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Managing the Energy-Saving of College Students:

Based on an Analysis of Comprehensive Information of the Energy-Saving Behaviors

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ABSTRACT

Gaining a comprehensive understanding of the energy-saving behaviors (ESB) of college students, who represent the backbone of the future society, is imperative for advancing energy conservation initiatives. This paper employs a PLS-SEM model with 2786 valid responses to investigate the determinants of college students' ESB within the comprehensive action determination model (CADM). The results show that (1) the applicability of CADM, including the theory of planned behavior, norm activation model, and ipsative theory of behavior, was confirmed in the context of college students' ESB. (2) The cultivation of energy-saving habits significantly contributes to the promotion of ESB. (3) The availability of energy-saving access has a positive impact on ESB. (4) Media's energy-saving promotional activities positively influence the energy-saving intention. (5) Energy-saving policy incentives exert a positive moderating influence on the transition from energy-saving intentions to ESB. Based on these empirical findings, this paper provides specific and target policy recommendations.

KEYWORDS

College Students, Comprehensive Action Determination Models, Energy-Saving Behaviors, PLS-SEM

INTRODUCTION

Global energy consumption has surged significantly in the past century, with the imprudent utilization of vast energy resources resulting in detrimental environmental, economic, and social consequences (X. Chen, Shuai, Wu, & Zhang, 2021; Xu & Lin, 2023). Particularly in the last two decades, the emission of greenhouse gases from energy sources has triggered many significant environmental challenges. These encompass critical issues such as global warming, the increased frequency of extreme weather events, adverse health effects due to air pollution, and other socio-economic issues (Cohen, Cowie, Babiker, Leip, & Smith, 2021; Ledda, Di Cesare, Satta, Cocco, & De Montis, 2021; Nawaz, 2021; Shi et al., 2022; T. Tang & Kim, 2023). Mitigating non-essential energy consumption and enhancing energy efficiency necessitates collaborative efforts from governments, businesses, and individuals.

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Governments play a crucial role in the formulation of energy policies, support for technological advancements, and the reinforcement of international cooperation (Z. Wang & Qiu, 2021; Xiaofan Zhao, Li, Wu, & Qi, 2014; Zheng, Deng, Li, & Yang, 2022; W. K. Zhu, Wang, Wang, Wu, & Yue, 2022). Enterprises contribute by employing energy-efficient manufacturing equipment, establishing effective energy management systems, and investing in energy-saving innovations (Caporale, Donati, & Spagnolo, 2023; Wu, Xue, Hao, & Ren, 2021; Zhuang et al., 2023). In the residential sector, the second-largest energy consumer in China following the industrial sector, energy conservation is predominantly achieved through modifications in residents' energy consumption behavior and the selection of energy-efficient products (Gao, Wang, Li, & Li, 2017; P. Zhu & Lin, 2022).

Numerous studies have examined residential energy-saving behaviors (ESB), primarily focusing on understanding micro-level individual behavioral choices. These studies can be categorized based on three key aspects: the object of the study, the theoretical models applied, and the investigation of factors impacting ESB. In terms of research objects, studies have focused on the ESB of urban residents(Agarwal, Sing, & Sultana, 2022; Belaïd & Joumni, 2020; Y. Ma & Liu, 2023b; Orset, 2021; Ru, Wang, & Yan, 2018) with some studies investigating ESB of rural residents (L. Li, Jin, Zhang, Qiu, & Liu, 2023; X. W. Ma, Wang, Lan, Li, & Zou, 2022; Yu et al., 2017; Xueyan Zhao, Cheng, Zhao, Jiang, & Xue, 2019). Additionally, there is a growing interest in studying specific groups in unique contexts, such as (Q. C. Wang, Ren, Liu, Chang, & Zuo, 2023), who explored the drivers of ESB among hotel guests using the extended theory of planned behavior (TPB), (Dixon, Deline, McComas, Chambliss, & Hoffmann, 2015; Tverskoi et al., 2021; Xie et al., 2021) examining ESB in the workplace, (H. Li, Wang, & Zhang, 2023) investigating the impact of social interaction on ESB among college school students, and various studies focusing on college school students (Du & Pan, 2021; Kurokawa et al., 2023; Lin & Yang, 2022; van den Broek, Walker, & Klöckner, 2019; B. Wang et al., 2021). This study explores the influencing factors of ESB among Chinese college school students, contributing to the growing body of knowledge.

The choice of students in college has two primary considerations that drive the research subjects: firstly, as energy consumers, higher education institutions like colleges present challenges in energy conservation. Secondly, as the future backbone of society, the awareness shaping and behavioral practices of students in college are crucial for shaping the future of society. As a component of residential energy consumption, different from daily family life, energy conservation in colleges has some unique characteristics and brand-new challenges, which are reflected explicitly in the following aspects: 1. The continuous and stable energy supply needed for teaching activities, experimental activities, and student daily life in college imposes elevated energy security demands. 2. Students typically reside in the same building, forming groups of four or more people living in the same room, and their pace of life is somewhat consistent, which results in concentrated energy demand during specific periods. 3. Due to the concentration of students in the campus area, all living energy consumption is centered in this space, resulting in a substantial overall energy demand for the campus. Furthermore, the college student population exhibits unique characteristics, which are reflected in the following aspects: 1. Compared with ordinary residents, college students have higher levels of education, which implies a higher degree of understanding of climate change and environmental pollution, making them more likely to raise energy-saving intentions and implement ESB. 2. College students predominantly engage in study, living, and recreational activities within the campus. Guiding students toward positive ESB has the potential to achieve comprehensive energy savings to a large extent. 3. College students, influenced by the educational environment, often have a heightened sense of social responsibility, which, coupled with the prevalence of energy-saving and environmental protection activities on campuses, motivates students to engage in ESB. 4. As a crucial segment of the future society, college students are poised to become leaders in various fields. Instilling energy-saving habits and maintaining awareness at this stage can significantly contribute to future societal energy sustainability and carbon neutrality.

In terms of theoretical model selection, several well-established theories have been demonstrated, among which the classical TPB and norm activation model (NAM) have been used the most in the study of ESB. According to (Christian A. Klöckner & Blöbaum, 2010), both the TPB and the NAM have their limitations to some extent. The TPB concentrates on intention's influence while overlooking the impact of other objective factors on behavior. On the other hand, the NAM emphasizes the effect of personal norms (PN) but disregards the influence of intention and other objective elements on behavior. In some instances, researchers have turned to the ipsative theory of behavior (ISP) to examine individuals' actions, allowing for a comprehensive examination of situational factors while neglecting the role of subjective factors. Habitual behaviors are often considered crucial determinants of behavioral choices, with past repetitive actions shaping intentions and behaviors. However, these studies overlook that habits can be shaped by situational factors and subjective norms (SN). In order to provide a more comprehensive analysis of ESB, this paper strives to enhance our understanding by utilizing the CADM as a well-established framework that has effectively explained various pro-environmental behaviors (Balundė, Jovarauskaitė, & Poškus, 2020; Joanes, Gwozdz, & Klöckner, 2020; Christian A. Klöckner & Blöbaum, 2010; Christian Andreas Klöckner & Oppedal, 2011; Z. Tang, Zhou, & Warkentin, 2022; van den Broek et al., 2019). By utilizing CADM, we aim to gain a comprehensive understanding of the ESB decisions of college students.

In addition to the factors mentioned above, various other influences have been explored concerning residential ESB, including individual demographic characteristics (Belaïd & Garcia, 2016; Matthies & Merten, 2022; Rainisio et al., 2022; Ru et al., 2018; Yang, Zhang, & Zhao, 2016), behavioral habits (H. Li et al., 2023; Q. C. Wang et al., 2023), policy development (Quaglione, Cassetta, Crociata, & Sarra, 2017; Shen & Sun, 2023; Z. Tang et al., 2022), media campaigns (Agarwal et al., 2022; Y. Ma & Liu, 2023a; Orset, 2021), and values (Sivapalan, Heidt, Scherrer, & Sorwar, 2021). This paper aims to encompass all these influences on CADM by utilizing CADM to enhance our understanding of the determinants influencing ESB among college students and enrich research on individual ESB in school.

This study makes marginal contributions in four aspects. First, most prior studies focus on the energy consumption of urban residents or household energy consumption and pay less attention to the energy consumption behavior of schools as a specific place. In this paper, we choose college students in key universities in China as the research object, focusing on exploring such a group that may be the backbone of the future society and may also become the future leaders in many fields and exploring the influencing factors of their ESB at the present stage will have a meaningful impact on promoting the formation of an energy-saving atmosphere in the whole society. Second, while existing research often relies on micro-survey data utilizing online or offline questionnaires, limited attention has been given to large-scale survey data concerning college students. This paper addresses this gap by gathering 2999 primary data points through questionnaires. These data encompass various dimensions, including individual and family statistical characteristics, energy environment considerations, and low-carbon awareness, thereby constructing a comprehensive micro-database specific to college students and their energy-related perceptions. Third, although existing studies on micro-individual ESB are also based on validating and exploring theoretical models, most of them are based on a single model. This paper integrates the NAM and the TPB. It adds factors such as past habits, policy incentives, publicity, and education to conduct a comprehensive analysis of college students' ESB based on CADM and further expand to obtain more comprehensive and integrated information. Finally, this paper extends its impact to the policy domain. By focusing on the young people who will be more affected by climate change in the future, this paper tries to clarify the influencing factors of young people's ESB and then puts forward the corresponding guiding policy suggestions. The subsequent policy recommendations are significant in addressing China's current energy challenges, mitigating environmental pollution, fostering an ecological low-carbon society, and advancing sustainable socio-economic development.

The subsequent sections of the article can be divided into four main parts. Section 2 outlines hypotheses regarding college students' ESB, grounded in the theoretical foundations of consumer behavior and CADM. Section 3 provides insight into the data sources and empirical methods employed in the study. Section 4 presents the empirical results, encompassing the assessment of the measurement model and path analysis. Finally, Section 5 serves as the conclusion, summarizing the empirical findings and provides targeting policy recommendations.

THEORETICAL BACKGROUND AND HYPOTHESES

CADM was first proposed by (Christian A. Klöckner & Blöbaum, 2010) as a comprehensive model that integrates the primary assumption of the TPB, the NAM, and the theoretical concepts of habit and situation. In this paper, CADM is applied to explore the ESB of college students. According to CADM, three primary sources could influence the individuals' intentions and behavior. (1) Intentional processes include attitude, SN[1], perceived behavioral control (PBC), and ESB. (2) Normative processes include SN, PN, and awareness of needs and consequences. (3) Situational influences, which include objective constraints and subjective constraints. (4) Habitual processes. All four sources interact complexly to directly affect the intentional processes (including intention and attitudes) and indirectly affect the behavior. Next, this paper will present the hypotheses based on CADM.

Intentional Processes

The "intentional process" component of CADM is primarily rooted in the TPB (Ajzen, 1985), which has been widely validated in numerous behavioral studies, such as (de Leeuw, Valois, Ajzen, & Schmidt, 2015; Martinho, Pires, Portela, & Fonseca, 2015; Rakhmawati, Damayanti, Jati, & Astrini, 2023; Xie et al., 2021). TPB posits that an individual's behavior is primarily determined by their intention, which, in turn, is influenced by SN and attitudes, also referred to as PN within CADM and PBC. In this study, ESB refer to the daily actions college students adopt to conserve energy. On the other hand, energy-saving intention (ESI) pertains to the willingness of respondents to engage in ESB. ESB of college students, like other behavioral decisions, should conform to the fundamental factors that determine behavior, primarily intention. SN encompasses the expectations and requirements for ESB imposed by some influential people around individuals, which includes expectations from government entities, educational institutions, family members, and friends. As a group living collectively, college students receive many influences on their behavior from school, family, and friends. PN denotes the personal students' disposition and evaluative judgments that respondents hold regarding ESB. College students' ESB, like other behaviors, should be consistent with the factors underlying behavioral decisions. Building upon the foundational tenets of the TPB, we formulate the following four hypotheses:

H1: Students' SN of energy-saving positively contribute to their ESI.
H2: Students' PN of energy-saving positively contribute to their ESI.
H3: Students' PBC of energy-saving positively contribute to their ESI.
H4: Students' PBC of energy-saving positively contribute to their ESB in daily life.
H5: Students' ESI positively contributes to their ESB in daily life.

Normative Processes

The normative processes in CADM are grounded in the NAM developed by (Schwartz, 1973). NAM is a theory with a solid empirical foundation, positing that individual behavior is influenced by three key factors: Awareness of Consequences (AC), Awareness of Responsibilities (AR), and PN. PN plays a central role as it directly shapes individual behavior while being affected by both AC and

AR. In our study, AC represents college students' perceptions of the outcomes of engaging in ESB. It reflects their assessments of such actions' potential personal and societal benefits.

On the other hand, AR signifies college students' awareness of the negative consequences of not adopting ESB, particularly concerning the potential adverse effects of global warming. Inevitably, students encounter information regarding the necessity of energy conservation and environmental changes in their daily academic and personal lives. This exposure leads to specific assessments of the outcomes associated with engaging in energy-saving behaviors (ESB), thereby directly influencing the formation of norms related to energy-saving behaviors. Simultaneously, these judgments regarding the consequences of participating in ESB contribute to developing a sense of responsibility for the potential adverse outcomes of not implementing ESB. This sense of responsibility, in turn, influences their norms. Drawing from CADM's foundational principles, we present hypotheses H6-9.

H6: Students' AC of ESB positively influences their AR for ESB
H7: Students' AC of ESB positively influences their PN of ESB
H8: Students' AR for ESB positively influences their PN of ESB
H9: Students' SN of ESB positively contribute to their PN of ESB

To comprehensively explore the determinants of ESB among college students, we consider the impact of individual values within the CADM framework. Previous research, including (Rokeach, 1968) and (Rokeach, 1973), has established the influence of personal values on attitudes and behavioral decision-making. College students, as a group with a higher level of education, have a more critical role to play in their behavior than residents. Values are widely recognized as representing the specific objectives individuals pursue in their lives (Schwartz, 1992). These values indirectly shape behavior through their influence on attitudes and norms. Within the framework of the Value-Belief-Norm (VBN) theory, values that drive pro-environmental behaviors are categorized into three primary groups: egoistic, altruistic, and biospheric values and each of these values influences pro-environmental behaviors by affecting AC (M. F. Chen et al., 1999; Stern, 2000). Egoistic value signifies the extent to which an individual prioritizes personal interests. A higher egoistic value implies a greater emphasis on personal interests and their heightened importance. In this study, we use the more colloquial personal value assessment (PVA) to describe it for ease of understanding.

Conversely, altruistic value reflects the importance attached to the welfare of others and society. It contrasts with egoism, indicating a higher regard for societal interests, which in this study is expressed by the more colloquial social value assessment (SVA), which means the degree to which an individual values societal interests. Biospheric value gauges an individual's valuation of the environment and natural ecology, and in this study, we use the more general term ecological value assessment (EVA) to describe it for understanding. VBN theory has been validated across various pro-environmental behaviors (Hiratsuka, Perlaviciute, & Steg, 2018; Hiratsuka, Perlaviciute, Steg, & Chen, 2015). Building upon existing research and considering the specific contexts explored in this dissertation, we present hypotheses H10 to H12.

H10: Students' PVA positively influences their AC of ESB
H11: Students' SVA positively influences their AC of ESB
H12: Students' EVA positively influences their AC of ESB

Situational Influences

CADM's situational influences are based on the ISP, which suggests that subjectively and objectively perceived situational constraints lead to the formation of behaviors (Frey, 1992). The subjective perceived situational constraints include Energy-saving self-belief (ESS), which indicates college students' beliefs about the implementation of ESB, and the stronger the personal beliefs, the stronger the student PBC about ESB will be accordingly. The source of objective constraints mainly comes from the individual's Eenegy-saving access (ESA), which indicates how convenient it is for the student to implement ESB, such as whether he/she has the relevant energy-saving knowledge, whether there is someone who can assist in the implementation of ESB, and so on. ESA also directly impacts ESB, and we therefore propose Hypotheses 13 to 15 in this paper.

H13: ESS of students positively influences their PBC of energy-saving
H14: ESA of students positively influences their PBC of energy-saving
H15: ESA of students positively influences their ESB

Habitual Processes

Habits have been the focus of psychological research for a long time and have an essential role in predicting behavior as intentions. Existing research on habits on behavior consists of two main perspectives, one of which holds that habits are formed spontaneously without the influence of any other factors and that habits themselves do not have an impact on behavior (Galla & Duckworth, 2015; Zemack-Rugar, Bettman, & Fitzsimons, 2007), while the other, more widely accepted view, holds that habits are influenced by as many factors in their formation as behavior and play a crucial role in directly practicing behavior (H. Li et al., 2023; Q. C. Wang et al., 2023). This paper is based on the CADM setting, which states that energy-saving habits (ESH) are mainly influenced by PN and PBC and directly affect behavior. Therefore, it proposes the hypotheses of this paper16-18.

H16: Students' PN of energy-saving positively contributes to their ESH.
H17: Students' PBC of energy-saving positively contribute to their ESH.
H18: Students' ESH positively contribute to their ESB.

The Effect of Energy-Saving Promotional Activities

In this paper, Energy-saving promotional activities (EPA) denote promotional activities on ESB made by the news media. For the student body, the daily exposure to many social media messages and their impact on student behavior should not be underestimated, and previous studies have shown that media publicity and education have a positive guiding effect on pro-environmental behaviors, especially on the PN of individuals, and also on their pro-environmental awareness, thus proposing H19 and H20 of this paper.

H19: EPA has a positive effect on students' PN of energy-saving
H20: EPA has a positive effect on students' ESI

The Moderating Role of Energy-Saving Policy Incentives

In this paper, Energy-saving policy incentives (EPI) denote the government's efforts towards ESB, including whether the government has made appropriate constraints and incentives for ESB and whether the government has advocated for residents to implement ESB actively. There is often a gap between the intention of pro-environmental behaviors and the actual behaviors, which external constraints or incentives could narrow. The ESB of college students is also affected by government policies or advocates from schools. Positive policy incentives can help motivate students who are already aware of energy saving to implement ESB, while strict restrictions can make it mandatory for students to practice ESB regardless of whether they are aware of it. So, the government policy incentives may narrow the awareness-behavior gap, as shown in H21 below.

H21: EPI plays a positive moderating role in the influence relationship between ESI and ESB.

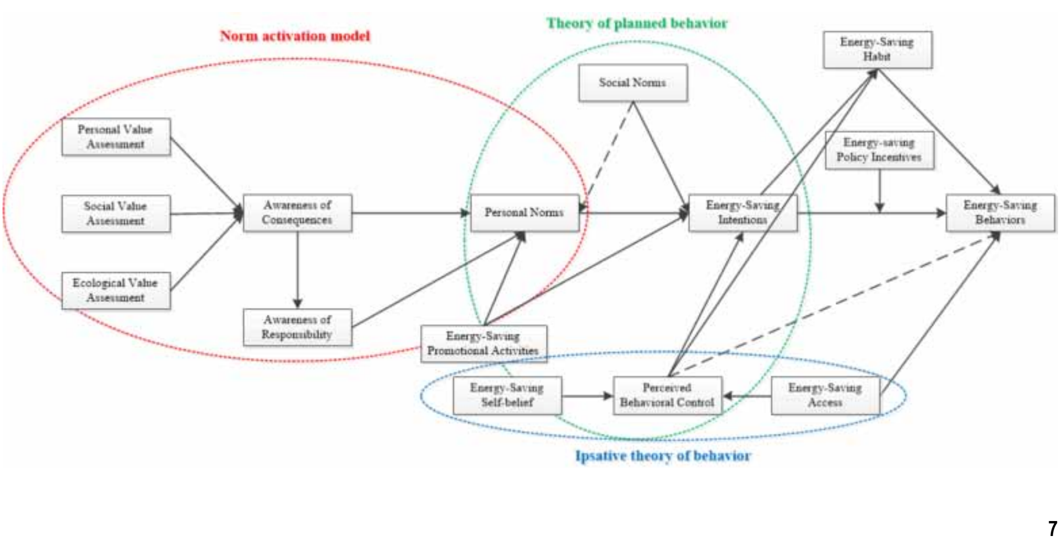
Based on the above hypotheses, the framework diagram of this paper is shown in Figure 1.

DATA AND METHOD

Participants and Data Collection Procedure

College Students' Cognition of Energy and Environment Survey (CSCES) is a questionnaire designed and distributed by the China Institute for Studies in Energy Policy (CISEP) at Xiamen University, which attempts to investigate contemporary college students' cognition of energy and the environment and identify the motivations and barriers to energy conservation, low carbon, and environmental protection in the college population. The questionnaire consists of four parts: the first part is the respondents' basic personal and family information, specifically including personal statistical characteristics, family statistical characteristics, classmates' situations, and life attitudes. The second part is the respondents' energy-related cognition and ESB, specifically including energy-related knowledge, energy-saving knowledge, energy-saving attitudes, ESI, and ESB. The third part is the respondents' low carbon-related cognition and low-carbon behaviors, specifically including low-carbon knowledge, intention, and willingness to pay for low-carbon behaviors. The fourth part is the respondents' perceptions of environmental pollution, willingness to participate, and willingness to pay for ecological protection behaviors, including takeaway boxes, plastic bags, express packaging, second-hand books, garbage classification, clean air, and new energy vehicles. The questionnaire was designed concerning the mature scale forms in existing relevant academic papers, and experts in energy economics, energy policy, micro-surveys, and behavioral decisions were invited to conduct several rounds of discussions and modifications to determine the final questions. Before the formal survey, a pre-survey of 100 samples was carried out on unrestricted college students. Based on the results of the pre-survey, experts were invited to discuss and revise the problems feedback from the respondents, the issues found by the volunteers in the process of the survey, and the problems that were present in the final recovered data to form a questionnaire that ultimately contained 240 questions. The questionnaire was imported into the Questionnaire Star platform, and the volunteers randomly chose the respondents to fill out the questionnaire by letting them open the link on their cell phones, iPads, or computers in person. This kind of face-to-face interviews combined with the online platform helped improve the data collection efficiency while guaranteeing the data's quality. The questionnaire was implemented in two batches: the first batch was implemented in December 2020-January 2021, the second batch was implemented in March 2021-April 2021, and the data collation was completed in May 2021.

Figure 1. Theoretical framework of the research



The primary respondents of the questionnaire were students enrolled in Xiamen University, and stratified random sampling was used for data collection. The number of people surveyed in each college was first roughly determined by the total number of students in each college of Xiamen University. Then, the number of people surveyed at different academic levels was determined by the ratio of the number of doctoral students, master's students and undergraduate students in various colleges. The distribution of the valid sample across colleges is shown in Table 7 in Appendix A.

The data for this study mainly came from Part I and Part II of the questionnaire, and the specific questions are described in Appendix B.

Measurement Instrument

The references on the measurement items are shown in Table 1, and the specific questions in the questionnaire are shown in Appendix B.

Method

In this paper, Partial least squares structural equation modeling (PLS-SEM) is selected to analyze empirical data, which is based on the variance of the data by interpreting and using the total variance assessment model. According to (Hair, Risher, Sarstedt, & Ringle, 2019), researchers should select PLS-SEM when (1) the analysis is concerned with testing a theoretical framework and exploring theoretical extensions of established theories. This paper is an exploratory study based on CADM to analyze ESB and explore a comprehensive model suitable for the ESB of college student groups by adding multiple factors to the study. (2) the structural model is complex and includes many constructs. The structural model of this paper is relatively complex, and there are a total of 11 latent variables. Each latent variable has at least three observational variables, and the relationship between each latent variable is relatively complex, so PLS-SEM is more suitable for this paper's research. (3) PLS-SEM works very well with large sample sizes. The adequate sample size of this paper is 2786, which is a large sample in management-related research. (4) the estimation of covariance-based structural

Table 1. References for measurement items for latent variables

Constructs	Abbreviation	References
Social Norms/Subjective Norms	SN	(Long et al., 2023; Ru et al., 2018; Yue, Long, & Chen, 2013)
Personal Norms/Attitudes	PN	
Perceived Behavioral Control	PBC	
Energy-Saving Intentions	ESB	
Energy-Saving Behaviors	ESI	
Personal value assessment	PVA	(Al-Shemmeri & Naylor, 2017; B. Wang, Wang, Guo, Zhang, & Wang, 2018)
Social value assessment	SVA	
Ecological value assessment	EVA	
Awareness of Consequences	AC	(B. Wang et al., 2018)
Awareness of Responsibility	AR	
Energy-Saving Self-beliefs	ESS	
Energy-Saving Access	ESA	(He, Blasch, van Beukering, & Wang, 2022)
Energy-Saving Habits	ESH	(H. Li et al., 2023; Q. C. Wang et al., 2023)
Energy-saving Promotional Activities	EPA	
Energy-saving Policy Incentives	EPI	(Z. Tang et al., 2022)

equation modeling (CB-SEM) requires that all variables meet the normality assumption. While PLS-SEM relaxes this part of the assumption, the source of data in this paper is questionnaire data. The options are presented in a five-point Likert scale, which may not necessarily meet the normality assumption of all variables' distribution. For all these reasons, PLS-SEM is the most suitable method for the study in this paper.

Descriptive Statistics

Through the two survey rounds, this paper finally recovered 2993 sample data. After excluding the data of incomplete filling answers, the final valid questionnaire is 2786, and the effective rate is 93.08%. Table 2 demonstrates the descriptive statistics of the valid samples.

Of the 2,786 valid samples, 1134 (40.70%) were male, and 1652 (59.30%) were female. Among the respondents, 2590 (92.96%) were Han Chinese, while 7.04% (N=196) represented various ethnic minorities. The age distribution of the participants ranged from 19 to 46 years old, with an average age of 25.20 years. Regarding religious beliefs, 94.94% had none, 66 participants reported having religious beliefs, and 75 respondents did not provide an answer. Regarding marital status, 97.99% of the participants were unmarried, 53 were married, and three did not respond. Among the valid samples, 48.53% were undergraduate students, 41.85% were master's degree students, and 9.62% were pursuing doctoral degrees, with a relatively even distribution across all academic levels. 66.33% (N=1,848) of the valid samples were members of the Communist Youth League, and 25.95% (N=723) were members of the Communist Party. Additionally, 876 respondents were from rural areas and townships, while 1,610 were from urban areas. Of the respondents, 36.68% (N=1,022) held agricultural hukou, while the rest held non-agricultural hukou. Regarding housing, 88.37% of the respondents' families lived in commercial or self-built houses, and 89.17% owned at least one property. Moreover, 64.87% of the respondent families possessed at least one small family car. During the school year,

Table 2. The descriptive statistics results for valid samples

Variable	Obs	Mean	Std. Dev.	Min	Max
gender	2786	1.593	0.491	1	2
age	2786	25.197	2.881	19	46
religion	2786	1.078	0.354	1	3
marriage	2786	1.022	0.168	1	4
stage	2786	1.611	0.656	1	3
grade	2786	2.289	1.095	1	6
political	2786	2.197	0.572	1	5
income	2786	2193.141	1020.619	0	12000
expense	2786	1856.285	868.033	500	16000
rural	2786	2.849	1.153	1	4
hukou	2786	1.983	0.871	1	5
property	2786	2.597	2.240	1	7
house	2786	2.717	1.284	1	7
car	2786	1.852	0.863	1	6
dormitory	2786	2.833	1.018	1	6
roommate	2786	3.106	2.158	-3	8
em	2786	0.930	0.256	0	1

most students resided in four-person dormitories (N=1,658, 59.51%). Students of the sample had an average income of 2193.14 RMB, with average expenses amounting to 1856.29 RMB.

EMPIRICAL RESULTS

The analysis in PLS-SEM is conducted in two distinct steps. The first step involves evaluating the adequacy of the measurement model, while the second step entails estimating the significance coefficients of the structural model, including the path coefficients. 300 iterations are chosen for input into the PLS-SEM algorithm to assess the fitness of the measurement model. Once the appropriate measurement model is determined using relevant metrics, bootstrapping with 5000 subsamples is employed to estimate the structural model and ascertain the significance levels of the paths (Chin, 2010). Before the analysis, the common method bias (CMB) of the recovered data was tested according to (Fuller, Simmering, Atinc, Atinc, & Babin, 2016; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), and the specific test results are shown in A. Table 2 shows that the first factor's variance explanation rate is 21.12%, less than 50%, so the CMB passes the test, and the data can be used for subsequent analysis.

Measurement Models

There are four main aspects to assessing the adequacy of the measurement model.

1. **Assessment involves examining the indicator loadings**. The specific judgment criterion is that the value of outer loading should be greater than 0.7, indicating that the construct explains more than 50 percent of the indicator's variance, thus providing acceptable item reliability. If the value of outer loading is less than 0.7, the item must be deleted. Table 3 shows the results of the four rounds of testing. The first stage (S1_all variables) adds all the items to the regression, and it is found that the outer loading of AC5, EPI4, ESA4, ESB3, ESS4, SN1, SN6, and SN7 is less than 0.7. After deleting these measurements of the question items, the second stage (S2_adjusted) analysis was conducted, and the results show that the outer loading of ESB4 and SN5 was less than 0.7. After deleting these two measurement items, the third stage (S3_ajusted) analysis was conducted, and the results show that the outer loading of SN4 was less than 0.7. Deleting this one measurement item, the fourth stage (S4_ajusted) analysis was conducted, and all the outer loading in the fourth stage is greater than 0.7, which meets the requirement.
2. **Assessment of covariance of formative indicators**. Variance Inflation Factor (VIF) is commonly used to assess the covariance of formative indicators, and a VIF value of 5 or more indicates significant covariance between formative measurement constructs. The results show that all potential variables have VIF values less than five except EVA1, EVA2, PN1, PN2, and PN3. After deleting those five items, the rest meet the requirement, and the details of VIFs are shown in Table 9 in Appendix A.
3. **Assessing internal consistency reliability**. Cronbach's alpha is an essential indicator for judging internal consistency, the threshold is greater than 0.7. Composite reliability (rho_a) and Composite reliability (rho_c) are approximately exact measures of construct reliability, with a threshold greater than 0.7. Table 4 demonstrates the relevant construct reliability and validity indicators for the response latent variables. The results in the table show that the internal consistency of all the items in the questions passed the test.
4. **Assess convergent validity and discriminant validity**. The average variance extracted (AVE) was used to judge the model's convergent validity and discriminant validity, which means the mean of the squared loadings of each indicator on the construct, with an acceptable value of greater than 0.5, indicating that the construct explains at least 50% of its item variance. The Heterotrait-monotrait ratio (HTMT) is also used to determine the model's discriminant validity,

Table 3. The results of outer loadings – List

	Outer Loadings			
	S_1 All Variables	**S_2 Adjusted**	**S_3 Adjusted**	**S_4 Adjusted**
AC1 <- AC	0.867	0.873	0.873	0.873
AC2 <- AC	0.823	0.819	0.819	0.819
AC3 <- AC	0.887	0.895	0.895	0.895
AC4 <- AC	0.870	0.887	0.887	0.887
AC5 <- AC	0.630			
AR1 <- AR	0.843	0.843	0.843	0.843
AR2 <- AR	0.878	0.878	0.878	0.878
AR3 <- AR	0.831	0.831	0.831	0.831
AR4 <- AR	0.738	0.738	0.738	0.738
EPA1 <- EPA	0.868	0.868	0.868	0.868
EPA2 <- EPA	0.821	0.821	0.821	0.821
EPA3 <- EPA	0.884	0.884	0.884	0.884
EPI1 <- EPI	0.747	0.793	0.797	0.797
EPI2 <- EPI	0.797	0.835	0.839	0.839
EPI3 <- EPI	0.827	0.829	0.823	0.823
EPI4 <- EPI	0.661			
ESA1 <- ESA	0.701	0.743	0.755	0.755
ESA2 <- ESA	0.875	0.875	0.869	0.869
ESA3 <- ESA	0.879	0.876	0.868	0.868
ESA4 <- ESA	0.657			
ESB1 <- ESB	0.839	0.861	0.898	0.898
ESB2 <- ESB	0.790	0.849	0.899	0.899
ESB3 <- ESB	0.573			
ESB4 <- ESB	0.731	0.689		
ESH <- ESH	1.000	1.000	1.000	1.000
ESI1 <- ESI	0.799	0.801	0.805	0.805
ESI2 <- ESI	0.722	0.719	0.715	0.717
ESI3 <- ESI	0.793	0.794	0.793	0.792
ESI4 <- ESI	0.844	0.845	0.845	0.845
ESS1 <- ESS	0.765	0.748	0.748	0.748
ESS2 <- ESS	0.761	0.741	0.741	0.741
ESS3 <- ESS	0.751	0.728	0.728	0.728
ESS4 <- ESS	0.657			
ESS5 <- ESS	0.760	0.786	0.785	0.785
ESS6 <- ESS	0.775	0.801	0.801	0.801

continued on following page

Table 3. Continued

	Outer Loadings			
	S_1 All Variables	S_2 Adjusted	S_3 Adjusted	S_4 Adjusted
ESS7 <- ESS	0.781	0.805	0.805	0.805
EVA1 <- EVA	0.957	0.957	0.957	0.957
EVA2 <- EVA	0.960	0.960	0.960	0.960
EVA3 <- EVA	0.946	0.946	0.946	0.946
PBC1 <- PBC	0.822	0.825	0.825	0.825
PBC2 <- PBC	0.876	0.878	0.878	0.878
PBC3 <- PBC	0.849	0.846	0.846	0.846
PN1 <- PN	0.828	0.828	0.828	0.829
PN2 <- PN	0.822	0.823	0.823	0.824
PN3 <- PN	0.804	0.804	0.805	0.806
PN4 <- PN	0.831	0.831	0.831	0.830
PN5 <- PN	0.807	0.807	0.807	0.806
PN6 <- PN	0.815	0.815	0.814	0.813
PVA1 <- PVA	0.834	0.828	0.828	0.828
PVA2 <- PVA	0.759	0.765	0.765	0.765
PVA3 <- PVA	0.894	0.895	0.895	0.895
SN1 <- SN	0.655			
SN2 <- SN	0.766	0.838	0.906	0.960
SN3 <- SN	0.762	0.838	0.907	0.962
SN4 <- SN	0.703	0.700	0.603	
SN5 <- SN	0.705	0.661		
SN6 <- SN	0.624			
SN7 <- SN	0.620			
SVA1 <- SVA	0.863	0.866	0.866	0.866
SVA2 <- SVA	0.776	0.769	0.769	0.769
SVA3 <- SVA	0.844	0.847	0.847	0.847
EPI x ESI -> EPI x ESI	1.000	1.000	1.000	1.000

Note: N=2786. The data in the table are the outer loading of each variable, and the red font indicates that the outer loading is more significant than 0.7, which needs to be eliminated in the final model analysis.

which means the average of item correlations across constructs relative to the (geometric) mean of the average item correlations measuring the same construct. The recommended threshold is less than 0.85, and Table 5 shows the HTMT for all latent variables, with diagonally shaded numbers indicating the values of the AVEs. The results show that all AVEs have values greater than 0.5, all HTMTs have values less than 0.85, and convergent and discriminant validity tests are passed.

Table 4. The result of construct reliability and validity - Matrix

	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)
AC	0.892	0.9	0.925
AR	0.841	0.843	0.894
EPA	0.821	0.827	0.893
EPI	0.757	0.765	0.86
ESA	0.777	0.773	0.871
ESB	0.761	0.761	0.893
ESI	0.799	0.803	0.870
ESS	0.862	0.869	0.896
PBC	0.808	0.81	0.886
PN	0.916	0.916	0.947
PVA	0.778	0.826	0.870
SN	0.917	0.917	0.960
SVA	0.77	0.772	0.868

Note: N=2786

Table 5. The result of heterotrait-monotrait ratio (HTMT) – Matrix

	AC	AR	EPA	EPI	ESA	ESB	ESH	ESI	ESS	EVA	PBC	PN	PVA	SN	SVA	EPI x ESI
AC	0.756															
AR	0.645	0.679														
EPA	0.624	0.566	0.737													
EPI	0.631	0.452	0.549	0.672												
ESA	0.629	0.545	0.649	0.669	0.693											
ESB	0.507	0.399	0.475	0.608	0.541	0.807										
ESH	0.436	0.305	0.404	0.513	0.483	0.714										
ESI	0.531	0.405	0.542	0.524	0.487	0.549	0.483	0.626								
ESS	0.685	0.47	0.559	0.609	0.581	0.586	0.498	0.571	0.591							
EVA	0.387	0.34	0.32	0.233	0.296	0.241	0.166	0.265	0.282							
PBC	0.178	0.165	0.216	0.144	0.208	0.187	0.151	0.209	0.191	0.202	0.722					
PN	0.725	0.678	0.587	0.458	0.538	0.338	0.277	0.401	0.486	0.352	0.147	0.856				
PVA	0.18	0.228	0.188	0.139	0.201	0.078	0.059	0.092	0.089	0.335	0.162	0.232	0.691			
SN	0.547	0.465	0.746	0.466	0.535	0.343	0.275	0.39	0.444	0.272	0.159	0.531	0.176	0.923		
SVA	0.377	0.361	0.37	0.298	0.349	0.249	0.181	0.254	0.307	0.72	0.26	0.384	0.545	0.316	0.686	
EPI x ESI	0.16	0.132	0.102	0.162	0.135	0.106	0.059	0.088	0.088	0.068	0.053	0.126	0.072	0.114	0.044	

Note: N=2786, the shaded diagonal figures indicate the square root of the AVE.

Hypothesis Testing

The above four testing steps verified the measurement model and the associated measurements, indicating that the structural model can be analyzed. The structural model adopted bootstrapping with 5000 subsamples to estimate the structural model and the significance level of the path, and the results are shown in Table 6 and Figure 2. The model fit was evaluated using the Standardized Root Mean Square Residual (SRMR) recommended by (Hair et al., 2019). The SRMR value for the model proposed in this paper was 0.065, below the threshold of 0.08, indicating that the model meets the requirements for a good fit.

The results of PLS-SEM demonstrate the suitability of the CADM for analyzing the ESB of college students. The hypotheses formulated within the theoretical framework were largely validated through empirical evidence. From the empirical findings, the following findings can be drawn:

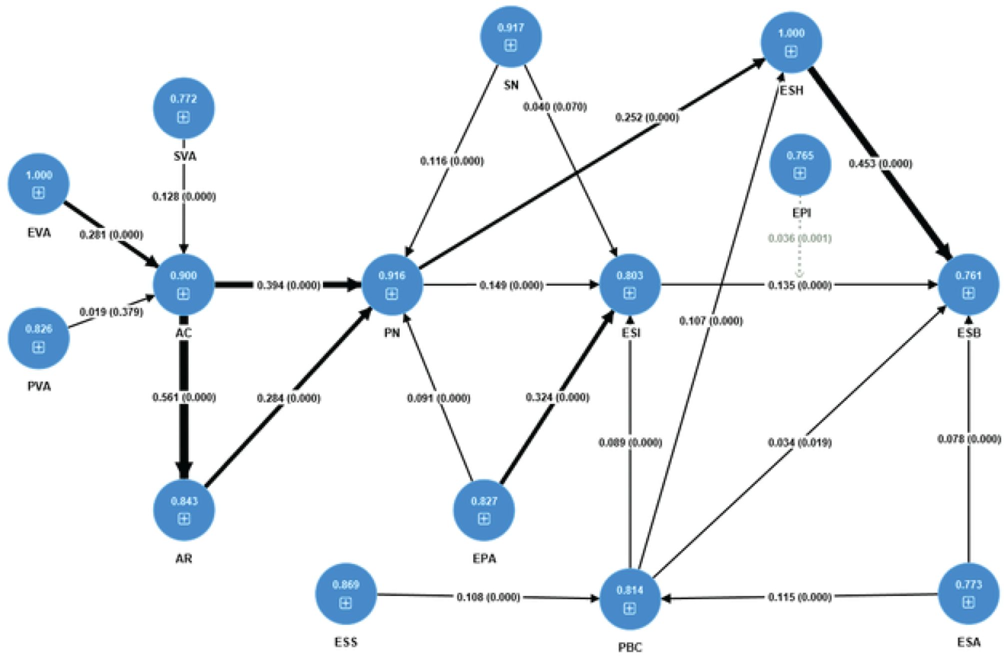
Hypotheses related to the TPB are validated on college students' ESB. SN demonstrates a positive and significant impact on ESI ($\beta = 0.040^{*}, p = 0.070$). which implies that the more norms and expectations about energy-saving from the surroundings, the more ESI the college students will have. And PN significantly affects ESI ($\beta = 0.149^{***}, p < 0.001$), emphasizing the significance of a student's attitude and perception of energy-saving in shaping their ESI. PBC exerts a significantly positive influence on ESI ($\beta = 0.089^{***}, p < 0.001$), which implies that a student's perceived control

Table 6. The results of hypothesis testing (bootstrapping)

	Hypothesis	Relationships	Estimates	S.E	T Statistics	P Values
TPB	H1	SN -> ESI	0.040	0.022	1.814*	0.070
	H2	PN -> ESI	0.149	0.020	7.584***	0.000
	H3	PBC -> ESI	0.089	0.018	4.969***	0.000
	H4	PBC -> ESB	0.034	0.015	2.342**	0.019
	H5	ESI -> ESB	0.135	0.018	7.493***	0.000
NAM	H6	AC -> AR	0.561	0.017	32.695***	0.000
	H7	AC -> PN	0.394	0.022	17.579***	0.000
	H8	AR -> PN	0.284	0.019	14.583***	0.000
	H9	SN -> PN	0.116	0.022	5.197***	0.000
	H10	PVA -> AC	0.019	0.022	0.880	0.379
	H11	SVA -> AC	0.128	0.029	4.393***	0.000
	H12	EVA -> AC	0.281	0.028	10.051***	0.000
ITP	H13	ESS -> PBC	0.108	0.022	4.858***	0.000
	H14	ESA -> PBC	0.115	0.025	4.567***	0.000
	H15	ESA -> ESB	0.078	0.020	3.834***	0.000
	H18	PN -> ESH	0.252	0.020	12.657***	0.000
	H19	PBC -> ESH	0.107	0.019	5.505***	0.000
	H20	ESH -> ESB	0.453	0.019	23.802***	0.000
	H16	EPA -> PN	0.091	0.022	4.100***	0.000
	H17	EPA -> ESI	0.324	0.025	12.946***	0.000
	H21	EPI x ESI -> ESB	0.036	0.011	3.219**	0.001

Note: N=2786, ***p<0.001, **p<0.01, *p<0.05, ns=not significant

Figure 2. Results of the PLS-SEM



Note: The numbers in the circle are Average Variance Extracted (AVE) of the latent constructs, the path coefficients and p values showed on the line, and the relative values are used to highlight paths

over their behavior effectively enhances their intention of energy-saving. Additionally, PBC has a directly positive effect on ESB ($\beta = 0.034^{*}, p = 0.019$), which indicates that increasing PBC significantly promotes individuals' engagement in ESB. Moreover, ESI has a positive effect on ESB ($\beta = 0.135^{***}, p < 0.001$), indicating that the practice of ESB depends on the cultivation of ESI.

The effect of PVA on AC ($\beta = 0.019^{ns}, p = 0.379$) is positive but not significant. This outcome suggests that while PVA may have some influence on a student's AC regarding energy saving, its impact is limited. This limitation could be attributed to the multifaceted nature of a student's PVA compared to the more straightforward influences of SVA and EVA, and the act of energy conservation itself will not positively impact students' benefits. Consequently, the overall assessment of a student's personal values does not significantly affect behaviors that might not directly benefit the individual regarding energy conservation. In contrast, SVA demonstrates a significant positive effect on AC ($\beta = 0.128^{***}, p < 0.001$), which means that students who place high importance on social values tend to have a more favorable assessment of the positive consequences of energy-saving, and the possible reason may be that saving energy, as a behavior that is beneficial to the overall welfare of society, is compatible with the notion of social values. Similarly, EVA also exerts a significant positive effect on AC ($\beta = 0.281^{***}, p < 0.001$), which indicates that individuals who prioritize ecosystem values tend to have a more positive assessment of the potential benefits of energy-saving. The rationale behind this observation is that energy conservation, as an environmentally friendly and ecosystem-beneficial behavior, closely aligns with the principles of ecosystem values. A student's overestimation of the importance of ecosystem values correlates with a favorable opinion of the role of energy-saving. Furthermore, AC positively and significantly influences both AR ($\beta = 0.561^{***}, p < 0.001$) and PN

($\beta = 0.394^{***}, p < 0.001$), and AR positively and significantly affects PN ($\beta = 0.284^{***}, p < 0.001$). These findings indicate that individuals who evaluate energy-saving benefits more highly tend to have a stronger sense of responsibility for conserving energy, further motivating their engagement in ESB. Lastly, SN has a significant positive effect on PN ($\beta = 0.116^{***}, p < 0.001$), which means that if a student's surrounding environment expects ESB from him, and influential people around him try to guide and discipline the individual to practice ESB, the individual's assessment and attitude towards ESB is friendlier, which in turn has an activating effect on the implementation of ESB.

ESS, as a subjective situational constraint, exerts a significant positive effect on PBC ($\beta = 0.108^{***}, p < 0.001$), while ESA, an objective situational constraint, also demonstrates a significant positive impact on PBC ($\beta = 0.115^{***}, p < 0.001$). Furthermore, both ESA exhibit significant positive effects on ESB ($\beta = 0.078^{***}, p < 0.001$). These findings align with the hypothesis of the ISP, indicating that college students with stronger beliefs in ESB and more excellent proficiency in using energy-saving products, coupled with increased exposure to energy-saving practices, possess enhanced control over the execution of ESB, which heightened control subsequently fosters greater intention and engagement in such behaviors.

The development of ESH is jointly influenced by PN ($\beta = 0.252^{***}, p < 0.001$) and PBC ($\beta = 0.107^{***}, p < 0.001$), with PN exhibiting a more decisive influence. Additionally, ESH significantly and positively contributes to the cultivation of ESB ($\beta = 0.453^{***}, p < 0.001$). This underscores the substantial role of ESH in shaping ESB. The development of ESB can be substantially enhanced by enhancing students' evaluations and attitudes towards ESB. Improving students' PBC can also significantly contribute to establishing personal ESH. Moreover, past habits related to ESB directly impact the continued practice of ESB in one's daily life and work. This supports the slang phrase "Habit is second nature," which has been confirmed to shape the ESH of college students, consistent with the conclusions about habit formation at this stage. The potential reason for this may be that the environment in which students live and various behaviors are highly repetitive; some behaviors will be repeated in the school environment, and the past behaviors will form inertia and become more likely to be performed at the next time.

EPA significantly and positively influences both PN ($\beta = 0.091^{***}, p < 0.001$) and ESI ($\beta = 0.324^{***}, p < 0.001$). The substantial coefficient values indicate that ESB's social promotion activities greatly enhance students' attitudes toward these behaviors and simultaneously elevate their intention of energy conservation. Social promotion activities, especially the various messages in social media, are necessary to influence public intention and attitudes. This influence is particularly pronounced within the student population, and several factors may contribute to this phenomenon. First, students tend to be more active users of social media platforms, amplifying the reach and impact of social media. Second, young people, including students, are generally more receptive to information, making them critical targets for intention-building efforts. Additionally, this demographic is often in a formative stage where attitudes and intentions are actively being shaped.

The observed significant and positive moderating effect of EPI ($\beta = 0.036^{***}, p < 0.001$) indicates that the positive impact of ESI on ESB becomes greater in an environment with more substantial policy incentives. In other words, robust policy incentives can narrow the gap between ESI and ESB. There are three possible reasons for this. First, the government's policies influence information transmission and guidance among college students. Once the school or society releases a relevant policy, disseminating the policy among the students will form a guiding effect, stimulating the latent intention and prompting individuals to attempt to translate this intention into specific behaviors. Second, positive policy incentives can help to alleviate the cost of practicing behaviors through specific incentives; third, strict policy restrictions can help to increase the cost of non-practicing behaviors, which will also make the original awareness that may not be able to implement actions have to be implemented. Second, positive policy incentives are crucial in alleviating the costs of adopting certain behaviors. Policies can effectively reduce the economic or effort-related burden associated with practicing ESB by providing specific incentives. Third, stringent policy restrictions can elevate the cost of not engaging in ESB, which could become a motivating factor, compelling students to implement actions they might not have considered otherwise. In other words, enforcing strict policies raises the stakes for non-compliance, encouraging the translation of intention into tangible behavioral changes.

CONCLUSION AND POLICY IMPLICATIONS

Based on the empirical results presented above, we draw the following conclusions and propose corresponding policy recommendations:

(1) The CADM can well explain the formation of ESB in college students, and by combining the TPB, the NAM, the ISP and habitual factors, we have obtained a more comprehensive understanding of the factors influencing ESB in college students. We recommend combining multiple theoretical models in future energy-saving or pro-environmental behavior research to obtain a more comprehensive understanding.
(2) PN and PBC have a significant positive effect on ESI, and the coefficient of PN is greatest. AC, AR and SN have a significant positive effect on PN, and AC has the most substantial effect. Additionally, AC is mainly affected by the three factors of PVA, SVA and EVA, and EVA exhibits a more substantial influence. Based on those findings, we suggest that we increase the content of environmental and social values in the daily education of schools to enhance students' assessment of environmental values and that we enhance students' awareness of the consequences of ESB and the formation of a sense of responsibility utilizing education and guidance, as well as create an atmosphere of energy conservation in the campus.
(3) The formation of individual ESH primarily stems from PN and PBC, and habit is also the most critical factor influencing ESB, which suggests that the formation of ESH is facilitated by individual self-discipline and that past ESH will play a decisive role in the practice of ESB in the future.
(4) PBC is significantly affected by ESS and ESA, indicating that strengthening personal beliefs and enhancing knowledge about ESB can effectively increase PBC. This, in turn, positively influences ESI and ESB, and our suggestion is to enhance personal beliefs in ESB through education and to increase personal knowledge of ESB by increasing the number of energy-efficiency labels on products and the popularity of energy-saving knowledge. We suggest using education to reinforce individuals' beliefs in environmental behavior and increase their knowledge of ESB by incorporating energy efficiency labels on products and promoting ESI.
(5) EPA has a significant positive impact on the formation of ESI and PN and has a significant influence on the formation of ESI, so our suggestion is to increase media publicity and education on ESB to a certain extent.
(6) The government's EPI exert a positive moderating influence on the transition from ESI to ESB. We suggest that practical policy guidance and incentives should be implemented to promote ESB. These conclusions and policy recommendations are drawn from the empirical findings and offer valuable insights into promoting ESB among university students and the wider community.

LIMITATIONS AND FUTURE RESEARCH

This paper has three main limitations that could be improved and refined in future studies.

1. In the data part, this paper only recovered information from students of one university. Although it is representative, future research can consider collecting data related to ESB from students of universities in different cities in different regions for a more adequate and comprehensive study.
2. The data recovered from the questionnaires are self-reported by the respondents, and although they can reflect the real thoughts of the respondents to a certain extent, it would be meaningful if the method of behavioral experiments could be used to explore energy-saving behaviors further.
3. The PLS-SEM used in this paper is suitable for exploratory studies such as this one. However, it does not include many statistical characteristics of individuals for analysis in the final regression, and other models can be considered to explore the influence of individual statistical characteristics on behavior.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Boqiang Lin: Conceptualization, Methodology, Writing – original draft.
Xia Wang: Conceptualization, Methodology, Software, Data curation, Writing – original draft.

CONFLICT OF 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.

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ENDNOTE

1 (Ajzen, 1991) replaces the expression social norms with subjective norms, so in this paper, SN is an abbreviation of subjective norms.

APPENDIX A

Table 7. The distribution of the valid sample across colleges

	Freq.	Percent	Cum.
School of Humanities & Communication	87	3.12	3.12
Department of Physical Education	11	0.39	3.52
School of Informatics	221	7.93	11.45
School of Public Affairs /School of Public Policy	81	2.91	14.36
School of Public Health	52	1.87	16.22
Institute of Creativity and Innovation	4	0.14	16.37
College of Chemistry and Chemical Engineering	183	6.57	22.94
School of Medicine	317	11.38	34.31
School of International Relations	33	1.18	35.5
South China Sea Institute	3	0.11	35.61
Graduate Institute for Taiwan Studies	24	0.86	36.47
Chinese International Education College	47	1.69	38.16
College of Foreign Languages and Cultures	86	3.09	41.24
School of Architecture and Civil Engineering	70	2.51	43.75
Institute of Education	29	1.04	44.8
School of Mathematical Sciences	48	1.72	46.52
School of Journalism and Communication	73	2.62	49.14
College of Materials	89	3.19	52.33
School of Law	116	4.16	56.5
College of Ocean and Earth Sciences	85	3.05	59.55
College of Physical Science and Technology	55	1.97	61.52
College of the Environment and Ecology	57	2.05	63.57
School of Life Sciences	71	2.55	66.12
School of Electronic Science and Engineering	93	3.34	69.45
Intellectual Property Research Institute	11	0.39	69.85
School of Sociology and Anthropology	36	1.29	71.14
School of Management	273	9.8	80.94
State Key Laboratory of Marine Environmental Science	223	8	88.94
College of Energy	50	1.79	90.74
School of Aerospace Engineering.	123	4.41	95.15
College of Arts	57	2.05	97.2
School of Pharmaceutical Sciences	46	1.65	98.85
Pen-tung sah Institute of micro-nano Science Technology	15	0.54	99.39
School of Marxism	17	0.61	100
	2,786	100	

Note: The data in the table shows the college distribution of the final valid 2786 samples, with students coming from 34 colleges of Xiamen University, and the distribution of the samples is consistent with the proportion of the number of students from this college in the total number of students in the university.

Table 8. The results of the Common Method Bias test

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative%	Total	% of Variance	Cumulative%
1	17.950	21.117	21.117	17.950	21.117	21.117
2	4.826	5.678	26.795	4.826	5.678	26.795
3	3.423	4.027	30.822	3.423	4.027	30.822
4	3.091	3.637	34.459	3.091	3.637	34.459
5	2.630	3.094	37.553	2.630	3.094	37.553
6	2.463	2.898	40.451	2.463	2.898	40.451
7	2.195	2.582	43.033	2.195	2.582	43.033
8	1.995	2.347	45.380	1.995	2.347	45.380
9	1.934	2.275	47.655	1.934	2.275	47.655
10	1.754	2.063	49.718	1.754	2.063	49.718
11	1.650	1.942	51.660	1.650	1.942	51.660
12	1.540	1.812	53.471	1.540	1.812	53.471
13	1.426	1.677	55.149	1.426	1.677	55.149
14	1.328	1.562	56.711	1.328	1.562	56.711
15	1.259	1.482	58.192	1.259	1.482	58.192
16	1.223	1.438	59.631	1.223	1.438	59.631
17	1.193	1.403	61.034	1.193	1.403	61.034
18	1.137	1.337	62.371	1.137	1.337	62.371
19	1.108	1.303	63.675	1.108	1.303	63.675
20	1.052	1.238	64.913	1.052	1.238	64.913
21	1.038	1.221	66.134	1.038	1.221	66.134
22	0.989	1.164	67.297			
23	0.941	1.107	68.405			
24	0.904	1.063	69.468			
25	0.884	1.040	70.509			
26	0.862	1.014	71.522			
27	0.830	0.976	72.498			
28	0.783	0.922	73.420			
29	0.772	0.908	74.328			
30	0.762	0.896	75.225			
31	0.743	0.874	76.099			
32	0.725	0.853	76.952			
33	0.698	0.822	77.774			
34	0.686	0.807	78.580			

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Table 8. Continued

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative%	Total	% of Variance	Cumulative%
35	0.673	0.791	79.371			
36	0.639	0.752	80.123			
37	0.625	0.735	80.858			
38	0.611	0.719	81.577			
39	0.605	0.712	82.289			
40	0.587	0.690	82.980			
41	0.568	0.669	83.648			
42	0.546	0.643	84.291			
43	0.540	0.635	84.926			
44	0.524	0.616	85.543			
45	0.505	0.595	86.137			
46	0.499	0.587	86.724			
47	0.492	0.579	87.303			
48	0.475	0.559	87.862			
49	0.475	0.558	88.420			
50	0.454	0.534	88.954			
51	0.446	0.525	89.479			
52	0.432	0.509	89.988			
53	0.428	0.504	90.492			
54	0.410	0.482	90.974			
55	0.391	0.460	91.434			
56	0.384	0.451	91.885			
57	0.374	0.440	92.325			
58	0.367	0.432	92.757			
59	0.362	0.426	93.183			
60	0.352	0.414	93.597			
61	0.350	0.412	94.009			
62	0.331	0.389	94.398			
63	0.317	0.373	94.771			
64	0.312	0.367	95.139			
65	0.309	0.363	95.501			
66	0.295	0.347	95.848			
67	0.288	0.339	96.188			
68	0.279	0.329	96.516			

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Table 8. Continued

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative%	Total	% of Variance	Cumulative%
69	0.267	0.314	96.830			
70	0.250	0.294	97.123			
71	0.244	0.287	97.410			
72	0.229	0.270	97.680			
73	0.210	0.247	97.927			
74	0.202	0.238	98.165			
75	0.201	0.237	98.402			
76	0.188	0.222	98.623			
77	0.182	0.214	98.837			
78	0.175	0.206	99.044			
79	0.149	0.176	99.219			
80	0.138	0.163	99.382			
81	0.128	0.150	99.533			
82	0.124	0.145	99.678			
83	0.106	0.125	99.803			
84	0.084	0.099	99.902			
85	0.083	0.098	100.000			

Note: Extraction Method is Principal Component Analysis

Table 9. The results of Variance Inflation Factor (VIF) value for each variable

	VIF
AC1	2.370
AC2	2.077
AC3	2.914
AC4	2.642
AR1	2.143
AR2	2.459
AR3	1.949
AR4	1.514
EPA1	1.950
EPA2	1.683
EPA3	1.969
EPI1	1.568
EPI2	1.702

continued on following page

Table 9. Continued

	VIF
EPI3	1.416
ESA1	1.227
ESA2	2.782
ESA3	2.791
ESB1	1.606
ESB2	1.606
ESH	1.000
ESI1	1.688
ESI2	1.331
ESI3	1.751
ESI4	1.991
ESS1	2.289
ESS2	4.259
ESS3	4.258
ESS5	2.701
ESS6	3.150
ESS7	3.000
EVA1	5.470
EVA2	5.875
EVA3	4.442
PBC1	1.658
PBC2	2.187
PBC3	1.751
PN1	6.840
PN2	7.076
PN3	5.172
PN4	3.310
PN5	3.120
PN6	3.426
PVA1	1.724
PVA2	1.447
PVA3	1.799
SN2	3.524
SN3	3.524
SVA1	1.899
SVA2	1.347
SVA3	1.844
EPI x ESI	1.000

Note: The data in the table are the values of VIF for all variables; according to (Hair et al., 2019), there may be probable collinearity issues when $\mathrm{VIF} \geq 5$. The results show that all potential variables have VIF values less than five except EVA1, EVA2, PN1, PN2, and PN3.

Table 10. The abbreviations list

Abbreviation	Content
ESB	Energy Saving Behaviors
CADM	Comprehensive Action Determination Model
TPB	Theory of Planned Behavior
NAM	Norm Activation Model
PN	Personal Norms
ISP	Ipsative Theory of Behavior
SN	Subjective Norms
PBC	Perceived Behavioral Control
AC	Awareness of Consequences
AR	Ascription of Responsibilities
VBN	Value-Belief-Norm
PVA	Personal Value Assessment
SVA	Social Value Assessment
EVA	Ecological Value Assessment
ESS	Energy-Saving Self-Belief
ESA	Energy-Saving Access
ESH	Energy-Saving Habits
EPA	Energy-Saving Promotional Activities
EPI	Energy-Saving Policy Incentives
CSCES	College Students' Cognition of Energy and Environment Survey
CISEP	China Institute for Studies in Energy Policy
CB-SEM	Covariance-Based Structural Equation Modeling
PLS-SEM	Partial Least Squares Structural Equation Modeling
CMB	Common Method Bias
VIF	Variance Inflation Factor
HTMT	Heterotrait-Monotrait Ratio
SRMR	Standardized Root Mean Square Residual

APPENDIX B

The Items Used as Indicators of the Latent Construct in the Model

Energy-Saving Behaviors (ESB)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

ESB1: I usually adjust my air conditioner's heating/cooling temperature to save energy.
ESB2: I usually adjust my water heater's temperature to save energy.
ESB3: I usually turn off the air conditioner and lights when the room is unused.
ESB4: I usually minimize the number of times I open the refrigerator and the time it takes to open the door when accessing the food in the fridge.

Energy-Saving Intentions (ESI)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

ESI1: I am willing to seek knowledge about energy conservation actively.
ESI2: I will turn off electrical appliances when not in use instead of leaving them on standby.
ESI3: I will actively participate in the Earth Hour Lights Out program.
ESI4: I am willing to become a low-carbon and energy-saving publicity volunteer in my community or school.

Energy-Saving Habit (ESH)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

ESH1: I have cultivated a habit of purchasing energy-efficient products.

Perceived Behavioral Control (PBC)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

PBC1: I am confident in achieving my goals when I put forth my best effort.
PBC2: I am capable of quickly finding solutions when faced with difficulties.
PBC3: I am adaptable to unexpected situations.

Energy-Saving Access (ESA)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

ESA1: I possess the financial resources to purchase energy-efficient products with equivalent functionality.
ESA2: I have the expertise to evaluate the energy efficiency of products with comparable functionality.
ESA3: I do not require assistance in making decisions regarding energy-efficient products.
ESA4: I do not rely on external sources to acquire specialized energy efficiency knowledge.

Energy-Saving Self-Belief (ESS)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

ESS1: I will make personal financial sacrifices to promote rational energy consumption behaviors.
ESS2: I am prepared to forego personal lifestyle conveniences to implement rational energy consumption behaviors.
ESS3: I prioritize adopting rational energy consumption behaviors over personal lifestyle comfort.
ESS4: I am willing to potentially challenge interpersonal relationships in my pursuit of rational energy usage.
ESS5: Despite escalating energy prices and increased living expenses, I advocate for developing novel energy sources.
ESS6: I endorse the augmentation of motor vehicle energy efficiency requirements, even if it increases daily transportation costs.
ESS7: I support raising the efficiency standards for household appliances, even if it entails higher purchase costs.

Personal Norms (PN)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

PN1: Residents' prudent utilization of energy is beneficial for environmental protection.
PN2: Residents' prudent utilization of energy is beneficial for energy conservation.
PN3: Residents' prudent energy utilization is the right thing to do.
PN4: The concept of energy conservation is worth advocating.
PN5: Compared to conventional products, energy-saving products contribute to reducing global carbon emissions.
PN6: The aspect of energy-saving is solidly anchored in my value system.

Social Norms (SN)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

SN1: The attitudes and behaviors of my family, friends, and teachers can influence my energy usage.
SN2: The attention of those around me to energy-saving behaviors motivates me to implement such behaviors.
SN3: Observing those around me practice energy-saving behaviors encourages me to do the same.
SN4: The government encourages me to adopt energy-saving lifestyles.
SN5: People who are important to me in my school encourage me to adopt energy-saving lifestyles.
SN6: My family members encourage me to adopt energy-saving lifestyles.
SN7: My friends encourage me to adopt energy-saving lifestyles.

Awareness of Consequences (AC)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

AC1: It is my responsibility to conserve energy.
AC2: Saving energy gives me a sense of accomplishment.
AC3: Saving energy is indicative of my environmental literacy.
AC4: Saving energy makes a positive contribution to the environment.
AC5: Saving energy is financially beneficial to me.

Awareness of Responsibility (AR)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

AR1: Global warming is a tangible reality that necessitates emission mitigation through energy conservation.
AR2: The global climate change issue is profoundly severe, requiring emission mitigation through energy conservation.
AR3: The excessive emission of greenhouse gases is the primary driver of global warming.
AR4: You express significant concern regarding global climate change.

Energy-Saving Policy Incentives (EPI)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

EPI1: The government has implemented well-established energy-saving and environmental protection policies.
EPI2: Government policies and regulations exert either constraining or promoting effects on my energy consumption behaviors.
EPI3: I am inclined to actively engage in residential energy consumption practices advocated by the government.
EPI4: I believe the government should subsidize households' adoption of energy-efficient and environmentally friendly products.

Energy-Saving Promotional Activities (EPA)

To what extent do you agree with the statement (1=Disagree completely, =Basically disagree, 3=Unsure, 4=Basically agree, 5=Completely agree):

EPA1: Effective promotional activities can incentivize me to use energy-efficient products.
EPA2: Media campaigns have equipped me with substantial knowledge and skills related to energy conservation.
EPA3: Understanding energy-saving techniques is crucial for me in the context of energy conservation.

Ecological Value Assessment (EVA)

Please describe your level of importance for the following "nouns" based on your real thoughts. (1 = Very unimportant, 2 = Relatively unimportant, 3 = Average, 4 = Relatively important, 5 = Very important):

PVA1: Individuals' right
PVA2: Personal wealth
PVA3: Personal social status.

SVA1: Social justice
SVA2: Social interests
SVA3: Social equality
EVA1: Protecting the environment.
EVA2: Preventing pollution.
EVA3: Living in harmony with nature.

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