significant impacts on individual behaviour.

5.4. Practical implications

We consider that our data has implications for communications around experiences such as power outages and flooding. Previous research has highlighted the importance of communications around power outages in order to reduce health and safety risks from maladaptive behaviour following the loss of power [34]. To date there has been little consideration of the potential for linking power outages to wider social issues of energy security and climate change, though previous research has highlighted opportunities for communications of this type in relation to flood experiences [4]. Adverse environmental and energy experiences may provide a window of opportunity with which to highlight the relevance of these social issues and the ways in which people can undertake prosocial behaviour in order to mitigate risks of climate change and energy security. Our data also adds to previous literature here by highlighting the potential for encouraging social energy saving behaviour; it is notable that social behaviour may also be considered a more impactful means of taking action to ameliorate environmental issues than individual behaviour.

5.5. Limitations

Limitations of our studies include the subjective nature of the question posed to participants concerning power outages and flooding which in both studies could be open to interpretation in terms of what actually constitutes 'experience'. However, we propose the subjective perception of experience is likely to be most relevant to the individual, their concerns and their behavioural decision-making. Importantly, given that our data is cross sectional, causality cannot be assumed. It is possible that greater levels of concern about energy security and climate change, or greater levels of individual self-interest (related to lower levels of individual sustainability), cause individuals to be more likely to recall, or consider themselves impacted by, a power outage or flood experience. Our sampling procedure also differed between studies; whilst neither study was nationally representative of the countries sampled, Study 1 used a quota sample gaining a broad range of participants whilst Study 2 used a smaller, opportunistic sample from Mexico City that may not be representative of broader public opinion. Participants were also recruited with information about the topic of study so that people who were particularly interested in energy issues may have been more likely to take part and therefore more extreme views may be overrepresented in our data here.

Furthermore, both of our studies examined behavioural intentions rather than actual behaviour, and therefore, we do not know whether intentions translate into behaviour. Whilst intentions are considered the most proximal indicator of behaviour, there is a well-known gap often observed where intentions often do not translate into actual behaviour [76]. Further research actually observing behaviour subsequent to environmental or energy experiences would be valuable in understanding the impacts of these experiences further. In addition, we represent energy saving behaviour using measures of energy saving intentions at home and at work; these measures do not represent the full range of energy saving behaviour that is possible. Given that our distinction between individual and social energy saving behaviour has indicated differences, we propose that further research consider further distinctions in behaviour, perhaps also examining energy saving community actions undertaken.

6. Conclusions

Our results indicate that environmental experiences have small but significant relationships with the way people think about and behave in relation to energy and climate change. Power outages and flooding experiences may therefore be 'windows of opportunity' [7,8] within which to engage people with broader energy issues and the issue of climate change in order to promote sustainable behaviour. Our findings imply that it may be useful to differentiate individual and social behaviour in engagement activities following environmental or energy experiences; given greater tendencies towards social behaviour (and potential greater impact) it may be more useful to focus efforts on promoting social sustainable actions.

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.

Acknowledgements

The authors would like to thank Cristina Vanegas-Rico for her help with material translation and José Antonio Campos-Gil and Maricela Irepan-Aguilar for their help with data collection. Support for the research conducted here was received from the Engineering and Physical Sciences Research Council (EPSRC) award (EP/K002589/1), from Horizon Digital Economy Research, EPSRC grant (EP/M02315X/1), and from the Trust in Autonomous Systems Hub, EPSRC grant (EP/V00784X/1). Data collection in Mexico was possible thanks to an International Collaboration Fund grant from the University of Nottingham awarded to Caroline Leygue.

Data statement

Survey data from both studies reported here have been archived at the UK data archive. Study 1 data is available here http://reshare.ukdataservice.ac.uk/853114/ and Study 2 data is available here http://reshare.ukdataservice.ac.uk/853210/.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2021.102143.

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