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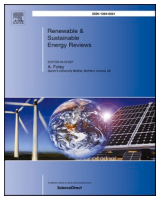

Moral licensing and habits: Do solar households make negligent choices?

Breda McCarthy

Department of Economics and Marketing, James Cook University, Townsville, QLD, Australia

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ABSTRACT

Orienting household behaviors towards more efficient use of energy in the home is crucial to climate change mitigation efforts. The objective of this work is to examine the social-psychological antecedents of energy curtailment in solar households. Using an online survey (n = 257) of solar households in Australia, the study validates an augmented model of planned behavior using partial least squares structural equation modeling (PLS-SEM). The study shows that the path of a standard construct, from perceived behavioral control to intentions, is interrupted by moral licensing, a concept that has been largely ignored in studies applying the standard model of planned behavior. The study provides fresh insight into how consumers vindicate wasteful energy consumption behavior through moral licensing. Amongst its contributions, the study shows that social influence is the most important driver of intentions and behavior. The habitualised use of energy has a significant, negative effect on behavior. This work has several recommendations for retailers and policy makers in global energy markets on how to minimise licensing and negligent habits, and at the same time, it opens up new research avenues in the ethical consumption discourse.

1. Introduction

Energy retailers are increasingly interested in persuading consumers to use less energy at critical periods. Since energy derived from fossil fuels contributes significantly to climate change and is one of the United Nations Sustainable Development goals, notably goal 7, affordable and sustainable energy [1], an understanding of the antecedents of energy curtailment is essential for policy makers and utilities. Approximately three-quarters of global greenhouse gas emissions can be attributed to the energy sector [2]. A reduction in residential energy use is achieved in two distinct ways: energy efficiency, which generally means improving the unit energy consumption of appliances (i.e., development of technical standards and labels) and behavioral change, which means reducing demand for energy [3]. While the rapid adoption of rooftop solar has been extensively explored and is welcomed as a solution to climate change, it poses problems for the reliability of the grid since supply fluctuates (i.e. solar only provides energy while the sun shines), so the ability to change consumption behavior is vital. Furthermore, usage of electricity at peak periods has led to an over-investment in the electricity grid in the Australian energy market [4]. In the absence of battery storage, households still need to conserve energy at peak periods. It is argued that one should not rely exclusively on renewable energy and ignore people' lifestyles and the everyday use of energy in the home [5]. Energy consumption by affluent households is reported to be a major catalyst of climate change and it has reduced the benefits arising from low-carbon technologies [6]. Since 2010, growing demand for residential energy, particularly for services such as cooling the home, using appliances and electrical devices, has practically cancelled energy efficiency gains [7]. Addressing the behavior of the household's occupant is challenging [8] but promoting a shift to sufficiency is crucial as it can bring major and lasting gains for society [9].

Residential energy consumption is a complex subject, and it is concluded that social-psychological factors [10] and demographic factors greatly influence behavior [11]. However, scholarly evidence of the impact of such factors has been inconclusive and mixed to date [12]. Seminal studies into pro-environmental behavior predate the rapid uptake of rooftop solar in mature markets [13], and attitudes towards energy curtailment in prosumer households, those that produce and consume electricity, are not well understood [14]. Energy-related behaviors can be adaptive after installing solar due to the increased awareness of energy consumption [15], and a sensitivity towards pro-ecological behavior [14]. Behavior can also be maladaptive due to the moral licensing effect, i.e., the view that the enactment of moral behavior in the past means that people are more inclined to perform immoral acts in the future without feeling guilty [16]. However, studies of motivations for energy use in solar households are scarce [17], albeit growing, and there is scope to further delve into the psychological drivers of residential energy demand [18]. There are large differentials

E-mail address: breda.mccarthy@jcu.edu.au.

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in the energy consumption patterns of households that are physically similar [19], and a key problem facing policy makers is how to change the behavior of household occupants, particularly those who have already made a significant investment in rooftop solar.

The objective of this study is to examine energy saving behavior in solar households using an augmented model of planned behavior, incorporating two additional variables, moral licensing and habits. It responds to a call by research to focus on the psychosocial antecedents of household adaptation behavior [20]. Meta reviews demonstrate that the theory of planned behavior [21] has been applied in diverse contexts [22], and the inclusion of moral norms into the theory has significantly improved its prediction power [23]. Moral licensing is arguably a counterpoint to a sense of moral responsibility that has been detected in studies of residential energy saving [24]. The potential for licensing to weaken intentions is largely unacknowledged in the theory of planned behavior, even though meta reviews of moral licensing in the field of psychology show there is theoretical support for the licensing effect [25] A key contribution of this study is that it provides an integration of concepts from two different streams of thought: moral licensing from the field of psychology and the theory of planned behaviour from the field of organisational studies. In a field that has direct implications for policymaking, practitioners need to know if the moral licensing effect is present or non-existent, and whether it is a relatively weak or strong predictor of behavior. Exploring the pathways through which moral licensing operates is important to the extent that it should reveal insights into salient demotivators of energy-saving and why people engage in more indulgent behavior. The prevailing view is that social norms are strongly associated with behavior [26], and there is scope to consider the potential for licensing to circumvent social influence. In addition, this study examines habits, as recommended by prior research [27], thus key variables in the theory of planned behavior are clearly accounted for in this study. The contributions of this study are as follows.

(1) It includes moral licensing as an additional construct in the theory of planned behavior, investigates its moderating effect, and offers a more complete understanding of its role in influencing energy curtailment.
(2) It applies an augmented model of the theory of planned behavior to energy curtailment in solar homes, a context that is underexplored. In doing so, it contributes to the growing body of knowledge on household climate change adaptation behaviors.
(3) The study focuses on a mature renewable energy market and proposes recommendations for the types of interventions that may be most suitable for solar households. It has policy implications for international energy markets, particularly less mature energy markets, that wish to promote rooftop solar, and at the same time, implement energy curtailment programs.

2. Framework for the development of the research hypotheses

2.1. Energy consumption

Energy analysts and policymakers alike consider domestic energy consumption to be a crucial lever for curbing greenhouse gas emissions. Although the determinants of energy saving behaviors is closely analysed, including household norms [28], economic motives, demographics and psychological factors (29), moral licensing is overlooked in the theory of planned behavior. Despite the importance of the topic, it is stated that "the residential energy consumption literature remains theoretically fragmented, inconclusive, and subject to continued debate" [30, p.1]. It is claimed that the topic of energy efficiency, "… who buys efficient technologies or uses technologies efficiently and why, remains underexplored" [31], p.2.

In terms of energy consumption, a distinction is made between energy efficiency and energy curtailment behaviors [8]. Efficiency behaviors result in less energy being used for an energy service; it often involves the purchase of an energy-efficient labelled appliance, or structural adjustment to the home (e.g., rooftop solar installation). The concept of curtailment refers to behavioral change and to everyday practices that do not involve any expenditure (e.g., turning off the air-conditioner) but may affect personal comfort [32]. Research shows that energy curtailment or conservation is motivated by a variety of factors. For example, it is reported that energy-related behaviors are influenced by household income [33], financial costs [34], sociodemographic variables and social responsibility motives [35]. The diffusion of low carbon technologies has contributed a great deal to the reduction in greenhouse gas emissions (GHG), yet studying behavioral change is important since moral licensing could offset some of the anticipated benefits from technology adoption [36]. There have been early studies of the energy-saving behavior of households after the adoption of low-carbon technologies, but they are few in number and the results are mixed [15]. Although studies on solar households have grown [37], it is still difficult to draw solid conclusions about energy consumption in households with PV systems.

Therefore, this study focuses on solar households since it is an interesting focus for exploring the moral licensing effect and the context speaks to research that seeks to understand household adaptation behavior [20]. For instance, individuals may respond to more heat waves by installing solar, but if they increase air conditioner use in non-daylight hours, that may have adverse systemic effects. This study aims to contribute empirically to the literature by including moral licensing and habits in the theory of planned behavior. Fig. 1 presents the conceptual model, illustrating the augmented theory of planned behavior.

2.2. The theory of planned behavior

The theory of planned behavior [21] has a significant following in the social sciences and many studies of occupants' energy behaviour have drawn on the theory [26]. The theory posits that behavior is driven by intentions, and intentions are an integrative variable and a product of three constructs: attitudes, subjective norms and perceived behavioral control [21]. There is a breadth of evidence that supports the applicability of this theory to energy conservation [38]. Prior research demonstrates that the theory predicts energy saving behavior in the home [39], as well as in workplaces, such as in Italy [40] and China [41]. The theory has been criticized for over-simplifying human behavior [42], and studies on energy use have extended the theory with numerous constructs, including moral obligation [39]. The behaviourist perspective posits that habit undermines rational and intentional decision-making [40]. In recognition of divergent perspectives, this study includes habits as an additional predictor variable, noting that both deliberate and habitual processes can proceed in parallel.

Ajzen defines attitude as "the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behavior in question" [21, p.188]. Early research shows that when consumers approve of the idea of saving energy in the home, they tend to adopt energy conservation behaviors [43]. Recent studies applying the theory confirm that attitudes predict the purchase of energy-efficient appliances [44] and residential energy saving [28]. A meta-analysis of the psychological predictors of energy saving shows that attitudes predict behavior, although the measures typically used do not reflect actual behavior, which tends to weaken the validity of the results [[45,121]]. In this study, it is hypothesised that attitudes influence intentions.

Along with attitudes, Ajzen defines subjective norms as "the perceived social pressure to perform or not to perform the behavior" [21, p. 188], showing that people's intentions are generally influenced by the societal norms or expectations. Fishbein and Ajzen (2011) distinguish between injunctive or subjective norms (i.e., perceptions of the actions that would gain other people's approval) and descriptive norms (i.e., perceptions of what others are actually doing) [45]. Thus, norms are effective for behaviors that are considered to be legitimate in

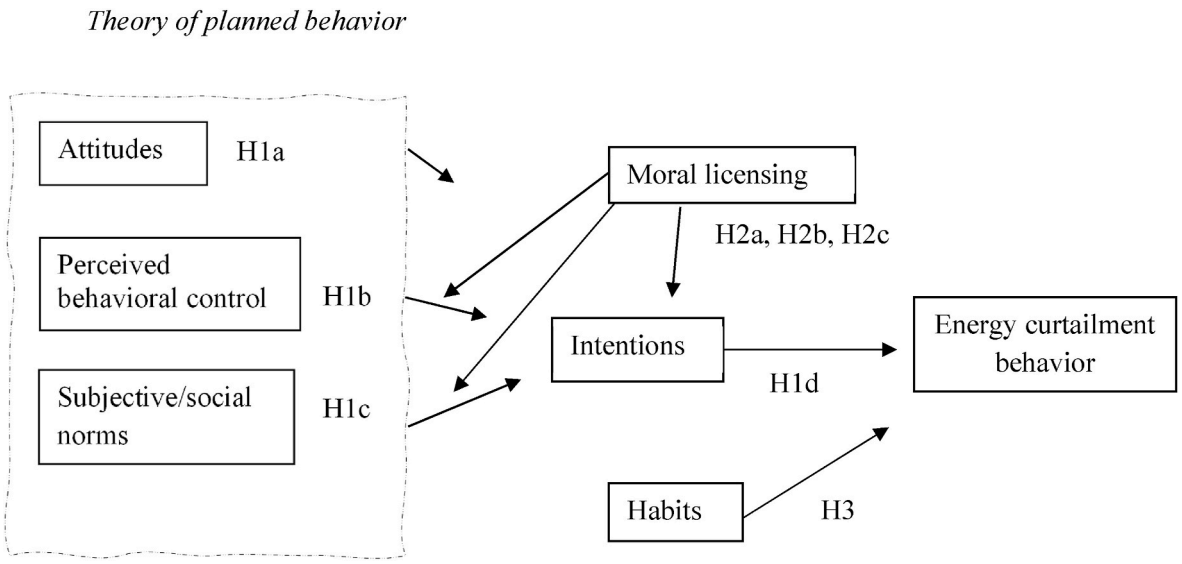

Fig. 1. Conceptual framework: Augmented model of planned behavior.

society and that are commonly practised, and norm-based interventions are seen as the key to fostering responsible practices [46]. For example, peer networks greatly assist in the diffusion of renewable energy [47]. The extent to which social approval exerts an influence on energy saving is the subject of debate. While norm-based messaging is seen as effective [48], studies report that appeals to social norms are not persuasive for all people and can 'backfire' if people deviate from the positive behavior of others [49]. Early research shows that the relationship between social influence and behavior also depends on the context, for example whether a product is publicly or privately consumed [50]. For example, battery storage systems lack visibility, and this attribute might reduce the influence of neighbours on purchase decisions [51]. Cognisant of the mixed evidence, this study seeks to investigate the influence of subjective norms on energy saving, a behavior that might reflect low norms.

Perceived behavioral control refers to a person's perception that the behavior is easy to perform. It captures two dimensions: capacity, which refers to the ability to carry out the behavior, and autonomy, which refers to the degree of control or discretion over the behavior, and it means that the person is not constrained by factors such as a lack of money, time, skills or even willpower [45]. In the context of energy, barriers such as motivations towards comfort and wellbeing [52] could be seen as uncontrollable factors. Since individual effort to save energy saving might be constrained by other household members, as well as by the desire to cater for their needs, it is possible that perceived control shapes intention, but not actual behavior. The evidence concerning the impact of perceived control on behavior is mixed. One study shows that perceived control directly predicts energy-saving behavior [24], whereas another study concludes that although it shapes intention, it is not directly associated with behavior [40]. The construct is consistently associated with intentions to save energy [53] and it predicts intentions to purchase energy-efficient appliances [44] and intentions to use small-scale solar energy [54]. In the broader literature on pro-environmental behavior, perceived control predicts recycling habits [55] and employees' engagement with sustainable practices in hotels [56]. In this study, the indirect influence of perceived control on behaviour is investigated. In this study, several hypotheses are proposed.

H1a. Attitudes positively influence energy curtailment intentions.

H1b. Subjective norms positively influence energy curtailment intentions.

H1c. Perceived behavioral control positively influences energy curtailment intentions.

H1d. Intentions positively and significantly affect energy curtailment behaviors.

2.3. Moral licensing

Moral licensing is a cognitive bias which leads people to act in an unethical or immoral way, but such actions are not accompanied by feelings of remorse or guilt [15]. According to Miller & Effron moral licensing "occurs when one's past actions (or current intentions) reduce one's concerns that one's future actions will be morally discrediting. Feeling that one has a moral license is thus empowering, as it permits people to do what they otherwise would not psychologically permit themselves to do" [57, p. 134]. One theoretical explanation for moral licensing is the self-regulation framework: which means that people mentally balance good deeds with bad deeds and may "refrain from good behavior when they have accrued a surplus of moral currency" [58]. According to Truelove, pro-environmental behavior is "subject to moral balance sheets" [59, p. 130]. Compensatory reasoning [60], also known as the compensatory ethics model [61], helps explain licensing, and it implies that if an individual is doing something to help address an environmental problem, then that action liberates the person from doing other things. An initial ethical choice (such as installing solar) might be rationalised and allow an individual to act out of self-interest at a later stage (i.e., use an air conditioner at night that draws on coal-fired electricity). The concept of neutralisation helps explain licensing and it shows that people rationalize their norm-violating behavior in order to protect their sense of self [62]. Moral licensing has received considerable attention in the field of social psychology [63]. The focus of such work is on investigating whether the moral licensing effect occurs, and how big the effects are on negative or undesirable behaviors [64]. There is a growing body of work that identifies moderators of licensing, such as personal values and identity [65] and cultural background [66]. Evidence of moral licensing remains ambiguous and is contested [67] One weakness of the licensing argument is that people are self-perceptive, are capable of observing their own behavior and they tend to seek consistency [63].

Research also suggests that consumers observe the responsible behaviour of others and use that as a moral licence or excuse to not follow suit [48]. Hence, appeals to social norms can backfire and be demotivating, particularly for people who were committed to sustainable actions in the past [48]. Given the knowledge gap in relation to the

mechanism by which moral licensing works, there are calls to explore the social influences on licensing [68]. Therefore, the theory of planned behavior, which includes subjective norms as a key construct, is applied in this study. Few, if any, studies have included moral licensing as an additional variable in the theory of planned behavior. A recent review lists ten variables that are typically used to extend the model [22] and although moral norms are counted, licensing is not. There is strong evidence that people make plausible excuses to justify moral transgressions and inconsistencies in behavior [69]. Since the theory of planned behaviour is concerned with goal-directed behaviour, any dampening of goal striving by licensing [65] needs to be investigated.

It must be acknowledged that other theoretical concepts, apart from the licensing concept, may explain increased energy use after solar installation. These include single-action bias [70], which means that a person is willing to take one action to address an environmental issue and then feels that no further action is needed. Contribution ethics refers to a belief that if one has made a fair contribution to societal goal, such as mitigating climate change, and then no further action is needed [71]. Moral licensing is related to the body of work on spillover effects [63]. Positive spillovers [72] means that nudging people to take up one pro-environmental behavior (i.e recycling) may lead them to take up further behaviors (i.e., avoiding waste). However, negative spillovers, can occur, where an intervention designed to increase pro-environmental behavior has the opposite effect [73]. For example, Tiefenbeck et al. (2013) showed that involvement in a water conservation trial reduced water consumption, but increased electricity consumption, and the explanatory factor was the moral licensing effect [74]. In the energy economics field, the 'rebound' effect is well documented, meaning that improvements in resource efficiency correspond to greater resource use [75]. A rebound effect has been observed in solar homes [76] and some households justify increased consumption by their access to "free" electricity [15]. Energy use is complex, and there may be non-economic explanations for increased electricity consumption in solar households (such as spending more time at home or purchase of an electric car) [77]. Economists view moral licensing as another form of rebound, but one that has a moral dimension, rather than simply being a price effect or a cost-saving issue [75].

Prior research indicates that self-efficacy [78], which has similarity with the perceived control concept, refers to confidence in one's ability to complete a task. Research shows that self-efficacy can activate positive spillovers [79]. Based on this argument, this study investigates whether moral licensing weakens perceived control. In this study, it is proposed that moral licensing dampens perceptions of control over behavior. Consumers may feel that they are capable of saving energy (and have positive attitudes towards the behavior) but may not really want to engage with the behavior since they have already done their part for the environment by installing rooftop solar, which can be construed as self-licensing. In addition, it is hypothesised that social pressures to avoid wasting electricity will be weakened by moral licensing. For instance, a person could justify their wasteful use of electricity to their in-group through the 'observed licensing effect' [68], whereby others have observed the installation of rooftop solar (a moral act) and have approved of it and are less likely to judge subsequent wasteful behavior. Based on the above arguments, it is hypothesised.

H2a. Moral licensing is significantly and negatively related to energy curtailment intentions.

H2b. Moral licensing moderates the relationship between perceived behavioral control and energy curtailment intentions.

H2c. Moral licensing moderates the relationship between social norms and energy curtailment intentions.

2.4. Habits

Habits are defined as a learned, automatic response to one's environment that is maintained in certain situations [80]. They are explained by the dual process theory, fast and intuitive, or slow and reflective [81], and habits are aligned with the first process. Prior research has found that energy saving is determined by habits [41], and examples include turning off lights and washing clothes in a full laundry load. Daily habits are generally seen as an obstacle to behavioral change [5] and since the propensity to perform behaviors automatically tends to make the individual less attentive to new information [82]. Even when people are motivated to save electricity for monetary reasons [83], many fail to change their behavior due to habitual responses to environmental cues [37]. In a meta-analysis, it is concluded that habits (or habit strength) are a direct predictor of behavior and should be included in the theory of planned behavior [84]. Recent research has confirmed that habits predict behavior in the private sphere [85]. The complex interplay between habit, intention and behavior has been explored. It is reported that habit is a strong predictor of intentions but is not directly associated with energy saving, at least in the workplace [40]. Earlier research found that habit is a strong predictor of intention, such as printing less paper, and also behavior, such as switching off lights and monitors [86]. A further complication is that habits can function as a positive or negative facilitator of behavior, in other words, habits can be 'good' or 'bad'. Since they are largely unconscious, self-reports may not precisely capture non-conscious processes [87]. In this study, it is hypothesised that general habits serve as an obstacle to energy saving, and it is assumed that habits are wasteful.

H3. Habits are significantly and negatively related to energy curtailment behavior.

3. Materials and methods

3.1. Research aim, questions, measurement and sample

This study aims to examine the antecedents of energy curtailment in solar households using an augmented model of planned behavior. The research questions are as follows.

1) Does an additional construct in the theory of planned behavior, such as habits, significantly contribute to the prediction of energy curtailment in solar households?
2) Which variables in the theory of planned behavior have a stronger relationship with behavioral intention in the context of energy curtailment in solar homes?
3) To what extent does moral licensing influence intentions and does it moderate the relationship between standard constructs in the theory of planned behavior and intentions?

The survey questions and scales were derived from prior studies that have validated the scales Table 1 presents the survey scales. Multiple item scales, rather than single-item constructs, were selected, as recommended by Hair et al. (2017) [88]. Seven-point scale with anchor points such as 1 = strongly disagree to 7 = strongly agree, and 1 = not at all important and 7 = very important were used. Questions on socio-demographic variables were included in the survey since these variables influence energy-saving [10] and data on age, gender, income and educational level, occupation and household size was collected. A pilot study was undertaken to test the survey and establish the reliability and validity of the adapted items. Around 69 surveys were collected from the staff and students at the author's university during pilot testing. After analysing the pilot data, some survey items were deleted from the survey and the wording of some questions was revised.

Before commencing the research, ethical approval from the author's university, notably the Human Research Ethics Committee, was obtained. The data collection stage was outsourced to a market research agency, Qualtrics, who maintains a research panel. Exclusion criteria consisted of people under the age of 18 and those who had no

Table 1
Survey scales.

Construct and definition	Measurement Items[1,2]	Source
Attitudes: the extent to which energy curtailment is valued by households, and whether positive (or negative) attitudes are held.	*Saving electricity is not enjoyable.** Saving electricity is not important.** Saving electricity is useless.** Saving electricity is beneficial. Saving electricity is good.	[21] [89]
Subjective norms: the extent to which households are influenced by the perceived expectations of important others or perceived societal norms of electricity-saving.	Most people who are important to me would be happy if I saved electricity. People who are important to me think that I should save electricity.	[21] [89]
Perceived behavioral control: a person's perceptions of how easy or difficult it is to perform the behavior; the degree to which a person believes that curtailing energy usage is under his or her control.	I believe that I am capable of saving electricity in my home. I have the knowledge and skills to save electricity in my home. If I wanted to, it would be easy for me to save electricity.	[21] [90]
Intentions: the likelihood that households will hold intentions to save energy.	I intend to conserve electricity in the future. I will conserve electricity in the future. I am ready to conserve electricity.	[21] [41] [91]
Behavior: the extent to which a person will perform a specific behavior		[21]
Energy Curtailment Behavior: the degree to which a person continuously performs energy curtailment behaviors (strives to save electricity) on a regular basis.	Leave items plugged in even after they have finished charging*. Turn off the lights when going out, even for short time. Reduce the use of the air conditioner, by opening the windows, using fans, etc. Unplug, or switch off, the main power of an electrical device, when not using it. Shorten the duration that the fridge door is kept open.* Use the washing machine when I don't have a full load of laundry*.	[52] [17]
Habits: the degree to which a person uses energy in an unconscious and habitual manner	In my daily actions, I use electricity without conscious thinking. In my everyday life, I do not give much thought to the way I use electricity.	[92]
Moral licensing: the degree to which past action liberates a person to act out of self-interest at a later stage.	Because I save with solar panels, I may allow myself some other things. I am already doing my part with the solar panels; therefore, it is not that important to restrict myself (more) in other areas. It does not matter how much energy you use if you have solar panels.	[92]

Note[1]: * refers to items removed in PLS-SEM model due to low reliability and validity scores.
Note[2]: ** items were reverse coded for analysis.

responsibility for paying the electricity bill. Purposive (non-probability) sampling was used and people who owned their own home, and who therefore had the capacity to install rooftop solar were recruited. Prior research shows that policy incentives for rooftop solar adoption in Australia favoured the middle-class and the tenancy population face constraints to installing rooftop solar on their rental properties [93].

Data was collected in 2022. The sample was screened for incomplete and low-quality responses and a large sample size of 609 was achieved, which included households who had not installed rooftop solar and households who had installed rooftop solar without battery storage (n = 257). The sample size (n = 257) is reasonable when compared with the average sample size of studies achieved for PLS-SEM modeling in the marketing (mean = 211) and hospitality (mean = 332) disciplines [94].

3.2. Data analysis, statistical techniques and controls

Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to analyse the data. The methodology is useful since it shows direct and indirect relationships between the variables, and thus goes beyond multiple regression. A significant difference between PLS-SEM and covariance-based structural equation modeling is the way the variables are treated. PLS-SEM uses weighted composites to measure a latent construct and measurement is viewed as an approximation [88]. In the social sciences, constructs tend to have a subjective and unobserved dimension, so treating constructs as approximations is realistic. The use of PLS-SEM in the social sciences has grown dramatically [88] and the technique has been used before to study energy saving [24]. It is the preferred analytical tool in this study for several reasons: it can be used when the data is non-normally distributed; when the sample size is small, it is recommended over co-variance based structural equation modeling due to its higher statistical power [88]. It assists with theory building and is appropriate when the focus is on exploring new relationships, starting from a hypothesised model that has good theoretical support [88] which is the case in this work.

Since all of the variables in the conceptual model are measured in the same survey, there is a risk of common method biases occurring [95]. The survey was carefully designed in line with recommendations in research [96]: scale items were constructed to be clear and unambiguous, anonymity was guaranteed to reduce the social desirability bias, and items were negatively and positively framed to reduce the acquiescence bias. Harman's single-factor test was employed, which is a post hoc procedure conducted after data collection. A factor analysis was undertaken, and the first factor accounted for 33.58 % of the variance, which is well below the threshold of 50 % [97]. This result means that none of the factors individually explain the majority of the variance. When assessing Smart PLS-SEM results, the variance inflation factor (VIF) values are useful when assessing collinearity [88]. In the results section, Table 5 shows that the inner VIF values are lower than 5, suggesting that the data is not overly affected by the common method bias problem.

The treatment of control variables in research is important since their omission might bias the results [98]. Research reveals that demographics play an important role in energy curtailment, and although mixed results are found for income, households who belong to higher income groups tend to be less likely to save energy [19]. Consequently, the effect of income on energy curtailment was tested. The relationships between income and intentions, and income and behavior, were not significantly significant and therefore income was excluded from the PLS-SEM modeling.

4. Results

4.1. Summary statistics

A description of the sample is shown in Table 2. The sample consists of rooftop solar adopters and is not designed to be representative of the population. There were more women (58.8 %) than men in the sample. In relation to age, respondents were mostly middle-aged and senior, which reflects the trend of higher rates of home ownership amongst older households [99], and the profile of middle-class adopters of rooftop solar in Australia [100]. Furthermore, older households use more energy than younger households since the occupants spend more time at home, hence they have more incentive to invest in energy-efficient products [19], such as rooftop solar. The major age cohorts were as follows: 36–45 years (9.7 %), 46–55 (10.1 %), 56–65 years (22.2 %), and 66–75 years (31.9 %). In relation to educational

Table 2
Description of the sample (n = 257).

Item		n	%
Gender	Men	108	42.9
	Women	149	58.8
Age	18–25	8	3.1
	26–35 years	15	5.8
	36–45 years	25	9.7
	46–55 years	26	10.1
	56–65 years	57	22.2
	66–75 years	82	31.9
	76 years or over	44	17.1
Education	Primary school, no qualification	21	8.2
	High school certificate	62	24.1
	Trade or vocational qualification	55	21.4
	Diploma of advanced diploma	41	16.0
	Bachelor's degree	63	24.5
	Post-graduate degree	15	5.8
Income group	Less than $30,000	41	16
	$30,000 to $64,999	89	34.6
	$65,000 to $99,999	49	19.1
	$100,000 to $149,000	39	15.2
	$150,000 to $199,000	16	6.2
	$200,000 to $249,000	3	1.2
	$250,000 to $299,999	1	0.4
	More than $300,000	19	7.4
	Prefer not to say	41	16
Income: subjective	Finding it very difficult to live on current income	11	4.3
	Finding it difficult to live on current income	29	11.3
	Coping on current income	106	41.2
	Living comfortably on current income	88	34.2
	Living very comfortably on current income	23	8.9
Household size	1 person household	33	12.8
	2 persons	148	57.6
	3 persons	37	14.4
	4 persons	25	9.7
	5 persons or more	14	5.4

level, 24.5 % of respondents reported having a bachelor's degree, which is close to the national average [101]. Household income varied, and most respondents were in the low- and middle-income brackets: $30,000 to $64,999 (34.6 %) and $65,000 to $99,999 (19.1 %). Using a subjective measure of income, most of the sample (41.2 %) reported that they were "coping on current income".

4.2. Evaluation of the measurement model: reliability and validity analysis

A reflective measurement model was chosen; basically this means removing an item from a scale does not alter the fundamental meaning of the construct and all of the indicators are interchangeable [88]. Evaluating a PLS-SEM model entails following a two-step process, where firstly the measurement model (outer model) is assessed and secondly, the structural model (inner model) is assessed [88].

Table 3 displays the results for internal consistency and convergent validity. The constructs have a high level of reliability and consistency. In relation to internal consistency, values for Cronbach's alpha, composite reliably (C.R) and Dijkstra-Henseler's Rho A are shown in Table 2. Values for Cronbach's Alpha range from 0.60 to 0.96, and apart from two values, all are close to, or well above, the threshold value of 0.7. The Rho A value is higher than 0.7 and less than 1 (although one value, at 0.64, is below the recommended figure). The values for composite reliability are greater than the recommended value of 0.7 [102]. The convergent validity measure comprises the average variance extracted (AVE), which surpass the threshold value of 0.5 [102]. The values of the factor loadings (which basically refer the extent to which each item within a factor correlates with the rest within the factor) are acceptable, meeting the threshold value, higher than 0.7. One indicator loaded on 0.62 but since it is a borderline value, it was not removed, particularly since Benitez et al. (2020) assert that slightly low values are not problematic if validity and reliability criteria are met [103].

Table 4 presents the results for the discriminant validity tests based on the heterotrait-monotrait (HTMT) criterion. The HTMT is a statistical technique that examines relationships between latent (unobserved) variables using observed techniques [94]. It is the ratio of the correlation between two constructs to the average of the correlations between the same construct and itself. If the HTMT exceeds a certain threshold (typically 0.85 or 0.9), it indicates a lack of discriminant validity [103]. Table 5 presents the results for the Fornell-Larcker criterion. This test is widely used in work applying PLS-SEM to assess discriminant validity, although recent research casts doubt on its efficacy [88]. The Fornell-Larcker criterion is based on the idea that the square root of the average variance extracted (AVE) for each construct should be greater than the correlations between that construct and other constructs in the model. The results presented in Table 5 fulfil these requirements.

4.3. Evaluation of the structural model

If the measurement model is deemed adequate, then the second stage proceeds to the examination of the structural model. As part of this stage, a bootstrapping procedure (and 5000 subsamples) was applied to assess the significance of the hypothesised relationships. Table 6 shows the results of the hypotheses testing and presents the multi-collinearity statistics (VIF), the f^2 values and the bias-corrected confidence intervals. Based on the results, all hypotheses, apart from one, are found to be significant.

Significance testing is used to determine significant relationships between variables and assess the validity of their hypothesised model. The path coefficients for the hypothesised relationships range from 0.11 to 0.36, and all are signficant, apart from the hypothesis related to the moderating effect of moral licensing on subjective norms. Fig. 2 shows the results of the structural model. The strongest (positive) relationship is found between subjective norms and intentions (t = 6.146), followed by attitudes and intentions (t = 4.557), perceived behaviorial control and intentions (t = 4.515). The relationship between habits and behavior was hypothesised to be negative, which was confirmed, as shown by the negative sign of the path coefficients in the table. Moral licensing has a direct (negative) influence on intentions and it moderates the relationship between perceived behavioral control and intentions. The hypothesis that moral licensing would have a moderating effect on the 'social norms-intentions' relationship was not confirmed. Fig. 3 shows the moderation graph with the simple slope analysis. The moderating effect is represented in colour, where the green, blue and red lines represent the high (+1 SD above the mean), mean, and low (−1 SD below the mean) values. At low levels of moral licensing (−1 SD), perceived behavioral control has a stronger impact on intentions, and at high levels of moral licensing, the reverse is true.

Table 7 shows that all of the inner variance inflation factor (VIF) values are below 5, which is threshold for multi-collinearity [88]. Effect size was calculated to show the impact of the variables on the R^2 value and the f^2 values are shown in Table 5. The f^2 value is used to assess the effect size of independent (or predictor) variables on dependent (or outcome) variables. Guidelines for assessing f^2 are that values of 0.02, 0.15 and 0.35, respectively, represent small, medium and large effects [[104,122]]. In our sample, the f^2 values for the hypothesised (significant) relationships range from 0.02 to 0.23, mostly indicating a small effect, and a medium effect for the 'subjective norms-intentions' relationship.

Mediation is one way that a researcher can explain the process by which one variable affects another. Table 6 reports the specific indirect effects. The results show that mediation occurs through three constructs, subjective norms, attitudes and perceived behavioral control, which are significant at the 0.05 level. Moral licensing is significant at the 0.10 level.

Table 3
Construct reliability and validity tests.

Survey items		Internal consistency			Convergent validity	Indicator reliability	HTMT (<0.85?)
Construct	Items	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted	Outer Loadings	
Attitudes to conserving		0.898	0.906	0.929	0.765		Yes
	Attitude 1					0.848	
	Attitude 2					0.890	
	Attitude 3					0.845	
	Attitude 4					0.913	
Energy curtailment behavior		0.604	0.643	0.783	0.549		Yes
	Practice 1					0.625	
	Practice 2					0.773	
	Practice 3					0.811	
Habits		0.903	0.903	0.954	0.912		Yes
	Daily habit 1					0.953	
	Daily habit 2					0.956	
Intentions		0.966	0.966	0.978	0.936		Yes
	Intention 1					0.968	
	Intention 2					0.974	
	Intention 3					0.960	
Moral licensing		0.785	0.846	0.87	0.692		Yes
	Licensing 1					0.725	
	Licensing 2					0.880	
	Licensing 3					0.881	
Perceived behavioral control		0.879	0.905	0.925	0.804		Yes
	Perceived control 1					0.922	
	Perceived control 2					0.920	
	Perceived control 3					0.845	
Subjective norms		0.875	0.887	0.941	0.889		Yes
	Subjective 1					0.951	
	Subjective 2					0.934	

Table 4
Discriminant validity test based on the heterotrait-monotrait ratio.

	Attitudes	Energy curtailment behavior	Habits	Intentions	Moral licensing	Perceived Behavioral. Control	Subjective norms	Moral Licensing x Perceived Control	Moral licensing x Subjective Norms
Attitudes									
Energy curtailment behavior	0.408								
Habits	0.395	0.435							
Intentions	0.627	0.380	0.488						
Moral licensing	0.379	0.400	0.462	0.341					
Perceived behavioral control	0.524	0.276	0.305	0.56	0.174				
Subjective norms	0.404	0.201	0.306	0.591	0.078	0.397			
Moral licensing x Perceived Behavioral Control	0.113	0.204	0.079	0.025	0.059	0.165	0.063		
Moral licensing x Subjective norms	0.052	0.059	0.127	0.015	0.13	0.065	0.046	0.298	

Table 5
Discriminant validity (the Fornell Larcker criterion).

	Attitudes	Energy curtailment behavior	Habits	Intentions	Moral licensing	Perceived Behavioral. Control	Subjective norms
Attitudes	**0.875**						
Energy curtailment behavior	0.282	**0.741**					
Habits	−0.358	−0.345	**0.955**				
Intentions	0.588	0.295	−0.456	**0.967**			
Moral licensing	−0.345	−0.251	0.392	−0.314	**0.832**		
Perceived behavioral control	0.477	0.191	−0.279	0.524	−0.153	**0.896**	
Subjective norms	0.364	0.156	−0.272	0.545	0.004	0.351	**0.943**

Note[1]: values on the diagonal (in bold) represent the square root of the AVEs while those off the diagonal are the correlations. The value of the diagonals is the highest value in any column.

Table 6
Structural estimates: hypotheses testing (bootstrapping).

Path: IV to DV	Std Deviation	Path Coefficient	T Values[12]	P Values	CI – Bias corrected (2.5 %)	CI – Bias corrected (97.5 %)	VIF (inner)	f Square
Attitudes → Intentions	0.063	0.287	4.557	0.000***	0.164	0.406	1.561	0.119
Habits-→Energy Curtailment Behavior	0.073	−0.266	3.662	0.000***	−0.393	−0.105	1.262	0.066
Intentions →Energy Curtailment Behavior	0.072	0.173	2.420	0.016*	0.025	0.308	1.262	0.028
Moral licensing → Intentions	0.047	−0.179	3.782	0.000***	−0.268	−0.082	1.185	0.061
Perceived Behavioral Control →Intentions	0.056	0.251	4.515	0.000***	0.141	0.357	1.380	0.103
Subjective Norms → Intentions	0.059	0.361	6.146	0.000***	0.247	0.474	1.239	0.237
Moral licensing x Perceived Behavioral Control →Intentions	0.038	−0.114	2.971	0.003*	−0.187	−0.037	1.124	0.031
Moral licensing x Subjective norms → Intentions	0.040	0.036	0.883	0.377	−0.041	0.117	1.115	0.003

Note[1]: The critical T values around 1.65, 1.96, and 2.58 are considered with the significance level of 5 %, 10 % and 1 % respectively (two tailed test).
Note[2]: *p < 0.05, **p < 0.1 and ***p < 0.001.

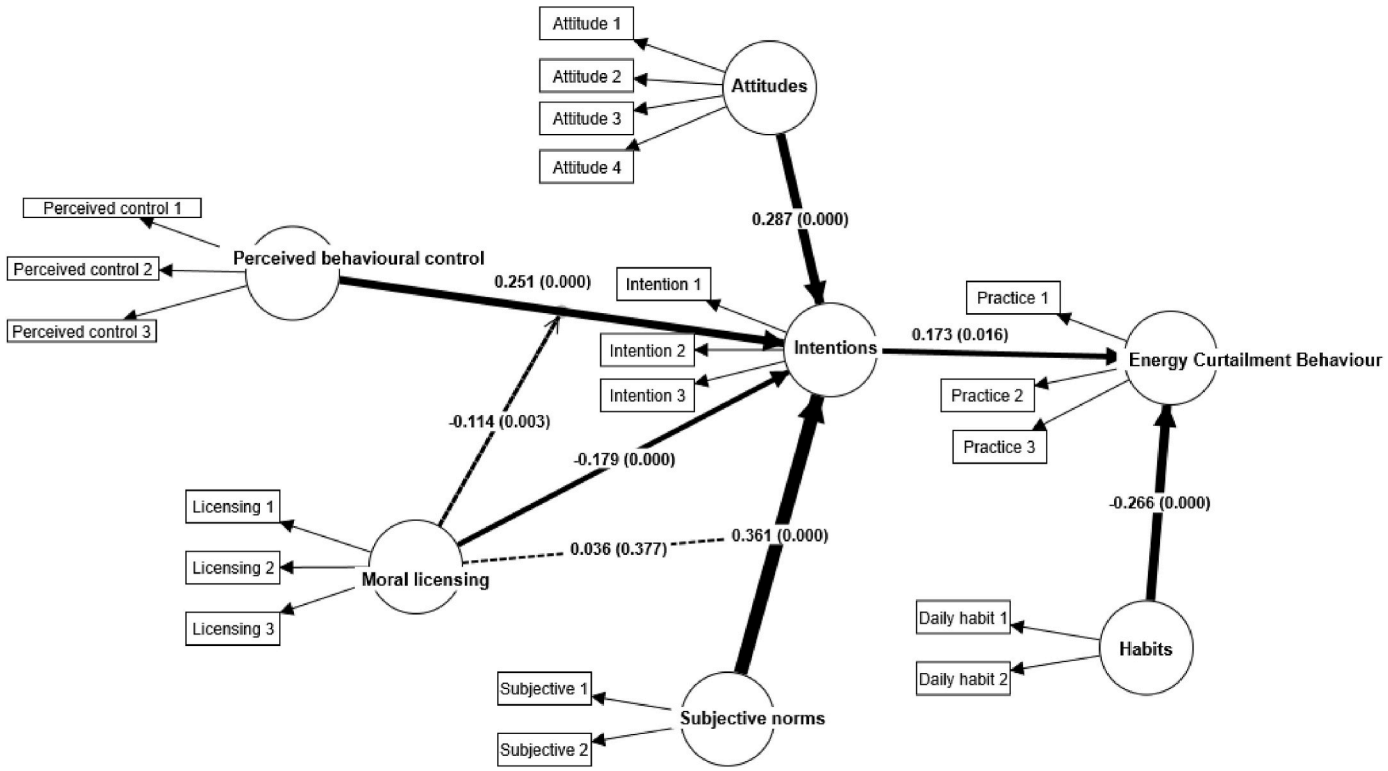

Fig. 2. Structural model and antecedents of energy curtailment. Note[1]: The critical T values around 1.65, 1.96, and 2.58 are considered with the significance level of 5 %, 10 % and 1 % respectively (two tailed test). Note[2]: *p < 0.05, **p < 0.1 and ***p < 0.001.

4.4. Further assessments of the structure model, explanatory power and the goodness-of-fit

Another test was conducted, namely the R-square (R^2) measure, which is widely used in regression analysis to assess the goodness-of-fit of a regression model. The R2 values ranges between 0 and 1, and larger values indicate a better fit of the model to the data. According to Hair et al., R^2 values of 0.20 are "seen as high in the field of consumer behavior" [88, p. 199]. In general, R^2 values of 0.75 and above are seen substantial, values of 0.50 and above are seen as moderate, and values of 0.25 and below are seen as weak. In this work, the R^2 value for intentions to save energy is 0.557, which indicates a moderate level of explanatory power. The R^2 value for energy curtailment behavior is 0.143, which represents a weak result. The results confirm that the extended theory of planned behavior explains energy curtailment intentions in the home, although it is likely that omitted variables account for the low R^2 value for behavior. The standardized root mean square residual is another statistical measure used to assess the overall fit of a structural equation model by assessing the discrepancy between observed and model-implied covariance matrices. The value for the residual in this study was 0.064, which is below the 0.08 threshold [103], and this suggests a good fit, meaning the model is well suited for confirming and explaining the antecedents of energy curtailment.

5. Discussion

The aim of this study is to empirically test an augmented model of planned behavior in the context of solar homes and. examine the influence of licensing and habits on energy curtailment. The findings show that the augmented theory of planned behavior (TPB) explains 56 % of the variance in intention and furthermore, mediation occurs through three of the standard constructs in the TPB. However, the predictive power of the theory for energy curtailment behavior is low (14 %). The results are not surprising since studies show mixed results, with one study on energy saving validating the theory for intentions [53] and another validating the theory for intentions and behavior [104]. In

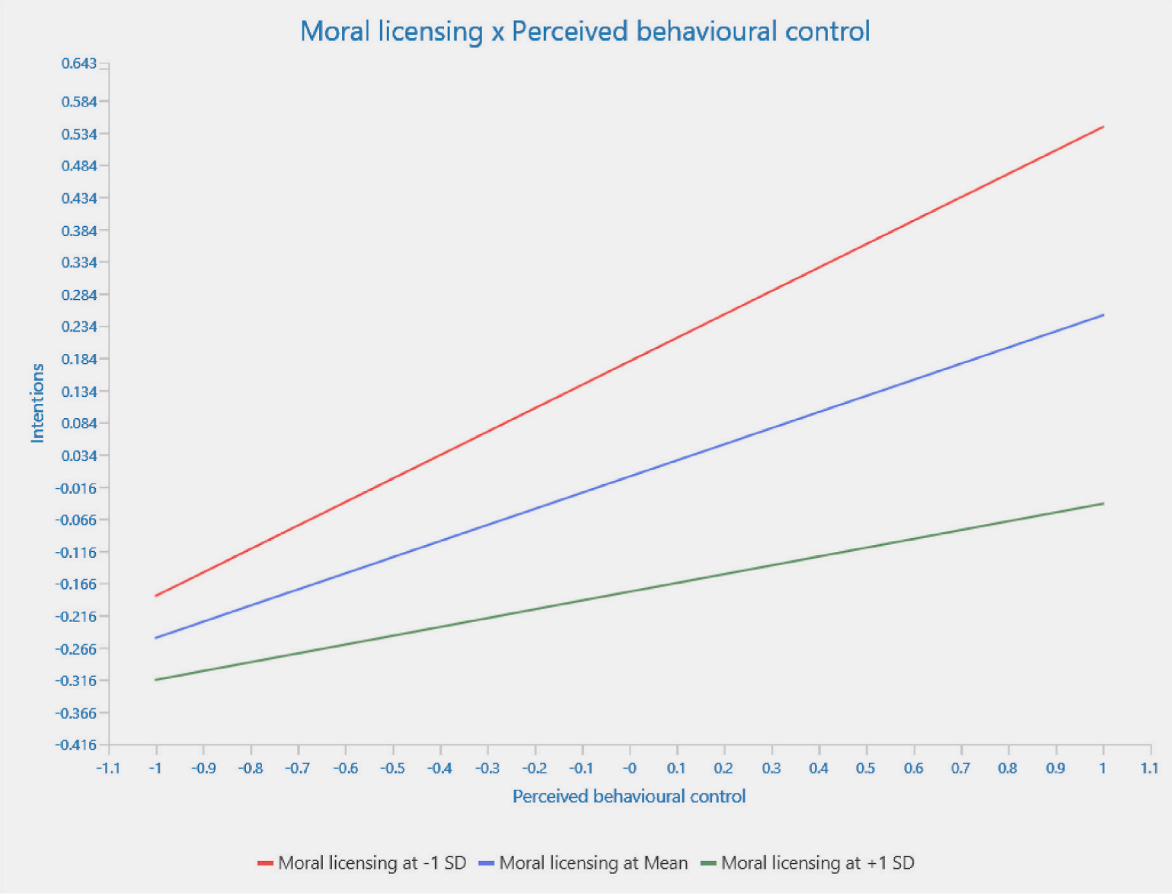

Fig. 3. Moderating influence of moral licensing.

Table 7
Results of hypothesis testing: specific indirect effects of the model (two tailed test).

	Path coefficient (β)	*T*-value	*P* value
Moral licensing x Subjective norms →Intentions - > Energy Curtailment Behavior	0.006	0.742	0.458
Subjective norms →Intentions →Energy Curtailment Behavior	0.063	2.164	0.031*
Attitudes →Intentions →Energy Curtailment Behavior	0.050	2.048	0.041*
Perceived behavioral control →Intentions - > Energy Curtailment Behavior	0.043	2.176	0.030*
Moral licensing x Perceived behavioral control →Intentions -→ Energy Curtailment Behavior	−0.020	1.682	0.093**
Moral licensing → Intentions →Energy Curtailment Behavior	−0.031	1.934	0.053**

Note[1]: * significant at the 5 % level, $p < 0.05$.
Note [2]: **significant at the 10 % level, $p < 0.10$.

addition, a meta analysis has found that the model predicts the variance in intention more strongly than the variance in behavior [105]. A good deal of research highlights the 'intentions-behavior' gap or the 'attitudes-behavior' gap, briefly explained as the lack of consistency between words and deeds [106]. Ajzen et al. (2011) also accepts that intentions do not automatically lead to actual behavior due to barriers [107]. For instance, while people express a strong environmental self-identity, they still rely heavily on air conditioners due to their personal needs for comfort and sound sleep [108]. In addition, structural factors influence energy consumption, i.e. the characteristics of the dwelling (i.e., lot size, square footage of the home, use of swimming pool pumps), and these factors, which were not addressed in this study, might explain why intentions are not the best predictor of actual behavior.

The strongest (positive) relationship was found between subjective norms and intentions, followed by attitudes and perceived behavioral control. In other words, intention formation is driven by the desire for approval, positive attitudes towards energy saving and perceptions that the task is easy to perform. The findings are aligned with prior research. For instance, prior work has found that perceived control predicts intentions to purchase energy-efficient appliances [44] and intentions to use small-scale solar energy [54]. Our work reflects findings by Nie et al. (2019) who concluded that subjective norms are the strongest driver of energy-saving [29]. Other studies also highlight the role of social expectations in energy conservation, such as Andor et al. [48] and Ru et al. [53]. A study of energy-saving intentions among low-income households in the United States found that attitudes and perceived behavioral control were the strongest preditors [109]. Yarimoglu and Gunay (2019) found support for subjective norms and attitudes, but not perceived control, at least in the context of green hotels [110]. Martinho et al. (2015) reported that attitudes explain the purchase of sustainable products much more than subjective norms or perceived behaviorial control [111]. In the context of recycling, one study found perceived behavioral control to be the most salient factor [112]. The mixed findings and lack of consensus over which factor is the most influential is not surprising given variations in the type of behavior and the context of the research. One of the interesting findings in this study is that the subjective norm construct is the most salient factor in the model, suggesting that there is pressure from other household members to save energy. The study used a measure of social norms that draws on strong ties rather

than weak ties [113], such as the desire to please people who are important to the respondent. A limitation of the theory of planned behavior is the lack of theorizing about who constitutes significant referent others [114] and it is argued that some reference groups are more important than others, and that strong ties are more influential than weak ties in the case of unobserveable behavior [115].

This study adds a layer of depth to previous research by adding moral licensing to the theory of planned behavior. Studying moral licensing in solar homes is important since licensing could offset some of the anticipated benefits from technology adoption [36]. The study demonstrates a negative relationship between moral licensing and intentions, which is aligned with prior studies on moral licensing [74]. The finding is also consistent with research seeking non-economic explanations for the rebound effect, which posits that installing solar, a pro-environmental act, gives people a license to consume solar energy more freely [37]. The finding may also be explained by the concept of compensatory reasoning [60]. The novelty of this study lies in exploring the moderating role of moral licensing and its impact on the standard constructs in the theory of planned behavior. It shows that perceived behavioral control and moral licensing act jointly to influence intentions. Perceived behavioral control predicts intentions when the level of moral licensing is low, and its influence on intentions is weaker when the level of moral licensing is high. There is limited evidence that moral licensing affects actual behavior, and perhaps this is because energy-saving behavior is habitual or constrained by structural factors. The results show that moral licensing does not have a moderating effect on the subjective norms-intentions relationship, suggesting that the desire for social approval is strong and it overrides self-licensing, a latent cognitive bias.

An additional construct, habits, were included in the model. This study reveals a direct link between habits and behavior, suggesting that energy behavior is influenced by unconscious and automatic processes. This finding is aligned with research into pro-environmental behavior [85], recycling behavior [55] and energy-related research that has found that energy saving in the workplace is determined by habits [41]. A meta review of the theory of planned behavior found that habits negatively impact behavior and campaigns need to focus on de-habitualizing behavior [84]. As noted in the Adua et al. (2021), behavioral change is important since habitual behavior could potentially erode some of the benefits associated with installing rooftop solar [5].

5.1. Implications for policy and practice

This study has recommendations for policy makers and energy stakeholders internationally. Although the research was conducted in Australia, the findings are relevant to other energy markets that have a growing share of renewable energy in the energy mix and that have ambitious decarbonisation goals. Educating prosumers on how to use energy wisely is necessary given the role of habits and moral licensing in negatively influencing intentions. Recommendations for behavioral modification campaigns are made and Table 8 outlines the interventions. Campaigns based on the re-enforcement of existing attitudes, the cultivation of a sense of control, and appeals to social norms are likely to be effective. Changing habits is difficult and complex [80], therefore providing contextual cues, such as reminders to adjust the thermostat, could be useful, and the promotion of smart plugs and switches, which are internet-based devices that automatically manage energy [116], and could be promoted as a substitution for breaking habits. Such devices could be bundled with rooftop solar by solar retailers. The findings on the moral licensing effect is especially relevant for targeted marketing communications. For instance, campaigns could target people's need for consistency in relation to attitudes and behaviors, and highlight cognitive biases. From a policy perspective, there are calls to achieve energy justice and make clean energy more accessible to renters, apartment dwellers and low socio-economic groups [93]. Although generalisations of the results of this study on home-owners are restricted, policy makers should fully consider the role of moral licensing in the policy-making process and encourage all households, current and future adopters of solar, to use the network efficiently.

Table 8
Example of messages framed to target the social-psychological antecedents of energy curtailment.

Antecedent/ factor	Example of message
Subjective norms	You know that your family will be happy with you if you save energy. Here are some energy-saving tips that will stop the nagging!
Attitudes	Saving electricity is a good thing to do, it benefits you, your household and the environment. Want to know more on how to save energy?
Perceived control	While we can't control the weather, we do have control over our electricity bills. Here are a few actions that we can all take to reduce our energy consumption.
Moral licensing	Think that having rooftop solar gives you a license to use as much energy as you like? Think again. Don't make excuses for not saving energy!
Habits	Break your habits. Try out a smart plug so you don't have to think twice about energy saving. Download our stickers and remind everyone at home to 'switch off'.

5.2. Limitations and directions for future research

As is the case with all studies, this study has limitations. For moral licensing to occur, there must be an initial moral action followed by a conflict of interest or a yielding to temptation [65]. The chosen research method, a cross-sectional survey, has its limitations. Unlike experiments in the field of psychology, this study did not use a sequential behavior paradigm (along with a baseline condition) to measure licensing. For instance, the initial behavior, installing solar, may not be an unambiguous signal of moral action. As noted by Mullen and Monin (2016), this may leave it unclear as to whether licensing was observed [65]; however moral licensing was measured using a valid scale in this study and solar adoption is linked to multiple motives, including environmental motivations [17]. Future research could employ longitudinal designs since they would offer good evidence of moral licensing.

Since energy use is complex and not readily explained by a small number of factors, additional theoretical concepts could be explored. There may be other explanations for not doing enough to save energy after installing solar. Some respondents might see view investment in solar and energy saving as substitutes, so installing solar indicates success in achieving a goal, so additional actions to save energy, are seen as substitutes and are less likely to be pursued [117]. According to the goal-framing theory [118], multiple goals – hedonic, gain and normative goals– guide environmental behavior, and future research could explore whether particular goals (i.e., hedonic) underpin moral licensing. Other factors such as the single-action bias [70] may explain a negative effect of investment in solar on energy saving efforts. Future research could consider the factors that might ignite, or neutralise, moral licensing effects such as moral norms and values, using the seminal 'values-beliefs-norm' theory [119].

The study relied on self-reported, as opposed to observed behavior, and survey responses on energy saving are susceptible to the social desirability bias [120]. There is likely to be a disparity between what people state about their behavior in a survey and how they behave in real life, the well-known 'intentions-behavior' gap [106]. Future research that combines actual electricity consumption, with an analysis of moral licencing over time, would be helpful in validating findings. However observation of behavior, such as securing access to electricity consumption data (via meters or electricity bills) is challenging in studies. Future studies that view energy consumption as a habitual practice are advised to consider useful strategies from the field of behavioral science that may break habits, as well as factors that could

moderate habits such as personality traits. Future work should study licensing in more detail and with a larger sample. Despite the limitations of the study, this work is a pertinent addition to research since it scrutinises licensing through the lens of the theory of planned behavior, a theory which has largely neglected this concept.

6. Conclusion

The main findings of this study are that the theory of planned behavior, augmented with licensing and habits, explains energy saving in solar homes. Incorporating the construct of moral licensing into the theory of planned behavior is the main theoretical contribution of this study. The adoption of rooftop solar has contributed a great deal to the reduction in greenhouse gas emissions (GHG) yet studying energy use in solar households is crucial since habitual behavior and moral licensing could offset some of the anticipated benefits from technology adoption. From a policy perspective, a greater understanding of energy use by prosumers facilitates the design of interventions aimed at curtailing energy use. Since the energy sector contributes to climate change, and solar adoption is designed to achieve crucial energy goals related to affordability and sustainability, research on end-users will remain important for policy makers.

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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.

Data availability

Data will be made available on request.

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Nomenclature

Abbreviations

PLS-SEM	Partial least squares structural equation modeling
IEA	International Energy Agency
VIF	Variance inflation factor
AVE	Average variance extracted
(HTMT) criterion	The heterotrait-monotrait
GHG	Greenhouse gas emissions

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