



CAUSAL FACTORS INFLUENCING DECISION - MAKING FOR SOLAR ROOFTOP INSTALLATION IN HOUSEHOLDS IN KRUNG THEP MAHA NAKHON

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Abstract

Electric energy is very important to national development and economic system in every sector. The government try to create stability in the electrical energy sector, using clean energy such as solar power to produce electricity. The objectives of this research were to: 1) study the level of government policy, marketing mix, perception of household, trust, and decision- making to solar rooftops installation in households; 2) examine the influence of causal factors, i.e., government policy, marketing mix, perception of household, and trust on decision- making solar rooftops installation in households; 3) propose a promoting guideline for decision making to installed solar rooftops in households in Krung Thep Maha Nakhon. This was a mixed-methods study. In the quantitative phase, the sample of 320 households that owns residences but have not installed solar rooftops in households was selected by using the multi-stage randomization technique. In the qualitative phase, in-depth interviews were conducted with 16 key informants, comprising of: 1) eight public and private sector executives, and 2) eight households that install solar rooftop in household.

The results indicated that: 1) government policy, marketing mix, perception of household, trust, and decision- making to install solar rooftops in households were at high levels; 2) marketing mix, perception of household, trust, and government policy had an overall influence on decision making to install solar rooftops in households at a statistically significant level of 0.01 with impact values of 0.94, 0.89, 0.64 and 0.43 respectively; and 3) a promoting guideline for decision - making to install solar rooftops in households in Krung Thep Maha was as follows: (1) The government has a clearly policy on financial support for households deciding to install solar panels on their rooftops; (2) The public and private sectors continuously use a variety of channels to communicate information about the benefits, value, and stability of electrical energy from the installation of solar rooftops in households; Providing knowledge and increasing awareness about renewable energy among citizens and society to encourage greater participation in using solar energy electricity generation; and (4) The collaboration

between the government and private sectors should be established to develop products, especially solar rooftop panels to be of high quality, standardized and affordable for the public. Therefore, the public and private sectors play an important role in raising awareness about the importance of renewable energy, encouraging individuals and stakeholders to increase its usage.

Keyword: Government Policy / Marketing Mix / Perception / Trust/ Decision- Making

Introduction

Electric power is important economically and sustainably for human life. Electricity is produced from power plants. *Fuel-based power plants* that directly affect the environment contribute to global climate change. The management of fly ash generated by coal-fired power plants is a problem in many countries. (Tiwari, Bajpai & Dewangan, 2019). Unlike electricity produced from power plants that do not use clean energy, hydropower, solar and wind power are used to generate electricity, they do not emit carbon dioxide. Non-fuel power plants are clean energy sources that can be replaced at future fuel-based power plants (Saidur, Rahim, Islam & Solangi, 2011). The governments of each country give priority to the production of electricity from non-fuel power plants. Support the production of electricity from clean energy as well as encourage the industrial sector to use more electricity from clean energy (Alam, Ahmad, Othman, Shaari & Masukujjaman, 2021). Solar energy is a clean energy that is used to generate more electricity. Especially in rural areas of some countries with high temperatures. India where solar energy is increasingly being used to generate electricity for community use (Prasad, Singh & Nagar, 2017) Solar energy is one of the greenest renewable energy, and the technology used is friendly to environment. It plays an important role in solving energy problems for sustainable development. Solar energy is an attractive resource for generating electricity by solar panels through the application of technology (Maka & Alabid, 2022).

Thailand prioritizes energy security under the adoption of clean energy. The government promotes the production of electricity from clean energy to reduce the impact on people's quality of life and the environment. Solar power generation has a total production target of 2,000 megawatts. The target is to generate 1,000 megawatts of solar rooftop electricity (Government Savings Bank Research Center, 2023). The government has set a policy to promote the installation of solar rooftops on household rooftops to generate electricity. The purchase of electricity generated by installing solar rooftops on household rooftops (Krung Thai Bank Research Center, 2021) In addition, the private sector has installed solar panels to generate electricity with solar energy for their own use, with many real estate operators starting to install solar panels on the roofs of houses for customers who buy single-detached houses and townhomes to create energy security for customers (KResearch Center, 2021).

The installation of solar rooftops on the roofs of Thai households has many limitations, especially traditional households that are not prepared to support the installation of solar rooftops on their roofs. According to the literature review, Scholars study the factors involved in the decision to install solar rooftops on the roof of households, as follows: Walters, Kaminsky & Gottschamer (2018) study found that in terms of cost prices, subsidy amount, reasonable energy price, technology

knowledge, Installation quality and self-reliance influence the installation of solar rooftops on the roof. Menon, Jerome & Sujatha (2020) study found that the factors influencing the decision to install solar panels in households consist of 9 factors: product Benefits, Price and cost after installation Government factors, product specification, Technology & Innovation, marketing factors, Household awareness and social factors and Qureshia, Ullahb & Arentsen (2017) specifies the cost of photovoltaic systems, lack of adequate financial support from the government, difficulties in using equipment, The lack of reliable vendors, is a major obstacle hindering the decision to install solar rooftop systems for small households.

Research Objectives

1. Study the level of government policy, marketing mix, perception of household, trust, and decision- making to solar rooftops installation in households.
2. Examine the influence of causal factors, i.e., government policy, marketing mix, perception of household, and trust on decision- making solar rooftops installation in households.
3. Propose a promoting guideline for decision making to installed solar rooftops in households in Krung Thep Maha Nakhon.

Research Hypothesis

1. Government policy influences the decision to install solar rooftops on households' roofs.
2. Marketing Mix influenced the decision to install solar rooftops on the roofs of households.
3. The perception of household influences the decision to install solar rooftops on the roof of households.
4. Trust influences the decision to install solar rooftops on the roofs of households.

Literature Review

The decision to install solar rooftops on the roof

Decision making is the process of choosing the best and most suitable option from multiple alternatives based on accurate information through careful review at every step (Sittipan Pooniad, 2021). Decisions are important for executives to choose from the many choices found in organizations and departments by choosing the best alternative. Before making a decision, all options should be evaluated on the pros and cons (Obi, 2016). Decision making is a process that minimizes uncertainty, making good decisions is an essential skill for success and effective leadership, Decisions are made by choosing from available opportunities and choosing the best to solve problems (Mulyono, Purba, Hadian, Syamsuri & Hasibuan, 2020). The decision to install solar rooftops on the roof of a household will have goals or expectations for the results that will be obtained after installing solar rooftops. Ashour et al. (2021) study found that households perceive positive perception of installing rooftop chains on rooftops, recognize that solar power will bring long-term benefits, generating income for households and reducing energy costs. Permadi & Dachyar (2022) found

that rooftop photovoltaic systems can generate clean electricity, contribute to the industry's economy, be cost-effective, and maximize benefits.

Than, Bui, Duong & Tran (2022) study found that awareness and concern for the environment led households to invest in installing rooftop chains on rooftops.

Government Policy

Thailand has a policy to support households to install solar rooftops on their rooftops to generate electricity with solar energy, support the establishment of photovoltaic power generation plants to generate electricity for sale. moreover Thailand has the largest photovoltaic power plant in Southeast Asia located in Lopburi (Department of Alternative Energy Development and Efficiency, 2017). The government provides cumbersome and complex regulatory support, Amendments and improvements to facilitate the industry and the public more. The Government Gazette (2013) states: Thailand supports regulations on the purchase of electricity from small power producers who wish to produce and distribute electricity to the Electricity Authority, This can be done conveniently. Financing with entities investing in solar power by offering low-interest loans to renewable energy projects to extend further support in the form of equipment leasing Carbon loans, financing and more (Office of the Board of Investment, 2016). Compliant with Thepratuanghthip & Rojniruttikul (2023) study found that government policy is important in the decision to install solar rooftops by the public sector, especially the government provides financial support to reduce the cost of installing solar rooftops, It will create incentives for households to install more solar rooftops. World Bank According to the Group (2020), the Turkish government needs to provide financial support to the private sector for solar installations and Ahmed, Tyurina, Smailova, Kurilova & Shulus (2019) study found that financing solar projects proved challenging due to their relatively high costs (both for solar energy and on rooftops). In addition, Sompop Padungpan (2015) stated that the government, supports the use of technology to promote and develop solar panel propellers to be able to move according to sunlight. Automatic for the benefit of receiving energy from the sun for maximum efficiency.

Marketing Mix

Marketing mix refers to a basic scheme or approach that is formulated for creating a product to meet the needs of the target audience and target market, where will the company compete, when and how. But also the ability to execute selected marketing mix decisions (Mohammed & Aimin, 2016). Marketing Mix consists of Product, Price, Place, and Promotion (Patcharapol Boonsopha and Thamma Tinna Srisuphan, 2021). The 4Ps of marketing mix consists of (1) product, (2) pricing, (3) place, and (4) promotion. The use of marketing and advertising marketing mix is one of the factors affecting the competitiveness of business enterprises (Zhukova, 2021). The marketing mix consists of product, price, distribution channels, and marketing promotion. It affects the competitive advantage of Oman's small and medium-sized enterprises statistically significantly (Al Badi, 2018). A study by Bosnjakovic, Cikiric & Zlatunic (2021) found that the quality of solar panels, price, and cost-effectiveness are important factors in deciding to install solar rooftops. And Lockett & Needham (2021) study found that expensive equipment costs, lack of consumer market information, This deprives households of incentives to use solar energy.

Perception of Household

Perception is a relational process between understanding, thoughts, feeling, memory, Learning & Decision Making. The cognitive process must have four elements: (1) stimulus causes perception such as situations, events, the environment around the body is, people, animals & Objects (2) Sense organs produce sensations such as eyes seeing, hearing ears, The nose smells, the tongue senses the taste, and the skin feels hot and cold (3) Previous experiences or knowledge related to exposed stimuli and (4) interpretation of tactile stimuli (McLeod, 2018). Perception can be achieved by three key processes : (1) selection is the process of turning stimuli into meaningful experiences, (2) organization occurs after a person selects information from the environment and organizes it in some way into categories and (3) Interpretation: Once the selected stimuli have been categorized, individuals understand and give meaning to those patterns (Qiong, 2017). The researchers reviewed the literature on perception and installation of solar rooftops on rooftops, as follows: Schulte, Scheller, Sloot & Bruckner (2022) meta-analyzes the application of solar energy to housing, Models are used to predict factors affecting the adoption of solar energy for housing. It was found that it consisted of perceived benefits, environmental awareness, The need for new things and subjective norms. Taghizadeh-Hesary, Yoshino, Inagaki & Morgan (2020) study found that perception of environmental impacts and demand for green energy are key factors affecting the supply and demand for solar panels in Japan. And Ayoub, Dastgir & Waqas (2019) study found that perceived benefits of the application of solar energy as clean energy, cost of use, Ease of use and attitude positively affect the intention of installing solar energy on the roof.

Trust

Trust is a relationship formed by communication between consumers, customers and entrepreneurs. When customers trust or trust the product, Products or services, trusting the operator or service provider affect the intention and decision to purchase. Trust affects customers' loyalty to brands and entrepreneurs' businesses (Shin, Amenuvor, Basilisco & Owusu-Antwi, 2019). A study by Patita Chaimunchuen and Visudtorn Jitaree (2023) found that the reason consumers decide to choose a solar power generation system in the upper northern region is because the company has a reliable reputation. Ding et al. (2021) study found that environmental perceptions, quality recognition and trust solar panels positively affect the satisfaction and decision of solar energy users. In addition, Phuong & Nghi (2020) study found that service quality is a key factor affecting customers' decision to install rooftop solar energy in the province. Binh Thuan, Vietnam and Kumar, Hundal & Kaur (2019) study found that the service quality of solar product dealers, correlated with perception and consumer expectations of solar products.

Research Methodology

Quantitative Research

Sample: Heads of households whose homes are located in the Bangkok area and have not installed solar rooftops on their roofs, 320 people. Consenting research volunteers, obtained through multi-stage randomization.

Research Instruments: The research instrument is a questionnaire of 1 questionnaire divided into 2 parts: 1) Sample personal information questionnaire 4 items and 2) a questionnaire of the opinions of the sample on latent and observational variables adopted in the study 64 items.

Instrument quality check: (1) Content validity by Index of Item -Objective Congruence (IOC) with IOC between 0.60-1.00 and (2) reliability as well. Cronbach's Alpha Coefficiency Method The total value is .959.

Data collection: (1) coordinate with the district directors of the six districts at random, Clarification of research objectives, Benefits, Custody of sample rights and collection courtesy Gather information with heads of households in all 6 districts and (2) submit a questionnaire via Google form to all 320 heads of household.

Data analysis: (1) Descriptive statistics: To describe the individual data of the 320 studied samples and to describe the scale of the 16 observable variables with frequency values (f), Percentage Value (%), Average (\bar{X}), Standard Deviation (S.D.) of information and (2) Structural Equation Model (SEM) analysis statistics to create structural equation models structure, test the relationship between latent and observable variables, and the findings between latent variables studied.

Qualitative Research

Key informants: (1) 4 public and private sector executives in total, 8 people in total; and (2) 8 heads of households installing solar rooftops on rooftops, 16 in total, selected according to research objectives (purposive sampling).

Research Tools: The instrument is a semi-structured interview form. 6 items, Open-ended questions to interview key informants

Data Analysis: content analysis

Findings

Present the research results to answer the 3 objectives as follows:

1. Level of government policy marketing mix perception of household trust and the decision to install solar rooftops on the roofs of households. It is averaged to a large extent. By government policy It has the 1st highest average, followed by perception of household marketing mix, trust and the decision to install solar rooftops on the roof, respectively. According to Table 1.

Table 1 Average, standard deviation, Interpretation and sequence of factors studied

Factors Studied	\bar{X}	SD.	Interpret the results	Order
Government Policy	4.03	0.52	High	1
Marketing Mix	3.87	0.46	High	3
Perception Of Household	3.94	0.44	High	2
Trust	3.84	0.49	High	4
The decision to install solar rooftops on the roof	3.79	0.54	High	5

2. Influence of factors of government policy, marketing mix, perception of household and trust that affects the decision to install solar rooftops on the roof of households. By analyzing structural equations, the researcher presents them sequentially. as follows

2.1 The results of the analysis of the relationship structure model are hypothetically modeled.

2.2 Analysis of the relationship structure model as an alternative model

2.3 Comparison results of hypothesis-based and alternative models

2.4 Hypothesis test results

Offered in the following order:

2.1 The results of the analysis of the relationship structure model are hypothetically modeled

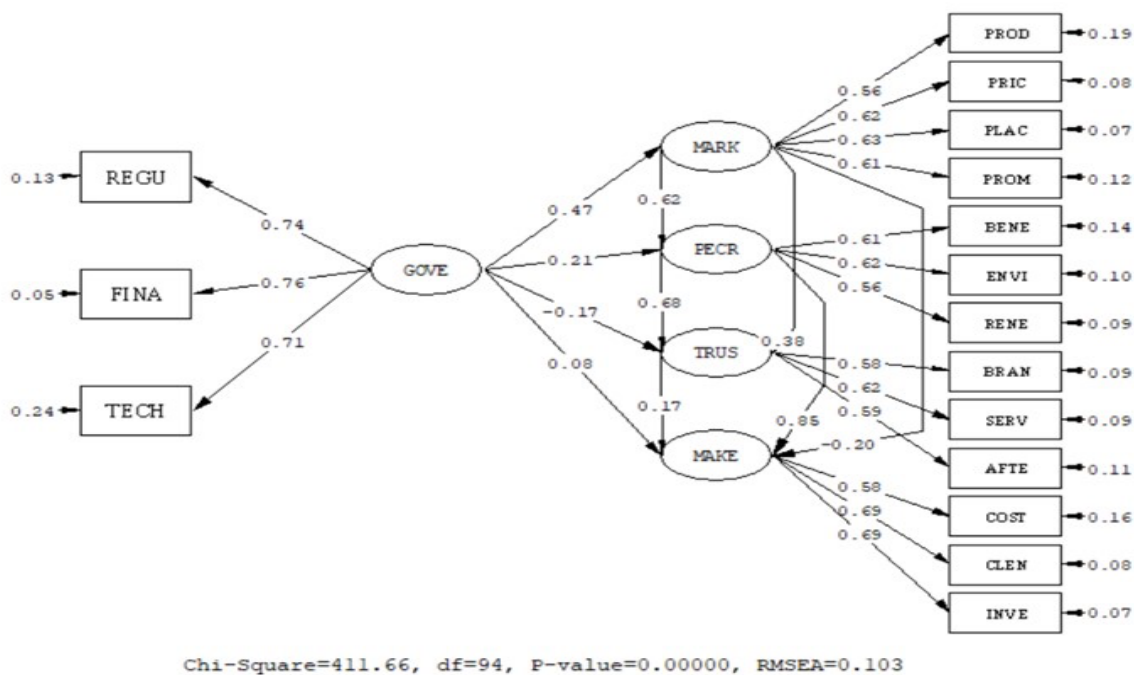


Figure 1 A hypothetical-based relationship structure model.

From Figure 1, when considering the hypothesis-based model that the researcher has developed from the relevant concepts and theories, there is no harmonization with the empirical data. Based on the calculated statistic, Chi-square = 411.66, df = 94, p-value = 0.0000, GFI = 0.86, AGFI = 0.80, RMR= 0.024, RMSEA = 0.103, CFI =0.98 and CN= 111.43, some key statistics have not met the required criteria.

The researcher conducted model modification based on recommendations for adjusting parameters in the model with Model Modification Indices (MI). Then adjust the parameters by agreeing to relax the preliminary agreement so that the tolerances can be correlated. Until the harmonization index values are consistent with the empirical data, an alternative model is obtained. The calculated statistic are Chi-square. = 44.75, df = 35, p-value =

0.12507, GFI = 0.98, AGFI = 0.93, RMR= 0.010, RMSEA = 0.030, CFI = 1.00 and CN = 390.78. Therefore, it can be concluded that structural equation model models are appropriate. Harmonize with empirical data Alternative models as shown in Figure 2.

2.2 The results of the analysis of the relationship structure model as an alternative model

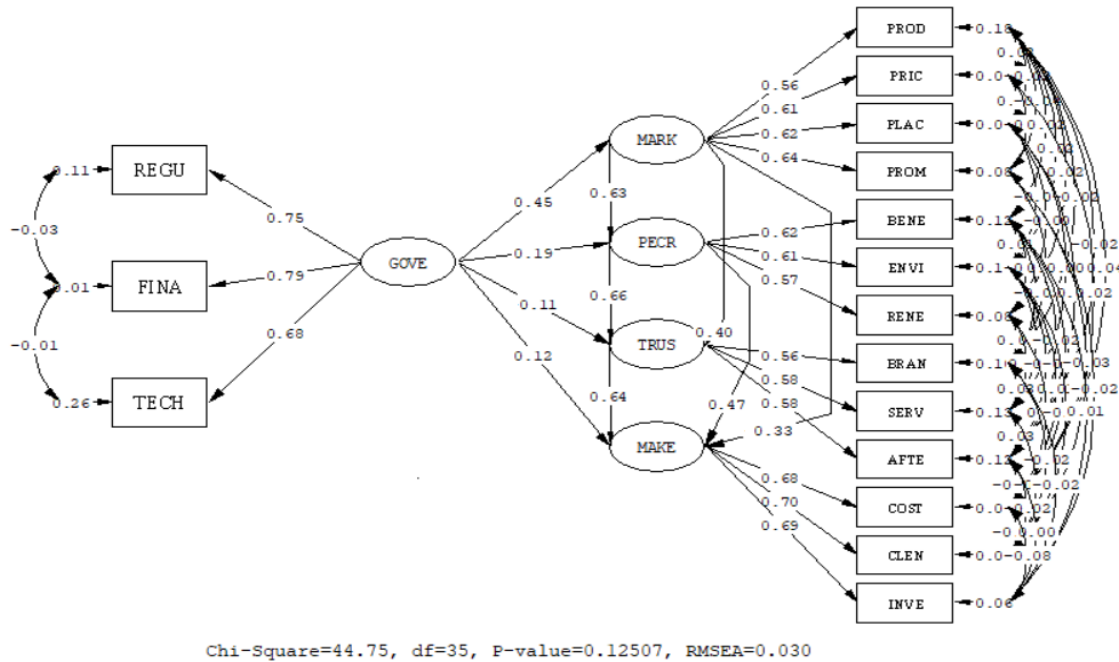


Figure 2 Alternative relationship structure model

2.3 Results of comparing models based on research hypotheses with alternative models

It presents the results of a comparison of hypothetical and alternative models to demonstrate that alternative models are more suitable and can be used better. It presents the results of a comparison of hypothetical and alternative models to demonstrate that alternative models are more suitable and can be used better and forms that are alternative models to empirical data. It is based on the statistics measuring the level of harmony and the harmonization index, Table 2.

Table 2 Results of comparison of research hypothesis-based models with alternative models

LIST	STATISTICS	HYPOTHETICAL MODEL	ALTERNATIVE MODELS	INTERPRETATION
1. Chi-square (χ^2)	* Low near 0	411.66	44.75	
	* Equal df	94	35	

Relative Chi-square	Quotient(χ^2 /df) < 2.00	4.38	1.28	SUITABLE
2. GFI	> 0.90	0.86	0.98	SUITABLE
3. AGFI	> 0.90	0.80	0.93	SUITABLE
4. RMR	Approach 0.00	0.024	0.010	SUITABLE
5. RMSEA	< 0.05	0.103	0.030	SUITABLE
6. CFI	*0.00-1.00	0.98	1.00	SUITABLE
7. CN	> 200	111.43	390.78	SUITABLE

2.4 Hypothesis test results

Based on the research hypotheses that defined four hypotheses, it was found that:

2.4.1 Government policy influences the decision to install solar rooftops on the roof of Households were statistically significant at the level of 0.01 with an overall influence value of 0.43, it is based on the assumption.

2.4.2 Marketing Mix influenced the decision to install solar rooftops on the roof of Households were statistically significant at the level of 0.01 with an overall influence value of 0.94, it is hypothetical.

2.4.3 The perception of households had a statistically significant influence on the decision to install solar rooftops on household rooftops at a level of 0.01 with an overall influence value of 0.89, it is hypothetical.

2.4.4 Trust had a statistically significant influence on households' decision to install solar rooftops on their roofs at a level of 0.01 with an overall influence value of 0.64, it is in line with the assumption.

3. Guidelines for promoting the decision to install solar rooftops on the roofs of households in Bangkok. They are as follows.

3.1 The government has a clear policy to provide financial support to households who decide to install solar rooftops on their roofs.

3.2 The public and private sectors use various channels to communicate useful information, Cost-effectiveness and electricity security from the continuous installation of solar rooftops on household rooftops.

3.3 Educate and raise awareness about renewable energy with people and society so that relevant parties can use solar energy to generate more electricity.

3.4 Creating public-private partnerships in product development Solar panels to be of high quality, standardized and reasonably priced for the public.

Discussion

The results of the hypothesis test revealed that the four latent variables consisted of: (1) government policy (2) marketing mix (3) perception of household and (4) trust influences the decision to install solar rooftops on households' roofs. Details are as follows:

1. Government policy has a statistically significant influence on households' decision to install solar rooftops on their roofs, based on hypotheses. It can be explained that the installation of solar rooftops by households, the head of household must carefully consider before making a decision on the price of installation, maintenance, performance and value government policy. Therefore, it contributes to building trust for heads of households in deciding to install solar rooftops on the roof. In line with the NHI (2021) study, it was found that government policies affect households' willingness to use solar energy. Similar to Nguyen, Vu, Greenland & Nguyet (2022), the study found that the Vietnamese government has a program to promote and play a role in inspiring households to adopt rooftop solar energy in Vietnam. In addition, Than, Bui, Duong & Tran (2022) study found that government policy is a key factor encouraging Vietnamese households to invest in installing solar energy on their roofs and Qureshi, Ullah & Arentsen (2017) study found that the barriers to solar rooftop adoption at the household level in Pakistan are due to the high cost of solar rooftop systems. lack of adequate financial support from the government to install small-scale solar power systems at the household level, Shortages and difficulties in using the equipment.

2. Marketing Mix has a statistically significant influence on households' decision to install solar rooftops on their roofs, according to hypotheses. Explain that installing solar rooftops on rooftops is related to quality, products and prices that affect the decision to install solar rooftops on the roof. Luckett & Needham (2021) study found that most homeowners are unaware of prices, products, the quality of renewable energy and the use of solar energy in the house are therefore not decided to install solar rooftops on the roof. Gupta (2021) study found that vendors' lack of effective marketing, especially providing consumers with price and product information, influenced consumers' decision to install solar rooftops on rooftops in India. For Kalpana (2018), it was found that marketing mixes to promote solar energy in traditional Sri Lanka, i.e. promotional marketing have little influence on customers, should be more environmentally and community-friendly marketing by applying environmental protection concepts and investments to create attraction with consumers. for Kuada, Mensah, Bujac & Bentzen (2019) study found that Ghanaian consumers evaluate the capabilities of foreign solar service providers as superior to local companies. And the price perception of solar energy is a major growth constraint.

3. The perception of households statistically significantly influenced the decision to install solar rooftops on the rooftops of households. Explain that the perception of household is important in the decision to install solar rooftops on the roof. Bilal & Andajani (2023) study found that perceptions about the use of solar panels in households have a significant positive impact on the intention to use solar panels. On the other hand, Cost awareness significantly adversely impacts the intention of solar panel applications. In addition, lifestyle has a significant positive influence on the intention of using household solar panels. In line with Zhang, Chou & Chen (2022) who studied it, it was found that consumer perceptions of environmental conservation, Perception of innovation and awareness of the

dangers of electricity use are positively correlated and affect the intention of using solar power systems in households. Similar to Chidembo, Francis & Kativhu (2022) study found that the perception of solar energy, reliability, value, Health and safety benefits affect the adoption of rooftop solar rooftops of rural households in the district. Vhembe, South Africa and Alrashoud & Tokimatsu (2019) study found that perceptions of environmental protection from global warming and unlimited energy supply are highly correlated with the adoption of photovoltaic systems. It also found that installation costs are the most significant obstacle to the adoption of photovoltaic systems in housing.

4. Trust has a statistically significant influence on households' decision to install solar rooftops on their roofs, according to hypotheses. It can be explained that installing solar rooftops on the roof is a one-time investment but costs quite a lot of money. Therefore, choosing a company or operator to install solar rooftops on the roof is important, trust is therefore one of the deciding factors. Horne, Kennedy & Familia (2021) study found that trust and utility perceptions affect the solar installation of homeowners in California. Similar to Zulu, Zulu & Chabala (2021), the study found that attitude, trust, perceived benefits, and personal norms influence the intention to adopt solar energy. Trust and perceived benefits also influence the willingness to adopt solar energy through attitudes. In addition, Ding et al. (2021) study found that environmental perception and quality perception positively affect the satisfaction of solar energy users, and trust in operators affects the satisfaction of solar energy users and Kumar, Hundal & Kaur (2019) study found that trust, service quality consists of reliability, response, Confidence, empathy, and tangibility influence the perception of users of solar products.

Suggestion

Electric energy is important both economically and in human life. Electricity generated from renewable energy such as hydropower, Wind and solar energy, considered clean energy and can be used as the main energy for national development. Thailand places great emphasis on solar power generation due to suitable terrain, Therefore, the government has a policy to encourage households to install more rooftop chains. The relaxation of regulations, as well as financial support for households equipped with rooftop chains and the resale of electricity to the Electricity Authority are important policies. However, it is important that the public and private sectors should take care of the price of solar rooftop installations as well as communicate the benefits, Cost-effectiveness and long-term investment in installing more solar rooftops.

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