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Predicting energy-saving behavior in Saudi Arabia using theory of planned behavior

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A B S T R A C T

The main objective was to examine the impact of social norms, habits, and perceived behavioral control towards intention and its impact on energy-saving behavior. Also, the direct effects of habits and perceived behavioral control were examined towards energy-saving behavior. The target population was based on citizens of Saudi Arabia while the data collection was conducted using a quantitative approach. The purposive sampling was used, and data was analyzed using PLS-SEM using SmartPLS 3.2.8. The results show that habits had insignificant impact on energy-saving behavior. The habits had a significant impact on intention. The intention had an impact on energy-saving behavior. The perceived behavioral control had an impact on intention. The social norms had an impact on intention. We recommend that people should enhance their perceived behavioral control by believing on their attitude and feelings towards developing positive intentions that further leads towards energy saving behavior.

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1. Introduction

Saudi Arabia's residential sector is noted for its heavy energy usage and CO_2 emission levels. The domestic market is the main source of energy resources (more than 50 percent) and as such provides a major opportunity for rising energy use and CO_2 pollution (Caravaggio, Caravella, Ishizaka, & Resce, 2019). This energy use was correlated with major environmental concerns such as climate change (IPCC, 2007) , and therefore had become the subject of a national energy strategy aimed at minimizing households' energy usage. No decrease in household energy use had been reported in recent decades (BEIS, 2018), given this strategy and improved energy performance in household appliances, leaving space for improving these policy initiatives. Present behavioral modification strategies directed at energy consumption used a broad variety of methods that (implicitly) seek to address energy expectations, attitudes, intentions, or social variables that were intended to affect the energy behavior of householders (Timm & Deal, 2016; Salari & Javid, 2017). At present, however, work had an agreement on which of these variables had a greater effect on energy behavior, keeping energy policymakers uninformed on where efforts can be better directed (Fjellså et al., 2021). Energy strategy aimed at lowering the energy use of households was likely to be more effective by mitigating and/or eliminating the most critical obstacles to the main factors underpinning energy behavior(Axon et al., 2018; Sen & Ganguly, 2017). Most strategies for behavioral improvement use a specific strategy that helps to create (stronger) energy conservation intentions. For starters, initiatives also emphasized the economic and environmental advantages of energy-saving behavior, while this might not be the most convincing approach (Gao, Wang, Li, & Li, 2017). Additionally, motivational strategies may require a kind of dedication where participants contribute to spending more resources in the future (Zhukovskiy, Batueva, Buldysko, & Shabalov, 2019). Nonetheless, recent studies on the efficacy of measures including commitments or target-setting reported mixed outcomes (Shen, Lu, & Law, 2019). The UAE had been the GCC's pioneer in climate control. The UAE, because of the buying power parity and estimated per capita GDP, was one of the top ten wealthiest 93 economies. This retains a competitive market system of 94, with limited confines on free markets and capital movement. Just 1/3 of the UAE's GDP originated from the oil sector in 95 2013 (Ulucak, İlkay, Özcan, & Gedikli,

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2020). In 96 2005, the UAE was one of the first large oil-exporting countries to ratify the UN Convention on Climate Change's Kyoto Protocol 97. The UAE vowed to minimize by 2020 carbon dioxide emissions by 98 per unit of GDP to 7 percent below 2009 levels Al-Mulali, Tang, Tan, and Ozturk (2019) and to minimize by 2030 total emissions by 30% (Ulucak et al., 2020). There have been seven Emirates in the UAE and each 104 usually establishes and enforces their own rules and regulations on the environment (MoCCE 105 2016).Waxin et al.,(2019) reported that 27% of the UAE companies studied had 106 environmental protection agencies, like ISO 14001, but just 10% for certification purposes (Waxin et al., 2019). Moreover, other initiatives centered on societal expectations to convince householders to reduce energy usage. It was adopted by the energy firm OPOWER to encourage energy efficiency among its consumers Kim (2017), after research had shown the effectiveness of social standards in consultation on energy consumption (Gu, Zhao, Yan, Wang, & Li, 2019). While this plan was successful, it was reported that declines in energy consumption were just 2.3–2.4%. Social standards may not had been used successfully or instead, social norms were not a primary factor of energy use(Andor, Gerster, Peters, & Schmidt, 2020). Behavioral improvements so low can also actually reflect a Hawthorne impact, which was a report that studied this influence of energy-usage measures accounted for a 2.7 percent decrease in energy consumption (Cai, Sam, & Chang, 2018).

Alternative energy conservation initiatives had recognized the normal essence of conserving resources and concentrated on improving certain behaviors(Soto et al., 2021; Mikulčić et al., 2016). When these stickers were put near where the action takes place, they may avoid energy-squandering behaviors (van den Broek, Walker, & Klöckner, 2019). This prompting process, however, had been criticized for having low and short-term consequences only (Ye & Titheridge, 2017).
Finally, strategies aiming at minimizing the usage of electricity by householders had often also concentrated on implementing systemic (i.e. physical) improvements to build conditions that promote productive energy behavior or entirely remove the need for behavior(Nafkha & Woźniakowski, 2018; Šćepanović et al., 2017). Homes may be built or innovated, for example, to promote energy conservation by home automation, which requires a control panel that automates the usage of lighting, heating, and protection(Härkönen et al., 2022; Fabi et al., 2017).

Nonetheless, work had shown that automation may impede environmental activities and can hinder assumed accountability for taking action Bolderdijk, Lehman, and Geller (2018) because it leaves householders with a loss of power at home (El-Bayeh et al., 2020; van den Broek et al., 2019). The loss of environmental awareness and social obligation was likely to inhibit beneficial spill-over consequences, in which participating in one pro-action raises the probability of participating in other, different non-environmental activities (Gholamzadehmir et al., 2019). Such examples of energy-saving strategies demonstrate the broad variety of field solutions and indicate a lack of agreement on the most successful strategy. Although a recent study had examined the efficacy of intervention trials aimed at inducing the recycling of domestic resources (Moojen, 2020), no research had explored why certain strategies succeed whereas others were less successful. The main factors of the behavior were being discussed (although these that differ across environments, demographics, time, etc.) was likely to be a key factor evaluating the effectiveness of energy-saving strategies(van den Broek et al., 2019).Hence, the main objective was to examine the effects of social norms, habits, and perceived behavioral control towards intention and its effect on energy-saving behavior. Also, the direct effects of habits and perceived behavioral control were examined towards energy-saving behavior.

The remaining paper is organized in four different sections. The literature review includes theoretical background. The methodology included research methods. The data analysis comprised of hypothesis testing. The last section consists of conclusion and discussion.

2. Literature review

To determine the relative impact of the numerous energy-use drivers, a specific context is required which consists of the related variables that affect behavior. Prevalent theories aimed at explaining the considerations of actions include planned behavior theory, norm activation theorySchwartz (1977), and value-belief-rule theory Stern (2000), although each of these frameworks focuses on a particular sub-set of variables that may affect behavior. A more modern model, the Comprehensive Action Determination Model (CADM), aims to combine planned behavior theory, standard activation mechanism, and multi-factor process Impassive theory (Klöckner & Blöbaum, 2010). The CADM borrows from the theory of planned behavior the belief that conduct derives from personal expectations to partake in a specific activity (Ajzen, 1985). Though little work has examined the relationship between intention and behavior in the area of energy usage, work into this relationship in other activities has repeatedly shown that intention and behavior associate just marginally with real actions, the so-called intention-behavior difference (Lange & Dewitte, 2019; Mahardika et al., 2019; Marchant et al., 2020; Gibson et al., 2021; Úbeda-Colomer, Ginis, Monforte, Pérez-Samaniego et al., 2019). Moreover, Sheeran and Conner (2019) found that intention often affects behavior in circumstances that are described as challenging and unpredictable, causing individuals to make deliberate choices regarding participating in a specific activity that is unlikely to be the case with other everyday energy activities. Such variables were incorporated into the CADM as objective restrictions and assumed behavioral regulation, categorized under situational stimuli as they represent (perceptions of) the context in which the behavior happens. These situational mechanisms are likely to circumvent energy-saving goals, as they can restrict the willingness of a householder to enforce these goals (Borozan, 2018; Chao, 2016; Van der Heijden, 2017). In addition to intention, conceptual, and situational procedures, the CADM often integrates repetitive processes into the model. Habits are programmed behavioral reactions to environmental

stimuli that promote the achievement of such expectations or end states (Sonnentag et al., 2022; Wohn & Ahmadi, 2019). In certain terms, behaviors are 1) achieved in healthy environments, 2) do not involve elevated rates of cognitive commitment, 3) are effective in meeting other targets, and 4) arise regularly. Many energy habits are assumed to be of a natural kind since certain habit requirements are fulfilled with the everyday usage of energy: energy use is efficient, frequently happens in stable settings (homes and workplaces), may be done automatically, (Merabet et al., 2022; Anantharaman, 2018; Kalis & Ometto, 2019). Jareemit and Limmeechokchai (2019) noticed that common behaviors of energy were best predicted from previous practice, whereas unusual behaviors of energy were better predicted from intentions. Given that strong habits (i.e. a high degree of behavioral automaticity in reaction to contextual indications) will preclude the introduction of new expectations, habits are likely to affect energy actions fairly strongly (Kalis & Ometto, 2019; Sheeran & Conner, 2019).

Through extending the model to energy-saving behavior, we argue that conventional mechanisms affect energy-saving behaviors. Certain deliberate methods, as well as normal procedures, and rational and discretionary regulation to conserve resources are supposed to affect energy-saving behavior. This pattern was extended to travel-mode options (Otto & Pensini, 2017), recycling habits (Wang, Guo, & Wang, 2016; Xiao & Siu, 2018), the introduction of modern heating technologies (SenGupta, 2017), and a variety of environmental practices (Gatersleben, 2018). Importantly, the paradigm has been used as a structure in recent experimental research to clarify young adults' views of the factors of their energy consumption (O'Brien et al., 2020; Thøgersen, 2018). As the CADM has succeeded in understanding different environmental practices Klöckner and Blöbaum (2010); Otto and Pensini (2017); Wang et al. (2016); Xiao and Siu (2018), this model believed would also be able to describe human energy-saving behavioral variations well. This would be expressed in a significant volume of variation described for action that saves energy (Du & Pan , 2021; Cohen, 1992). Based on the literature on energy use discussed above, we conclude that repetitive processes Anantharaman (2018); Jareemit and Limmeechokchai (2019); Kalis and Ometto (2019); Sheeran and Conner (2019) and situational effects Borozan (2018); Van der Heijden (2017) are the best predictors of energy-saving behavior. Social norms impact tremendously about the development of individual beliefs. Social impact has a significant effect on the purpose of participating in environmental practices and it has also been shown that clear social expectations are important to promote the acceptance of different environmental behaviors (Onwezen et al., 2021; Munjal, 2019). Perceived behavioral control helps in establishing the intention to save energy and thus encourage energy-saving behavior in an individual. Changes in behavior towards energy-saving practices are important in energy conservation. Therefore, this study has hypothesized that:

H_1: *Social norms have a significant effect on intention.*
H_2: *There is an impact of Habits on intention.*
H_3: *There is an impact of Perceived behavioral control on intention.*
H_4: *There is an impact of Habits on energy-saving behavior.*
H_5: *There is an impact of Perceived behavioral control on energy-saving behavior.*
H_6: *There is an impact of Intention on energy-saving behavior.*

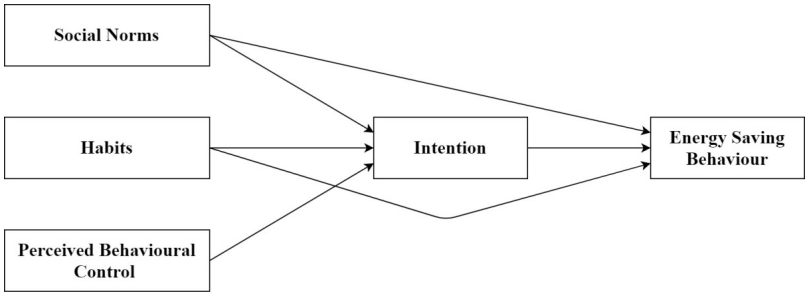

Fig. 1. Conceptual Model

3. Research method

The quantitative approach has been identified as extensively applied because of its ability to provide a high amount of data within efficient time and cost (Cavana, Delahaye, & Sekaran, 2001; Mukhlis et al., 2022; Mohammad, 2019). The quantitative approach has a major benefit that provides relatively more generalizable results (Mohammad , 2020; Boudlaie et al., 2022; Saunders, Lewis, & Thornhill, 2009; Kumar & Phrommathed, 2005). Therefore, a quantitative approach had been used to provide a more systematic way for data collection. The explanatory research type has been completely based on providing enhanced data or information towards the researcher. The basic concept of this research type can be identified as investigating the research objective and its variables in an extensive process so that the logical based conclusions can be generated (Kothari, 2004). Hence, explanatory research type was used in this study for an in-depth understanding of the research objective. The correlational design can be identified as a non-experimental and it conducts examining the relationships and provides only naturally occurring relationships (Al-Abbadi et al., 2022; Blessing & Chakrabarti, 2009). This design can only be conducted in a naturally based environment and provides such results that can be effective in future studies as well (Welman, Kruger, & Mitchell, 2005). Therefore, correlational design was used to examine the relationships between variables in a natural

environment. The population of this study is the citizens of Saudi Arabia associated with energy-saving behavior; however, the demographic profile of the respondents has been discussed in Table 1.

Table 1
Demographic statistics (N = 342)

		Frequency	Percent
Gender	M	204	59.6
	F	138	40.4
Age Group	21 years - 29 years	282	82.5
	30 years - 39 years	24	7
	More than 40 years	36	10.5
Education	Undergraduate	90	26.3
	Graduate	174	50.9
	Post-Graduate	78	22.8
Occupation	Student	90	26.3
	Self-Employed	102	29.8
	Retired	78	22.8
	Unemployed	72	21.1

The purposive sampling technique can be identified as a non-probability and it collects data from those respondents that have been highly close towards research variables (AL-Zyadat et al., 2022; Creswell, 2002). This sampling involves the researcher's judgment as well because the researcher selects the respondents that provide more specific information (Sekaran & Bougie, 2010). Therefore, purposive sampling was used for data collection because it provided relatively helpful data for generating effective results. The PLS-SEM analysis process has been based on two different models known as measurement and structural model (Hair, Sarstedt, Ringle, & Mena, 2012). This technique helps in conducting or examining complex models and provides relatively effective hypothesis results as well. The PLS-SEM also gives more reliable findings and provides the predictive relevance of variables as well (Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014). Hence, PLS-SEM using SmartPLS 3.2.8 was applied for hypothesis testing because it provides more effective mediation results.

4. Data analysis

4.1. Measured model

Table 2 below shows the measurement model results.

Table 2
Measurement model

Variables	Items	Loadings	Alpha	CR	AVE
Energy-Saving Behavior	ESB1	0.898	0.908	0.942	0.844
	ESB2	0.940			
	ESB3	0.918			
Habits	HB1	0.658	0.718	0.786	0.558
	HB2	0.636			
	HB4	0.915			
Intention	IN2	0.844	0.861	0.906	0.707
	IN3	0.753			
	IN4	0.845			
	IN5	0.913			
Perceived Behavior Control	PBC1	0.677	0.835	0.862	0.679
	PBC2	0.959			
	PBC3	0.813			
Social Norms	SN2	0.865	0.788	0.872	0.694
	SN3	0.813			
	SN4	0.821			

The above table has a recommendation that threshold for outer loadings is 0.70 and all values must be higher than it for being accepted (Hair et al., 2014). Also, the table contains values of AVE and CR for which the threshold is given as 0.50 and 0.70 respectively (Hair et al., 2011). So, the table had shown all the values following the threshold.

Table 3
The summary of Fornell-Larcker Criterion

	ESB	HB	IN	PBC	SN
Energy-Saving Behavior	**0.919**				
Habits	0.198	**0.747**			
Intention	0.786	0.139	**0.841**		
Perceived Behavior Control	0.138	0.201	0.162	**0.824**	
Social Norms	0.397	-0.056	0.417	-0.013	**0.833**

The above table 3 in discriminant validity has a recommendation given by Fornell and Larcker (1981) that bold and diagonal values should be higher in their constructs when being compared to other values.

Table 4
The results of Cross Loadings

	ESB	HB	IN	PBC	SN
ESB1	**0.898**	0.204	0.694	0.199	0.418
ESB2	**0.940**	0.119	0.796	0.090	0.334
ESB3	**0.918**	0.234	0.667	0.095	0.347
HB1	0.078	**0.658**	0.085	0.284	-0.005
HB2	-0.012	**0.636**	0.090	0.229	-0.106
HB4	0.227	**0.915**	0.129	0.102	-0.053
IN2	0.707	0.095	**0.844**	-0.012	0.382
IN3	0.503	0.171	**0.753**	0.188	0.301
IN4	0.736	0.188	**0.845**	0.148	0.339
IN5	0.668	0.021	**0.913**	0.235	0.375
PBC1	0.025	0.111	-0.009	**0.677**	-0.054
PBC2	0.148	0.204	0.172	**0.959**	-0.054
PBC3	0.073	0.138	0.086	**0.813**	0.068
SN2	0.342	-0.044	0.429	-0.019	**0.865**
SN3	0.202	-0.093	0.233	-0.001	**0.813**
SN4	0.413	-0.017	0.328	-0.007	**0.821**

The above table 4 in discriminant validity has a recommendation given by Hair et al. (2014) that those values that have been made bold must be higher in their constructs when compares it to their values in other constructs. Hence, all values are according to the recommendation.

Table 5
The summary of Heterotrait-Monotrait Ratio (HTMT)

	ESB	HB	IN	PBC	SN
Energy-Saving Behavior					
Habits	0.173				
Intention	0.876	0.212			
Perceived Behavior Control	0.121	0.289	0.174		
Social Norms	0.452	0.113	0.476	0.112	

The above table 5 in discriminant validity has a recommendation given by Henseler, Hubona, and Ray (2016) that all the values should be less than the 0.90m mark for acceptance. Hence, the table had all values less than 0.90.

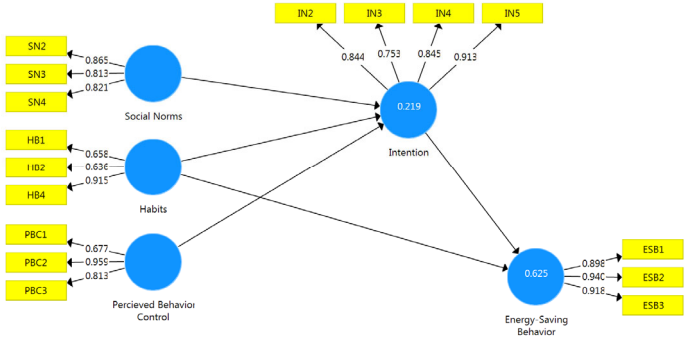

Fig. 2. PLS Algorithm using SmartPLS

4.2 Structural model

Table 6
The results of Path Analysis using PLS-SEM

	Estimate	S. D.	T-Stats	Prob.
Habits → Energy-Saving Behavior	0.091	0.058	1.571	0.116
Habits → Intention	0.134	0.054	2.485	0.013
Intention → Energy-Saving Behavior	0.773	0.022	34.685	0.000
Perceived Behavior Control → Intention	0.141	0.083	1.686	0.092
Social Norms → Intention	0.426	0.036	11.950	0.000

The above table 6 had showed the hypothesis testing. The habits (0.091, $p > 0.10$) had insignificant impact on energy-saving behavior. The habits (0.134, $p < 0.10$) had a significant impact on intention. The intention (0.773, $p < 0.10$) had a significant

impact on energy-saving behavior. The perceived behavioral control (0.141, $p < 0.10$) had a significant impact on intention. The social norms (0.426, $p < 0.10$) had a significant impact on intention.

Table 7
The results of Predictive Relevance

	R Square	Q Square
Energy-Saving Behavior	0.625	0.498
Intention	0.219	0.146

In the above Table 7, energy-saving behavior was predicted by (0.625) 62.5 percent and intention was predicted by (0.219) 21.9 percent. In addition, Q-Square values were greater than absolute zero.

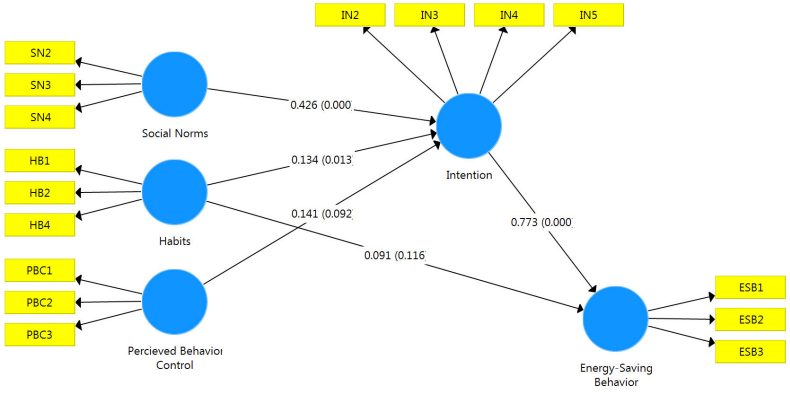

Fig. 3. PLS Bootstrapping using SmartPLS

5. Conclusion

This research applied the CADM to determine the relative energy-saving behavior drivers' effect. Results found that 1) the model could compensate for a considerable amount of variation in energy-saving behavior, and 2) situational and repetitive processes were better equipped to compensate for energy-saving behavior, whereas conventional and intentional processes have no predictive ability. The results of this research provide new insight into the essence and context of energy behavior. The capacity of this model to describe energy-saving behavior can be due to the use of behaviors and assumed and objective influence, since these factors have been shown to meaningfully predict actions – although this was not the case for purpose. Consequently, these observations indicate that contextual influences are particularly critical for interpreting energy behavior. Past theories of environmental behavior believed that behavior is intentional and that such motives are developed by a cognitive mechanism through which people evaluate the consequences of actions and behavioral normative meaning (Ajzen, 1985). The observations also indicate that this normative mechanism affects intention, but the results imply that in line with previous research, such energy-saving thoughts may not appear to turn into energy-saving actions (Vainio, Pulkka, Paloniemi, Varho, & Tapio, 2020). Therefore, the results of this study indicate that the reverse could be valid for energy behavior: this activity may be entirely irrelevant to intentions, yet heavily motivated by behaviors yet perceived and rational capacity to regulate energy intake – confirming reports from previous energy studies (Kalis & Ometto, 2019; Shen et al., 2019; Van der Heijden, 2017).

The significant effect of assumed and objective behavioral regulation of this paradigm is likely to be specific to energy activity, owing of particular to the high context-dependence of the actions. This should be remembered, though, that such effects are likely to relate in healthy settings to persons, i.e., people who appear to stay comfortably within the same household. Disrupted environments can contribute to behaviors depending more on intentional mechanisms (Carden & Wood, 2018; Mahardika et al., 2019; Wallner, Kundi, Hohenblum, Scharf, & Hutter, 2016; Yoo, Hayford, & Agadjanian, 2017). These results indicate that the emphasis of energy conservation policies will move from encouraging householders to energy-saving to environment-friendly improvements to promote this action – particularly in such a way that energy-saving behaviors are promoted. Traditional energy management strategy for a large part consists of soft policy interventions directed at creating behavioral improvement through awareness and encouragement. The results of this analysis suggest that this is impossible for everyday energy behavior, which may understand why the implementation of opportunities did not necessarily contribute to substantial decreases in domestic energy consumption (Asensio & Delmas, 2016).

Also, it was found that perceived behavioral control and intentions were significantly related with energy-saving behavior and this result was in relation with Ali, Malik, Pereira, and Al Ariss (2017); Ali, Ullah, Akbar, Akhtar, and Zahid (2019); Gao et al. (2017); Koon, Chan, and Sharma (2020) that both the factors helped in engaging in energy saving. Also, social norms had found significantly affecting the intention of people that were in relation with (Ali et al., 2019). Evidence also indicates that the integration of societal expectations into energy input results only in short-term energy savings. Participants themselves often assert that environmental social expectations will not convince them to modify their energy habits

(Thøgersen, 2018). The restricted results observed in the literature of social standards on energy activity had been compatible with the findings of this research. Like, it was found that not societal standards, but habits and contextual influences had been shown to have a significant impact on energy behavior(Wang, Lin, & Li, 2018), which implies that such variables will be the subject of policies aimed at inducing the conservation of domestic energy every day. In addition, the recommendation had been given regarding the results of this study. For instance, people should be engaged in such social norms that increases their intentions towards energy saving and helps in creating a proper plan towards energy usage. Similarly, according to the findings of this study it had been recommended that people should enhance their perceived behavioral control by believing in their attitude and feelings towards developing positive intentions that further leads towards energy saving behavior.

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