Quoc Nghi Nguyen; Thi Hong Loc Hoang; Van Nam Mai

Article

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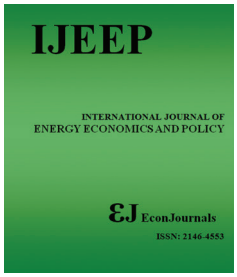

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Applying the Theory of Planned Behavior to Analyze Household Energy-Saving Behavior

Quoc Nghi Nguyen[1]*, Thi Hong Loc Hoang[1], Van Nam Mai[2]

[1]School of Economics, Can Tho University, Can Tho, Vietnam, [2]School of Graduate, Can Tho University, Can Tho, Vietnam.
*Email: quocnghi@ctu.edu.vn

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ABSTRACT

Energy consumption in residential areas is increasing which leads to greenhouse gas emissions and environmental pollution. Household energy-saving behavioral intentions are diverse and influenced by many different factors. This study approaches the theory of planned behavior (TPB) with an integrated perspective (economic-oriented, technology-oriented, and behavior-oriented perspective) to demonstrate affecting factors to the energy-saving intention of households in Vietnam. Applying the structural equation modeling (SEM), the study has pointed out the above affecting factors include subjective norms, perceived behavioral control, perceived benefits, attitude, product quality, and energy policies. In which, the "perceived benefits" factor has the most impact on the energy-saving intention of households.

Keywords: Theory of Planned Behavior, Behavioral Intention, Energy Saving, Household
JEL Classifications: C52, C78, M59

1. INTRODUCTION

Recently, the proportion of residential energy consumption in total energy consumption has increased significantly (Nie et al., 2019; Irfan et al., 2021; Zhang et al., 2021). Energy-saving behavior is one of the most important factors, which greatly affects the energy consumption of residential areas and is easily affected by energy policies (Abrahamse and Steg, 2009, Manjunath et al., 2014). According to Yeboah and Kaplowitz (2016), efficient use of energy contributes to changing user behavior, thereby improving energy-saving practices. Changes in individual behavior in terms of energy consumption can bring great benefits and reduces greenhouse gas emissions and negative consequences for the environment (Lokhorst et al., 2015).

The topic of household energy-saving behavioral intentions has received the attention of researchers around the world (Hori et al., 2013; Yue et al., 2013; Chen et al., 2017; Trotta, 2018; Wang et al., 2018a; Ding et al., 2019; Mansor and Sheau-Tingi, 2019; Nie et al., 2019; Ahmad et al., 2022). Household energy-saving behavioral intentions are proven to be diverse and influenced by many different factors. Studies on household energy-saving behavioral intentions mainly focus on three research directions, including (i) economic-oriented perspective, (ii) technology-oriented perspective, and (iii) behavior-oriented perspective (Zhou and Yang, 2016; Arawomo, 2017; da Silva and Cerqueira, 2017). There are few studies on household energy-saving behavioral intentions approaching from an aggregate point of view. Therefore, this study approaches the theory of planned behavior (TPB) with an integrated view to figure out factors affecting the energy-saving intention of Vietnamese households (Figure 1).

2. THEORETICAL BASIS AND RESEARCH HOSPHONES

2.1. Theoretical Basis

The theory of Planned Behavior (TPB) has been widely used in recent studies to explain how a person develops behavioral

Figure 1: Proposed research model

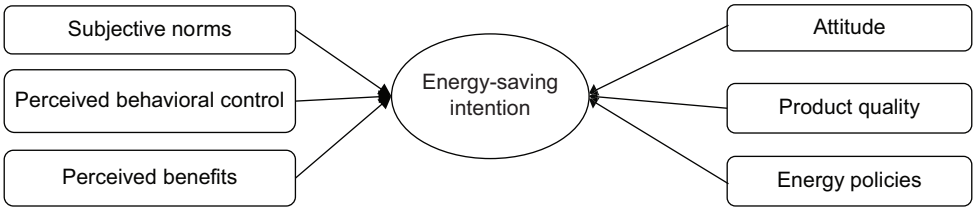

Table 1: Interpretation of observed variables in the research model

Factor	Observable variables	Scale
SN	SN1: I save electricity because my neighbors do the same	Likert 1–5
	SN2: My family members encourage me to save electricity	Likert 1–5
	SN3: My friends encourage me to save electricity	Likert 1–5
	SN4: Energy saving is a matter of social concern	Likert 1–5
	References: Tan et al. (2017), Wang et al. (2018a)	
PBC	PBC1: I know what I should do to save electricity	Likert 1–5
	PBC2: I think it is not too difficult to reduce electricity usage	Likert 1–5
	PBC3: I know how to use electricity efficiently	Likert 1–5
	PBC4: I can save electricity easily	Likert 1–5
	References: Abrahamse and Steg (2009), Wang et al. (2018a)	
PB	PB1: Saving electricity helps reduce costs for the household	Likert 1–5
	PB2: Saving electricity is beneficial for the household	Likert 1–5
	PB3: Saving electricity makes family life better	Likert 1–5
	PB4: Saving electricity helps protect the ecological environment	Likert 1–5
	References: Zhang et al. (2014), Hien and Chi (2020)	
ATT	ATT1: Saving electricity at home is necessary	Likert 1–5
	ATT2: Saving home electricity helps improve the air environment	Likert 1–5
	ATT3: Saving home electricity is important to reduce CO_2 emissions	Likert 1–5
	ATT4: The quality of family life is still high when saving electricity	Likert 1–5
	References: Abrahamse and Steg (2009), Wang et al. (2018a)	
PQ	PQ1: Prioritize buying products with energy-saving labels	Likert 1–5
	PQ2: Pay more attention to products that apply scientific and technological advances to save energy	Likert 1–5
	PQ3: Customer feedback on energy-saving features is an important factor in purchasing decisions	Likert 1–5
	References: Zhang et al. (2018), Thanh Nguyen et al. (2021)	
EP	EP1: Policies and regulations play essential roles in promoting and encouraging me to save electricity	Likert 1–5
	EP2: I save electricity because of policies and regulations related to electricity saving	Likert 1–5
	EP3: I save electricity because I am affected by electricity usage policies and regulations	Likert 1–5
	EP4: I save electricity because I was guided on how to use electricity efficiently	Likert 1–5
	References: Zhang et al. (2018), Thanh Nguyen et al. (2021)	
ESI	ESI1: I intend to save home electricity in the future	Likert 1–5
	ESI2: I will make a plan to save electricity in my house in the future	Likert 1–5
	ESI3: I will try to save electricity in my house in the future	Likert 1–5
	ESI4: I will use energy-efficient appliances to save electricity in the future	Likert 1–5
	References: Wang et al. (2018a), Hien and Chi (2020)	

SN: Subjective norms, PBC: Perceived behavioral control, PB: Perceived benefits, ATT: Attitude, PQ: Product quality, EP: Energy policies, ESI: Energy-saving intention

intention (Han et al., 2017; Ye et al., 2017). The TPB is the most widely used among the various models and theories to demonstrate energy-saving behavioral intentions (Rivis et al., 2009).

The TPB of Ajzen (1991) was extended from the theory of Reasoned Action - TRA (Fishbein and Ajzen, 1975). It was developed due to the limitation of the previous theory on the assumption that human behavior is based on mind control. Similar to the TRA, the central factor in the TPB is the individual intention to perform a certain behavior. In this theory, the author believes that the intention to perform the behavior is influenced by three factors such as attitude towards the behavior, subjective norms, and perceived behavioral control.

According to Fishbein and Ajzen (1975), behavioral intention reflects the strength of an individual's intention to perform a specified behavior. Intentions are signs that a person is willing and try to make an effort to perform a behavior; or it is a state of readiness to perform a certain behavior and is considered a precondition before performing a behavior (Ajzen, 1991; Armitage and Conner, 2001; Conner and Sparks, 2005). The intention is an individual's process of action to achieve future behavior (Mowen and Minor, 2001; Zhao and Othman, 2010). According to Bosnjak et al. (2020), the intention is an antecedent of behavior, an important factor to lead to behavior.

2.2. Research Hypotheses

2.2.1. Relationship between subjective norms and the intention to save energy

Subjective norms are defined as an individual's perception with that individual's key references considering whether should or should not perform a certain behavior (Fishbein and Ajzen, 1975;

Ajzen, 1991). Subjective norm is defined as the perceived external social pressure or expectation of a particular group of people or society to perform certain behaviors (Fishbein and Ajzen, 1975; Ajzen, 1991; Ajzen and Fishbein, 2000). Subjective norms are the best predictor of a person's behavior (Caputo, 2020; La Barbera and Ajzen, 2020). Several studies have demonstrated a positive relationship between subjective norms and household energy-saving intention (Hori et al., 2013; Chen et al., 2017; Wang et al., 2018a; Ding et al., 2019; Mansor and Sheau-Tingi, 2019; Nie et al., 2019; Hien and Chi, 2020). Thus, the research hypothesis H1 is proposed as follows: Subjective norms positively affect the intention to save energy in households.

2.2.2. Relationship between perceived behavioral control and the intention to save energy

Perceived behavioral control is understood as the perception of the difficulty of enacting a behavior (Ajzen, 1991; Fornara et al., 2016; Sembada and Koay, 2021). Perceived behavioral control is a very essential factor in predicting an individual's future behavior (Klöckner, 2013; Ajzen, 2019; La Barbera and Ajzen, 2020). As presented by Bosnjak et al. (2020), the greater the perceived behavioral control, the stronger the intention to perform that behavior. Perceived behavioral control has a positive relationship with family energy-saving intention (Chen et al., 2017; Zhang et al., 2014; Wang et al., 2018a; Mansor and Sheau-Tingi, 2019; Nie et al., 2019; Fu et al., 2021; Ahmad et al., 2022). Therefore, the research hypothesis H2 is suggested as follows: Perceived behavioral control positively influences the intention to save energy in households.

2.2.3. Relationship between perceived benefits and the intention to save energy

The perceived benefit is a type of emotional perception that positively influences an individual's behavior (Tsujikawa et al., 2016). Perceived economic benefits and environmental benefits have a positive influence on the behavioral intention to save energy (Wang et al., 2011; Zhang et al., 2014). Studies related to energy-saving behavioral intention topics have shown that perceived benefits have a positive effect on household energy-saving intentions (Banfi et al., 2008; Dianshu et al., 2010; Wang et al., 2011; Zhang et al., 2014; Steinhorst et al., 2015; Zhou and Yang, 2016; Hien and Chi, 2020; Fu et al., 2021; Ahmad et al., 2022). Then, the research hypothesis H3 is proposed as follows: Perceived benefits positively impact the intention to save energy in households.

2.2.4. Relationship between attitude and the intention to save energy

According to the TPB, attitude is considered a significant factor in determining behavioral intention. The more positive person's attitude towards a behavior, the more likely that person intends to perform a behavior (Ajzen, 1991). Attitude is a significant factor related to an individual's intention to perform a behavior (Verplanken and Orbell, 2003; Bosnjak et al., 2020; Caputo, 2020). Recent studies have shown that an energy-saving attitude positively affects household energy-saving intention (Zhang et al., 2014; Chen et al., 2017; Wang et al., 2018a; Ding et al., 2019; Mansor and Sheau-Tingi, 2019; Nie et al., 2019; Hien and Chi, 2020). Therefore, the research hypothesis H4 is proposed as follows: Attitude positively affects the intention to save energy in households.

2.2.5. Relationship between product quality and the intention to save energy

Residential areas can contribute significantly to environmental conservation and sustainable development by using energy-efficient products (Ali et al., 2019). According to some studies, the purchase and use of energy-saving appliances help reduce household energy consumption (Ali et al., 2019, Sukarno et al., 2015; Hua and Wang, 2019). Recent studies have demonstrated the influence of energy-saving product quality on household energy-saving behavioral intentions (Yue et al., 2013; Trotta, 2018; Zhang et al., 2018; Thanh Nguyen et al., 2021). The research hypothesis H5 is proposed as follows: Product quality positively affects household energy-saving intention.

2.2.6. The relationship between energy policies and energy-saving intention

Energy policy is an important tool to reduce the intensity of energy use (Yuan et al., 2009), contributing to improving energy efficiency (Dos Santos et al., 2013). Social policies and regulations have an impact on the formation and change of family energy-saving behavioral intentions (Wang et al., 2011). Researchers have demonstrated a positive relationship between energy policies and household energy-saving intentions (Abrahamse and Steg, 2009; Mizobuchi and Takeuchi, 2012; Manjunath et al., 2014; Wang et al., 2018b; Zhang et al., 2020; Hien and Chi, 2020; Yue et al., 2020; Thanh Nguyen et al., 2021; Fu et al., 2021). Therefore, hypothesis H6 is proposed as follows: Energy policies positively affect the intention to save energy in households.

Based on the above literature review and research hypotheses, the study uses the group discussion method (qualitative research) with 8 households living in Ho Chi Minh City which has the largest population in Vietnam. The results of the group discussion help identify appropriate scales for the research model (Table 1). The proposed research model is as below.

3. RESEARCH METHODOLOGY

3.1. Analytical Methods

The study uses quantitative analyzes in the following order. Step 1: Test the reliability of scales by Cronbach's Alpha to eliminate observed variables with low reliability; Step 2: Exploratory factor analysis (EFA) to evaluate the convergent and discriminant validity; Step 3: Confirmatory factor analysis (CFA) to test the appropriateness of the research data; Step 4: Structural equation modeling (SEM) to test the research hypotheses.

3.2. Data Collection Method

According to Tho (2011), the sample size for the study depends on many factors such as the analytical method and the required reliability. To ensure the reliability of the SEM, the sample size needs to be large because it is based on the theory of sample distribution (Raykov and Widaman, 1995). To ensure reliability in testing the suitability of the SEM model, a sample size from 100 to 200 is acceptable (Hoyle, 1995). Reasonable sample size must achieve

a minimum of 200 observations for the SEM test (Hoelter, 1983, Kline, 2011). So this study aims to collect at least 200 observations.

The study surveyed three cities in Vietnam (Ho Chi Minh City, Da Nang City, and Can Tho City). These are 3 cities directly under the Central Government, of which Ho Chi Minh City has the largest population in Vietnam. The survey period was from March to April 2022. The study used quota sampling to collect data. The survey criteria are household size, occupation, and location of residence. In the context of the Covid-19 epidemic, the online interviews via google forms were used to collect detailed information from the respondents. To increase the enthusiasm of the respondents, they will receive a souvenir gift after completing the survey. After eliminating unsuitable questionnaires, a total of 306 valid questionnaires were included in the tests.

Table 2 shows that the demographic characteristics of respondents are diverse, fully reflecting the representative standards of the survey subjects. The proportion of males and females is almost equal (52.61% of males and 47.39% of women). Most respondents are in the group of 36-50 years old, accounting for the highest proportion (47.39%). In terms of education, the majority of respondents have college degrees (22.22%) and university degrees (36.60%). The most common family structure is the 2-generation family (42.16%). The occupation of respondents is diverse, the most common are office workers, small businesses, and engineers.

Table 2: Structure of the study sample (n=306)

Category	Frequency (%)
Gender	
Male	161 (52.61)
Female	145 (47.39)
Age	
20–35	68 (22.22)
36–50	145 (47.39)
51–65	93 (30.39)
Family structure	
Single	34 (11.11)
1 generation	88 (28.76)
2 generations	129 (42.16)
3 generations	55 (17.97)
Monthly income (VND)	
Under 10 million	48 (15.68)
10–20 million	138 (45.10)
20–30 million	73 (23.86)
Over 30 million	47 (15.36)
Education level	
Junior high school	25 (8.17)
High school	57 (18.63)
Intermediate	26 (8.50)
College	68 (22.22)
University	112 (36.60)
Post-graduate	18 (5.88)
Occupation	
Office staff	55 (17.97)
Small business	44 (14.38)
Engineer	45 (14.70)
Doctor	26 (8.50)
Manager	39 (12.75)
Worker	36 (11.76)
Teacher	35 (11.44)
Retired	12 (3.92)
Others	14 (4.58)

Regarding monthly income, respondents with an income from 10 to 20 million VND account for the highest proportion (45.10%).

4. RESEARCH RESULTS AND DISCUSSION

4.1. Evaluate the Reliability of the Scales

To test the reliability of the scales, the study uses Cronbach's Alpha reliability coefficient to test the internal correlation between observed variables. According to the test results in Table 3, all scales have Cronbach's Alpha values greater than 0.8. The corrected item-total correlation of all observed variables is greater than 0.3 (Nunnally and Bernstein, 1994), so no variable is excluded from the research model (Nunnally, 1978; Peterson, 1994; Slater, 1995). Therefore, all observations are satisfactory and suitable for the EFA.

According to the EFA result (Table 3), the statistical values of convergent and discriminant validity of the research scales are guaranteed: (1) Factor loading values are all > 0.5 (Hair et al., 1998; Hair et al., 2010); (2) Testing the appropriateness of the model with KMO = 0.912 (Hair et al., 1998; Kline, 2011); (3) Bartlett's test on the correlation of observed variables meets the requirements with the Sig. = 0.000 (Hair et al., 1998; Kline, 2011).

Table 3: Scale reliability test result

Observed variable	Mean	SD	Factor loading	Cronbach's alpha
SN				
SN1	3.395	0.990	0.864	0.890
SN2	3.395	0.978	0.767	
SN3	3.470	0.978	0.776	
SN4	3.307	0.942	0.829	
PBC				
PBC1	3.558	0.980	0.789	0.900
PBC2	3.483	0.902	0.884	
PBC3	3.483	0.948	0.781	
PBC4	3.519	0.909	0.843	
PB				
PB1	3.643	1.021	0.674	0.872
PB2	3.725	0.999	0.887	
PB3	3.709	1.029	0.813	
PB4	3.601	1.013	0.744	
ATT				
ATT1	3.209	0.927	0.877	0.896
ATT2	3.202	0.943	0.778	
ATT3	3.022	0.892	0.795	
ATT4	3.300	0.876	0.822	
PQ				
PQ1	3.653	1.013	0.868	0.824
PQ2	3.673	1.007	0.732	
PQ3	3.692	1.013	0.691	
EP				
EP1	3.640	0.794	0.726	0.847
EP2	3.630	0.840	0.758	
EP3	3.669	0.856	0.733	
EP4	3.571	0.815	0.804	
ESI				
ESI1	3.630	1.00698	0.731	0.870
ESI2	3.588	0.99526	0.787	
ESI3	3.568	0.96676	0.811	
ESI4	3.558	1.04872	0.670	

SD: Standard deviation, SN: Subjective norms, PBC: Perceived behavioral control, PB: Perceived benefits, ATT: Attitude, PQ: Product quality, EP: Energy policies, ESI: Energy-saving intention

The cumulative variance test reaches 74.59% higher than 50% (Anderson and Gerbing, 1988). Therefore, 7 factors are created from 27 observed variables and are consistent with the scales.

Based on Table 4, statistical indicator values are guaranteed as follows: Chi-square/df = 1.564 < 2; The TLI and CFI reach values of 0.960 and 0.966 and higher than 0.9; RMSEA = 0.043 < 0.08 (Anderson and Gerbing, 1988; Hair et al., 2014). This proves that the model fits the market data. The standardized regression weights of scales are greater than 0.5 and the unstandardized regression weights are statistically significant, so the model reaches convergent validity. Besides, the correlation coefficients among factors are all <1 and the standard deviation is <0.05. Therefore, the research model achieves discriminant validity (Hair et al., 2014). In addition to this, the composite reliability (Pc) and average variance extracted (Pvc) all satisfy the conditions. The minimum value of Pc = 0.80 and Pvc = 0.50 all meet the requirement for statistical validity (Fornell and Larcker, 1981). To conclude, all scales in the model meet the requirements in terms of value and reliability, so they are suitable for the next SEM test.

4.2. Research Hypothesis Test

Structural equation modeling (SEM) is used to test the research hypotheses. The analytical result is in table. Based on Table 5, all research hypotheses are accepted with a 99% significance level. The relationships between factors are explained in detail below.

Hypothesis H1: Subjective norms positively affect household energy-saving intention. According to the estimation result, subjective norms and the household's energy-saving intention have a positive relationship, with a standardized estimated value of 0.182. This shows that, if the family is under social pressure (community, friends, colleagues, neighbors, influencers), they tend to save energy. This result confirms that subjective norms play an essential role in energy-saving intention. The study result is consistent with studies proposed by Hori et al. (2013), Chen et al. (2017), Wang et al. (2018a), Ding et al. (2019), Mansor and Sheau-Tingi (2019), Nie et al. (2019), Hien and Chi (2020).

Table 4: Confirmatory factor analysis test result

Indicator	CFA value	Comparative index	Reference resources
χ^2/df	1.564	≤2	Anderson and Gerbing (1988), Hair et al. (2014)
TLI	0.960	≥0.9	
CFI	0.966	≥0.9	
RMSEA	0.043	≤0.08	

CFA: Confirmatory factor analysis, RMSEA: Root mean square error of approximation, CFI: Comparative fit index, TLI: Tucker-Lewis index

Hypothesis H2: Perceived behavioral control positively affects household energy-saving intention. This hypothesis is accepted with a statistical significance of p = 0.000 and the standardized estimated value of 0.169. This shows a positive correlation between perceived behavioral control and household energy-saving intention. The study result is consistent with some studies proposed by Chen et al. (2017), Zhang et al. (2014), Wang et al. (2018a), Mansor and Sheau-Tingi (2019), Nie et al. (2019), Fu et al. (2021), Ahmad et al. (2022). This concludes that perceived behavioral control is an important factor that positively affects the intention to save energy in families.

Hypothesis H3: Perceived benefits positively impact the intention to save energy in households. According to the test results in Table 5, perceived benefits are positively correlated with energy-saving intention, with the standardized estimated value reaching 0.211 and statistical significance p = 0.000. This is the factor that has the most impact on household energy-saving behavioral intention. This finding confirms that the perception of economic benefits and environmental benefits positively influence behavioral intention to save energy (Wang et al., 2011; Zhang et al., 2014). The research result is similar to studies proposed by Banfi et al. (2008), Dianshu et al. (2010), Steinhorst et al. (2015), Zhou and Yang (2016), Hien and Chi (2020), Fu et al. (2021), Ahmad et al. (2022).

Hypothesis H4: Attitude positively affects the intention to save energy in households. This hypothesis is accepted with a statistical significance of p = 0.000 and a standardized estimated value of 0.177. This shows that there is a positive correlation between energy-saving attitude and energy-saving intention. Attitude is one of the best predictors of the intention to perform an individual behavior (Caputo, 2020). The research result is consistent with studies proposed by Zhang et al. (2014), Chen et al. (2017), Wang et al. (2018a), Ding et al. (2019), Mansor and Sheau-Tingi (2019), Nie et al. (2019), Hien and Chi, (2020).

Hypothesis H5: Product quality beneficially impacts household energy-saving intention. According to the estimation result, product quality and energy-saving intention have a positive correlation, with a standardized estimated value of 0.177 and a statistical significance of p = 0.000. If energy-saving products are high-quality, easy to identify, and accessible, the household's intention to save energy will be higher. The research result is similar to studies by Yue et al. (2013), Trotta (2018), Zhang et al. (2018), and Thanh Nguyen et al. (2021).

Table 5: Research hypothesis test

Relationship	Unstandardized			Standardized estimated value	Significance	Hypothesis
	Estimated value	SE	CR			
ESI ← SN	0.173	0.054	3.188	0.182	***	H1: Accepted
ESI ← PBC	0.163	0.061	2.683	0.169	***	H2: Accepted
ESI ← PB	0.181	0.056	3.242	0.211	***	H3: Accepted
ESI ← ATT	0.165	0.060	2.760	0.177	***	H4: Accepted
ESI ← PQ	0.170	0.064	2.659	0.177	***	H5: Accepted
ESI ← EP	0.227	0.067	3.397	0.195	***	H6: Accepted

SE: Standard error, CR: Critical ratio, SN: Subjective norms, PBC: Perceived behavioral control, PB: Perceived benefits, ATT: Attitude, PQ: Product quality, EP: Energy policies, ESI: Energy-saving intention, *** shows 1% significance level

Hypothesis H6: Energy policies positively affect household energy-saving intention. This hypothesis is accepted after considering the standardized estimated value of 0.195 and the statistical significance of p = 0.010. This shows a beneficial correlation between energy policies and household energy-saving intention. This confirms that energy policies are an important tool to reduce the intensity of household energy use, contributing to improving energy efficiency. The finding is consistent with studies proposed by Abrahamse and Steg (2009), Mizobuchi and Takeuchi (2012), Manjunath et al. (2014), Wang et al. (2018b), Zhang et al. (2020), Hien and Chi (2020), Yue et al. (2020); Thanh Nguyen et al. (2021), Fu et al. (2021).

5. CONCLUSION

The study focuses on proving the factors affecting the intention to save energy of households from an integrated point of view (economy-oriented, technology-oriented, and behavior-oriented perspective). The study has developed a model applying the theory of planned behavior (TPB) to demonstrate the factors affecting the energy-saving intention in Vietnam. Research data were collected from households in 3 cities (Ho Chi Minh, Da Nang, and Can Tho). Applying the structural equation modeling (SEM), six research hypotheses are accepted. Factors that positively affect the intention to save energy include subjective norms, perceived behavioral control, perceived benefits, attitude, product quality, and energy policies. In which, the "perceived benefits" factor has the strongest impact on the intention to save energy. The study provides a useful scientific basis for building policies to control household energy consumption behavior, as well as opens up new research directions on energy-saving behavioral intentions.

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