



Factors Influencing the Intention to Use Solar Rooftop Energy of Households in Thailand

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ARTICLE INFO

Article history:

Received: 12 February 2022

Revised: 21 June 2022

Accepted: 12 August 2022

Keywords:

Attitude

Government policy

Subjective norm

Intention to use

ABSTRACT

As economic growth influences the higher demand for using electricity, there is a need to increase the norm and attitude influencing the intention to generate green electricity, which is a key source of energy to drive the country's economy and development. Therefore, the objectives of this research were to study the total, direct, and indirect effects of the variables on the intention to use solar rooftop energy of households in Thailand, and to develop a model of the government policy and subjective use of solar rooftop energy of households in Thailand. This study was a quantitative research in which a set of questionnaires was used as an instrument to collect data from 240 samples, i.e., houses in all regions of Thailand. The samples were obtained by convenience sampling, and the data analysis relied on descriptive statistics and the structure equation model (SEM). The results showed that "Government Policy", "Subjective Norm", and "Attitude" had positive effects on the intention to use solar rooftop energy of households in Thailand. The model conformed to the empirical data with a significance level of 0.001. However, the government should set a security policy for the development of electricity generation by mixing sources of fuels in order to reduce the risk of heavily relying on a certain type of fuel. The transmission system should also be developed for greater reliability along with promoting the use of renewable energy to enhance the electric energy security of the country in the future.

1. INTRODUCTION

Electricity is a key source of energy to drive the economy and development of each country. Specifically, in the past two decades, Thailand has been one of the countries with unceasing economic growth resulting in a huge increase of the need to use electricity. This is related and has conformed to the growth of the GDP, which found that the rate of electricity use has increased by average 4.46% annually in the past three years. Consequently, the power sector has had to generate electricity in order to support the growing need for driving the economy as aforementioned. Moreover, it is predicted that the total electricity consumption will increase more than twofold in the next 20 years or from 198,204 GWh in 2017 to 430,693 GWh by 2037. Furthermore, electricity imported from the neighboring countries, i.e., Lao PDR., Myanmar, China, Cambodia, and Malaysia have tended to continually increase. The rate of importing electricity is currently at 6.4%, which is still lower than the policy that does not allow electricity imports of over 15% of the total amount of energy [1]. Thus, Thailand still tends to rely on great amount of energy from other countries. This affects the

energy security, economic development, and very low energy security [2]. That is why the policy to quickly supply national sources of energy must be implemented together with renewable energy development in the country. Most renewable energy that can be developed is from solar energy. Even so, it still contains some limitations, e.g., a large space is required; agricultural areas are used, and it is an intermittent energy source as it needs sunlight. Nonetheless, Cardenas et al. [3] conducted a study on assessing the combined effects of the diffusion of solar rooftop generation, energy conservation and efficient appliances in households. They found that the use of solar rooftop energy in households according to the case study in Columbia could save costs on the electricity bill and reduce pollution. Similarly, Kim et al. [4] undertook research on an integrated adoption model of solar energy technologies in South Korea and found that the quality of the perception of the benefits and trust was necessary to determine the people's attitudes toward the use of solar energy. This further conformed to Pavel [5], who stated that consumers' perception of the benefits of solar energy was that it did not only reduce the greenhouse effect, but the people could

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also take part in generating electricity from rooftop solar cells. Due to the problems as stated, the researchers were interested in studying the variables with the direct, indirect, and overall effects on the intention to use solar rooftop energy of households in Thailand and to develop a model of the government policy and subjective use of solar rooftop energy of households in Thailand. The purposes were to show the key roles of electricity generation by solar rooftop from residential houses, to create knowledge and understanding, and to guide the concerned persons to view the variables affecting the interest to solar rooftop energy.

2. LITERATURE REVIEW

Attitude

Attitude is a key psychological concept [6]. Some academicians have defined attitude as an index indicating how an individual think and feels toward his/her surroundings and situations. An attitude is based on a belief that might affect future behavior. Kotler [7] defined attitude as a tendency learned by an individual in order to behave following his/her satisfaction or dissatisfaction toward a thing. Fredricks et al. [8] also suggested that a hidden tendency to respond to the level of satisfaction or dissatisfaction toward a thing is a psychological result, too. Moreover, attitudes conform to consumers' ideas and beliefs toward products [9, 10] conducted a study on the intention to adopt photovoltaic systems depending on the homeowners' expected personal gain and behavior of their peers. It was found that basic satisfaction and consumers' attitudes were the key factors to predict purchase intention. Additionally, Engelken et al. [11] conducted a study on the basic factors that led to the motivation of influencing the intention of a household to buy parts of a renewable energy system. The results revealed that subjective attitudes and perception of behavior control were the key predictive tools of the purchase intention. Hence, policy planners could promote the purchase behavior of homeowners by using the strategies of the financial benefits and subjective norm. The researchers of this current study applied these concepts and theories to understand the attitudes toward solar rooftop energy installation of households in Thailand. Hence, various academicians and researchers have summarized the observed variables, i.e., 1) cognitive component, 2) affective component, and 3) behavioral component [4, 12, 13, 14, 15, 16, 17].

Government Policy

Zhang et al. [18] defined the concept of a government policy as the terms or conditions drafted by the government of each country in order to show its vision, mission, and transparency of its administration, including rigidity to clarify those terms and conditions related to solar PV system installation and production; for example, educating

consumers, conducting research and development (R&D), and providing financial support [19], including the promotion and support of the industry of renewable energy product manufacturing by the government of each country, so that those products would become recognized and accepted by people in all sectors [20]. Long et al., [21] conducted a study on the photovoltaic industry policy implemented in China and concluded that apart from the legal obstacles as the risks of ambiguity, the technological limitation in terms of accessing solar cell installation was also an impediment. Thus, it is required for the industry and the government to cooperate in an information sharing mechanism, so that entrepreneurs would obtain updated information to develop the photovoltaic industry. This conformed to the research of Kilinc-Ata [22]. Therefore, the researchers of this current study concluded that a government policy refers to the terms of the promotion and support from the government for R&D and solar energy system installation to be recognized and accepted by the people in all sectors. Thus, various academicians and researchers have summarized the observed variables, which included 1) technological support, 2) economic support, and 3) regulatory support [23, 24, 25].

Subjective Norm

Another key factor influencing purchase behavior and purchase intention is word of mouth. Most marketers prefer using advertising and the publicizing of products and services through individuals so as to reach targets quickly [26]. Moreover, Stephen Read [27] stated that social pressure arises from potential groups of people on individuals to intend to do something. Whether or not consumers or targets will purchase those products or services depends on any potential people influencing their attitudes, decision-making, and behavioral change by convincing the listeners to defer to their emotions and feelings [28] until the listeners' attitudes or viewpoints finally change as per the expectation of those speakers [29]. Subjective norm was suggested in the theory of planned behavior. It explained that before intention occurs, subjective norm might be shown following the reference groups before the action. Subjective norm also influences attitudes and behavior, which affect the intention later on. People with a subjective norm behave by following the reference groups that are necessary for them. The more subjective norm an individual has, the more it affects their intention without any ethical and unethical decision-making [30, 31]. Norazah [32] conducted a study on consumers' intention to buy and use pirated software and found that a significant and positive relationship existed between reciprocal fairness, procedural fairness, subjective norm, attitude, and the consumers' intention toward software piracy. In the same way, Yoon [33] revealed that ethical commitments; e.g., attitude, subjective norm, and perceived behavioral control influenced the behavioral

intention of individuals with digital piracy. Therefore, various academicians and researchers have concluded the summarized observed variables that included 1) social pressure, 2) normative belief, and 3) motivation to comply with the reference [5, 28, 34].

Intention to Use

Purchase intention is a behavior showing the tendency of the purchase decision-making [35]. This is similar to the prediction or expectation of consumers' behavior in the future. With the purchase intention, consumers may decide to buy or not buy a product or service. However, if there is a positive tendency of a purchase, purchase behavior will occur. Furthermore, behavior is usually influenced by obtaining information about the attributes and quality of the products and services [36]. Thus, the heart of product manufacturing is to be aware of customers' needs, feelings, and obtained value from the consumption. These are the key factors of the intention to use or purchase intention with sustainability. Hence, studies on the intention to use renewable energy require consumers' needs and attitudes, which would lead to the intention to use the products as stated [37]. Likewise, Abreu et al. [38] found that subjective norm had positive direct effects on attitudes, and that attitudes had positive direct effects on the adoption of a rooftop PV system over buildings in the United States of America. As such, various academicians and researchers have concluded that the observed variable was the behavioral intention [39, 40, 41].

3. METHODOLOGY

The development of a structural equation model of the factors influencing the intention to use solar rooftop energy of households in Thailand was a mixed research methodology. For the quantitative research, the data were explored based on the current situation. A set of questionnaires was used for conducting a survey with the homeowners from August to September 2018. The qualitative research included an in-depth interview, literature review, and observation by the researchers, experts from the solar energy industry, and executives as well as employees from the related public and private agencies. The questionnaires were used as a research instrument to collect data from 240 samples, i.e., houses in all regions of Thailand. The convenience sampling was used for randomizing the population in each stratum. Data analysis relied on descriptive statistics and the structure equation model (SEM). A seven-point Likert rating scale [42] was used for designing the measurement tool or the questionnaires. Then, 30 sets of the questionnaires were used for collecting the data from homeowners to be used in

the pretest in order to check the reliability by Cronbach's Alpha. The pretest result showed the value of .957, which was over 0.70; implying a high reliability. The sample size in this research was set at the ratio of 20 samples per one observed variable [43] for the accurate estimation, for being used as good representatives of the population [44], and for using with a normal curve distribution. The total required samples as per the conditions were 240 households (12 x 20 = 240). The data were analyzed by AMOS to evaluate the relationships between the variables.

4. RESULTS AND DISCUSSION

The research model is shown in Fig.1. The analyzed results of the multiple variables and multiple regression of the SEM were combined together in order to check the relationships between the variables (Hair et al., 2010). It was found that Chi-square = 36.397, df = 28, p = 0.133, CMIN/DF = 1.300, GFI = 0.977, CFI = 0.996, AGFI = 0.935, and RMSEA = 0.035. The model conformed to the empirical data with a significance level of 0.001. When considering the standard regression weight and squared multiple correlation (R^2), a high value was found, and thus the observed variables could not be disregarded. To conclude, the model of the factors influencing the intention to use solar rooftop energy of households in Thailand conformed to the empirical data [43, 44].

Referring to Table 1, the "Intention to Use" had a standard regression weight between 0.884-0.950 with an R^2 or squared multiple correlation between 0.782-0.902. The "Subjective Norm" had a standard regression weight between 0.721-0.921 with an R^2 or squared multiple correlation between .520-.847. "Attitude" had a standard regression weight between 0.821-0.979 with an R^2 or squared multiple correlation between 0.475-0.949. "Government Policy" had a standard regression weight between 0.777-0.923 with an R^2 or squared multiple correlation between 0.603-0.852.

The analysis results were conveyed to propose the following equation:

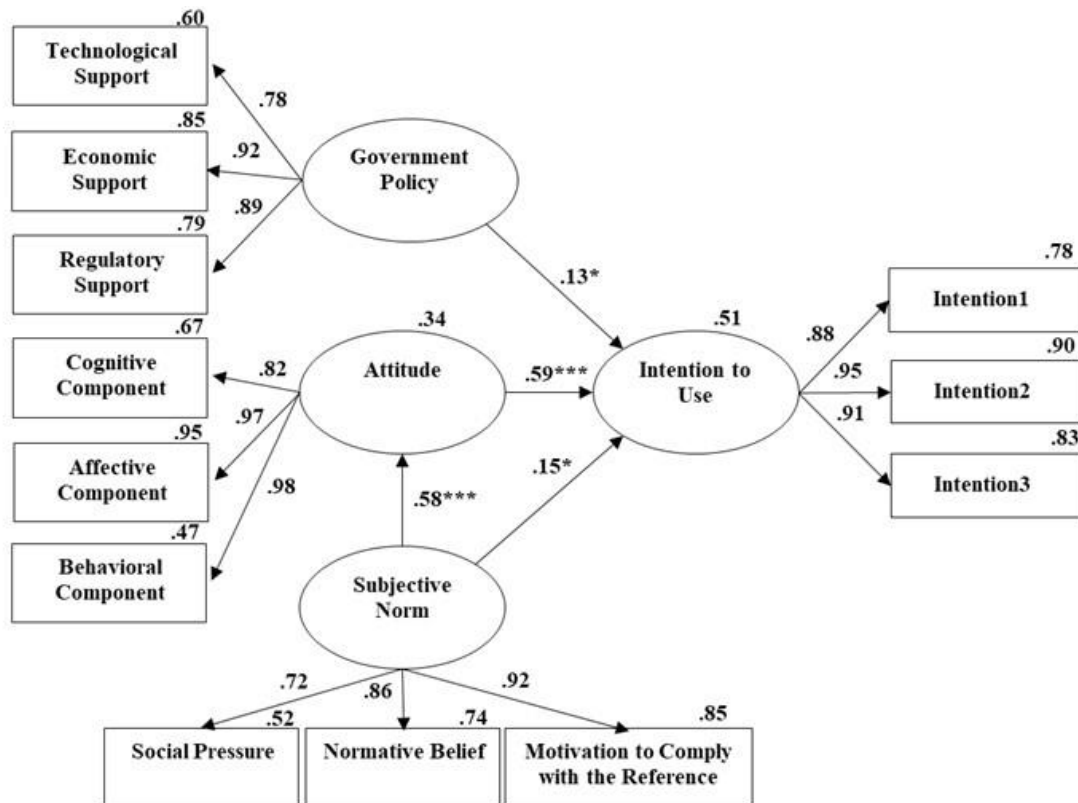
$$\text{Intention to Use} = 0.13[\text{Government Policy}] + 0.59[\text{Attitude}] + 0.15[\text{Subjective Norm}], R^2 = 0.51 \quad (1)$$

According to the equation (1) in above, it was found that the "Intention to Use" was positively and significantly affected by "Government Policy," "Attitude," and "Subjective Norm." The variation of the "Intention to Use" could be explained as 51%.

Table 1. The analysis of the relationships between the variables in the structural equation model

Relationship between Variables	Standard Regression Weights	S.E.	R ²	C.R.	p
Attitude <-- Subjective Norm	.580	.065	.336	8.531	***
Intention to Use <-- Government Policy	.133	.079	.509	2.536	.011
Intention to Use <-- Subjective Norm	.146	.086		2.088	.037
Intention to Use <-- Attitude	.585	.088		8.617	***
Intention1 <-- Intention to Use	.884	.062	.782	15.153	***
Intention2 <-- Intention to Use	.950	.052	.902	19.296	***
Intention3 <-- Intention to Use	.912		.832		
Behavioral <-- Attitude	.979	.131	.475	9.437	***
Affective <-- Attitude	.974		.949		
Cognitive <-- Attitude	.821	.048	.675	17.165	***
Economic <-- Government Policy	.923		.852		
Regulatory <-- Government Policy	.886	.056	.786	18.807	***
Technogical <-- Government Policy	.777	.058	.603	15.412	***
Social <-- Subjective Norm	.721	.077	.520	9.598	***
Normative <-- Subjective Norm	.858		.737		
Motivation <-- Subjective Norm	.921	.073	.847	12.903	***

Note: The significance level *** p < .001.



Chi-square (χ^2) = 36.397, df = 28, p = .133, CMIN/DF (χ^2/df) = 1.300, GFI = .977, CFI = .996, AGFI = .935, and RMSEA = .035

Fig.1. Final model.

Table 2. Hypothesis testing results

Hypothesis	Coef.	t-test	TE	DE	IE	Results
H1: Intention to Use <-- Government Policy	.133	2.536	.133	.133	.000	Supported
H2: Attitude <-- Subjective Norm	.580	8.531	.580	.580	.000	Supported
H3: Intention to Use <-- Attitude	.585	8.617	.585	.585	.000	Supported
H4: Intention to Use <-- Subjective Norm	.146	2.088	.485	.146	.339	Supported

Note: Coefficient refers to the Beta, TE: Total effects, DE: Direct effects, IE: Indirect effects, and Coefficient: coef.

Hypothesis Testing Results

According to the hypothesis testing and effect assessment between the variables based on the consideration of the C.R. (t-value) and p-value, it was found that C.R. was over 1.96 in all hypotheses. Thus, this concluded that the analysis results supported all hypotheses. The analysis results of the effects of the factors are shown in Table 2.

According to H1: "Government Policy" had direct effects on the "Intention to Use". The hypothesis testing results revealed that the standardized coefficient (coef.) = 0.133. Thus, H1 was accepted with statistical significance.

According to H2: "Subjective Norm" had direct effects on "Attitude". The hypothesis testing results revealed that the standardized coefficient (coef.) = 0.580. Thus, H2 was accepted with statistical significance.

According to 'H3: "Attitude" had direct effects on the "Intention to Use". The hypothesis testing results revealed that the standardized coefficient (coef.) = 0.585. Thus, H3 was accepted with statistical significance.

According to 'H4: "Subjective Norm" had direct effects on the "Intention to Use". The hypothesis testing results revealed that the standardized coefficient (coef.) = 0.146. Thus, H4 was accepted with statistical significance.

The study revealed that "Government Policy", "Attitude", and "Subjective Norm" influenced the intention to use solar rooftop energy of households in Thailand. The hypothesis testing results significantly supported the research in all hypotheses. "Attitude" was the factor with the highest effects. The acceptance by the family and society was a key factor influencing the use of a solar rooftop. The public sector also supported the R&D in terms of a solar rooftop system more than before. The results conformed to the study of Engelken et al. [11], who found that attitude, perception, and behavioral control were the key predictive tools of the purchase intention. In addition, the purchase behavior of the homeowners could be promoted by the strategy of the information about the financial benefits and subjective norm. The study of Kilinc-Ata [22] revealed that the economic policy affected investors on their investment in solar energy installation. For this reason, the public sector must promote investment in order to fulfill the people's needs. In contrast, Stephen Read et al. [27] suggested that social pressure influences individuals to have a purchase intention toward products or

services, including potential people influencing their attitudes, decision-making, and behavioral change to defer the emotions and feelings of the speakers [28]. Advertising media about a solar rooftop were also taken into account, e.g., TVs, magazines, or social networks. They were the key factors that could make users interested in and intend to use a solar rooftop system.

Therefore, from the study results, it can be analyzed that, in practice, Government Policy, Subjective Norm, Attitude, and Subjective Norm are important factors influencing intention to use solar rooftop energy of households in Thailand. People's attitude is the most important factor in predicting behavioral intention in their decision-making which is based on experiences in impression of something. Therefore, behavior will be expressed according to emotions and feelings in the decision-making process to choose the one that is most appropriate, as well as having access to the knowledge that the use of solar cells is easy and convenient to use and beneficial for daily consumption in practice. However, most people tend to look at their own interests first regarding the benefit from solar rooftop, then the benefit to the society such as the environment awareness usually comes later.

5. CONCLUSION

Nowadays, the economy keeps growing strongly; thus, the world's need to use electricity has hugely increased followed by the trend of environmental conservation. Hence, the policy to quickly supply national sources of renewable energy must be implemented. Renewable energy that mostly comes from a solar power plant is a form of natural energy that would never be exhausted and can be recycled for continuous use. Furthermore, the public sector has a measure to seriously promote more electricity purchase. Still, an advantage of the less use of fossil fuels for electricity generation is the reduction of pollution due to fuel transportation and combustion during the process of electricity generation. Thus, this study on solar energy in households would be beneficial to educational institutions and private entrepreneurs with an interest in participating in solar rooftop entrepreneurship. In addition, public agencies could apply the factors of "Government Policy", "Attitude", "Subjective Norm", and "Intention to Use,"

which are parts of the decision-making for people to join the Residential Solar Rooftop Project which the Ministry of Energy aims at 10,000 MW in 2038. Those agencies could also set the related policies or provide support that could fulfill the people's expectation and help build electric energy security in the future.

In addition, the recommendation of the research is that the government should support the regulation as it is very important of the intention to use solar rooftop. The regulation has to be clear and easy to apply including the purchasing amount and price of electricity to the grid must be convincing and attractive to the homeowners as well as the tax policies and the compulsory measures for new buildings to be installed the solar rooftop system

In addition, there should be education or knowledge transfer to the public about basic knowledge of solar rooftop so that the public will feel that it is something that they can easily understand and adapt to use as one of the household appliances that can provide clean natural energy for maximum benefits to the homeowners who install solar rooftop.

ACKNOWLEDGMENT

The authors would like to present our gratitude to the experts, private specialists, and the Ministry of Energy for the useful advice and good support to this research.

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