WEP Warwick Evans Publishing

International Journal of Natural Resources and Environmental Studies

ISSN: 3006-2012 (Print), ISSN: 3006-0834 (Online) | Volume 6, Number 1, Year 2025
DOI: https://doi.org/10.62051/ijnres.v6n1.05
Journal homepage: https://wepub.org/index.php/IJNRES/index

Study on the Influence Factors of Sustainable Energy Use Behavior

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ABSTRACT

China is both the world's largest clean energy market and the world's largest polluter. However, nearly a third of the world's CO_2 emissions also come from China. The Chinese government recognizes the importance of changing household lifestyles and energy consumption patterns to achieving the "two-carbon goal". Therefore, vigorously promote residential photovoltaic power generation (PV) and the transition from traditional fossil fuels to renewable energy sources (such as solar power generation). This paper studies the influencing factors on residents' willingness to conduct sustainable energy use.

KEYWORDS

Willingness to use sustainable energy; Residential photovoltaic systems (PV); Perception; Social impact.

1. INTRODUCTION

Solar energy is typically considered one of the most sustainable options for households or communities. Distributed photovoltaic installations at the user end reduce transmission losses on the public grid, lower grid operation costs, and small-scale power generation offers greater safety and stability, higher utilization efficiency, and a lower proportion of wasted solar energy. The adaptability of photovoltaics also makes them suitable for areas where other solutions are difficult to implement (Zhao et al., 2023). According to statistics, residential consumption accounts for two-thirds of global carbon emissions (Liu et al., 2023).

Schulte et al. (2022) points out that the adoption of residential photovoltaic systems (PV) is seen as a crucial component of the sustainable energy transition. By October 2021, the number of residential PV installations in China had exceeded 6 million households, impacting over tens of millions of individuals (Shali Wang 1 & and Shuangshuang Fan 1, 2023). The cumulative installed capacity of residential PV increased from 0.93GW in 2016 to 20GW in 2020, with an annual growth rate exceeding 40%. To facilitate this process, it is essential to identify the determinants of solar energy adoption. Most existing survey literature on factors influencing the willingness to use sustainable energy focuses on technical, economic, and environmental benefits, poverty alleviation performance, and political impact (Shaw & Sergueeva, 2019). However, less obvious psychosocial factors (e. g., community awareness, perceived risk, perceived value) can also have a significant impact on individuals' willingness to participate in solar PV adoption. China is a personal sentiment society, especially in the west, in which the perspective of social influence and environmental awareness affects the sustainable energy use behavior of residents. Iuliana Petronela Gârdan and Gârdan (2023)

show that attitudes towards renewable energy consumption are strongly influenced by the other latent constructs with perceived utility, social influence and concern for the environment being among the most determining ones. Behavioral intentions and the actual consumption behavior for RE are more and more clearly expressed in terms of decisions regarding the type of renewable energy technology preferred by consumers.

William Philip Wall (2021) indicates that the findings of the study indicated that perception of self-effectiveness, environmental concern, renewable energy awareness, and beliefs about renewable energy benefits have a significant and positive effect on consumers' intention to adopt renewable energy. This study explored the influence factors of social residents on the willingness or behavior of purchasing solar PV panels.

1.1. Effects of Perceived Value(PV) on behavioural Intention(BI) and Usage Intention Sustainable energy(UISE)

According to Zeithaml (1988), perceived value is defined as the overall evaluation of the utility of a product or service based on consumers' perceptions of what they receive and what they must spend. Zeithaml (1988) also argues that perceived value is personal and subjective; consumers have different views on perceived value depending on their own circumstances, thus there are many ways to break down perceived value into various components. Most researchers believe that perceived value has two influential components: "utility value" and "enjoyment value" (Gutman, 1982).

Zeithaml (1988) emphasized the definition of perceived value, which is the most widely accepted definition. He proposed that perceived value is "the overall assessment of utility by consumers, based on their perception of gains and losses." Woodruff (1997) further expanded the definition of perceived value, suggesting that customer value is the preference and evaluation of product attributes and their utility by customers, which either help or hinder them from achieving their goals in specific environments; this extension has been accepted by many scholars.

The study of perceived value and its influence on consumer consumption intention and behavior has attracted the attention of scholars for many decades ago. Numerous studies have shown that, Perceived value influences consumer attitudes and behaviors (Chen et al., 2012; Gardan et al., 2023; Muhammad Irfan, 2021; Wang et al.,2019; Woodruff, 1997; Zeithaml, 1988; Han Chenchen & Zhang Hongmei, 2022; Hu Yingen et al., 2020; Li Lulu et al., 2022; Yuan Xiangling, 2022; Zhang Penggui, 2018; Zhao Min & Wang Lu, 2019; Zhong Kai, 2013). Chen et al. (2012) pointed out that perceived value is significantly associated with purchase intention, and Gardan et al. (2023) also pointed out that intention to renewable energy consumption is strongly influenced by other potential structures, among which perceived utility is one of the most decisive factors. The research of Hu Yingen et al. (2020) shows that the perceived value of consumers affects their purchase intention and behavior through the paid value of farmers' withdrawal from the homestead. Wang et al. (2019) pointed out that perceived gain was significantly and positively correlated with public acceptance. Han Chen Chen and, Zhang Hongmei (2022) pointed out that the perceived value and trust of consumers in the process of using the travel APP have a significant positive impact on their continuous use intention. Shaw and Sergueeva (2019) found that perceived value positively affects consumers' willingness in the mobile business context. Liu Fang and, Li Hanwei (2023) proposed that value can be perceived in the process of exchange, use or experience, and influence the behavior of consumers. Perceived value helps to predict the behavioral outcomes of individuals in the field of social marketing (Yuan Xiangling, 2022). Zhong Kai (2013) proposed that utilitarian value and hedonic value affect individuals' repeated purchase intention in the network situation. Nguyen et al. (2024) found that perceived value positively affects consumers' willingness in mobile commerce situations. Individual acceptance of Internet financial management platforms belongs to the consumption behavior of financial services. Since previous research suggests that individual perceived value influences the willingness to consume, individual willingness to adopt is influenced by the perceived value of fintech

platforms. There are also individual literature Muhammad Irfan (2021) stating that consumers' beliefs about the benefits of PV have no significant impact on their willingness to adopt PV. Roy and Mohapatra (2022) noted the non-significant impact of perceived value on residents' solar use, indicating macro forces hindering adoption, and this finding may be directly related to the low adoption rate of PV in India. Even with a general level of awareness and knowledge of alternative energy sources, the average consumer is still not fully aware of the details related to the installation that may be complementary to existing power sources of electricity.

1.2. Effect Perceived Risk(PR) towards behavioural Intention(BI) and Usage Intention Sustainable energy(UISE)

Perceived Risk The initial concept was extended from psychology by Bauer (1960) at Harvard University. Risk perception refers to an individual's ability to discern the risks involved or associated with specific activities (Komendantova, 2012). He believed that any purchasing behavior of consumers may not be able to determine whether their expected outcomes are correct, and some outcomes might make consumers unhappy. Therefore, there is an inherent uncertainty about the outcome in consumer purchasing decisions, and this uncertainty is the original concept of risk.

Cox (1967) elaborated on the concept of perceived risk following Bauer's (1960) research. He argued that the fundamental assumption in the study of perceived risk theory is that consumer behavior is goal-oriented, with a set of purchase objectives for each purchase. When consumers subjectively cannot determine which consumption choice (location, product, brand, style, size, color, etc.) best aligns with or satisfies their goals, perceived risk arises. Alternatively, when the outcome after a purchase does not meet the expected goal, the potential adverse consequences also generate perceived risk.

When it comes to renewable energy, this means an individual's assessment of the risks associated with its use. This leads to another concept: risk tolerance. The adoption of specific technologies strategically depends on an individual's perception of risk and their level of risk tolerance. If someone believes that using renewable energy is relatively low-risk compared to other energy sources, they may adopt renewable energy; the opposite is also true.

Perceived risk variables are important antecedent variables in the study of individual consumption behavior. For new energy technologies, as a technology product that has not been popularized, people's understanding of new energy technologies is limited to the emotional level and there is great uncertainty, so it is appropriate to include them into the theoretical model of this paper. Perceived risk in this paper refers to the risks that may be encountered in the use of sustainable new energy sources in the local area.

Research has long explored the impact of perceived risk on consumer intentions and behaviors. Numerous studies have shown that perceived risk influences consumer usage intentions (Chen et al., 2012; Marakanon & Panjakajornsak, 2017; Wang et al., 2019; Han Chenchen & Zhang Hongmei, 2022; Li Chuang et al., 2021; Liu Ruyi, 2020; Shao Peng et al., 2020; Yin Jielin et al., 2019). Chen et al. (2012) pointed out that the perceived risk has no correlation with the purchase intention of the hydrogen electric motorcycle. Chen et al. (2012) pointed out that individual perception and intention of ev risk are inversely related. That is to say, if consumers think that the purchase of electric vehicles will bring financial pressure on later maintenance and maintenance, possible personal safety concerns caused by driving failure, and the time cost of charging, their intention to buy electric vehicles will also decrease. Marakanon and Panjakajornsak (2017) shows that perceived risk and customer trust have a direct impact on customer loyalty. Wang et al. (2019) mentioned that perceived risk was significantly and positively associated with public acceptance.

1.3. Effect Social Influence(SI) towards behavioural Intention(BI) and Usage Intention Sustainable energy

Social influence refers to the social phenomenon where individuals or groups use their social power to change others 'attitudes or behaviors in a specific direction. Or, it can be described as an individual's perception of others' opinions about adopting a particular technology and the extent to which these opinions influence their decision to accept and use the technology. The effectiveness and degree of this impact are constrained by the actors, communicators, and recipients involved.

Social influences also play a decisive role in the attitudes and behaviors of consumers (Bollinger & Gillingham, 2012; Gardan et al., 2023; Kulviwat et al., 2009; Li et al., 2022; Muhammad Irfan, 2021; Roy et al., 2021). Social interaction (peer) effect is considered as a potentially important factor in the spread of new products. For environmentally friendly products or technologies, both marketers and policy makers are interested in the existence of causal peer effects because social spillover effects can be exploited to accelerate procurement (Bollinger & Gillingham, 2012).

Therefore, to better understand individual photovoltaic adoption decisions, it is necessary to gain a deeper understanding of the interactions and influences among photovoltaic stakeholders. Drawing on social psychology literature, this paper defines social influence as changes in decision-makers' behavior caused by the actions of another stakeholder (Raven, 2008). Since stakeholders may participate at different stages of decision-making with varying degrees of involvement, the term "stakeholder dynamics" describes the roles stakeholders play in the photovoltaic adoption process, related to environment and time, as well as the extent of social impact (Scheller et al., 2021).

Gardan et al. (2023) points out that attitudes toward renewable energy consumption are strongly influenced by other underlying structures, with social influence being one of the most decisive factors. Kulviwat et al. (2009) results show that both social influence and adoption attitudes have a positive impact on consumers' willingness to adopt innovations. Moreover, the relationship between social influence and willingness to adopt is stronger when innovation is consumed openly rather than private. With the enhancement of villagers' community awareness, the willingness to adopt solar energy increases first and then decreases. In general, the locals have a strong desire to be independent, unwilling to blindly follow government policies, and actively responding to the promotion of solar energy by respected local community leaders (Li et al., 2022). The opinions of peers, relatives, neighbors and society profoundly influence the thinking of local residents, noting that the perception of neighbor involvement has a positive impact on consumers' willingness to adopt renewable energy. Factors such as social impact have a positive impact on consumers' willingness to adopt sustainable energy sources (Muhammad Irfan, 2021). Roy et al. (2021) pointed out the behavioral intention that social influence positively affects solar energy adoption. Roy and Mohapatra (2022) also noted that the significant impact of social influences on consumer behavioral intentions suggests that there are strong social factors in terms of status, which may benefit consumers' use of solar generators. The results of Shaw and Sergueeva (2019) show a positive response to the move by respected local community leaders to promote solar energy. Iuliana Petronela Gardan and Gardan (2023) noted that policy makers can exert social influence in their efforts to act for national energy and climate plans. According to the previous definition of social influence, this paper believes that social influence refers to the influence of neighbors on the willingness of community residents to adopt new sustainable energy technologies. Especially in the western region is obviously different from the characteristics of a second-tier cities, formed on the basis of kinship tribe, some studies show that in the "acquaintance society", the most effective way is to use the network to promote agricultural technology, and the role of "opinion leader" plays a key role in this respect, their views and actions will have a significant impact on other community residents.

1.4. Effects of Enviromental Awareness(EA) on behavioural Intention(BI) and Usage Intention Sustainable energy

Environmental awareness (EA) is defined as the level of awareness households have about environmental challenges and their determination to address these issues. A key aspect of consumer acceptance of new technologies is awareness (Merikle et al, 2001). From the perspective of RE, awareness is considered to be residents' knowledge of RE technologies, as well as their understanding of their costs, efficiency, and related issues (Komendantova and Yazdanpanah 2017).

Environmental awareness (EA) is defined as the family's perception of environmental dilemmas and the determination to address these problems. Research on the influence of environmental awareness on consumer behavior has attracted the attention of scholars for many decades ago. Numerous studies have shown that, Environmental awareness plays a decisive role in consumers' attitudes and behavior (Austmann & Vigne, 2021; Gardan et al.,2023; Iuliana Petronela Gardan & Gardan, 2023; Li et al.,2022; Muhammad Irfan, 2021; Shaw & Sergueeva, 2019) and (Wall, W. P., Khalid, B., Urbanski, M., & Kot, M. 2021) are both mentioned.

Environmental awareness, as a kind of thought and concept, has existed since ancient times. But as a term and the connotation of modern environmental awareness contained in this term is new. Simply put, environmental awareness in this paper refers to the awareness of environmental protection. Modern environmental awareness was first advocated in the West, and the Chinese translation of the word comes from "Environmental Awareness". Internationally, the term "environmental awareness" and its connotation of modern environmental awareness appeared in the 1960s.Environmental awareness can precede environmental behavior. However, even if people have ecological awareness, they may not necessarily exhibit eco-friendly behavior. Environmental awareness is the first step towards becoming an informed consumer (Carlson, 2005). We can say that environmental awareness is realized through ecological motivation, which manifests as eco-friendly behavior. There are essentially two attitudes used to predict eco-friendly behavior: one towards nature itself and another towards eco-friendly behavior.

In 1968, American scholar Roth first introduced the concept of environmental literacy (Environmental literacy), which closely aligns with the meaning of environmental awareness. In fact, environmental literacy can be considered synonymous with environmental awareness. At the time, the media believed that environmental pollution was caused by those who were environmentally blind (Environmental illiterates). Roth then proposed how to identify citizens with environmental literacy, leading to the introduction of the concept of environmental literacy.

As far as China is concerned, the term "environmental awareness" first appeared in formal occasions at the second National Environmental Protection Conference held in 1983 (see Comrade Liao Hansheng's written speech at the second National Environmental Protection Conference on December 31,1983). Environmental awareness has been gradually accepted by the international community. In some developed countries, environmental awareness has become a trend and has gradually become a part of people's consciousness. It not only requires regulating individual lifestyle, but also requires regulating community and whole society's lifestyle and economic activities

Economic motivation, environmental issues, and the desire to improve China's national image are the strongest predictors for adoption (Li et al., 2022). Austmann and Vigne (2021) shows that whether a person is concerned about climate change and sustainability, that is, having environmental awareness, may affect his decision to buy an electric car. The underlying hypothesis is that an increase in EA leads to more EV sales, and thus more EV registrations. Gardan et al. (2023) pointed out that attitudes towards renewable energy consumption are strongly influenced by other potential structures, among which environmental attention is one of the most decisive factors. Iuliana Petronela Gardan and Gardan (2023) The results show that attitudes towards renewable energy consumption are strongly influenced by other potential structures, of which perceived utility, social impact and focus to the

environment are the most decisive factors. The behavioral intention and actual consumption behavior of renewable energy are increasingly clearly reflected in the preference of consumers for the type of renewable energy technology, and the correlation with variables such as education level and higher income is also easily emphasized.

Muhammad Irfan (2021) pointed out that influencing factors such as environmental awareness have a positive impact on consumers' willingness to adopt RE. The results of Shaw and Sergueeva (2019) show that environmental problems and the desire to improve China's national image are the strongest predictors of adoption. Chapter summary

This study analyzes the impact of perceived value, perceived risk, social influence, and environmental awareness on sustainable energy use, supported by empirical literature. The significant effect of social influence on consumer behavioral intentions indicates strong social factors in status display, which may encourage consumers to use solar generators. The influence of environmental awareness highlights the growing concern among today's residents about ecological environments. Overall, perceived value, perceived risk, social influence, and environmental awareness are closely related to the willingness to use sustainable energy.

1.5. Effects of behavioural Intention(BI) on Usage Intention Sustainable energy(UISE)

Iuliana Petronela Gardan and Gardan (2023) points out that behavioral intentions are expressed as the results of prior antecedents such as knowledge, usefulness, expectations, beliefs, and attitudes. Intentions can be further articulated through specific behaviors like loyalty, word-of-mouth, or willingness to pay. In the context of renewable energy consumption, from the perspective of environmental protection capabilities, this form of perceived utility represents a significant antecedent for behavioral intentions, aligning with trust that can lead individuals to positive actions toward new technological forms.

Intention has always been a crucial factor in research. An individual's behavior is influenced by their intention, making it the core antecedent variable for action. People's intentions regarding the use of sustainable energy determine specific usage behaviors. Previous scholars have applied the technology acceptance model to numerous research fields. This paper primarily builds on previous studies and makes modifications to fit the specific context of this study. Therefore, the scale design mainly references Davis (1986) and Ajzen (2006), who provide more detailed measurement scales.

The concept of intention belongs to the category of psychology. The rational behavior theory of Fishbein and Ajzen defines the behavior intention as the subjective probability of an individual taking a specific behavior. From this point of view, the purchase intention is the subjective probability that consumers are willing to buy a certain product. To predict the consumer behavior, we must start with understanding the consumers' purchase intention. Although the consumers have the purchase intention and do not necessarily implement the purchase behavior, the occurrence of the purchase behavior must be based on the existence of the purchase intention. Purchase is a kind of behavior, willingness is a kind of psychological activity, Purchase intention means thinking about the purchase behavior, and positive purchase intention will lead to the occurrence of purchasing behavior. He Yewei (2017) defined the intention to buy new energy vehicles as the plan and intention of consumers to buy new energy vehicles.

If consumers believe that electric vehicles can improve the quality of life and easy to drive can improve their tendency to buy electric vehicles, the stronger the experience of ease and usefulness of electric vehicles, the more positive their purchasing attitude towards electric vehicles (Chen, 2020). Roy et al. (2021) found that the intention to adopt solar energy has a positive impact on switching behavior. RoyandMohapatra (2022) noted an encouraging finding regarding the relationship between behavioral intention and switching behavior. The study results indicate that if consumers are

persuaded to adopt SSPV (behavioral intention), they may switch from their existing home power source to an alternative one.

Iuliana Petronela Gârdan and Gârdan (2023)The results show that attitudes towards renewable energy consumption are strongly influenced by the other latent constructs with perceived utility, social influence and concern for the environment being among the most determining ones. Behavioral intentions and the actual consumption behavior for RE are more and more clearly expressed in terms of decisions regarding the type of renewable energy technology preferred by consumers.

Regarding the acceptance process of renewable energy technologies, people will gradually become aware of the negative environmental impacts of using classic "brown" energy sources, such as noise and air pollution, climate change, and biodiversity destruction in certain geographic areas. Due to rising energy prices and insufficient energy supply, living standards and safety levels have declined. Therefore, how people define their views on accepting new technologies in the energy sector, along with the risks and benefits these technologies bring, shapes the extent of individual norms' expression and updates in consumption and acceptance behaviors.

2. CHAPTER SUMMARY

This study analyzes the impact of perceived value and perceived risk on sustainable energy use, which is supported by empirical literature. In general, Enviromental Awareness， Social Influence， perceived value and perceived risk are closely related to the willingness to use sustainable energy.

ACKNOWLEDGMENT

This work was financially supported by Anhui Xinhua University Innovation Team Project (Kytd202204).

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