A STRUCTURAL EQUATION MODEL OF FACTORS INFLUENCING INTENTION TO USE SOLAR ROOFTOP ENERGY OF HOUSEHOLDS IN THAILAND

PONGSAPAT THEPPRATUANGTHIP

A DISSERTATION SUBMITTED IN FULFILLMENT OF
THE REQUIREMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
IN INDUSTRIAL BUSINESS ADMINISTRATION
KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG
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ABSTRACT

This research aimed to 1) develop a model of the government policy, attitude, the subjective norm, and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand; 2) to examine the model fit of the government policy, attitude, the subjective norm, and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand, and 3) to study the direct effect, indirect effect, and total effect of the variables on the intention to use solar rooftop energy of households in Thailand. Mixed methods were used, i.e., quantitative research and qualitative research. For the quantitative research, the on-line and hardcopy questionnaires were used as the instrument for collecting the data. The samples comprised 320 homeowner and household members in residence in a type of detached houses, townhouses, duplexes, townhomes, row houses, or shop houses which has the roof space exposed to sunlight. Then, the data was analyzed by percentage, mean, standard deviation (SD), skewness, kurtosis, Confirmatory Factor Analysis (CFA), and analysis of the casual relationship. The obtained analysis results were conducted further in the form of qualitative research with an in-depth interview with the experts, executives, users, and senior officers from related energy authorities involved in solar rooftop energy

For the general data of the respondents, 174 or a little over half of the total number of participants were female (54.38%). The highest number of respondents were aged between 31-40 years (89; 27.81%). About half of the total number of respondents had graduated with a bachelor's degree (139; 43.44%). A little over half of the total number of respondents were corporate employees (174; 54.38%). About one third of the total number of respondents received a monthly

income less than 35,000 Baht (127; 39.69%). Most of the respondents lived in detached houses (235; 73.44%). At least half of the total number of respondents were house members (162; 50.63%). A little over half of the total number of respondents lived in houses aged more than 10 years (184; 57.50%). Nearly half of the total number of respondents paid a monthly electricity cost between 1,001-3,000 Baht (142; 44.38%). According to the survey by the assessment of the general knowledge on a solar rooftop, it was found that 54 respondents or 16.88% replied the correct 4 questions out of 10 questions. Moreover, the level of their overall self-knowledge assessment about a solar rooftop was still quite low ($\overline{X}$ = 2.77; SD = 1.512). According to the analysis results of the level of the factors, it was found that attitude had the highest mean ($\overline{X}$ = 5.28), followed by perceived usefulness ($\overline{X}$ = 5.18), the subjective norm ($\overline{X}$ = 4.18), intention to use ($\overline{X}$ = 4.05), and the government policy ($\overline{X}$ = 3.16).

According to the CFA results, it was found that the scale had convergent validity with significant standard regression weights in all variables. Then, the Structural Equation Model (SEM) was analyzed and the model fit was examined. The results found that the (χ^2) = 80.705, df = 63, CMIN/DF (χ^2/df) = 1.302, p = .055, GFI = 0.960, CFI = 0.994, AGFI = 0.922, NFI = 0.975, and RMSEA = 0.035. It was found that the intention to use was positively and significantly affected by attitude, perceived usefulness, subjective norm, and government policy. The variance of the intention to use could be explained as 61% (R^2 = 0.61). The remainder was affected by other factors. In addition, the study shows that the intention to use is indirectly influenced by subjective norm statistically significant. The intention to use is also indirectly influenced by perceived usefulness statistically significant. Both of these factors increase an indirect effect to intention to use solar rooftop. This was congruent with the in-depth interview results, which agreed that the attitude, perceived usefulness, subjective norm, and government policy were the key factors of users' confidence. When consumers perceived the rules, regulations and obtained values, this would affect the positive attitude toward the use and intention to use a solar rooftop.

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CHAPTER 1

INTRODUCTION

1.1 Background and significance of the research

The solid growth of Thailand's economy for the past two decades has brought a highly increasing demand of electricity consumption resulting in a greater amount of electricity to be produced in the country. Electricity is a key source of energy that drives the economy and national development. That is why electricity consumption has increased because of the close relationship with the gross domestic product (GDP), or it may have increased in compliance with the country's economic growth. According to Table 1.1, in the year 2019, the total electricity consumption was 192,956 GWh, which increased from 2014 in which the total electricity consumption was only 168,685 GWh. The rate of electricity consumption that increased approximately 2.88% per year in the past five years motivated the government sector to generate more electricity to support the demand for electricity consumption to drive the economic system. Presumably, such demand would also increase more than twofold in the next 20 years to be 430,693 GWh in 2037 (Energy Policy and Planning Office, 2018). The sectors with the most electricity consumption during January – February 2018, included the industrial, business, and household sectors with the portions of energy consumption being 49%, 25%, and 22%, respectively (Ministry of Energy, 2018).

Table 1.1 Statistics of the GDP, electricity consumption and importation of electricity of Thailand

	2014	2015	2016	2017	2018	2019
GDP[(1)] (billion USD)	407.37	401.30	412.35	455.28	504.99	520.00
Electricity consumption[(2)] (GWh)	168,685	174,833	182,847	185,124	187,832	192,956
Importation of electricity[(2)] (GWh)	12,260	14,414	19,825	24,427	26,669	25,547

Source: (1) GDP by Country Statistics from the World Bank during 2010-2019, 2020

(2) Energy Statistics of Thailand 2020, EPPO, 2020

Due to the insufficient generation of electricity in Thailand to fulfill the demand of consumption while such demand had kept increasing every year, there was an inevitable need for the importation of electricity from neighboring countries (refer to Table 1.1). This also affected the national energy security. The importation of electricity was in compliance with the memorandum of understanding (MOU) for the cooperation for electricity with the neighboring countries. Consequently, Thai government signed an MOU with Lao PDR, Myanmar, China, and Malaysia to purchase electricity from these countries at 7,000 1,500 3,000 and 300 Megawatt (MW), respectively (Ministry of Foreign Affairs, 2013). The importation of energy in Thailand is currently at 6.4%, which is still lower than the volume set by the policy of not to import more than 15% of the total amount of energy (Electricity Generating Authority of Thailand, 2016). Moreover, there is the possibility of increasing the importation of electricity from the above-mentioned countries in the future.

Nowadays, besides importing electricity from neighboring countries, most of fuels for generating electricity are fossil fuels that can be depleted; e.g., natural gas and coal. In 2017, Thailand generated most of its electricity from natural gas (over 60%), followed by coal and lignite (18%) (Energy Policy and Planning Office, 2018). The domestic sources of fuels in Thailand are very limited. According to the BP Statistical Review of World Energy 2019, it showed that the proved reserves of natural gas of Thailand in 2018 was only 6.6 trillion cubic feet, which was different from other countries. For example, Russia had the most proved reserves of natural gas up to 1,375 trillion cubic feet, followed by Iran at 1,127.7 trillion cubic feet. Furthermore, even neighboring countries like Indonesia and Malaysia had proved reserves of natural gas at 97.5 and 84.5 trillion cubic feet, respectively (refer to Table 1.2), which was much more than Thailand. The data implied that although these countries adjoin one another, the amounts of natural gas in each particular country may highly vary due to different geological conditions and petroleum systems.

Table 1.2 Proved reserves of natural gas

Country	Russia	Iran	China	Indonesia	Malaysia	Vietnam	Thailand
Reserves of natural gas (trillion cubic feet)	1,375.0	1,127.7	214.4	97.5	84.5	22.8	6.6

Source: BP Statistical Review of World Energy, 2019

The amounts of the reserves of natural gas in Thailand have been estimated that they could be used for only 10 years (Energy Policy and Planning Office, 2017). Apart from the limited amounts of domestic fuels, pollution from fossil fuel combustion for generating electricity has also created an effect. When considering a long-term national plan for generating electricity, Thailand tends to inevitably rely on importing energy from other countries even more. Apart from the effect on higher electricity charges, it also finally affects the energy security, economy as well as social development. According to a survey on energy security in 25 countries with a large energy user group, it was found that the energy security of Thailand was always behind from the others. The best ranking that Thailand was placed was 17th out of 25 countries in 1985. After that, the country's ranking has declined to 24th ever since 2005 in accordance with Table 1.3 (Global Energy Institute, U.S. Chamber of Commerce, 2018). This implies that energy security in Thailand has been very low.

Table 1.3 Energy security rankings for large energy user group (1980-2016)

Country	1980	1985	1990	1995	2000	2005	2010	2014	2015	2016
Australia	4	5	4	5	6	8	9	8	8	8
Brazil	14	8	9	10	12	10	15	13	14	17
Canada	7	7	6	6	7	7	8	7	7	7
China	23	23	23	21	20	21	19	18	17	15
Denmark	16	10	7	7	4	4	4	4	4	5
France	15	15	11	9	8	11	10	12	11	11
Germany	19	20	19	16	9	5	6	9	9	9
India	18	18	22	20	22	22	22	22	22	20
Indonesia	8	12	12	12	17	19	21	19	19	19
Italy	10	14	15	14	14	17	16	17	18	18
Japan	20	21	18	19	19	14	14	20	20	21
Mexico	1	1	1	2	3	3	3	6	6	4
Netherlands	13	11	13	11	10	15	12	14	13	13
New Zealand	3	2	5	4	5	6	5	5	5	6
Norway	2	3	3	3	2	2	1	1	1	1
Poland	17	19	17	18	15	13	13	10	10	10
Russia	-	-	-	24	21	20	18	11	12	12
South Africa	11	13	14	15	13	12	17	15	15	14
South Korea	21	22	21	23	24	23	23	23	23	23
Spain	12	16	10	13	16	16	11	16	16	16
Thailand	22	17	20	22	23	24	24	24	24	24
Turkey	6	6	16	17	18	18	20	21	21	22
Ukraine	-	-	-	25	25	25	25	25	25	25
United Kingdom	5	4	2	1	1	1	2	2	3	3
United States	9	9	8	8	11	9	7	3	2	2

Source: Global Energy Institute, U.S. Chamber of Commerce, 2018

For this reason, Thailand must implement the policy of the speedy acquisition of national energy sources, including renewable energy, which is acquired from nature and can never be depleted. It can be renewed and can replace fossil fuels; e.g., coal, petroleum, and natural gas that basically release large amount of carbon dioxide into the atmosphere, which is a key cause of global warming. Moreover, fuel diversification is required for the acquisition of various fuels for generating electricity together with bilateral cooperation development within the ASEAN countries to acquire new sustainable sources of energy or buy more electricity, so to promote the security of the national electrical system (Energy Policy and Planning Office, Ministry of Energy, 2014).

Simultaneously, the government has set the national security policy of the development of electricity generation. According to the policy, electricity acquisition must be done through the diversification of fuels for generating electricity in order to reduce the risks of relying on any one type of fuel. Additionally, the security of the electrical power system must be strengthened by the development of a transmission system network to create more connectivity and higher reliability. Such development would be regarded as the key goal for the national policy of electricity development along with promoting the use of renewable energy. (Energy Policy and Planning Office, Ministry of Energy, 2019).

In 2008, Thailand announced the 15-year Renewable Energy Development Plan (2008 - 2022) with the goal to have 20.3% of renewable energy in the generating system, which would be increased to 25% in future plans. As for the Alternative Energy Development Plan (AEDP) during 2015 - 2036 (AEDP 2015), renewable energy was set to increase to 30% by the end of the plan in 2036. Furthermore, in 2018, the AEDP 2018 was issued with an adjusted higher goal for renewable energy to 33% of the total generating capacity. This latest plan focused on solar energy as it is considered most potential in Thailand to be developed as a new source of energy to the country in terms of cost and efficiency.

According to the AEDP 2015, it was expected to have a total solar installation of 6,000 MW in 2036. However, by the end of 2017, 2,849 MW of solar power system had been completed. In addition, according to the AEDP 2018, the targeted installation during 2018-2037 would increase to 12,725 MW from solar rooftops and solar floating. Thus, the total goal of solar power by the end of 2037 is 15,574 MW. Overall, the goal of the AEDP 2018 for generating electricity from renewable energy is a total of 29,358 MW, an increase from the former plan that showed the portion

of renewable energy by the end of the plan to be from 30% to 33% with the portion of solar energy up to 53.05% of all renewable energy.

The sequence of the renewable energy development plan from 2008-2019 is displayed in Figure 1.1. The portion of renewable energy tends to keep increasing, as it has been predicted that half of the electricity generated worldwide in the next 20 years would rely on solar and wind energy (Bloomberg, 2019).

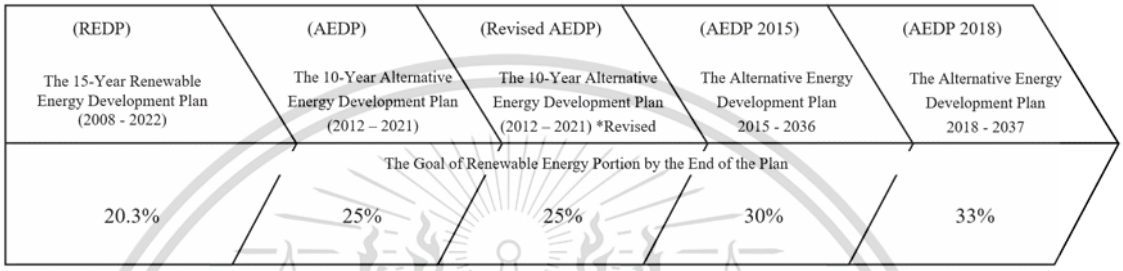


Figure 1.1 The sequence of the renewable energy development plan and goal

Source: Ministry of Energy, 2019

As a result of the Alternative Energy Development Plan, Thailand has started using clean electricity generated by itself to reduce the importation of electricity from neighboring countries. Initially, the development project was implemented gradually with the most developed renewable energy coming from solar energy. This was because Thailand is located in the equatorial zone, and it receives a higher amount of solar energy than other countries where are far from the equator. According to the data from satellites and metering stations by the Department of Alternative Energy Development and Efficiency (DEDE), it was found that Thailand could generate approximately 4.5-5.5 kW/m^2 of solar energy per day nationwide, which was quite higher than other regions. It is also estimated that Thailand possesses the capability of generating solar energy up to 40,000 MW (Chiang Mai University, 2010; Ministry of Energy, 2010).

By 2011, the expansion of the renewable energy project development could be seen. Most of the projects were from solar power plants with the serious measures to promote purchasing electricity through the subsidized rates of an attractive solar energy tariff. The number of solar power plants increased with the installation of plants in 2011 being at 242 MW, and 823 MW by the end of December 2013. By December 2018, the generating capacity of solar power had increased rapidly to 3,449 MW (Ministry of Energy, 2019). It was over half the goal at 6,000 MW,

which is expected to be achieved by the government sector in 2036. Still, most of the solar power plants are in the form of a ground-mounted solar apart from others that can be installed as a solar rooftop and solar floating.

Despite the successful goal of renewable energy in the past, most were from solar farms with ground-mounted solar panels that require large spaces and sometimes encroach on agricultural land. The owners of solar farms are mostly either business entrepreneurs or private and public companies with the particular purpose to sell electricity to the grid of the electricity authorities. This is actually not in compliance with the objective that aims to allow users to generate electricity on their own premises before selling the surplus electricity to the grid. This is the principle of generating electricity in the form of a solar rooftop. However, installation cost of solar rooftop on the buildings or houses was not economically worthwhile in the past due to the very high costs. There were no benefits from the economies of scale. Those benefits would have emerged from the capability of business units to produce larger numbers of products until the average production cost per unit became lower.

The tangible development of solar rooftop energy was started in 2013 following the announcement on September 6, 2013, by the Energy Regulatory Commission in purchasing a total of 200 MW of electricity from solar rooftop. The feedback was satisfactory at a certain level but not in full as announced. Specifically, the application was only 130 MW, and this energy was not continually developed because there had been no further announcement about purchasing any solar energy from that time on. However, since 2016, the government has paid more attention to solar rooftop energy because of the rapid technological advancement and lower equipment and installation costs. Thus, rooftop owners could simply generate electricity by themselves from their own roof. The governmental support could be obviously noticed from the 2018 power development plan (PDP2018) announced on April 22, 2019, which has focused on the promotion of generating and utilizing renewable energy in the country as a key form of energy, particularly from solar generation. The goal is to generate electrical energy by the end of 2037 from residential solar rooftop project on households at 10,000 MW which accounts for 55.02% of the total goal from all renewable energy at 18,176 MW in accordance with Table 1.4.

Table 1.4 Target of renewable energy in Thailand in accordance with PDP2018

Residential solar rooftop on households	10,000 MW
Solar floating	2,725 MW
Biomass	3,376 MW
Biogas	546 MW
Wind	1,485 MW
Industrial solid waste	44 MW
Total	**18,176 MW**

Source: Ministry of Energy, 2019

The residential solar rooftop project on households is a new dimension of the electricity generation in Thailand with no need for fuel combustion. The public would not only take part in generating electricity from solar rooftop, they could also sell surplus electricity to the grid which is belonged to the electricity authorities. This would help save electricity bills in houses and encourage homeowners to earn extra income from selling surplus electricity. The government started the residential solar rooftop project on households in the first phase as the pilot project for the first year at 100 MW. The project was announced for application on May 24, 2019, with the objectives to promote homeowners who own electricity meters to install solar rooftop system for generating electricity, and to sell the surplus to the electricity authorities. The installation must not be over 10 kW/household, and the selling rate to the grid is at 1.68 Baht/unit within 10 years. Nonetheless, the number of applications to participate in the project has not yet reached the goal. There were 2,244 applicants in the first two months, so the total amount of the installations was only 11.2 MW, which was still far from the goal of the first year that was set at 100 MW.

Although the government has tried to promote more use of solar rooftop energy and the equipment is cheaper because of the developed technology, solar rooftop is still not widely accepted due to several reasons. For example, lack of communication to the public and knowledge transfer to the people, subsidy from the government, complicated government policies from solar rooftop agencies, ambiguous rules and regulations in some points, unfair charges, high expenditure due to the regulations from the government agencies, and low price of selling electricity to the grid. As a result of these problems, this research studied and reviewed the relevant concepts and theories to

search for factors influencing intention of Thai homeowners to use solar rooftop on their households.

According to the 2010 housing census of Thailand which was conducted in every 10 years by the National Statistical Office, it was revealed that there was a total of 19,664,165 households spread throughout the country. Most of them were detached houses; 15,599,247 households or equivalent to 77.83% of the total households; 1,463,688 households or 7.30% are Townhouse / Duplex / Town home and 2,601,230 households or 12.98% are Row house / Shop house (National Statistical Office, 2010). These houses used their roof space just to prevent sunlight and rain. Hence, if the roof spaces are also utilized for generating electricity, there would be a huge revolution in the generation of electricity for the country. Generally, a house has been regarded as the last unit that uses electricity. Therefore, electricity authorities must transmit electricity from large power plants that still rely on combustible fossil fuels to these houses. If each house can generate rooftop electricity on its own, this would help reduce such burden of the government. Furthermore, if there is any surplus electricity left in each house, it can be sold back to the grid. The homeowners would thus become both producers and consumers, or so-called "prosumers." This would be disruptive to the electricity generating industry and would also affect the GDP as well as higher economic growth rate of the country. Furthermore, if homeowners as the major electricity users consume more solar rooftop energy, the advantage would be the reduction of the use of fossil fuels for national power generation. In addition to saving limited national resources, this could help reduce pollution resulting from transportation fuel and combustion in the electricity generating process.

From the literature review in the relevant industries about solar rooftop such as the electric vehicle which is friendly to an environment as it helps reduce the burning fossil fuels and helps people make awareness to protect environment (Jiang, 2016) was used as its concept in preserving an environment is similar to the solar rooftop. It was also found that there is the Theory of Planned Behavior by Ajzen (1985) showing that attitude and subjective norm is related to the intention to use. Literature about solar rooftop is quite new to Thai society and thus it is linked to the Theory of Technology Acceptance Model (TAM), which was developed by Davis (1986). From TAM, the perceived usefulness may be influential to the attitude and will then cause the behavioral intention. The perceived usefulness is beneficial for both the users themselves such as saving household electricity bills and for the environment such as reducing the global warming problem.

In addition, it was found from the literature review that the government policy is one of the factors influencing Malaysian consumers' intention to purchase green energy produced from solar panels (Aziz et al., 2017). However, the literature gained from this study is in other contexts of the research scope which causes the gap in the research in what direction if the research framework obtained from literature review is conducted further in Thailand.

The researcher aims to bring a conceptual framework and variables obtained from the literature review that contains direct and indirect effects on the intention to use solar rooftop energy from households in Thailand. The study would be useful for educational institutions and private entrepreneurs who are interested in doing solar rooftop businesses in Thailand. In addition, the government agencies would also acknowledge the factors influencing the decision-making of the people in participating in this residential solar rooftop project on households, so as to issue policies or provide support that would meet the people's demands, as well as achieve the goals to strengthen the energy security of Thailand in the future.

This research revealed the key roles of generating solar rooftop energy to the national energy industry along with creating knowledge, understanding, and awareness of all involved parties on the factors influencing people's interest in solar rooftop. This will fill the gap emerging from the review of the relevant literature in the study of generating electricity in Thailand.

1.2 Research questions

1.2.1 What are the model of the government policy, attitude, subjective norm and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand. How did these models relate to one another and congruent with the empirical data?

1.2.2 Which factors contain the direct, indirect, and total effects on the intention to use solar rooftop energy of households in Thailand?

1.3 Research objectives

1.3.1 To develop a model of the government policy, attitude, subjective norm and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand.

1.3.2 To examine the congruity between the empirical data and the developed model of the government policy, attitude, subjective norm and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand.

1.3.3 To study the direct, indirect, and total effects on the intention to use solar rooftop energy of households in Thailand.

1.4 Research scope

For the research of the model of the policy, attitude, subjective norm, customer knowledge management, and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand, the scope of this research is as follows:

1.4.1 Population

The population in this research is 19,664,165 houses in Thailand (National Statistical Office, 2010). These houses have roof space that can be installed with the solar panels. There are 3 categories in this research as the following:

1) Detached House

2) Townhouse / Duplex / Town home

3) Row house / Shop house

1.4.2 Variables

For the variables in this research, the researcher has studied and reviewed literature and related researches as follows:

1.4.2.1 Exogenous Latent Variables consist of the following:

(1) Government Policy, which consists of 3 observed variables:

1) Technological Support

2) Economic Support

3) Regulatory Support

(2) Subjective Norm, which consists of 3 observed variables:

1) Social Pressure

2) Normative Belief

3) Motivation to comply with the referent

(3) Perceived Usefulness, which consists of 3 observed variables:

1) Personal Benefit

2) Environmental Benefit

3) Awareness of cost reduction

1.4.2.2 Mediator Latent Variable consists of the following:

(1) Attitude, which consists of 3 observed variables:

1) Cognitive Component,

2) Affective Component

3) Behavioral Component

1.4.2.3 Endogenous Latent Variable consists of the following:

(1) Intention to Use, which consists of 3 observed variables:

1) Behavior Intention

1.4.3 Timeline

For the research implementation was divided into three parts as follows:

Part 1: The study of the secondary data from different national and international sources.

Part 2: The collection of quantitative data (primary data) by a set of questionnaires as an instrument. The data collection would take three months, starting from December 2019 to January 2020.

Part 3: The collection of qualitative data by an in-depth interview with 11 experts, executives in the solar energy industry, relevant government agencies and potential users in order to confirm the data obtained from the analysis of the questionnaires whether there is any statistical significant relationship among variables in solar energy industry in Thailand.

1.4.4 Statistics for data analysis

This study relied on statistical testing to ascertain that the findings would represent the entire population with the confidence level of 95%. AMOS was used for the analysis of relationship of all the variables through the structural equation modeling to confirm the research study based on all observed variables in the conceptual framework.

1.5 Research benefits

1.5.1 To be useful for policy makers at all levels for setting visions, missions, policies, and organizational strategies for the development of the solar energy industry in Thailand.

1.5.2 To be useful for entrepreneurs and private companies to create and maintain a successful advantage over competitors in the solar energy industry in Thailand.

1.5.3 To be useful for educational institutes or academicians who are interested in research and development as well as technology improvement regarding solar energy industry in Thailand.

1.6 Definitions

The definitions in this research are described below.

1.6.1 Household referred to a living place of general people. It could consist of an individual or more living in the same location. They supply or use indispensable consumer goods all together. Those people may or may not be relatives; for example, a household with one person or with parents and children living together. It could also consist of relatives, housemaids, workers, or friends.

1.6.2 Renewable energy referred to inexhaustible natural energy that could be renewed for daily use; such as solar energy, wind energy, biogas, hydro energy, wave energy, tidal energy, geothermal energy, etc. It could replace fossil fuels or conventional energy; such as, coal, petroleum, and natural gas that releases large amounts of carbon dioxide into the atmosphere, which is the key cause of global warming.

1.6.3 Solar rooftop energy referred to electricity generated from solar irradiance through solar cell panels installed on the rooftop of a house, plant, or building and turn it into a direct current before transmitting it to an inverter to become an alternative current. The final generated electricity would be used in the house, plant, or building. In addition, this electricity could be sold to nearby users or distributed to the grid of electricity authorities.

1.6.4 Intention to Use means the intention of the homeowner to procure and install a solar rooftop system to utilize the benefits from generated electricity by hiring a contractor to design and

install a system on their roof. The homeowner might search for information and have conversations with others about their experiences with solar rooftop systems before making a decision.

1.6.5 Government Policy means the regulations of the government to promote and support the development and installation of solar power systems to become known and accepted by people.

1.6.6 Attitude means the level of thought and mental state of the person from knowledge, understanding and the perception of the homeowner towards the solar rooftop in both satisfaction or dissatisfaction, which is the result of experience and the environment that is likely to influence the person to express the reaction to support or deny the matter.

1.6.7 Subjective Norm means the belief or pressure received from influential surrounding people on the homeowner for the use of a solar rooftop energy.

1.6.8 Perceived Usefulness means the awareness of the homeowner in value and benefits gained from using the solar rooftop, which improves efficiency, eco-friendly use, and quality of life.

1.6.9 Customer Knowledge means information and facts about the solar rooftop acquired from the experience or education and understanding of the homeowners.

CHAPTER 2

LITERATURE REVIEW

The researcher studied and reviewed the relevant Thai and English documents, textbooks, and research studies to obtain the research framework. The literature review was classified into the following areas:

2.1 General Information of Solar Power Rooftop in Thailand

2.2 Theories and Concepts of the Intention to Use

2.3 Theories and Concepts of the Government Policy

2.4 Theories and Concepts of Attitude

2.5 Theories and Concepts of the Subjective Norm

2.6 Theories and Concepts of Perceived Usefulness

2.7 Theories and Concepts of Customer Knowledge

2.8 Variables Relationship Analysis

2.9 Conceptual Framework

2.10 Research Hypotheses

2.1 General information of solar power plants in Thailand

Due to the increasing world temperature caused by greenhouse gas emissions, people have become more aware of global warming. At the same time, Thailand has planned to minimize the import of electricity and fossil fuels from foreign countries, so solar power is one of the alternatives for generating electricity. It is possible because Thailand is located along the equator, so it is the area with a higher amount of average solar radiation than other regions per year. The potential of each region depends on the solar radiation; the high irradiance has more potential in producing solar energy. The Global Solar Atlas calculated from satellite imagery (refer to Figure 2.1) shows that the countries with high potential in solar power are mostly located along the equator and Australia, including Thailand.

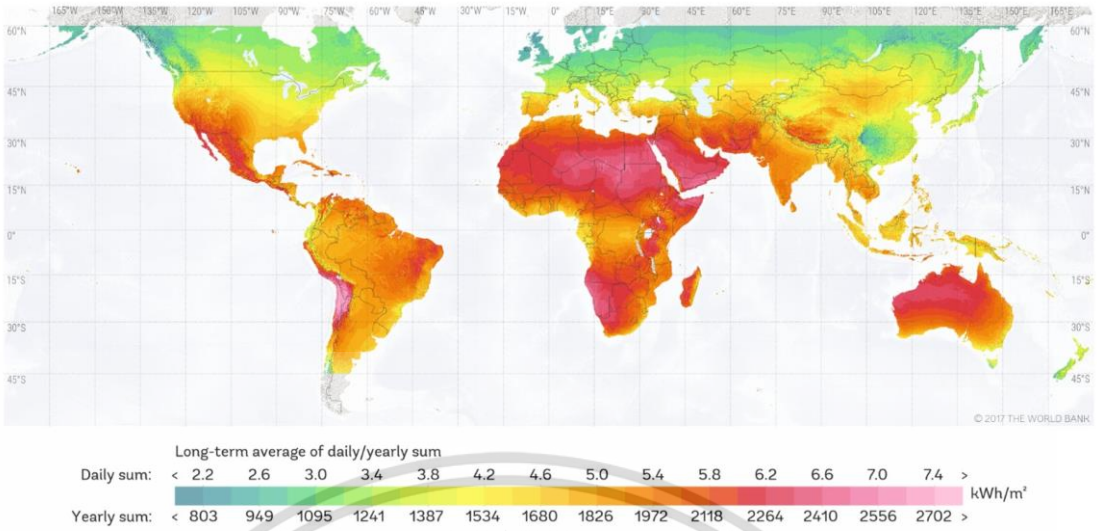


Figure 2.1 Global solar atlas

Source: http://globalsolaratlas.info

An analysis of the average radiation per square meter per day of the cities around the world revealed that although the intensity of solar radiation in Bangkok was lower than some cities in other foreign countries, the promising city that installed a lot of solar power system; such as, Berlin in Germany, had 46% less intensity of solar radiation than Thailand (refer to Figure 2.2).

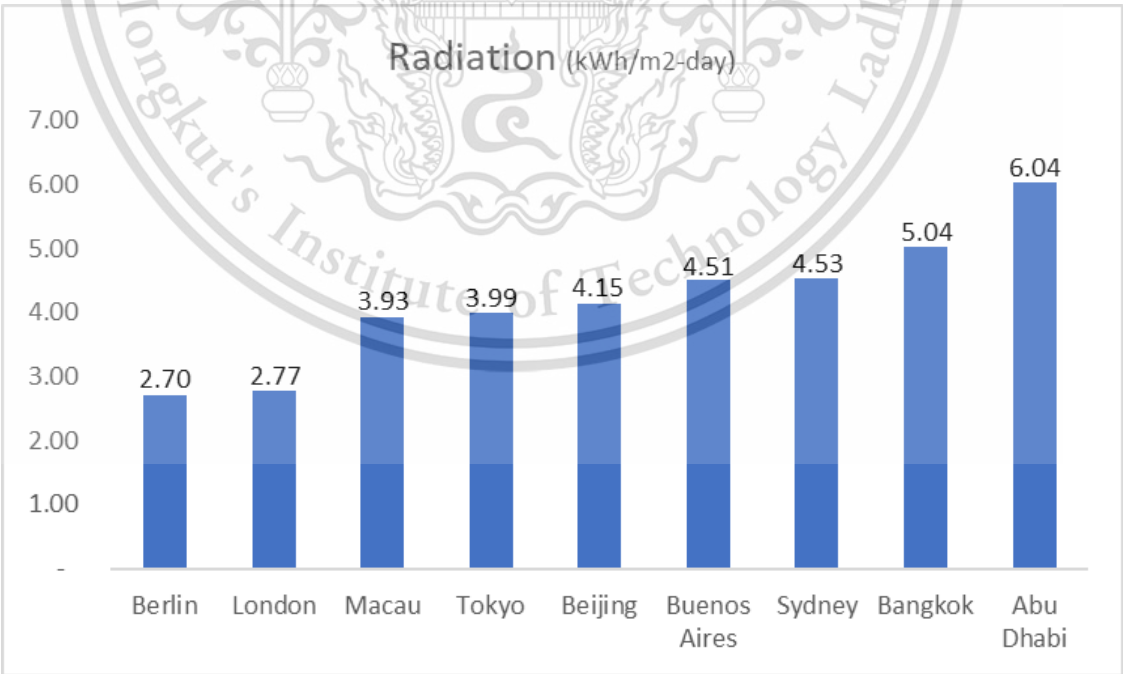


Figure 2.2 Average radiation per square meter per day of the cities

Source: http://pveducation.org

Though Thailand and the neighboring countries in ASEAN have high potential for solar power, the utilization to develop a solar farm or solar rooftop installation is very low. As such, there is high possibility to develop more solar power projects to be prime energy source. Referring to Figure 2.3, the leading countries that have installed solar generation systems are China, Germany, and India, with the capacity of 126,000 MW, 43,000 MW, and 20,000 MW, respectively. However, the total capacity of the ASEAN countries is only 5,000 MW, which 3,000 MW is produced in Thailand (Ministry of Energy, 2017).

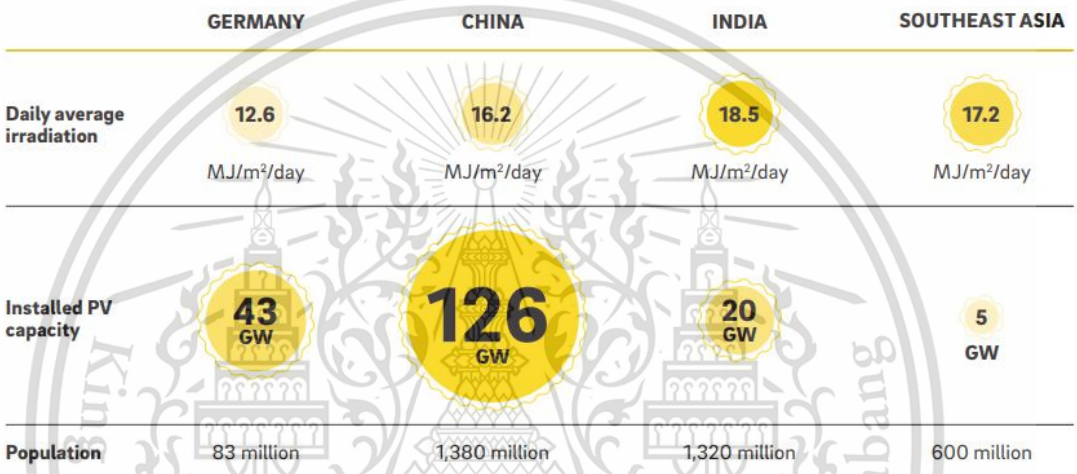


Figure 2.3 Solar potential and installed capacity in selected countries/regions in 2017

Source: Solar Power: Prospects in Southeast Asia, Conergy & Roland Berger, January 2019

In addition, as can be seen in Figure 2.4, the solar radiation in each region of Thailand was affected by the northeast monsoon and southwest monsoon, and the highest solar radiation of most regions was between April and May, with 20 - 24 megajoules/square meter per day. In considering the solar map, it showed that the area with the average highest solar radiation was the Northeast region covering part of Nakhon Ratchasima, Buri Ram, Surin, Si Sa Ket, Roi Et, Yasothon, Ubon Ratchathani, and Udon Thani, as these locations were the highlands with low rainfall, so it had a low rate of cloud condensation. Moreover, there were some areas in the Central Region at Suphan Buri, Chainat, Ayutthaya, and Lop Buri, which the average solar radiation per year was 19 - 20 megajoules/square meter per day. These areas accounted for 14.3% of the entire country area. The average daily solar radiation per year of the regions throughout the country was 18.2

megajoules/square meter per day reflecting that Thailand had the high potential for solar power (Department of Energy Development and Promotion, 1999; Faculty of Science, Silpakorn University, 1999).

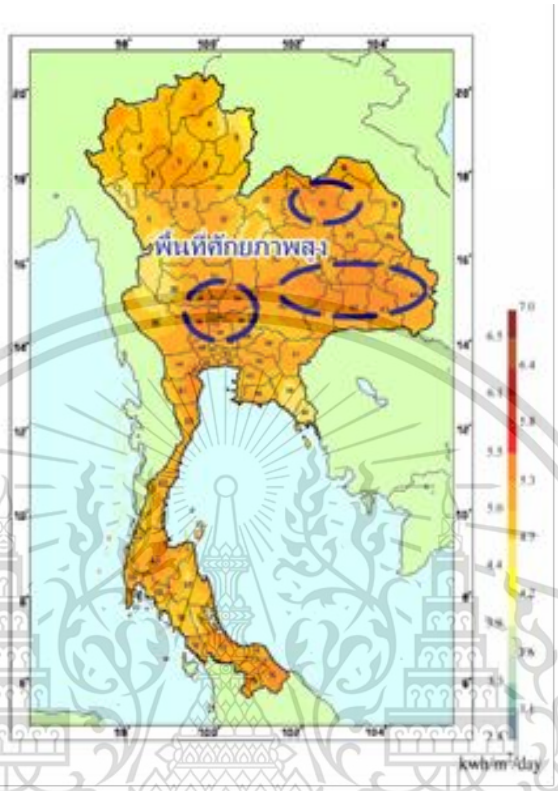


Figure 2.4 Solar map of Thailand

Source: Department of Energy Development and Promotion, 1999; Faculty of Science, Silpakorn University, 1999

Solar power is clean natural energy, which has high potential and is endless energy source, so the electricity generation from solar cells has gained more importance. Using solar power strengthens the security of the electrical system of Thailand and is a way to mitigate the global warming issue. Furthermore, solar cells can be used with a solar water heater, solar cooling and solar drying systems, which are generally utilized for agricultural and fishery products; such as, to dry vegetables, fruit, herbs, and aquatic animals (The Association of Siamese Architects under Royal Patronage by the Institute of Siamese Architects, 2015).

2.1.1 Background of solar cells

Electricity generation from the sun needs a solar cell or photovoltaic cell, which is the electrical equipment that transforms solar energy into electrical energy. The root of the word

"photovoltaic" is derived from the Greek language φῶς (phôs) meaning “light”, and the word "volt", which is the unit of electromotive force that originated from the family name of an Italian physicist, Alessandro Volta who pioneered electricity generation and invented an electric battery (wikipedia.org). Moreover, the word "photovoltaic" has been used in the United Kingdom (UK) since 1849.

Evidence regarding the photovoltaic cell indicated that it was first experimented in 1839 by the 19-year-old French physicist, A.E. Becquerel. The result of an experiment in his father’s laboratory showed that when two types of metal were immersed in solvent, they generated a little electric charge when they were exposed to white light. Becquerel called this circumstance a photovoltaic effect; however, he could not explain how it generated the electricity. Then, a solar cell was first invented in 1883 by Charles Fritts who coated gold with a very thin layer of a selenium semiconductor to be a junction that only had 1% efficiency. In 1905, Albert Einstein explained that light consisted of energy in the form of a photon. When there was an incidence of light on the semiconductor, the electrons had more energy and became independent. When they were connected with the closed circuit, it generated the electricity. With this explanation, he won the Nobel Prize in Physics in 1921. Later, Russell Ohl registered a patent on solar cell made from the semiconductor in 1946, which was discovered when he was working with a transistor.

In 1954, the first practical solar cell was developed at Bell Laboratories by Daryl Chapin, Calvin Souther Fuller and Gerald Pearson. They discovered the technology to create the new P-N junction by spreading a substance into a crystalline selenium semiconductor, which the efficiency was 6% higher than that of the former discovered selenium (currently, solar cell efficiency has been developed to 20%). Afterwards, Les Hoffman, CEO of Hoffman Electronics Corporation directed his Semiconductor Section to pioneer the mass production of solar cells. During 1954-1960, Hoffman developed the efficiency of the solar cell from 2% to 14%, and his invention was used for toys and miscellaneous use (www.wikipedia.com).

It was likely that the success of the Hoffman Electronics Corporation was the first step that solar cells would be used more widely. At the same time, the space, satellite, and spaceship projects were developed, and the most applicable solar cells were used as the power source for those projects. In 1959, the United States launched Explorer 6 satellite that installed a large solar cell panel as the wings. This was proof for the success. The following solar cell models were designed swiftly; however, the improvement went slowly and only focused on the use for space.

The development of the solar cell for electricity generation purposes began in 1990 in Europe where the electricity tariff was very high (www.wikipedia.com).

In ASEAN, Thailand was the first country that used solar cells to generate the electricity in 2006. The government sector purchased solar power by supporting the adder in the solar power purchasing agreement at the rate of 8 Baht per unit (kWh). Although it did not initially have a very high response because of the high cost and the few sources for loans, it became more popular after the cost dropped and commercial banks were familiar with the business and recognized the low risks and approved the loans. This was also beneficial for the investors to have the lower cost. Then, in 2013, there was the first time an announcement to purchase electricity from solar rooftops.

2.1.2 Function of the solar cell and the application to generate electricity

A solar cell transforms solar power into electrical power. The semiconductor; such as, silicon is processed through a scientific process to be a pure sheet. The electric pressure generated by the only solar cell is very low, so a number of cells are connected in a series connection to increase the electromotive force. Many sets of solar cells are assembled onto the solar cell panel or photovoltaic module (PV module), which will be installed as an array to facilitate its use (refer to Figure 2.5).

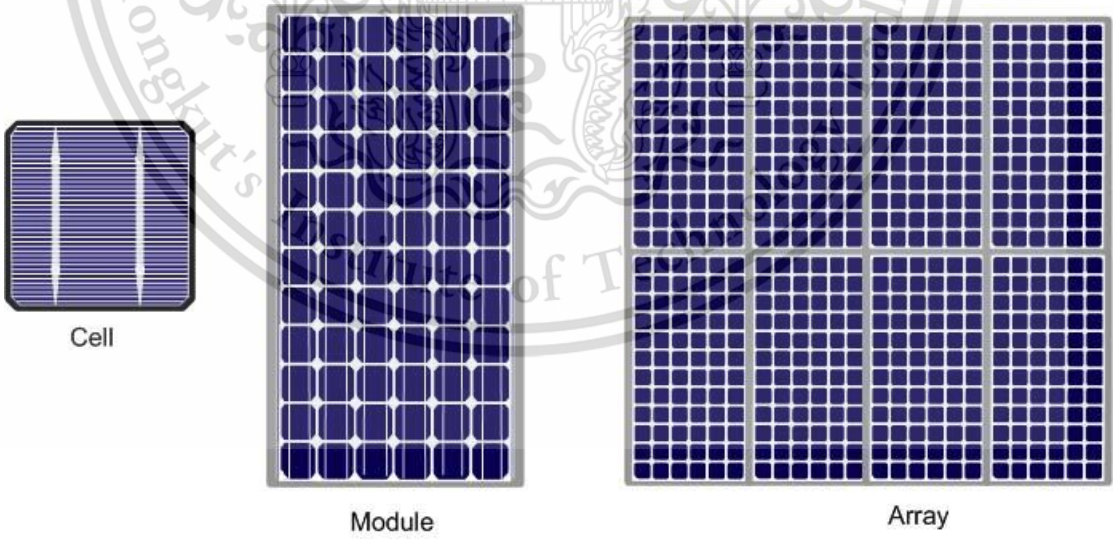


Figure 2.5 Cell, PV panel, and array

When the light, which is a powerful electromagnetic wave, is exposed to the semiconductor, it transfers the power which causes the movement of the electrons in the semiconductor. As a result, this generates a direct current (DC) to flow from the PV panel, which is connected in a parallel connection, and sends the DC from all the panels to a combiner box, which is the electrical equipment to retain the electricity (refer to Figure 2.6).

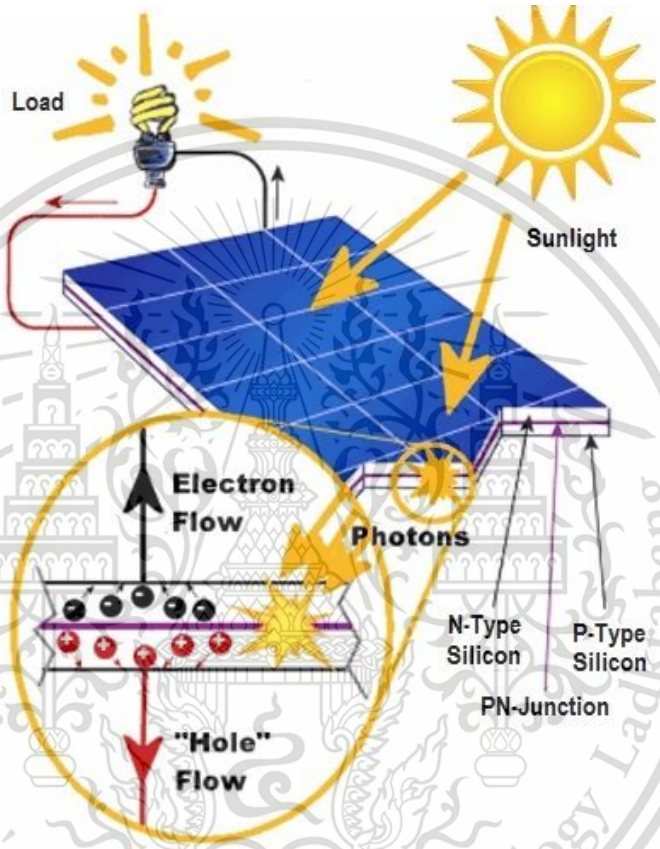


Figure 2.6 Function of solar cells

Source: http://www.electricaltechnology.org

Figure 2.7 shows the components of electricity generation from sunlight. To use the DC, it should be processed through the inverter to transform the DC to an alternating current (AC), which is the same system as that of the electricity authorities. Electricity generated from solar panel is transformed to the AC and can be used immediately with electrical appliances. The remaining energy can be transferred to an energy storage system or transmitted to the grid of the electricity authorities (with the approval of the relevant government agencies). A transformer to adjust the voltage of the electricity from the solar power to suit the voltage level of the electrical appliance.

The common voltage of households in Thailand is 220 Volt. In the case of selling the power to the electricity authorities, the voltage should be adjusted to match with the grid at the grid connection. In Thailand, the distribution voltage levels are 22, 33 and 115 kV, respectively and must by transmitted through a meter to count the number of units sent to the grid.

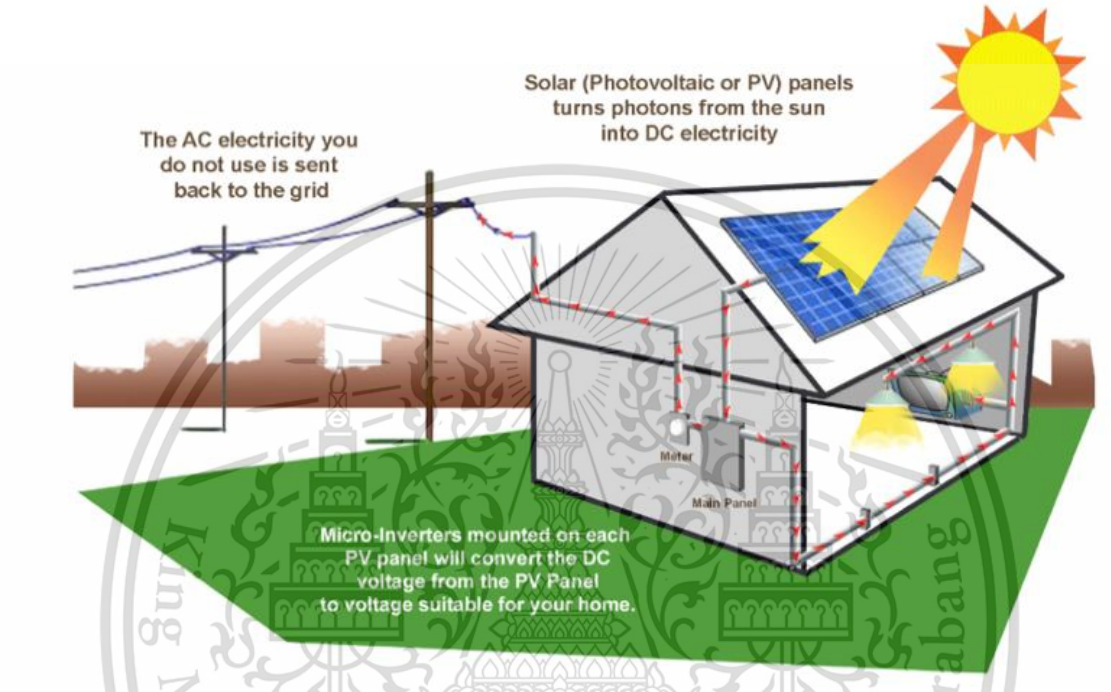


Figure 2.7 Components of the solar power generation

Source: http://www.sunlitesolar.com.au

Currently, the technology for generating electricity from solar power is classified into two types, photovoltaic solar technology and solar thermal technology, which is good for a desert area where the temperature is high with few clouds. However, a solar cell is the main component of either of these technologies. A solar cell can be classified into two types as follows:

1) Crystalline silicon: At first, it was a single crystalline or known as monocrystalline, which was one of the first types of solar cells invented and distributed for commercial purposes. It is a 300-micron thick silicon sheet, or called a wafer. The major material is silicon (Si), which is very popular and the same substance used for a computer chip in computers and electronic equipment. Silicon is a non-toxic substance extracted to be a pure ore and is widely used because it is inexpensive, durable and reliable. Nevertheless, the weakness of silicon is the purification and formation in a substance form, which is expensive and breakable. Moreover, other materials used

to make a solar cell are gallium arsenide (GaAs) and cadmium telluride (CdTe). However, they are costly and there is no proof on the working life period. The production of monocrystalline solar cells as the solar panel (PV module) is shown in Figure 2.8.

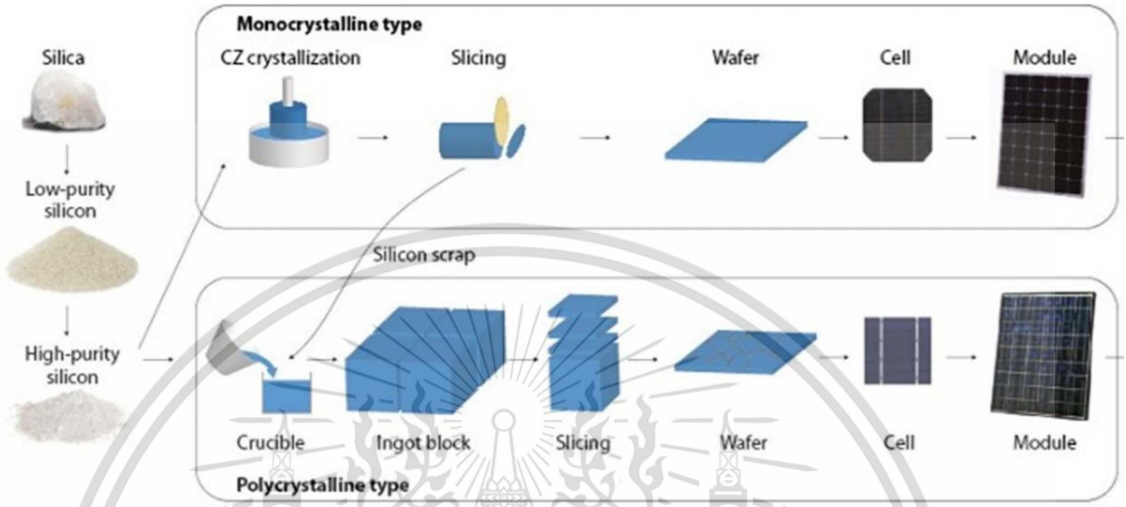


Figure 2.8 Producing monocrystalline solar cells in the panel

Source: The University of Toledo, Department of Physics and Astronomy

Later, a polycrystalline silicon solar cell was invented, which is a thin solid silicon sheet. This was developed to be a solar cell to reduce the cost of monocrystalline solar cells. It maintains the properties and efficiency of the monocrystalline type at a lower cost. When it is assembled as a panel, the capacity of each panel increases from 240 watts to 350-400 watts at the same size, for this reason, it is very popular in most solar plants today. In general, the quality of the monocrystalline and polycrystalline types is not different; however, the monocrystalline type is 10% smaller in size at the same watt, which makes it suitable to be installed in a limited space, particularly on a solar farm in foreign countries where the cost of land is very high. In Thailand, land is not a problem since the land at the average price is not so high; thus the polycrystalline type, which is cheaper, is more used.

The difference between two solar cell types is the crystalline surface (refer to Figure 2.9). If it has a different color tone and pattern from the small crystalline surface in the cell panel, it is a polycrystalline. Monocrystalline has a solid texture with one color. Nevertheless, the process of the cell production is the same. The polycrystalline type has less efficiency than the monocrystalline

type by about 2-3%. Coloring agent can be added to make a colorful panel; such as, blue, green, or black. However, the weakness of both types is their fragility.

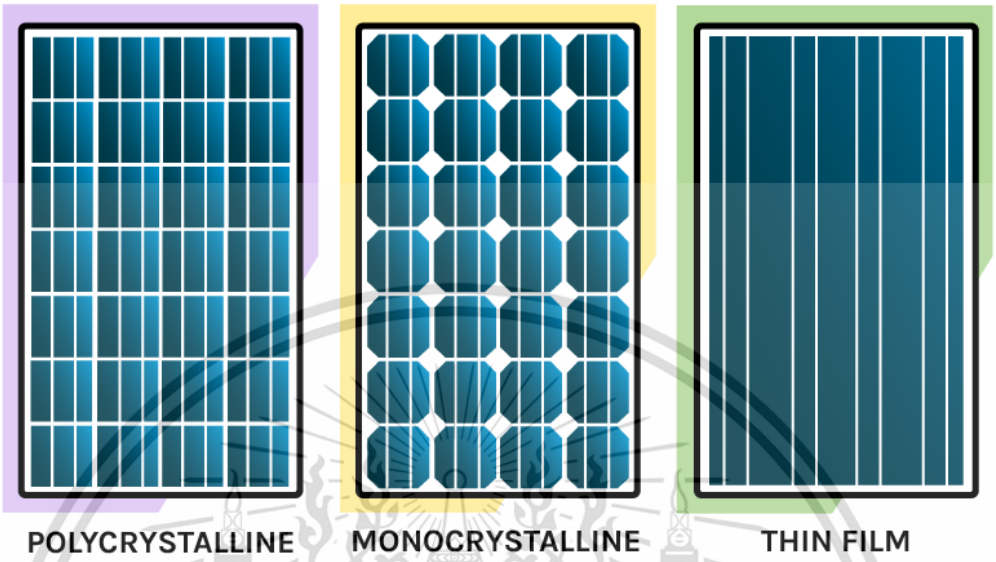


Figure 2.9 Comparison of monocrystalline, polycrystalline and thin film

Source: https://mysolarquotes.co.nz

2) Thin film: This is the most recently invented and developed technology known as an amorphous solar cell, which was developed in the laboratory to save the production cost and time. The semiconductor is made into a 0.5 micron thin film and inserted in between double-layer glass. The cell has a lighter weight and is more flexible than the crystalline type. Silicon is one of the semiconductor types used for making this solar cell panel, which was very popular in the large power plants during 2008-2012. Other semiconductors; such as gallium arsenide (GaAs), copper indium diselenide (CuInSe2) and cadmium telluride (CdTe) are expensive, so they are not popularly used on a land area but mostly for satellites.

In addition, when the polycrystalline solar cell panels could be manufactured at a low cost because China established a number of production plants during 2011-2015, the thin film solar cell lost its popularity. This was because it had a high cost and was able to be fabricated only in a small size and low capacity (only 120-150 watts per panel). Therefore, more space was required for the installation. The Natural Energy Development (NED) plant in Lop Buri province is a sample of a project using thin film solar cells, and the largest solar power plant using this type of panel in

Thailand and ASEAN. The plant's capacity is 63 Megawatts, and it is situated on an area of 1,400 rai (224 hectares) with 640,000 panels from the Sharp Corporation being used. The plant started supplying electricity to the Electricity Generating Authority of Thailand (EGAT) on December 22, 2011 (www.ned.co.th).

The largest size of the polycrystalline solar cell panels in 2018 consisted of 72 cells with a capacity of 350 watt. The normal panel size could be carried by two persons; it is one meter wide, two meters long, 45 millimeters thick, and weighs 25 kilograms/panel. The front of the panel consists of laminated glass, which allows the light to penetrate and prevents scratches. The panel should prevent humidity because it is installed outdoors and exposed to the sunlight and rain. The materials are water and humidity resistant; such as, silicon or ethylene vinyl acetate (EVA). The frame made from robust material; such as, aluminum, is used to prevent the panel's breakage. A frameless panel can also be used if the glass strength is enhanced. Nevertheless, it might have a problem with the clamp fasteners; the vibration from a strong wind or the ground instability might cause the breakage of the solar cell panel glass. For this reason, the frameless type is not popular. Generally, a solar cell panel has a 3% of performance degradation in the first year when exposed to the light and 0.7% in the following years. The manufacturer gives 25 years for the power output warranty and 10 years for the product warranty.

Thailand has developed solar power plants to generate electricity to the grid of electricity authorities since 2006 with financial support to increase the subsidy at 8 Baht/unit (Ministry of Energy, 2018). Initially, it was not well received due to the high construction cost. Most solar power plants were ground-mounted structure which the solar panel is installed on a mono pole, multi pole, or on a cement basement. Currently, solar power generation in Thailand is classified into 3 types as follows:

1) Solar ground mount

The solar cell panel is installed on a pole or concrete base at a tilted angle of 10-15% depending on the location. This type of solar plant in Thailand is mostly a medium to large size located in a wide area and supplies power to the electricity authorities. Since it uses a vast space, it is called a solar farm. In the past, the construction area was 20-25 rai/MW. However, solar cell panel technology has been rapidly developed, so it has more efficiency at a smaller size; therefore, the maximum required space for construction is 10 rai/MW. The risk of solar farms is flooding. If it is located in an area that has the risk of flood in the rainy season, the water level might reach the cable and solar

cell panel; for example, the flood disaster in 2011 resulted in the serious damage of some solar plants in Ayutthaya province.

The solar cell panel that generates the electricity is mostly a fixed type. Consequently, the panels receive sunshine only some periods of time in each day since the sun moves all the time. Therefore, the tracking system is designed to allow the solar cell panel to move and follow the sun throughout the day; enhancing the electricity generation efficiency for 10-20%. However, the cost is higher than that of the fixed type. Currently, there are tracking solar power plants in Thailand such as SPP Two Co., Ltd. by EGCO Group. The operators have special knowledge about controlling the panel's deflection to receive as much solar radiation as possible for each period during the day (www.egco.com).

2) Solar rooftop

This kind of solar cell panel is installed on the roof; such as, the roof of a house, small garage or large factory or warehouse, using an off-grid or on-grid system. Thailand started this rooftop policy in 2013 by allowing the installation for personal use. Later on, a PV rooftop was approved to be installed to supply to the electricity authorities with the feed-in tariff (FiT) rate depending on the type of house and size of the building or factory installed (Ministry of Energy, 2017).

3) Solar floating

This is a new installation design on a floating structure or pontoon. It was mostly used at the beginning of a government project, which had a water surface area in a reservoir. This has become popular among the private sector to install it at a smaller reservoir; moreover, this type of solar system recently became more popular in some foreign countries as technology has been developed rapidly and its cost is decreasing. In Thailand, the first large solar floating project was developed by SCG Chemicals Co., Ltd. in Rayong province, which the installation size was 1 MW and has been in commercial operation since 2018 (www.scg.com/innovation/floating-solar-farm). The solar floating uses a limited area and as the solar panels are installed closed to the water, the coldness of water enhances the efficiency of the solar generation. Moreover, the solar floating plant also mitigates the problem of growth of underwater seaweed and reduce evaporation because the panel blocks the solar radiation to the water surface.

A solar power plant also requires a small number of operators and less maintenance compared to a plant using other fuel sources; such as, natural gas or coal. Because the working life

of a solar panel is usually longer than 20 years. For commercial purposes, the seller provides the power output warranty at 90% for 20 years and 80% at 25 years. If the efficiency is lower than the warranty within the warranty period, the buyer can change the panel. Additionally, all the equipment in the system is a fixed installation, so the damage from wear and tear is low. However, the operation and maintenance of a solar power plant requires a proficient engineer for the highest efficiency. In addition, regular cleaning of the solar panel is needed to remove the dust and dirt, which will minimize its efficiency resulting in lower output. With regards to maintenance, bird droppings should be removed as well; otherwise, these block the sunlight and finally cause a hot spot, which damages the solar panel. Chemicals should also not be used with the panel; only water is allowed. The external panel is glass and plastic coated with a waterproof chemical; such as, silicone, which reacts to the chemical. This leads to the damage of the solar panel and could make the warranty null and void.

2.1.3 Development of the solar power plant in Thailand

Thailand has used solar power to generate electricity for 40 years to upgrade the quality of life of people in remote areas, particularly in communication, sanitation, public health and education. The Electricity Generating Authority of Thailand (EGAT) has compiled the data of solar power in Thailand and foreign countries since 1978. Initially, solar cells from foreign manufacturers were imported to be used in the agencies under EGAT for radio communication, flashing light system, as a data recorder, seismograph, light system at the survey officer's residence, etc. In 1987, Thailand began to use solar power for the purpose of pumping water in the Northeastern Green Project to resolve the drought problem. Later, the Department of Alternative Energy Development and Efficiency (DEDE) (former Department of Energy Development and Promotion), Ministry of Energy, and Department of Public Works and Town and Country Planning (former Public Works Department), Ministry of Defense offered financial aid to install a solar power system for pumping and charging batteries in remote areas in 1990. At the beginning of 1997, solar power was generated to be applied for the purpose of household use and education of schools in the rural areas. Moreover, solar power generation was also used in the national parks and wildlife conservation areas of the Royal Forest Department. In 2005, the solar power generation system was used in households in remote areas with the financial support from the government sector under the governance of the Provincial Electricity Authority (Energy Policy and Plaaning Office, 2014).

Since 2006, the use of solar power generation in Thailand has changed. There was a 20-year concession to generate solar power to supply to the grid of electricity authorities at with an adder at 8 Baht per unit (kWh) with a target for the solar power generation system to be 50 MW. Subsequently, the 15-year Alternative Energy Development Plan (2008-2022) was announced in 2008, so the number of solar power plants increased rapidly. The number of solar power plants installed in 2011 and 2012 was 242 and 387 MW, respectively. This increased to 823 MW at the end of 2013. At the beginning of the solar power development in Thailand, it is noted that the solar power plant was only a solar ground-mounted type. Eventually, the capacity of the on-grid solar system increased dramatically reaching 1,420 MW at the end of December 2015 and 3,025 MW in September 2017. The number was more than half of 6,000 MW, which was more than half of the expected number set by the government for the year 2036 (Ministry of Energy, 2018).

As a result of the advantages of solar power, the government has attempted to promote the private sector to participate in the development of solar power plants by providing support through taxation measures and offering additional incentives. For example, there were privileges from the Board of Investment (BOI) to promote investment; and other benefits from the government; such as the support of academic information, import tax exemption for solar panels and equipment, capital loans and working capital from financial institutes. Therefore, since 2006 after the application of private solar power producers, the Ministry of Energy motivated them by offering the adder in the power purchase agreement at the rate of 8 Baht per unit (kWh) to add 8 Baht on top of the selling tariff. Although there has been a lot of promotion, there was still a low number of project participants because the construction costs were very high. Additionally, solar power was a new innovation, and investors hardly found sources of loans since the commercial banks were not familiar with such business and recognized it is high risk. However, the situation improved at the beginning of 2009 due to the efficient technology and the lower cost of solar power equipment and construction. Thus, more investors became interested in the solar power projects. From June 2010, the government reduced the adder to 6.50 Baht per unit because of the lower cost of the solar panels from increasing mass production from China. Finally, the Ministry of Energy ended the adder support in 2014 and adjusted the rate to be Feed-in Tariff (FiT), which was the fixed rate throughout the concession period, and did not vary to the base tariff and the adjustable tariff or called float time (Ft), which is the electricity charge that varies to the cost of the production, transportation, and distribution system from the factors that were out of the electricity authorities'

control. The use of the FiT rate was the development of the renewable energy project like in other developed countries. Afterwards, the Energy Regulatory Commission (ERC) applied the FiT rate to the pending pipeline solar projects, which are the solar farms that 178 applicants pending for approval since June 2010. Finally, approval was given to 171 applicants with a total of 969 MW with the FiT rate at 5.66 Baht per unit. Furthermore, the government called for bidding of the cooperative solar farms in 2017 with the FiT at 4.12 Baht per unit with a total generating capacity of 272 MW throughout the 25-year power purchase agreement (Ministry of Energy, 2018).

The solar PV rooftop was substantially developed in 2013 after the announcement by the ERC regarding the Solar Rooftop Project on September 6, 2013, for 200 MW. The government purchase the electricity from the solar rooftop installed on the house at 6.85 Baht per unit (kWh) throughout the 25 years of the power purchase agreement. This project received a positive response, but it did not reach the expected number, as only 130 MW was applied (Ministry of Energy, 2019), but the development ceased because there was no further purchase afterwards. Until 2016, the government established the project Solar Rooftop Phase 2, called 100 MW Residential Solar Rooftop Project that aimed to test and compile the data of solar power generation in the household for personal use (Electricity Regulatory Commission, 2017). The homeowners did not receive an electricity charge from the solar power flowing into the grid, but they will get exception of a meter fee for three years. In 2019, Thailand announced the Residential Solar Rooftop Program on Households, which was in line with the Power Development Plan 2018 (PDP 2018), which aimed to have solar rooftop installation on households for 10,000 MW at the end of 2036. People were encouraged to have self-consumption and supply the surplus to the government sector at the rate of 1.68 Baht per unit (kWh). The first year was targeted at 100 MW and started on May 24, 2019. The participants have to install solar rooftops and completed the synchronization to the grid by the end of 2019.

Apart from self-consumption and supplying solar power to the grid, the output could be transmitted to the Energy Storage System (ESS) or “battery” to use at nighttime. The project minimized the peak demand of the country, which also mitigated the burden of the government to construct a large power plant to respond to the peak demand. However, at the end of 2019, the number of project participants have still not reached the target of 100 MW (Ministry of Energy, 2019). The development of the solar power plant in Thailand is shown in Figure 2.10.

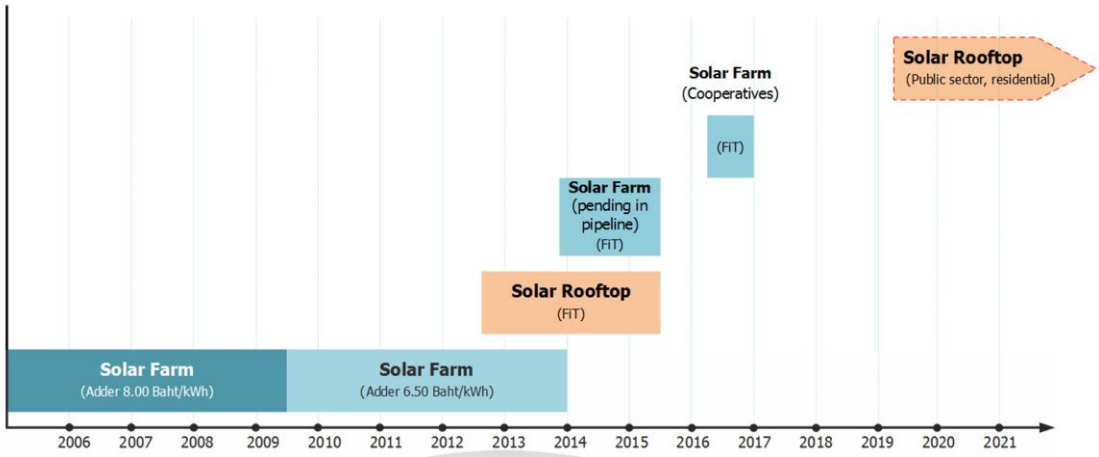


Figure 2.10 Development of the solar power plant in Thailand

2.1.4 Future of the solar rooftop

It is expected that solar rooftop will be the disruptive technology that becomes the main energy source of the world instead of fossil fuels. The production cost of solar panels per watt has continuously decreased within the past 40 years. It decreased 50% during the five-year period during 2011 to 2015 while the power output efficiency increased at the same rate (Bloomberg New Energy Finance, 2016). Therefore, a solar rooftop has become more popular due to its direct and indirect benefits. For instance, it reduces the use of energy at 8-45% depending on the application; the solar rooftop saves 15% of electricity to the homeowners, cools down the house, and reduces the use of an air conditioner (Thanyaluckphak, 2016). Furthermore, solar power is sustainable energy causing zero pollution and that helps minimize the global warming problem. Countries throughout the world recognize these benefits and have installed a solar farm and solar rooftop to be widespread. In the past two decades, from 2000-2018, the global cumulative installed solar photovoltaic capacity has increased rapidly from 288 MW in 2000 to 509,300 MW in 2018.

Currently, more innovations and technologies are being created to support the transactions relating to the solar rooftop; such as, blockchain, which is one of the energy innovations that applies software to manage solar power trading. The solar power producers can sell the power directly to the consumers regardless of the electricity authorities, called the peer-to-peer (P2P) energy trading. In Thailand and Southeast Asia, BCPG Public Company Limited, an affiliated company of Bangchak Corporation Public Company Limited, was the first company that applied blockchain technology from Australia to the Town Sukumvit 77 Project in Bangkok. Official trading will be started at the end of 2019. The project shall install a solar rooftop with the

capacity of 635 KW. This system will allow residents to become the energy producer and consumer at the same time, or as it is called prosumer. It is expected that this project would save the electricity cost at 15% per unit and would be environmentally-friendly by reducing the amount of carbon dioxide by 530 tons per year compared to the use of fossil fuel power. Thailand's energy regulator or ERC is currently setting the regulations to support the power generation and trading of this new form of power (Electricity Regulatory Commission, 2019).

It is not only the private sector that has become aware of and developed new technologies to use with solar power, but also the government sector that is aware of the impacts of the electricity authorities' revenue when the public and industry produce and trade energy among themselves. Therefore, the government sector has to adjust the organization and develop new technologies; for example, Provincial Electricity Authority (PEA) are considering to provide service in managing solar energy through their distribution lines via their blockchain. This is because the private sector still needs the distribution lines that are belonged to the electricity authorities although they trade the solar power by blockchain. For this reason, the electricity authorities earn revenue from the wheeling charge and other service fees. Furthermore, the Metropolitan Electricity Authority (MEA) signed a memorandum of understanding (MOU) with Naresuan University for the research of National Energy Trading Platform (NETP) Project in 2018. The goal of this cooperation was to set up the platform of blockchain, which would facilitate the power trading between the solar power producers and the consumers at the national level. In the future, the private investors that trade solar power through blockchain will be able to connect their platform to this national platform. It is expected that the NETP shall support the solar power generation to cover all provinces, which will be a new form of power generation and management to prepare for future changes (Ministry of Energy, 2019).

It is not only the solar rooftop generation system, but also the energy storage system that will be very vital for the popularity of the solar rooftop. For this reason, a battery is very important and affects the orientation of the policy setting for solar power in Thailand. In addition, a battery system is one of the significant mechanisms of the Energy 4.0 policy set by the Ministry of Energy. Nevertheless, the battery system is still costly, and the cost of electricity produced from solar rooftop and energy storage system is higher than tariff from the grid. However, if the cost of the battery decreases and the consumers are able to afford it, the battery could be used to store the solar power to be used when there is no sunlight. This would be a significant change of power generation

where the households and factories would be able to generate and store the power by themselves. They would no longer use conventional fuels; such as, oil, coal, or biomass fuels that are costly cause pollution from combustion.

The promotion for solar power generation, which is one of the forms of renewable energy, of the government through the BOI's privileges, the flexibility of the license to facilitate the approval process, and the guidelines for increasing the target of the renewable energy supply to 30-40%, has benefits for the solar farm and solar rooftop. Although the solar rooftop development is still in the initial stage, the private sector and the public have already widely installed the solar panels. As a result, the electricity authorities have to adjust the organizational structure to deal with the decreasing purchase of electricity from buyers because the factories, offices, and households will be able to generate solar power themselves. Moreover, it is predicted that the cost of solar rooftop equipment and battery will decrease, which will make solar rooftop become more popular in the near future.

2.2 Concepts and theories of Intention to Use

Intention to use is a behavior showing the potential of a consumer to use products or services. It is the prediction of consumer behavior in the future. When there is the intention to use, a consumer may decide to use or decline. However, when there is positive possibility, the using behavior follows (Dodds et al., 1991). Furthermore, Kotler (2000) referred to the intention to use as being an efficient measure of consumer behavior. Most consumers choose to purchase a product or employ service to satisfy their need and fulfill their daily activities routine. The key component of product manufacturing is to be aware of the demand, perception, and value that customers will receive from using the products or services. It is the main variable leading to the sustainable intention to use or purchase. Kotler, Armstrong and Opresni (2016) stated that an actual purchase by a consumer begins from awareness, knowledge, liking, preference, and conviction, which are the factors affecting intention behavior. For this reason, these factors were applied to this research.

Currently, consumers are more interested in renewable energy in order to reduce the use of fossil fuels which cause air pollution from fuel combustion in power generation process. The use of renewable energy begins when they believe that this kind of energy is clean and eco-friendly. Renewable energy is created from natural resources such as solar energy, which we can reuse

limitlessly (Akinwale et al., 2014). Therefore, research on the intention to use renewable energy requires awareness of the demands and attitudes of consumers, which could lead to the intention to use.

From the literature review, many scholars have studied the definition of the intention to use, as shown in Table 2.1.

Table 2.1 Definitions of Intention to Use

Scholars/Researchers	Definitions
Ajzen (1991)	An unnoticeable but measurable cognitive behavior. It is the initial behavior causing the expression of the following behavior and the variable that can accurately predict the behavior.
Dodds, Monroe and Grewal (1991)	The attitude of the consumer towards the products that has the external factor as the stimulus to construct the intention to purchase the product.
Kaiser et al. (1999)	Partial attitude towards a specific action and the standard of the reference group.
Spears and Singh (2004)	The deliberate planning of the consumer or the intention to attempt to purchase a product at a specific time or in any situation.
Fishbein and Ajzen (2010)	The readiness or possibility of a person to express any behavior.
Huijts, Molin, and Steg (2012)	The behavior arises from the attitude and social background of the consumer, leading to action in the future.
Kotler (2014)	The decision to choose one way or another and process it to get the choice using various methods.
Lee et al. (2015)	Behavior arising from the attitude and perception of benefits from certain products and services.
Wu (2016)	The behavior constructed from the perception of the characteristics and quality of products and services.
Ali et al. (2019)	Behavior arising from beliefs and personal preferences toward certain products and services.
Febina et al. (2019)	Intention to purchase products and services from a distributor.
Xiao et al. (2019)	An action that is performed based on belief and personal sense.

From Table 2.1, the researcher and scholars gave various definitions of the intention to use. It was concluded that the Intention to use referred to the intention of the homeowner to procure and install a solar rooftop system to utilize the benefits from generated electricity by hiring a contractor to design and install a system on their roof. The homeowner might search for information and have conversations with others about their experiences with solar rooftop systems before making a decision.

The related theories to the individual intention based on the human psychology principle were often applied as the guideline or framework for studying the factors affecting the attitudes of individuals to accept something. The Theory of Reasoned Action (TRA) was developed and proposed by Fishbein & Ajzen (1975) and Ajzen & Fishbein (1980). It explained general human behavior as involving the behavior of humans caused by the use of logic and reference information to make the decision to do or not do something. Therefore, the prediction of human behavior should take the related or affected factors into consideration. The factors affecting individual behavior include behavioral intention, which is influenced or stimulated by the attitude and subjective norm, as shown in Figure 2.11. In other words, the intention of an individual is dependent on attitude towards the behavior, as aligned with the subjective norm. If an individual intended to do something or was influenced by people close to him, there would high potential that he would take that action.

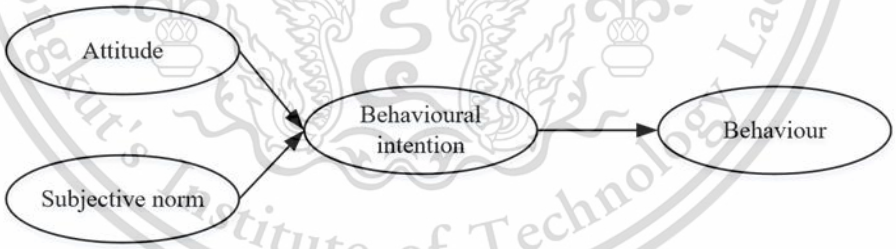


Figure 2.11 Theory of Reasoned Action (TRA)

Source: Ajzen and Fishbein,1980

In 1985, Ajzen developed the Theory of Planned Behavior (TPB) from the Theory of Reasoned Action proposed by Ajzen and Fishbein (1980). He added perceived behavioral control to the theory. It explained that the individual behavior was affected by three influences, as shown in Figure 2.12.

1. Attitude towards the Behavior: This was the evaluation of whether it was a positive or negative action. It was considered a personal factor. If the person believed that any action had a positive impact, it was likely that the person would have a positive attitude towards such behavior. On the other hand, his attitude was likely to be negative if the person believed that the behavior had a negative impact. A positive attitude would lead to the intention to perform the behavior.

2. Subjective Norm: This was the perception that other people who were important to the person wanted or did not want that person to perform such behavior. If the person perceived that those people suggested any behavior or wanted him to perform such behavior, there was the possibility that he would follow and behave.

3. Perceived Behavioral Control: This was the perception to recognize whether it was easy or difficult to perform such behavior. If the person was able to perform such behavior in a situation and control the desired outcome, it was likely that he would perform the behavior.

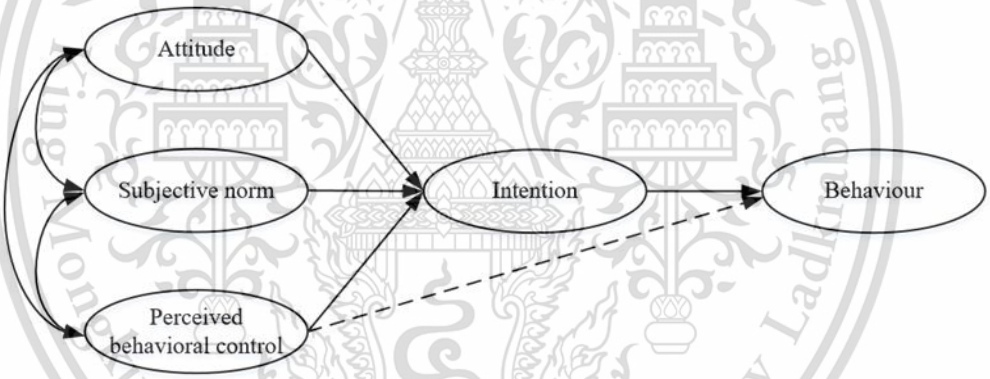


Figure 2.12 Theory of Planned Behavior (TPB)

Source: Ajzen, 1985

Theory of Planned Behavior has been applied and referred widely in researches concerning marketing and industrial fields, such as advertisements, public relations, psychology, healthcare, and energy. For instance, research by Engelken et al. (2018) applied the Theory of Planned Behavior as the research framework for the roles of subjective norm in the research, “Why homeowners strive for energy self-supply and how policymakers can influence them”. The results showed that attitude, subjective norm and perceived behavioral control were the important predictors of purchase intention. Similarly, Abreu et al. (2019) examined the new trends in solar

power in a comparative study assessing attitudes towards the adoption of rooftop solar. They discovered that subjective norm had a direct and positive impact on attitudes, whereas attitude also had a direct and positive influence on the adoption of rooftop PV systems for buildings in the United States.

The concepts and theories mentioned herein are concepts used to understand the intention to use solar rooftop energy by the households in Thailand. The researcher studied from the literature review, concepts, theories, and researches about factors related to the intention to use. Scholars and researchers have concluded observed variables, as shown in Table 2.2.

Table 2.2 Literature review of Intention to Use

Scholars/Researchers	Latent variables	Observed variables	Industries
Thompson et al. (2006)	Intention to use	Behavior to make a decision to use a service	Technological products
Kim et al. (2014)	Intention to use	Intention to use behavior	Solar energy
Maoyan, Zhujunxuan and Sangyang (2014)	Intention to purchase social media	Decision making to purchase behavior	Social media
Fornara et al. (2016)	Intention to use	Behavioral intention	Renewable energy
Han et al. (2017)	Intention to adopt	Acceptance behavior	Electric vehicle
Sreen et al. (2018)	Purchase intention	1) Pre-purchase intention 2) Intention to purchase behavior	Green products
Weng et al. (2018)	Intention to use	Behavioral intention	Multimedia
Yu and Lee (2019)	Intention to purchase	Continuing support	Upcycled products

From Table 2.2, it could be summarized that the observed variables for the intention to use is behavioral intention; as shown in Tables 2.3.

2.2.1 Behavioral Intention

Behavioral intention was the connecting point of taking action and dismissing the intention to take action. A number of researchers and scholars have given their definition of behavioral intention, as shown in Table 2.3.

Table 2.3 Definitions of Behavioral Intention

Scholars/Researchers	Definitions
Fishbein and Ajzen (1975)	The expression leading to the process during decision making.
Ajzen (1991)	Behavior arising from interest in something.
Bigne et al. (2001)	The response or emotional decision making on any product at a certain time.
Thompson et al. (2006)	The prediction on product use in the future.
Ananda and Herath (2008)	The behavior of a consumer to use something because of the influence of personal interest.
Thirumalai and Sinha (2011)	The intention to purchase and use products and services, based on the satisfaction of the consumer on such business.
Ahmed and Sathish (2017)	Behavior leading to the acceptance of something.

From the above definitions in Table 2.3, it could be concluded that behavioral intention was the behavior of the homeowner caused by the intention to use solar rooftop energy and the willingness to use it more in the future.

From the review of literature, concepts, theories, and researches of the factors related to the intention to use, the model comprised 1 observed variable, as shown in Figure 2.13.

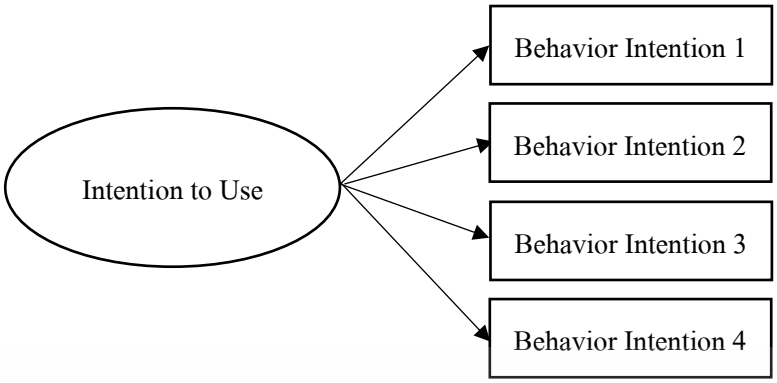


Figure 2.13 Model of Intention to Use

2.3 Concepts and theories about Government Policy

Thailand is one of the countries where solar power has high potential. Further, it is the first country in ASEAN that announced the incentive to generate electricity from solar rooftop systems, which is the most appropriate technology for households at present in order to minimize the expenses of electricity use. Moreover, it mitigates the peak demand during the high utilization period, which is the burden of the government and involves investing a significant amount of money in constructing large power plants to support the high demand. For this reason, the government sees the significance of policy setting for solar power development to gain the highest benefits for all. The increased popularity of solar rooftop in Thailand was steered by the Feed-in-Tariff project (FiT), which was first announced in 2013. FiT allowed people to install solar rooftops and sell solar power to the electricity authorities. The second phase of the project (free solar rooftop) and the third phase (residential solar rooftop on household) were announced in 2016 and 2019, respectively. Besides, the Ministry of Energy established the Energy Conservation and Promotion Fund Office, which organized activities to promote quality of life development by using solar power, aiming for (1) the solar pumping system to decrease costs and expand agricultural opportunity, (2) the solar power system for opportunities in distance learning and educational innovation, (3) the solar power system to enhance people's quality of life in rural areas. The total capacity of the 3 systems was 7,709 kilowatt (kW) and 13,407 kW for fiscal years 2018 and 2019, respectively.

Currently, as of September 2018, Thailand has installed enough solar cells for 3,250 MW (Energy Policy and Planning Office, 2019), consisting of solar farms and solar PV rooftops as well

as other government projects. The Ministry of Energy promotes and supports the solar rooftop system and aims to generate solar power for 6,000 MW according to the Power Development Plan 2015 (PDP 2015). Therefore, the remaining power target to achieve is 2,750 MW. Later, the Power Development Plan 2018 (PDP 2018) was announced on May 24, 2019. The objective was to install additional 12,725 MW of solar power by the end of 2036. The plan is divided into two phases: residential solar rooftops on households for 10,000 MW and the solar floating projects for 2,725 MW, which will be responsible by the Electricity Generating Authority of Thailand (EGAT). Anyhow, the Ministry of Energy also promotes solar power for the community such as the solar pumping project, for which 1,087 pumps have been installed and 1,446 pumps will be installed in 2019. Furthermore, there is the promotion on solar power generation in 439 schools and 239 health-promoting hospitals in remote areas (https://energy.go.th).

Nevertheless, the government policy has not been responded to people's demands. As a result, participation in the solar rooftop project in 2013, 2016 and 2019 did not achieve the target, even though there were some incentives such as the fee exemption or the selling of power to the system. Aside from the high cost, there were some concerns about the efficiency and burden of maintenance, which influenced people's interest in the solar rooftop system (Potisat et al., 2017). One factor that obstructs the acceptance of using solar rooftop power in Thailand is the inconsistency of laws and regulations. As stated by the Factory Act B.E. 1992, any facility installing power-generating equipment with a capacity from 5 horsepower or 3.73 kW is considered a factory. In other words, a house that installs solar panels and the invertors for which the total capacity is more than 3.73 kW is classified as a factory. Thus, the homeowner must apply for a factory license from the Energy Regulatory Commission (ERC). Moreover, the homeowner shall apply for other licenses such as Building Modification Permit. After the installation, the homeowner has also to apply for the Controlled Energy License from ERC if the solar PV rooftop capacity is more than 200 kW but does not exceed 1,000 kW. In addition, the connecting of the solar rooftop to the grid is required according to the regulations of Provincial Electricity Authority (PEA) and the Metropolitan Electricity Authority (MEA), which has a complex and unclear process that takes time to get approved. Therefore, the government has to consider a solution to this conflict by reviewing and amending the laws and regulations to facilitate the growth of green energy development (Sukamongkol, 2016).

From the literature review, a number of scholars have given definitions for the term "government policy", as shown in Table 2.4.

Table 2.4 Definitions of Government Policy

Scholars/Researchers	Definitions
Zhang et al. (2013)	Terms or conditions that are drafted by the government of a country to project its vision, mission, and transparency in nation administration.
Cardenas et al. (2017)	The promotion and support of renewable products and related manufacturing industry by the government of each country to promote renewable energy products to become well-known and accepted by all sectors.
Child et al. (2017)	The strictness of the government in the declaration of terms and conditions related to the installation/generation of solar PV, such as providing knowledge to consumers, R&D support and financial aid.

From Table 2.4, the researcher concluded the definition of **the government policy as the regulations of the government to promote and support the development and installation of solar power systems to become known and accepted by people.**

A good policy should 1) direct the operational guidelines to achieve the objectives and construct understanding among the people and all related parties to know the direction and how to implement such a policy, 2) be simple and in writing, 3) point out the regulations and practices for the future, 4) be flexible and adjustable if needed, 5) be logical and practical, 6) give opportunity to the practitioner to interpret and make decisions to perform, and 7) be audited and monitored periodically for performance and be revised from time to time (Massie and Douglas, 1985).

From the above concepts regarding the government policy on the installation of residential solar rooftop systems in Thailand, researchers and scholars studied more literature review, concepts, theories, and researches about the latent variables related to the government policy, concluding the observed variables as shown in Table 2.5.

Table 2.5 Literature review of Government Policy

Scholars/Researchers	Latent variables	Observed variables	Industries
Chaianong and Pharinon (2015)	Government Policy	1) technology support 2) economic support 3) regulatory support	Solar PV rooftop
Kilinc-Ata (2015)	Government Policy	1) technology support 2) economic support 3) regulatory support	Solar PV / renewable energy
Sukamongkol (2016)	Government Policy	1) technology support 2) economic support 3) regulatory support	Solar PV rooftop
Long et al. (2017)	Government Policy	1) technology support 2) economic support 3) regulatory support	Solar PV

From Table 2.5, it could be concluded that the observed variables of the government policy comprised 3 variables: 1) technological support, 2) economic support, and 3) regulatory support; as shown in Tables 2.6-2.8.

2.3.1. Technological Support

Solar rooftop technology has been developed rapidly and its popularity steers the manufacturing of solar rooftop equipment for sale in great numbers. Some of it becomes understated and outdated. Some users buy items because they lack the proper knowledge and understanding. Besides, experts in this field are scarce and most problems occur because of the lack of experience in installing and designing the solar rooftop equipment. The researchers and scholars gave the definition of the technology support, as shown in Table 2.6.

Table 2.6 Definition of Technological Support

Scholars/Researchers	Definitions
Chaianong and Pharinon (2015)	The support of resources used in the production or service production such as the lack of knowledge and experience in the production of labor, as well as the sufficiency of the production material or technology.
Sukamongkol (2016)	The sufficiency of technology and knowledgeable personnel in the research, development, and creation of solar rooftop systems.
Potisat et al. (2017)	The support of the ability and efficiency in manufacturing products and the period of using the innovations in research and development as well as the product manufacturing process.

From the above definitions in Table 2.6, it could be concluded that **technology support refers to the support of technology in installing residential solar rooftop systems in household in Thailand in terms of technology accessibility, knowledge of personnel, and the availability of modern and efficient equipment.**

2.3.2. Economic Support

This is the support and subsidy due to limited budget and high cost with the decreasing purchasing power of the consumer. The insecurity of the economic system, on both national and global levels, has great impact on the installation of solar rooftops. The researchers and scholars provide the definitions for economic barrier in Table 2.7.

Table 2.7 Definitions of Economic Support

Scholars/Researchers	Definitions
Chaianong and Pharinon (2015)	The avoidance of risk of the economy based on limited budget and insecurity in the national and global economic system.
Tongsopit et al. (2016)	The support of investment because solar rooftop installment requires high cost compared to the benefits.
Potisat et al. (2017)	Economic support to solve the problem in the continuing decreased purchasing power by the consumer.

From the definitions given in Table 2.7, **economic support refers to the investment support to install solar rooftops of households in Thailand, which depend on limited budget and the insecurity in the national and global economic system.**

2.3.3. Regulatory Support

The component of regulatory support is the purpose to reduce risk caused from the overlapping of the application of outdated and unclear laws, as well as the exceeding regulations to legislate the law relating to residential solar rooftops. The researchers and scholars provided definitions for the regulatory support, as shown in Table 2.8.

Table 2.8 Definitions of Regulatory Support

Scholars/Researchers	Definitions
Chaianong and Pharinon (2015)	The assistance for signing agreement between the government and household to use the renewable power product and service.
Tongsopit et al. (2016)	The regulatory scheme to solve unclear risk, uncertainty, and complication of the agency to enforce the government policy to support the installation of renewable power systems.
Potisat et al. (2017)	The rules and regulations and the clear policy setting in public utility of the government.

From Table 2.8, **the regulatory support is the assistance to facilitate the understanding of rules and regulations and to reduce complexity of the leading agency in policy setting to promote residential solar rooftop households.**

From the review of literature, concepts, theories, and researches on the factors of the government policy by the scholars and researchers, the model comprised of the 3 observed variables was concluded, as shown in Figure 2.14.

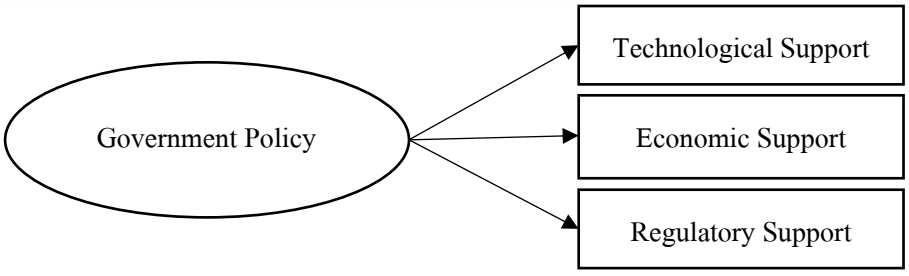


Figure 2.14 Model of Government Policy

2.4 Concepts and theories about Attitude

Attitude is a significant concept in social psychology and communications field. For the definition of attitude, a number of scholars have given definitions that it was an index to show how a person thinks and feels about the people around them, the objects and environment, as well as the situation. Attitude is rooted in the belief that something might affect future behavior. Thus, attitude involves the readiness to respond to a stimulus and it is an assessment to like or dislike a matter. It is the interpersonal communication that is the result of receiving a message that leads to a certain behavior (Rogers, 1978).

The root word of attitude comes from Latin, Aptus, meaning tend to or the way the person thinks or feels towards someone or something. Further, it is the notion that a person takes in behaving around someone to express how he feels. Kotler (1997) gave the definition that, "attitude is the possibility that the person learns to behave in harmony with the satisfaction or dissatisfaction toward something. Thus, attitude is very important to consumer behavior (Huang et al., 2004). The Theory of Reasoned Action and Theory of Planned Behavior can apply attitude as the main concept to predict the behavioral intention of people.

From the literature review, the definition of attitude is concluded in Table 2.9.

Table 2.9 Definitions of Attitude

Scholars/Researchers	Definitions
Kendler (1963)	The readiness of a person to show a behavior to support or resist against another person, institute, situation, or concept.
Munn (1971)	A thought or idea that a person has towards an object, person, situation, or institute, and the suggestion to accept or deny, which would make the person react with the same behavior constantly.
Fishbein and Ajzen (1975)	Belief and the positive or negative feelings of a person towards something.
Ajzen and Fishbein (1980)	The positive and negative evaluation of the person towards the behavior expression.

Table 2.9 (Continue)

Scholars/Researchers	Definitions
Ajzen (1991)	The level of satisfaction or dissatisfaction of a person on the evaluated subject.
Schiffman and Kanuk (1994)	The expression of the internal feeling reflecting how a person tends to be satisfied or dissatisfied about something.
Sparks et al. (1994)	The thought about technology indicating the belief of a person in terms of the ability in technology to reduce the barrier to social development in the future.
Miller (2005)	The outcome of the belief relating to a specific behavior which is processed within the person.
Fishbein and Ajzen (2010)	The hidden possibility to respond to the satisfaction and dissatisfaction towards something that is the result of psychology.
Kim et al. (2010)	Thought and belief of the consumer in the product.
Chaiklin (2011)	opinion that identifies a verbal expression as behavior.
Reyes-Mercado and Rajagopal, (2017)	The favorable or unfavorable assessments of the outcomes that lead to the particular behavior.
Yu and Lee (2019)	The personal belief in something.

From Table 2.9, the researcher concluded that **attitude refers to the level of thought and mental state of the person from knowledge, understanding and the perception of the homeowner towards the solar rooftop in both satisfaction or dissatisfaction, which is the result of experience and the environment that is likely to influence the person to express the reaction to support or deny the matter.**

Ajzen and Fishbein proposed their perspective on attitude in that it was the reflection of the belief in behavior and the evaluation of the matter affected by the attitude, whether positive or negative. Attitude is one of the important variables of behavioral intention, according to the Theory of Reasoned Action and Theory of Planned Behavior, which can be applied in the renewable power industry such as the following researches:

- the adoption of renewable energy technologies in Mexico (Reyes-Mercado and Rajagopal, 2017),
- Intentions to adopt photovoltaic systems depend on homeowners' expected personal gains and behavior of peers (Korcaj et al., 2015), and
- Why homeowners strive for energy self-supply and how policy makers can influence them (Engelken et al., 2018).

There were scholars who classified the components of attitude into the following 3 parts (Triandis, 1971; Johns, 1996; Sharon and Saul, 1996; Gibson, 2000; Beri, 2008; Schermerhorn, 2000; Siegfried, 2004):

1. Cognitive Component: The use of logic by a person that is the result of personal belief To classify the differences, results, advantages, and disadvantages.

2. Affective Component: It refers to preference, dislike, fondness, hate, or fear which are personal emotions.

3. Behavioral component: It refers to the action tendency of the individual towards the situation or product.

From the above theories and concepts, they were the concepts used to understand the attitude towards the installation of solar rooftop of the household in Thailand. The researcher used more studies from the literature review, concepts, theories, and researches about the factors related to attitude. The observed variables could be concluded as shown in Table 2.10.

Table 2.10 Literature review of Attitude

Scholars/Researchers	Latent variables	Observed variables	Industries
Haddock and Zanna (1998)	Attitude	1) Affective 2) Cognitive 3) Behavior	Psychology
Trafimow and Sheeran (1998)	Attitude	1) Affective 2) Cognitive 3) Behavior	Psychology

Table 2.10 (Continue)

Scholars/Researchers	Latent variables	Observed variables	Industries
Bodur et al. (2000)	Attitude	1) Affective 2) Cognitive 3) Behavior	Psychology
Al-Swidi et al. (2014)	Attitude	1) Pleasant 2) Belief	Organic food
Kim et al. (2014)	Attitude	1) Affective 2) Cognitive 3) Behavior	Solar energy
Fathema et al. (2015)	Attitude	1) Pleasant 2) Belief	Technology
Korcaj et al. (2015)	Attitude	1) Affective 2) Cognitive 3) Behavior	Solar energy
Ahmad et al. (2017)	Attitude	1) Affective 2) Cognitive 3) Behavior	Residential solar energy
Thong et al. (2017)	Attitude	1) Affective 2) Cognitive 3) Behavior	Residential solar energy
Engelken et al. (2018)	Attitude	1) Affective 2) Cognitive 3) Behavior	Renewable energy / solar energy
Yu and Lee (2019)	Attitude	1) Pleasant	Upcycled products

From Table 2.10 and the concept of a Structural Theory of Attitude Dynamics (Rosenberg et al., 1960), it could be concluded that the observed variables of attitude are comprised of 3 variables including 1) cognitive component, 2) affective component, and 3) behavioral component; as shown in Tables 2.11-2.13.

2.4.1 Cognitive Component

Attitude as the result of the cognitive component is mostly based on the personal belief of the consumer in something. Rosenberg et al. (1960) explained that it is the checking of perception of the person from thought and belief towards an object or the circumstance to use the logic to summarize and conclude the belief to assess such a thing. Besides, a number of researchers and scholars have defined the cognitive component, as shown in Table 2.11.

Table 2.11 Definitions of Cognitive Component

Scholars/Researchers	Definitions
Crow et al. (1995)	The problem-solving process using knowledge that develops the cognitive and thinking process of the individual, which is processed gradually and differently by each individual.
Johns (1996)	The perception of the opinion and belief of the individual that derives from the logical thinking process.
Sharon and Saul (1996)	The belief to access any matter based on belief, imagination and recognition.
Gibson (2000)	The perception of the individual using logic and reason to access the belief to express something.
Schermerhorn (2000)	Attitude that reflects the belief, opinion, knowledge, and information the individual has, which reflects the thoughts of the individual.
Kim et al. (2014)	The perception of information from many sources that leads to the belief in quality and properties of the product and service.
Chowdhury and Salam (2015)	The belief that derives from the knowledge and opinion of the individual via perception from many sources of information.
Weng et al. (2018)	Recognition of the value and importance of a product or service.

From the definition in Table 2.11, it could be concluded that the **cognitive component refers to the understanding and thinking skill by using knowledge and logic of the homeowner on the decision making to use solar rooftop energy, based on different beliefs depending on various factors such as learning, information searching, experience, sense, and observation.**

2.4.2 Affective Component

The affective attitude of the consumer is derived from the experience of the consumer on something based on personal preference or impression. Rosenberg et al. (1960) explained that it was the emotional feeling that was consistent with good or bad thinking. If the individual had good thoughts about something, he would have positive feeling towards it. On the other hand, if the individual had bad thoughts about something, he would feel negatively towards it. Besides, researchers and scholars have provided definitions for the affective component, as shown in Table 2.12.

Table 2.12 Definitions of Affective Component

Scholars/Researchers	Definitions
Sharon and Saul (1996)	The positive or negative feelings or both positive and negative feelings toward the target.
Gibson (2000)	Learning of behavior from parents, teachers or friends.
Al-Swidi et al. (2014)	An impression in the expected matter.
Kim et al. (2014)	The feelings and thoughts of the individual about the product or service.
Chowdhury and Salam (2015)	The positive or negative feeling of the individual towards a product or service.
Weng et al. (2018)	The difference in the emotion and feeling of each individual that derives after consuming a product or service.
Schermerhorn (2000)	A specific feeling relating to the personal impact from the stimulus, leading to the attitude.

From the definition shown in Table 2.12, it can be concluded that the **affective component refers to the positive or negative feeling or both positive and negative feelings of the homeowner on the decision making to use the solar rooftop energy.**

2.4.3 Behavioral Component

The behavioral component showed the analysis thinking process and the alternative of the consumer to do something. Rosenberg et al. (1960) explained that the behavioral component was the readiness to take action as the result of thoughts and feelings. There is the potential to perform,

or if there is an appropriate stimulus, the action will take place. Moreover, the researchers and scholars gave some definitions, as shown in Table 2.13.

Table 2.13 Definitions of Behavioral Component

Scholars/Researchers	Definitions
Ajzen (1991)	The consideration that personal behavior always relates to the desires of the people around the individual.
Johns (1996)	The intention to behave towards a person or object with one or more methods such as showing friendliness or aggression. The behavior tendency is from the thoughts and feelings of the individual about the person or object.
Sharon and Saul (1996)	The behavior tendency or tendency of expression to the target.
Gibson (2000)	The intention to express or show behavior towards a person in any way.
Schermerhorn (2000)	The intention to behave in one way or another, based on a specific feeling or attitude of the individual.
Kim et al. (2014)	The behavior showing due to the affective component, which is through the decision making process.
Chowdhury and Salam (2015)	The response of an individual according to the feelings and emotions toward the product or service.
Lee et al. (2015)	The intention to use the most appropriate item.

From the definitions given in Table 2.13, **the behavioral component refers to the tendency of the behavioral response of the homeowner on the decision making to use the residential solar rooftop, based on belief, emotion, and personal perception such as support, rejection, and neutrality.**

From the review of literature, concepts, theories, and researches on the factors related to attitude by the scholars and researchers, the following model comprised of 3 components was obtained, as shown in Figure 2.15.

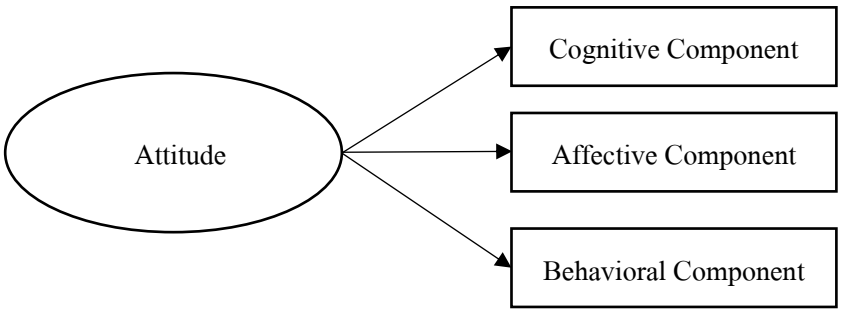


Figure 2.15 Model of Attitude

2.5 Concept and theories about Subjective Norm

Word-of-mouth is one of the significant factors influencing the purchasing behavior of consumers, especially word-of-mouth from family members, other relatives, close friends, experienced people, and famous people or experts. For this reason, most marketers advertise products or services using these people to approach the target group more quickly. A consumer or target group will more likely buy a product or use a service depending on who has influence on their attitude, decision making and change in their behavior. Verbal persuasion is used to influence the listener to change their attitude and perspective (Kotler, Armstrong and Opresni, 2016).

From the literature review, there were a number of scholars who gave definitions for the subjective norm, as shown in Table 2.14.

Table 2.14 Definitions of Subjective Norm

Scholars/Researchers	Definitions
Ajzen and Fishbein (1980)	Personal perception that people around them who are important to them want them to do or do not want them to do that behavior.
Ajzen (1991)	The perception of an individual that other people who are important to him want him or do not want him to do a certain behavior. If the individual perceives that people who want him to behave in a certain way, it is likely that he will follow their desire.

Table 2.14 (Continue)

Scholars/Researchers	Definitions
Finlay, Trafimow and Moroi (1999)	The belief or perception that important people believe that he should or should not exhibit a certain behavior, and the individual wants to follow the expectation of the reference group.
Bamberg (2003)	The influence of people closed to the individual on the intention to perform an action.
Miller (2005)	If the reference group that the individual gives importance to is not significant, they have no influence on that person's behavior.
Ajzen (2006)	Normative beliefs that have been pressured by society.
Read et al. (2013)	The social pressure that derives from influential people making an individual act and do things in a certain way.
Mascherek et al. (2014)	The behavior that derives from awareness of the pressure from others.
Singh et al. (2014)	The personal belief that an individual is being pressured by others or by people close to them.
Rai and Beck (2015)	It is the important perspective that a person recommends another individual does or does not do something. It is the behavior and motivation with willingness to do or not to do something important.
Reyes-Mercado and Rajagopal (2017)	The complete belief in the opinions of the people around the individual.
Zhang (2018)	A positive or negative attitude towards something that comes from belief in others' opinions.

From Table 2.14, the researcher conclude that the definition of **subjective norm is the belief or pressure received from influential surrounding people on the homeowner for the use of a solar rooftop energy.**

Subjective Norm was proposed in the concept of the Theory of Planned Behavior, which Ajzen (1985) developed from the Theory of Reasoned Action by Ajzen and Fishbein (1980). It explained that, before having the intention to do something, there might be conformation to a

reference group that has influence on the attitude towards that behavior and led to the behavioral intention. The individual would follow the reference group who was deemed important to the individual. The more the individual followed the reference group, the more it affected the intention to do something, regardless of the ethical or unethical nature of the decision-making (Bommer et al., 1987; Kreie and Cronan, 1999).

The researcher reviewed the literature and researches about the subjective norm and found that there were numerous scholars and researchers who studied and concluded the observed variables, as shown in Table 2.15.

Table 2.15 Literature review of Subjective Norm

Scholars/Researchers	Latent variables	Observed variables	Industries
Yoon (2011)	Subjective Norm	1) Social pressure 2) Normative belief 3) Motivation to comply with the referent	Software
Norazah, Ramayah, and Norbayah (2011)	Subjective Norm	1) Social pressure to perform or not 2) Strength of normative belief 3) Need to comply with the referent	Software
Singh et al. (2014)	Subjective Norm	1) Normative beliefs	Marketing
Reyes-Mercado and Rajagopal (2017)	Subjective Norm	1) Normative beliefs 2) Online social networks beliefs	Renewable energy
Kruse et al. (2018)	Subjective Norm	1) Normative beliefs	Marketing

From Table 2.15, it could be summarized that the observed variables for the subjective norm comprised 3 variables: 1) social pressure, 2) normative belief, and 3) motivation to comply with the referent; as shown in Tables 2.16-2.18.

2.5.1 Social Pressure

The researcher studied the relevant researches about this observed variable, which the scholars and researchers gave definitions, as seen in Table 2.16 below.

Table 2.16 Definitions of Social Pressure

Scholars/Researchers	Definitions
Ajzen and Fishbein (1980)	The individual shall carry out a behavior because the important people around him wants him to, such as friends, parents, teachers, and the society he is living in.
Bommer et al. (1987)	The attitude of the individual towards any behavior is influenced by the important people who agree that the individual should do it.
Ajzen (1991)	The important people to the individual such as parents, friends, or others in society are the people who define the belief as to whether the individual should or should not do something.
Siegfried (2004)	Among teenage group, friends are the most important people who put pressure on an individual, rather than parents or teachers.

From the definition above, the researcher concluded that **social pressure is the influence or pressure from society or the referent that is important to the homeowner regarding the tendency to use solar rooftop energy.**

2.5.2 Normative Belief

The researcher studied the relevant researches about this observed variable, which the scholars and researchers gave definitions, as seen in Table 2.17.

Table 2.17 Definitions of Normative Belief

Scholars/Researchers	Definitions
Ajzen and Fishbein (1980)	The motivation to have the same behavior as the referent expected.
Ajzen (1991)	The perception of the individual to know how much he wants to do the behavior the referent wants him to do.
Bhattacherjee (2000)	Encouragement from the media such as watching ads builds the need of the audience to follow the ads.
Reyes-Mercado and Rajagopal (2017)	Personal belief and behavior derive from people close to a person.
Kruse et al. (2018)	Attitude and behavior are caused by important people in life such as family, relatives and close friends.

From the definition above, the researcher concluded that **normative belief is the belief of the homeowner to use solar rooftop energy because it followed the expectations of other people who are important in his life and the he realizes it.**

2.5.3 Motivation to Comply with the Referent

The researcher studied the relevant researches about this observed variable, which the scholars and researchers gave definitions, as seen in Table 2.18.

Table 2.18 Definitions of Motivation to Comply with the Referent

Scholars/Researchers	Definitions
Ajzen and Fishbein (1980)	Motivation to exhibit the behavior expected by the referent.
Ajzen (1991)	The perception of an individual concerning how much he wants to follow the behavior that is expected by the referent.
Bhattacherjee (2000)	Encouragement from the media such as watching ads builds the need of the audience to follow the ads.
Mascherek et al. (2014)	Belief in a person who is more mature.
Sun et al. (2015)	Belief from listening to a lecturer or speakers in the events.

From the definition above, the researcher concluded that **motivation to comply with the referent refers to the motivation that the homeowner wants to use solar rooftop energy to respond to the expectation of the referent that has influence on such homeowner.**

From the review of concepts, theories, and relevant researches about the subjective norm, which comprised the observed variables, it was found that there were 3 variables as shown in Figure 2.16.

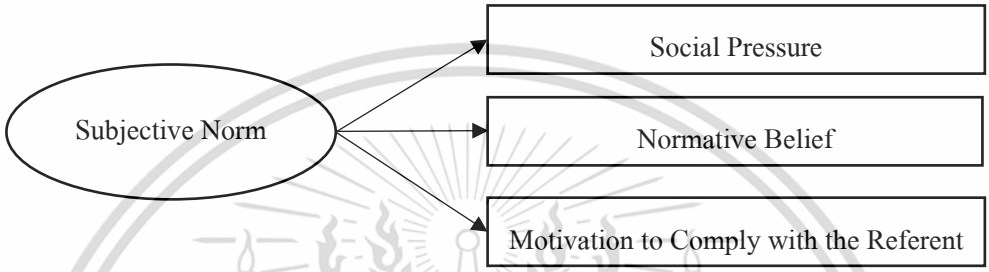


Figure 2.16 Model of Subjective Norm

2.6 Concepts and theories about Perceived Usefulness

Perceived usefulness is the perception of quality, efficiency and outcome from using the product or service (Römer et al., 2015). Hence, marketers must study and understand the customers or target groups in order to respond to their demands, which finally lead to the intention of customers to continuously use the product or service in the future. Teo et al. (2015) stated that the perceived usefulness of the consumer about innovation and technology was different based on personal attitude and belief. Thus, marketers should pay attention to the useful information presentation to the customer to build confidence in them while using the product. From the literature review, definitions for perceived usefulness were given by scholars and researchers, as shown in Table 2.19

Table 2.19 Definitions of Perceived Usefulness

Scholars/Researchers	Definitions
Davis (1989)	Level of personal belief in using the system or the intention to develop their personal performance.
Römer et al. (2015)	The recognition of benefits about the quality, efficiency, and outcome of using the product or service.
Teo et al. (2015)	The belief that the product or service enhances better life.
Abdul Aziz et al. (2017)	The use of an eco-friendly product.
Wang et al. (2018)	A positive attitude towards innovation.
Yim et al. (2018)	Facilitation that upgrades performance.

From Table 2.19, the researcher conclude that the definition of the **perceived usefulness is the awareness of the homeowner in value and benefits gained from using the solar rooftop, which improves efficiency, eco-friendly use, and quality of life.**

The relevant concepts and theories concerning perceived usefulness are from the Technology Acceptance Model (TAM), which is based on the Theory of Reasoned Action (TRA) by Ajzen & Fishbein's (1980) and the Theory of Planned Behavior by Ajzen (1991). TAM was developed by Davis (1986) and improved the measurement of attitude towards the use of technology, which was previously proposed by Davis (1989) and Davis, Bagozzi and Warshaw (1989).

The TAM model was one of the key theories explaining the process and prediction of acceptance of the user for using information technology. It emphasized the study on the intention to use with perceived usefulness and perceived ease of use that affected attitude; consequently leading to the behavioral intention to use and affecting the actual use of technology products. The model is shown in Figure 2.17.

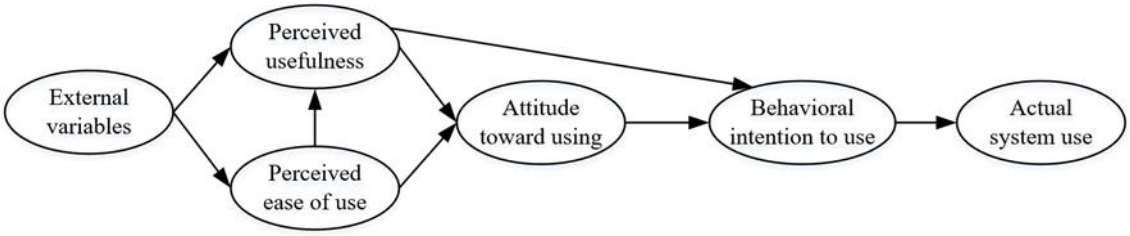


Figure 2.17 Technology Acceptance Model (TAM)

Source: Davis, 1989

The TAM model described the concept to understand the basics of technology acceptance and application. It has been validated for the past 3 centuries within different technological fields aside from information technology, which was first used it in 1986. Besides, the TAM model has been used in researches extensively in various contexts such as marketing, business, psychology, public health, and renewable energy. Samples of researches that applied the TAM model include "An integrated adoption model of solar energy technologies in South Korea" (Kim et al., 2014) and "Thailand smart grid adoption in residential electricity consumer" (Saengsuwa, 2017). This research studied the intention to use solar rooftop technology, which is the new thing in Thai society that homeowners can produce electricity on their own roofs. Therefore, the researcher applied concepts of the Technology Acceptance Model and the Theory of Planned Behavior, which was developed from the Theory of Reasoned Action, to conduct the research.

There were also researchers who examined the primary principle for human demand related to perceived usefulness and found that generally consumers have their personal perception to consider the efficiency and result of consuming the product or service. It showed the expectation of the consumer on the product or service. In other words, consumer would perceive the usefulness of the product or service if the product or service fulfilled their demand. Kotler and Armstrong (2017) proposed the factors leading to perceived usefulness according to Maslow's hierarchy of needs, which details the basic needs of humans, as shown in Figure 2.18.

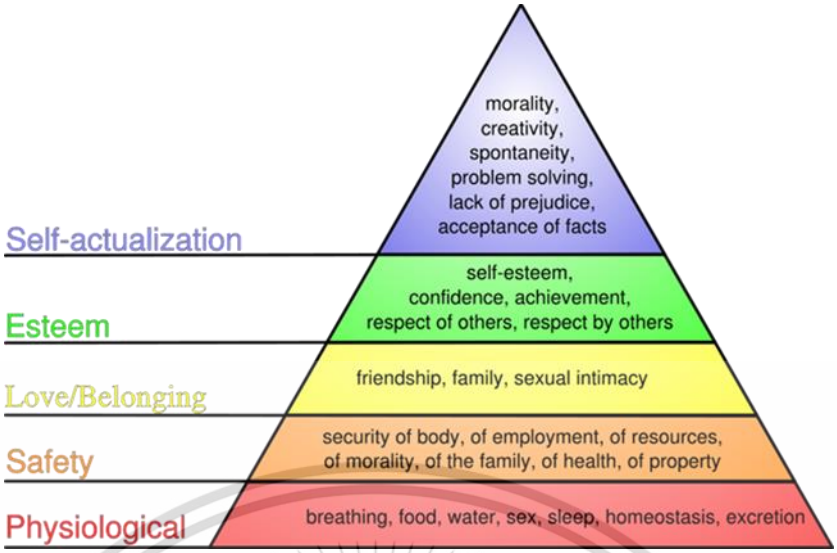


Figure 2.18 Maslow's hierarchy of needs

Source: Maslow, 1943

From Figure 2.18, Maslow's hierarchy of needs explains the perspective of the marketer, as follows.

1. Physiological needs: The need for the product or service that is indispensable and necessary for living, such as shelter, health, food, water, sleep, clothes and medicine.

2. Safety needs: The need for the product or service that is efficient for daily life and for safety, security, and convenience, such as job security, financial security, journal safety, and better quality of life.

3. Love/belonging or social needs: The need for the product or service that creates a relationship and connection with the individual appropriately. The advancement of technology responds to this kind of need very well, particularly the online social need that is very popular today.

4. Esteem needs: The need for the product or service that upgrades the value or capability of the individual, which leads to acceptance from society. It relies on belief and personal preference. For example, some consumers believe that using a high-value product or service makes them admired by others. Meanwhile, some consumers believe that using a hi-tech product will make them become a technology leader in other people's opinions.

5. Self-actualization needs: The need for the product or service or technology that enhances the potential and efficiency of the individual in all dimensions so the individual becomes

successful or achieves a goal. For instance, consumers who have a concern about their shape will always look for health products and services or an exercise service for their good health.

The concept of Maslow's hierarchy of needs is a tool and guideline for designing products and services. In addition, it is the key component leading to perceived usefulness in that it is the competency in producing the efficient product or service that can respond to the consumers' demand.

From the literature, concepts, and theories review about the Theory of Technology and Maslow's hierarchy of needs, as well as researches about the latent variables related to the perceived usefulness, the observed variables could be summarized as shown in Table 2.20.

Table 2.20 Literature review of Perceived Usefulness

Scholars/Researchers	Latent variables	Observed variables	Industries
Römer et al. (2015)	Perceived usefulness	1) Personal benefits 2) Environmental benefits	Electricity storage
Ahmad et al. (2017)	Perceived usefulness	1) Personal benefits 2) Environmental benefits 3) Awareness of cost reduction	Residential solar energy
Wang et al. (2018)	Perceived usefulness	1) Personal benefits 2) Environmental benefits 3) Awareness of cost reduction	Electric vehicle
Weng et al. (2018)	Perceived usefulness	1) Personal benefits	Multimedia

From Table 2.20, it can be concluded that the observed variables for perceived usefulness comprised 3 variables: 1) personal benefits, 2) environmental benefits, and 3) awareness of cost reduction; as shown in Tables 2.21-2.23.

2.6.1 Personal Benefit

Consumers are always aware of what they received from consuming the product or service. Therefore, marketers should give importance to consumers' perception after consuming the product

or service. There have been scholars and researchers who gave definitions for personal benefits, as shown in Table 2.21.

Table 2.21 Definitions of Personal Benefit

Scholars/Researchers	Definitions
Ahmad et al. (2017)	The ability to respond to an everyday need
Wang et al. (2018)	Better quality of life
Weng et al. (2018)	Convenience in living

From the definitions in Table 2.21, **personal benefit refers to the homeowners having convenience and benefits from using solar rooftop energy, in one way or another.**

2.6.2 Environmental Benefit

This involves the awareness of using energy-saving or eco-friendly products or services. A number of scholars and researchers have given definitions for the term, as shown in Table 2.22.

Table 2.22 Definitions of Environmental Benefit

Scholars/Researchers	Definitions
Gernon et al. (1999)	The benefits received from the reduction of electricity generated from oil.
Rinkesh Kukreja (2009)	The benefits of renewable energy as an alternative source for electricity generation to minimize the impact of greenhouse effect and not destroy natural resources.
Römer et al. (2015)	The sustainability and security of energy saving.
Ertz et al. (2016)	Being environmentally friendly throughout the period of use.
Ahmad et al. (2017)	The ability to store energy for future use.
Wang et al. (2018)	The safety of a product that will not cause short circuit.

From the above definitions in Table 2.22, **environmental benefit refers to the positive perception of the homeowner on the pollution reduction and environmental improvement resulting from the use of solar rooftop energy.**

2.6.3 Awareness of Cost Reduction

Aside from the quality of the product or service, the consumer is aware of other expenses related to the product or service, such as the cost of maintenance and repair as well as the reduction of electricity expenses. Various scholars and researchers have given definition of the awareness of cost reduction, as shown in Table 2.23.

Table 2.23 Definitions of Awareness of Cost Reduction

Scholars/Researchers	Definitions
ASIC (2012)	The reduction of partial expenses to have some amount left for spending in the future or for an emergency.
Römer et al. (2015)	The reasonableness and worthiness of usage.
ASIC (2012)	The reduction of partial expenses to have some amount left for spending in the future or for an emergency.
Römer et al. (2015)	The reasonableness and worthiness of usage.
Ahmad et al. (2017)	The saving of electricity expenses from using residential solar photovoltaic technology.
Wang et al. (2018)	The saving of household expenses.

From the above definitions in Table 2.23, **awareness of cost reduction refers to the homeowner perceiving that electricity expenses reduced after using the residential solar rooftop.**

From the review of literature, concepts, and theories about the factors related to perceived usefulness, the model included 3 variables, as shown in Figure 2.19.

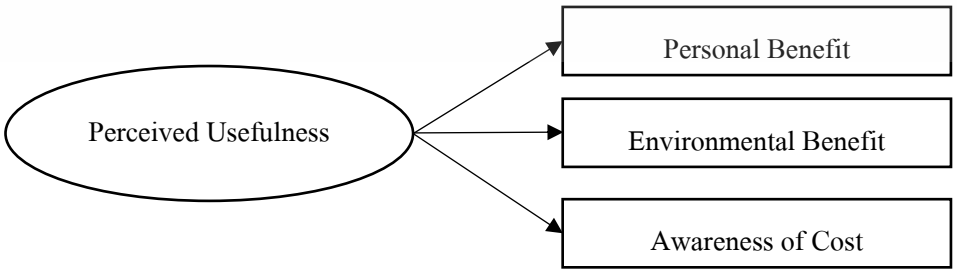


Figure 2.19 Model of Perceived Usefulness

2.7 Concepts and theories about Customer Knowledge

Customer knowledge is a key factor for successful business based on customers' demand, preference, satisfaction and dissatisfaction toward something. Customer knowledge or perspectives can be effectively applied to organizational management for the highest benefits (Najat, 2017). Knowledge from customers obtained by the organization is raw data that requires the synthesis process to acquire quality and measurable data. With the primary data analysis and evaluation, the organization would be able to sustainably utilize such quality data to business management (Najat, 2017). Likewise, Rowley (2002) stated that customer knowledge was the most crucial factor for business. Therefore, the application of customer knowledge is an organization's core strategy that is very significant for creating value to customers.

From the above literature review, many scholars have given definitions for customer knowledge management, as shown in Table 2.24.

Table 2.24 Definitions of Customer Knowledge

Scholars/Researchers	Definitions
Merriam-Webster Dictionary	Truth or conditions of the perception of a familiar and experienced matter.
Oxford Advanced Learner's Dictionary	Fact, information and skills obtained from experience or education. An understanding of a theory or practice in something.
Plato	An exhibiting specific characteristic of a matter comprising three key factors: reasonableness, truth and belief.
Blackwell, Miniard and Engel (2001)	Quantity of data in the memory of an individual influencing his/her interpretation and decision-making.
Wayland (2003)	Customer knowledge, as well as the acquired experience, is effective information, which makes profit for a company.
Zanjani et al. (2008)	Information received from the communication between an organization and customers.
Carlson et al. (2009)	Information that the consumers are interested in.

From Table 2.24, the researcher concluded the definition of customer knowledge that it was information and facts about the solar rooftop acquired from the experience or education and understanding of the homeowners.

Therefore, the researcher concluded that customer knowledge was essential for residential solar rooftop installation in Thailand because the related businesses would need to know about the demand and problems of the customers in order to apply to the production process and service, which would lead to the highest sustainable satisfaction of customers toward a solar rooftop system.

The researcher collected data to do research about solar rooftop by researcher's own scheme and described in chapter 4.

2.8 Variable relationship analysis

From the study of a structural equation model of factors influencing the intention to use solar rooftop energy among households in Thailand, the researcher examined and reviewed the literature and researches related to the exogenous latent variables, mediator variables, and endogenous latent variables. The relationship between the variables was concluded as follows.

2.8.1 Relationship between Government Policy and Intention to Use

The decision to purchase is a step that the consumer makes for the best choice to fulfill a need or resolve a problem. Therefore, what happens in this step is the intention to purchase a product or service. However, this intention may not lead to the actual purchase because there are other factors and preparatory conditions. Thus, the decision to purchase depends on the intention to use, the situation while making a decision, and the duration of time used to make a decision. From the study on the variables affecting the intention to install solar rooftop, there are various factors such as the government policy, cost of equipment and installation, and maintenance (Roche et al., 2010; Zhang et al., 2013). From the literature review, various researches were identified that examined the government policy and the intention to use as follows.

Jiang (2016) conducted a study concerning "Purchase intention for electric vehicles in China from a customer-value perspective." The results showed that the factors affecting the intention to purchase electric vehicles stemmed from environmental awareness as well as the government policy in environment in China.

Aziz et al. (2017) examined the factors influencing Malaysian consumers' intention to purchase green energy produced from solar panels. The study investigated the factors influencing Malaysian consumers' intention to purchase solar panels. A questionnaire survey was utilized to collect data from Malaysian consumers who did not use solar panels. The Theory of Reasoned Action (TRA) was used as the framework. The research model was obtained as shown in Figure 2.20. The research results showed that the perceived government policy, solar panel aesthetics, environmental concern and demographic factors (education and income level) were related with intention to purchase.

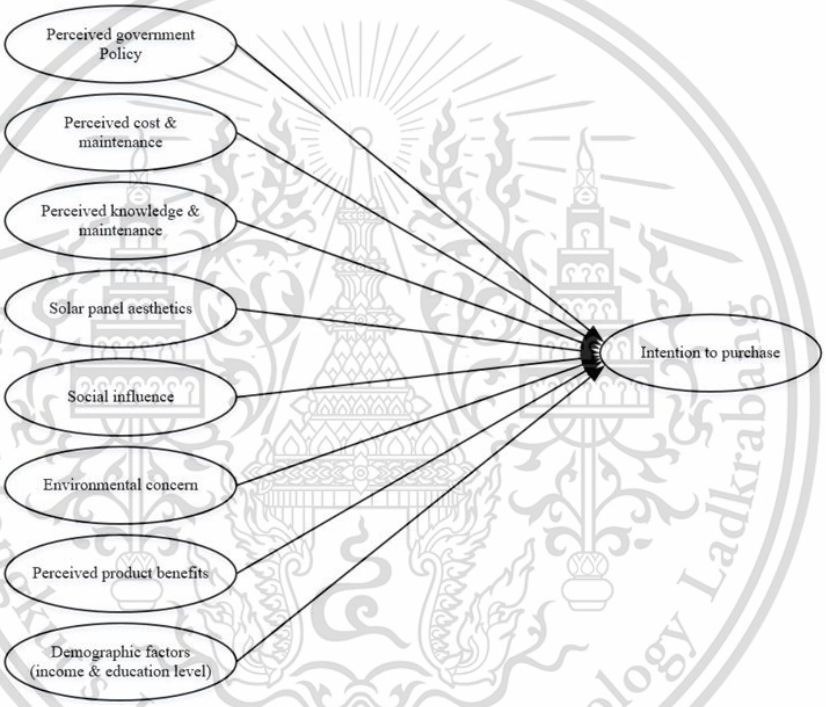


Figure 2.20 Proposed model cited from Aziz et al. (2017)

Wang et al. (2017) examined the impact of policy measures on consumer intention to adopt electric vehicles in China. The variables were the financial incentive policy, the information provision policy, the convenience policy, and the adoption intention. It was found that these three policies had a direct and positive influence on the adoption intention, as shown in Figure 2.21.

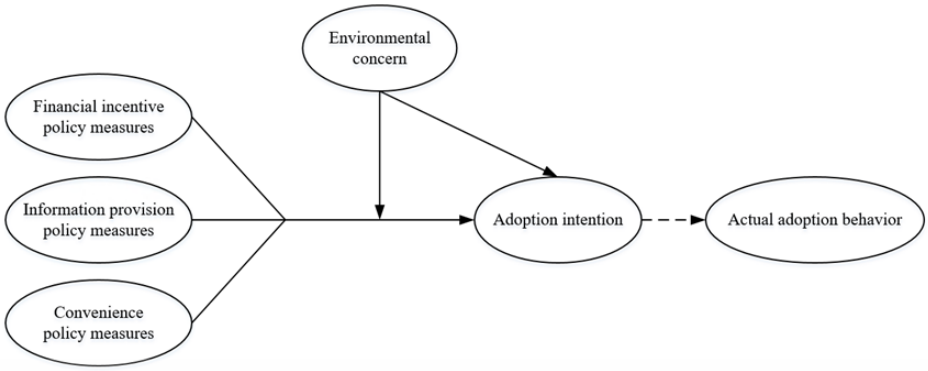


Figure 2.21 Proposed model cited from Wang (2017)

Huang and Ge (2019) investigated the consumer purchase intention of electric vehicle in Beijing. A total of 502 valid survey responses from potential customers in Beijing were obtained in 2018, and a structural equation model (SEM) was used for an empirical analysis of the factors influencing EV purchasing intention. Based on the theory of Planned Behavior, the results revealed that monetary incentive policy measures as well as other factors such as attitude and cognitive status had a significant and positive effect on consumers' intention to purchase EVs in Beijing. However, non-monetary incentive policy measures had no significant impact on purchasing intention, as shown in the model in Figure 2.22.

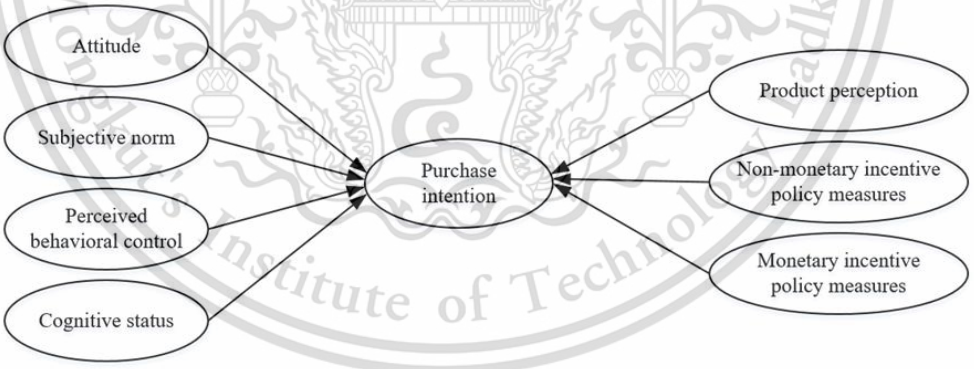
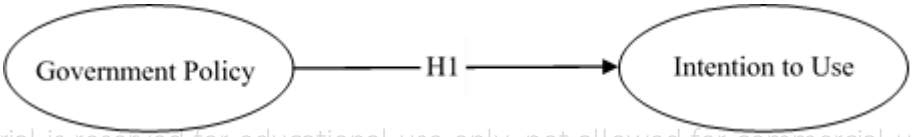


Figure 2.22 Proposed model cited from Huang and Ge (2019)

From the literature review, it led to the hypothesis that the government policy had a direct influence on the intention to use solar rooftop energy.



2.8.2 Relationship between Subjective Norm and Attitude

A subject norm had an influence on attitude. People behave based on what they perceive from the people who are important to them (Chang, 1998; Shepherd and O'Keefe, 1984; Shimp and Kavas, 1984; Vallerand et al. 1992). Some researchers examined the concepts, theories, and researches related to the subjective norm and attitude as follows.

Robinson et al. (2013) conducted research on the GIS-integrated agent-based model of the residential solar PV diffusion in Austin, USA. The variables included the attitude toward behavior, the subjective norm, the perceived behavioral control, and the actual control. The research outcomes showed that the subjective norm positively influenced the attitude toward the behavior of consumers on products and services.

Sreen et al. (2018) studied the impact of culture, behavior and gender on green purchase intention. The variables included the subjective norm, the perceived behavioral control, the attitude towards green products, and gender. The Theory of Planned Behavior was applied to Indian people who were educated urban consumers and preferred to use eco-friendly products. The results indicated that the subjective norm had a direct and positive influence on the attitude towards green products, as shown in Figure 2.23.

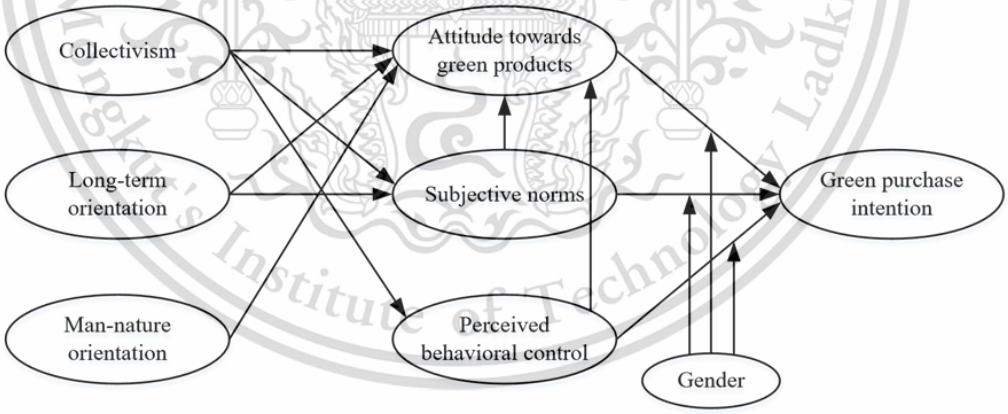
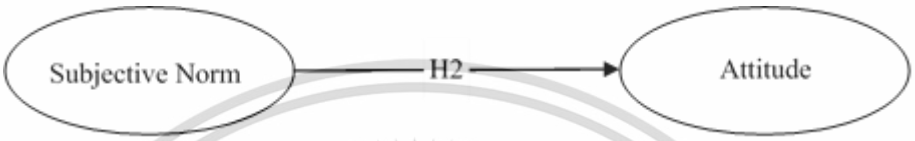


Figure 2.23 Proposed model cited from Sreen et al. (2018)

Abreu et al. (2019) examined the new trends in solar and conducted a comparative study assessing attitudes towards the adoption of rooftop solar. The attitude, subjective norm, and perceived behavioral control were the variables in the research. The research result illustrated that the subjective norm positively and directly influenced the attitudes towards the adoption of rooftop PV systems installed on top of buildings in the United States.

Ali et al. (2019) investigated the determinants of consumer intentions to purchase energy-saving household products in Pakistan. The independent variables of the research included attitude, subjective norm, and perceived behavioral control. The results showed that the subjective norm had a direct and positive influence on the attitude to purchase energy-saving products in Pakistan. From the above literature review, the hypothesis that the subjective norm had a direct influence on the attitude was concluded.



2.8.3 Relationship between Attitude and the Intention to Use

Attitude is an important notion of social psychology and communication, which is widely applied. It is the index showing the thinking of a person towards the people or environment around them, including the situations. Attitude based on a belief is likely to affect future behavior. Therefore, attitude is the readiness for a response to a stimulus and is the evaluation factor to express satisfaction or dissatisfaction about an issue. It involves interpersonal communication, which is the result of the perception of the matter that affects future behavior (Rogers, 1978). The researcher studied the concepts, theories, and related researches concerning the attitude and intention to use, as expressed below.

Claudy, Peterson and O'Driscoll (2013) examined the understanding of the gap between attitude and behavior for renewable energy systems using the behavioral reasoning theory. The study was conducted by the structural equation on the intention to use renewable energy systems among people in Ireland. The researcher applied a phone survey with 254 house owners and found that attitude had a significant positive influence on the intention to use renewable energy systems, as shown in Figure 2.24.

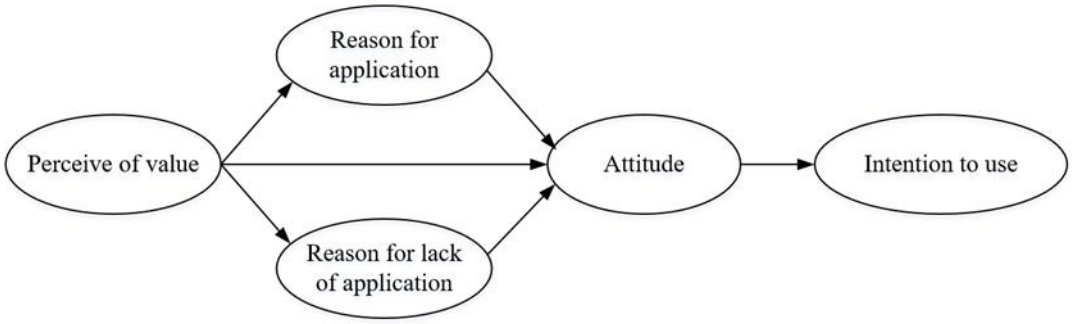


Figure 2.24 Proposed model cited from Claudy, Peterson and O'Driscoll (2013)

Kim et al. (2014) conducted research on an integrated adoption model for solar energy technologies in South Korea. A questionnaire was used with 1,772 people in the sample group. The obtained data was analyzed using the Structural Equation Model to examine the significant factors affecting people's intention to use solar energy technologies. The research results showed that attitude towards solar energy technology positively influenced the intention to use solar energy technologies in South Korea with statistical significance, as shown in Figure 2.25. The researcher recommended that future studies should examine personal factors such as gender and age as well as conduct research in other countries to compare the results.

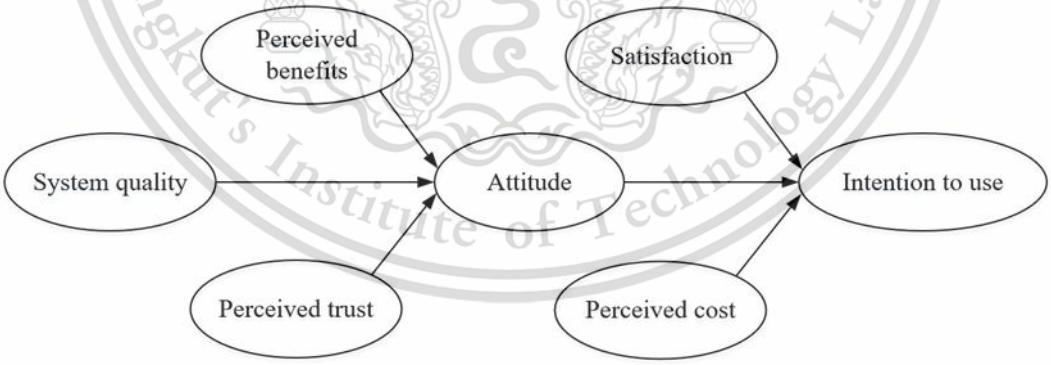


Figure 2.25 Proposed model cited from Kim et al. (2014)

Römer et al. (2015) did a research on "Smart Energy for Robinson Crusoe: an Empirical Analysis of the Adoption of IS-Enhanced Electricity Storage Systems". Data was gathered from 339 decision-makers for modifications to privately-owned houses in Germany. The variables

included perceived ease of use, perceived usefulness, attitude, and the intention to use. It was found that attitude had a positive influence on the intention to use the Electricity Storage System (ESS) with statistical significance, as shown in Figure 2.26.

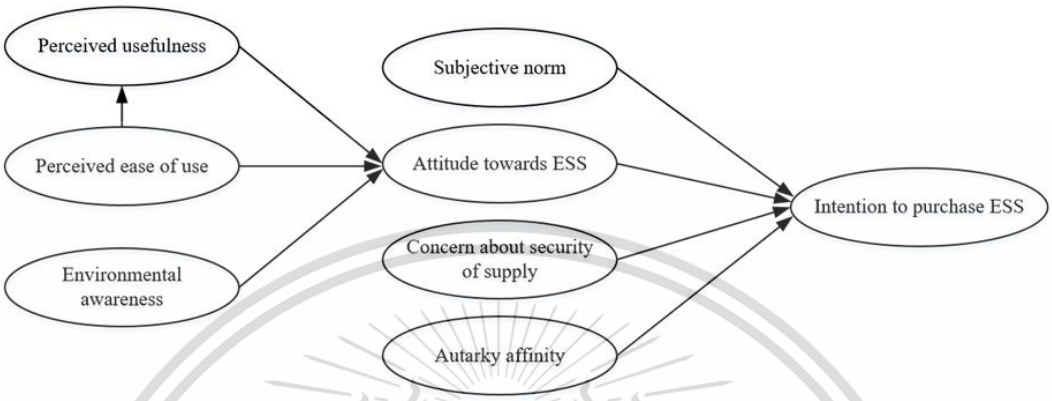


Figure 2.26 Proposed model cited from Römer et al. (2015)

Yazdanpanah, Komendantova and Ardestani (2015) studied the structural equation of the factors affecting the public acceptance and willingness to use renewable energy sources in Iran. They used a questionnaire to collect data from 260 university students in Esfahan, Iran. The results illustrated that attitude and perceived behavioral control had a significant positive influence on the intention to use renewable energy, as shown in the model in Figure 2.27.

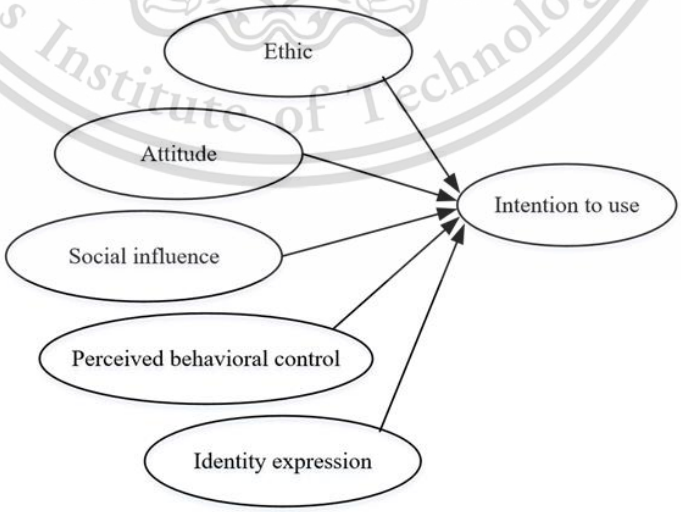


Figure 2.27 Proposed model cited from Yazdanpanah, Komendantova and Ardestani (2015)

Chen, Xu and Frey (2016) conducted a study "Who wants solar water heaters and alternative fuel vehicles? Assessing the social–psychological predictors of adoption intention and policy support in China". Renewable energy technologies such as solar water heaters and alternative fuel vehicles are widely accepted in China. The use of Theory of Planned Behavior was applied to examine the social and psychological factors. The results indicated that environmental attitudes had a highly positive influence on adoption intention and policy support for solar water heaters and alternative fuel vehicles, as shown in the model in Figure 2.28.

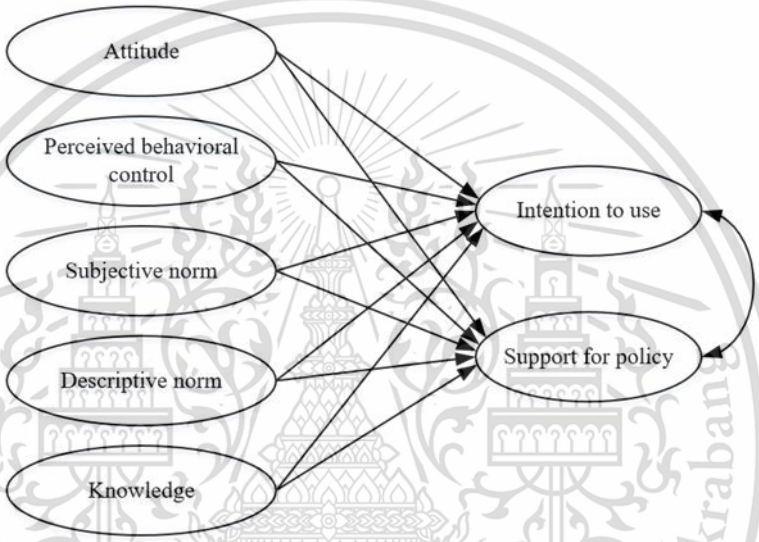


Figure 2.28 Proposed model cited from Chen, Xu and Frey (2016)

Mohammad and Baharun (2016) examined the effect of perceived value and personal value in affecting the attitude to purchase organic products. The independent variables included environmental consciousness, health consciousness, religiosity consciousness, perceived quality, and perceived safety. It was found that all the factors had a direct influence on the attitude to purchase organic products. Moreover, such attitude positively affected the intention to purchase organic products among Malaysian consumers.

Ahmad et al. (2017) studied public acceptance of residential solar photovoltaic technology in Malaysia and found that attitude towards using solar PV technology had an influence on the behavioral intention to use solar PV technology in Malaysia, as shown in the model in Figure 2.29.

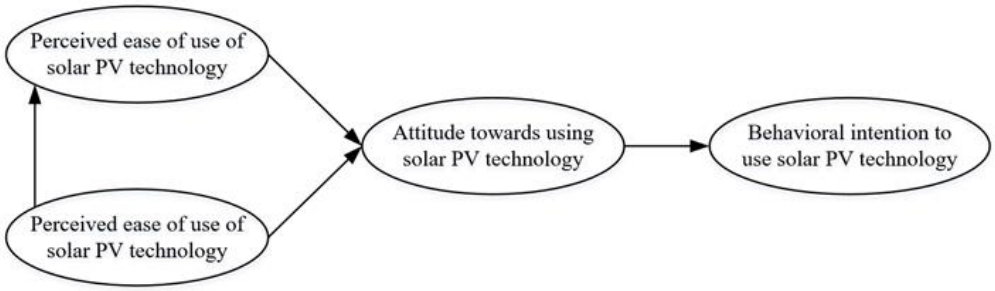


Figure 2.29 Proposed model cited from Ahmad et al. (2017)

Jeamwittayanukul (2017) studied public knowledge of nuclear technology and its effect on the intention to use electricity from nuclear power plants in Thailand. The study results showed that knowledge of nuclear technology and power had a direct and positive influence on the attitude towards nuclear power plants. Furthermore, such attitude directly affected the intention to use electricity from nuclear power plants among people in Thailand.

Reyes-Mercado and Rajagopal (2017) investigated the adoption of renewable energy technologies in Mexico: The role of cognitive factors and innovation attributes. They found that beliefs about the consequences of adopting renewable energy technologies were significant in constructing the consumers' attitudes towards renewable energy technologies. Such an attitude accurately predicted the behavioral intentions to adopt renewable energy technologies in Mexico, as shown in the model in Figure 2.30.

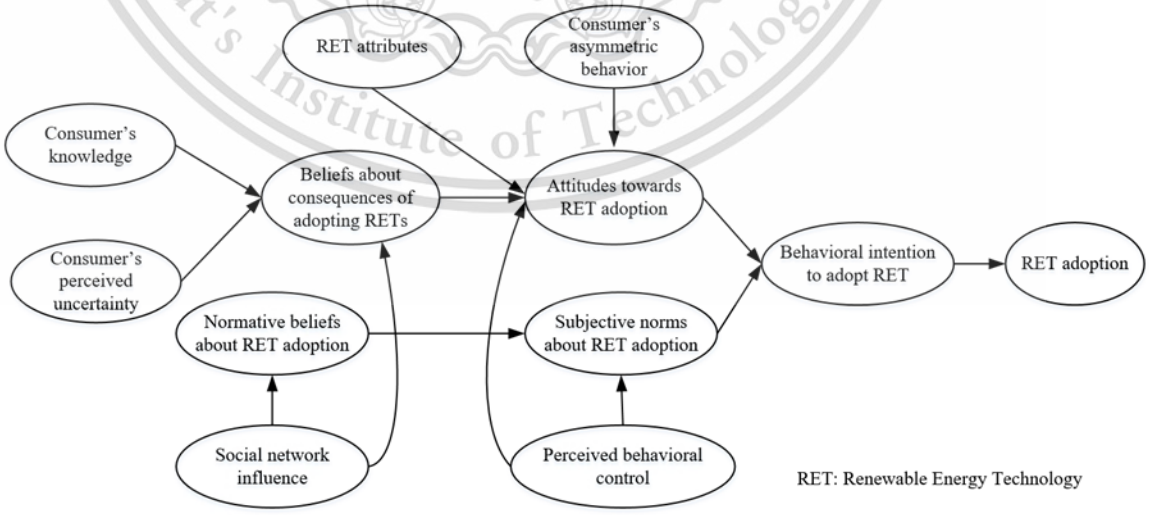
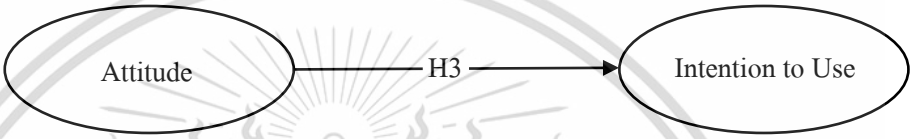


Figure 2.30 Proposed model cited from Reyes-Mercado and Rajagopal (2017)

Yu and Lee (2019) conducted a study in the United States on the effects of consumers' perceived value on the intention to purchase up-cycled products. The independent variables were green value, functional value, emotional value, aesthetic value, social value, and self-expressive value. The results showed that these variables had a direct influence on product attitude, which was the mediator variable. Such attitude also showed positively influenced the intention among Americans to purchase up-cycled products.

The literature review led to the hypothesis that attitude had a direct influence on the intention to use solar rooftop energy.



2.8.4 Relationship between Subjective Norm and Intention to Use

The more a person conforms to others, the more it affects their intention to do something, regardless of ethics in terms of being right or wrong (Bommer et al., 1987; Kreie and Cronan, 1999). Ajzen (1991) gave the definition that it was the perception of a person that other people who were important to him wanted him to behave in a particular way. If he perceived that an important person behaved in the way he wanted to behave, it was likely that he would listen and follow that behavior. The intention to perform any action depended on the strength of the reference group based on the environment and motivation of the need to follow the reference group. For the review of the related literature, there were some significant researches about the subjective norm and intention to use, as follows.

Yun and Lee (2015) examined the structural equation model of the factors defining the societal readiness toward renewable energy system adoption. The researcher created the questionnaire to survey the opinion of 735 people in various states in the United States. The results indicated that attitude, subjective norm, and perceived behavioral control had a positive influence on the intention to use renewable energy with statistical significance, as shown in the model in Figure 2.31.

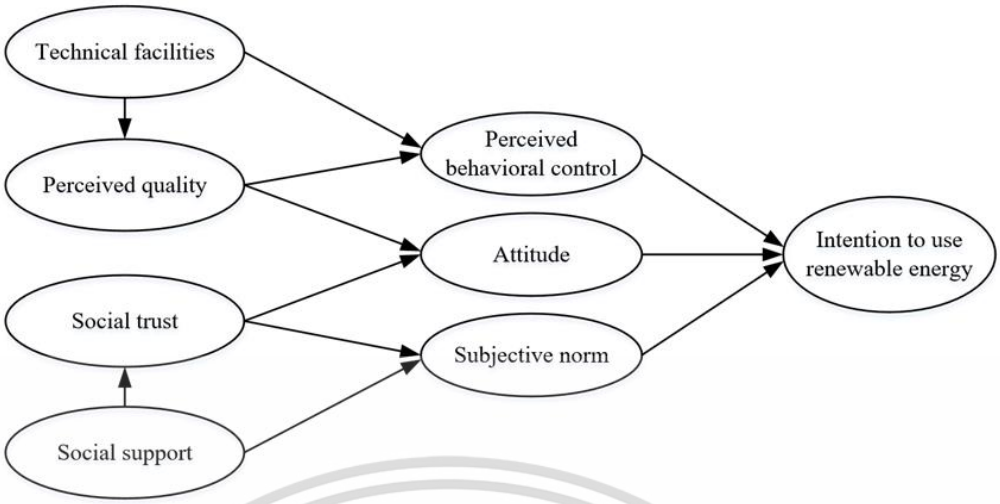


Figure 2.31 Proposed model cited from Yun and Lee (2015)

Vassanadumrongdee and Kittipongvises (2017) investigated the factors influencing source separation intention and willingness to pay for improved waste management in Bangkok, Thailand. Most developing countries, including Thailand, tend to be faced with the lack of recycling facilities and inadequate source separation practices. By extending the theory of planned behavior and employing 1,076 questionnaires in a survey, both subjective norms and knowledge on MSW situation were found to have a positive correlation with Bangkok residents' source separation intention and the willingness to pay, as shown in the model in Figure 2.32.

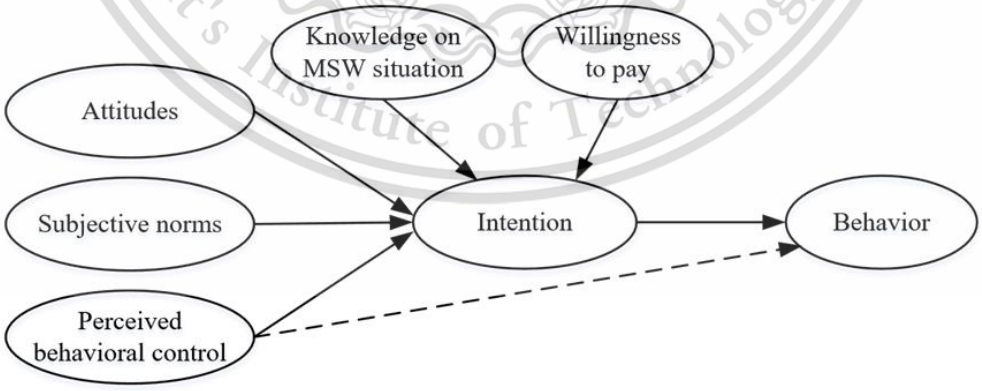


Figure 2.32 Proposed model cited from Vassanadumrongdee and Kittipongvises (2017)

Engelken et al. (2018) conducted a study concerning “Why homeowners strive for energy self-supply and how policy makers can influence them”. Due to decreasing subsidies from the German government, behavioral motivations among households had changed by starting to adopt various technologies to supply their own energy. The data is comprised of 20 qualitative interviews and 395 quantitative questionnaires among homeowners in Germany. Besides attitude, subjective norm and perceived behavioral control were the important predictors of households’ purchase intention for renewable energy system, as shown in the model in Figure 2.33.

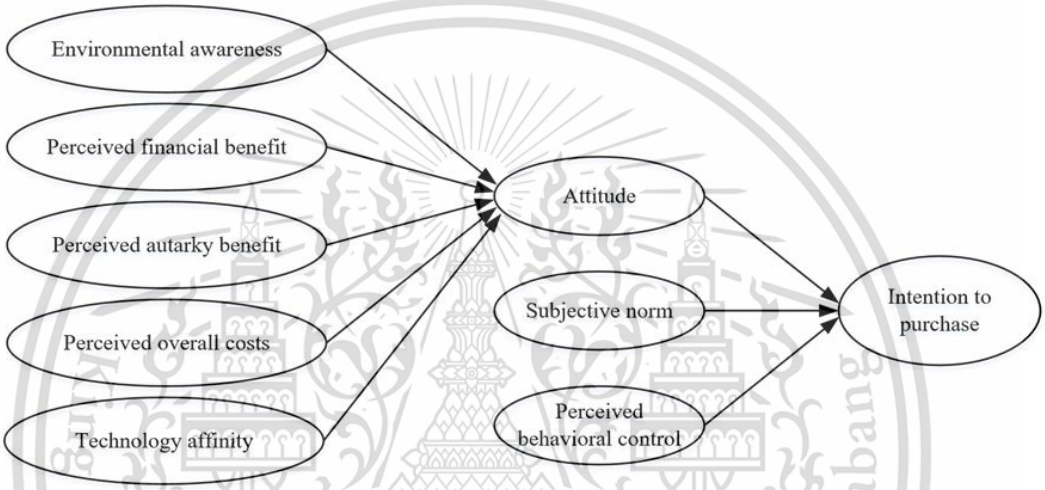


Figure 2.33 Proposed model cited from Engelken et al. (2018)

There were also some researches, as mentioned earlier, that involved the relation between the subjective norm and intention to use, as follows.

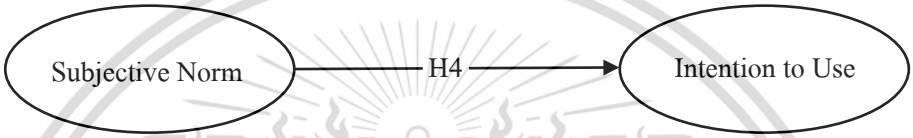
As mentioned in 2.8.1, Huang and Ge (2019) found that subjective norm had some impact on the purchasing intention of electric vehicles in Beijing, as shown in Figure 2.22.

As mentioned in 2.8.2, Sreen et al. (2018) studied the impact of culture, behavior and gender on green purchase intention in India. They discovered that subjective norm had a positive and direct influence on the intention to purchase green products, as shown in Figure 2.23.

As mentioned in 2.8.3, Chen, Xu and Frey (2016) conducted the study “Who wants solar water heaters and alternative fuel vehicles in China?” They utilized the model of the Theory of Planned Behavior with attitudes towards renewable energy, perceived behavioral control, subjective and descriptive norms, and knowledge of renewable energy as the variables that affected

the intention to use solar water heaters and alternative fuel vehicles. In addition, they found that subjective norm positively affected the intention to support solar water heaters and alternative fuel vehicles, as shown in Figure 2.28. Besides, Reyes-Mercado and Rajagopal (2017) studied the adoption of renewable energy technologies in Mexico and found that subjective norms about the adoption of renewable energy technologies was significant and influenced the behavioral intention to adopt renewable energy technologies among Mexican households, as shown in Figure 2.30.

The above literature review seems to support the hypothesis that subjective norm has a direct impact on the intention to use solar rooftop energy.



2.8.5 Relationship between Perceived Usefulness and Attitude

Most renewable technologies are developed for electricity generation and distribution, receiving energy from natural resources such as wind, water and solar. Numerous researchers and scientists agree that solar power is the natural energy that best matches the lifestyles and living of people globally. Moreover, there is the possibility that it will become the main resource for electricity generated to households in the future (Ahmad et al., 2017). Nevertheless, solar rooftop installation is not preferable in some regions of the world such as in Thailand. There have been many researchers examining this matter and found the relationship between perceived usefulness and attitude, as follows.

Korcaj et al. (2015) examined the intention to adopt photovoltaic systems depending on homeowners' expected personal gains and the behavior of peers. Data was collected from 200 homeowners who did not own a PV system. The results indicated that the first factor affecting attitude about installing a solar PV system was the perceived environmental benefit and the overall cost of PV systems in relation to long-term use, as shown in the model in Figure 2.34.

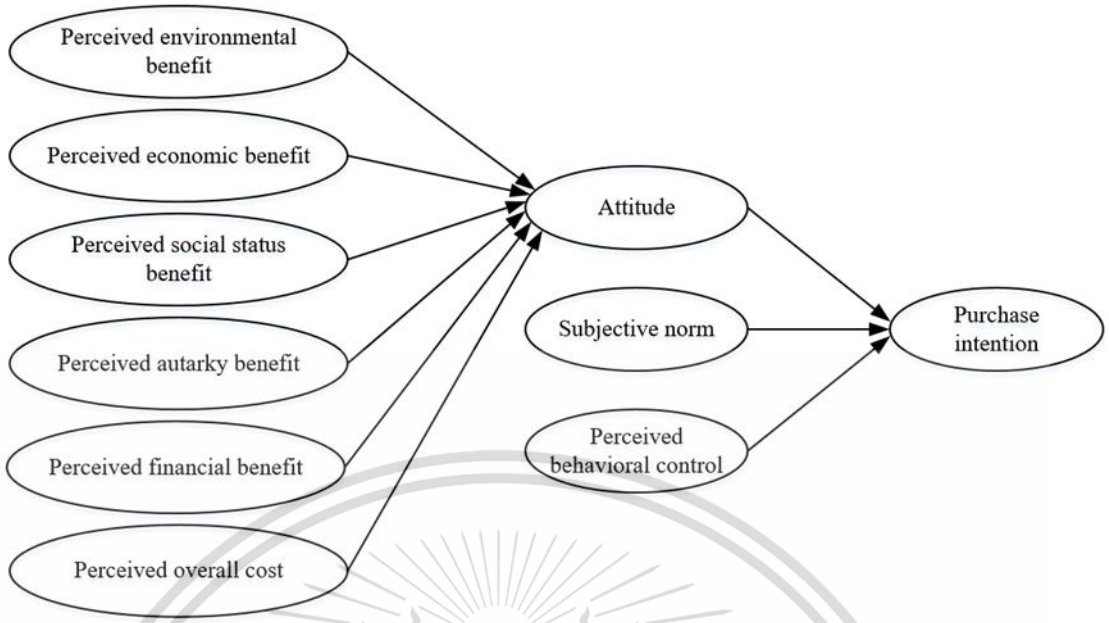


Figure 2.34 Proposed model cited from Korcaj et al. (2015)

Nikou (2018) conducted the study about consumers' perceptions on smart home and smart living. Data was collected from households in Finland. The variables included perceived usefulness, perceived ease of use, relative advantage, and consumer perceived innovativeness. The research results showed that these variables had a positive influence on the mediator variables of attitude towards using smart home technology. Such attitude is also a factor of the intention to use smart home technology in Finland, as shown in the model in Figure 2.35.

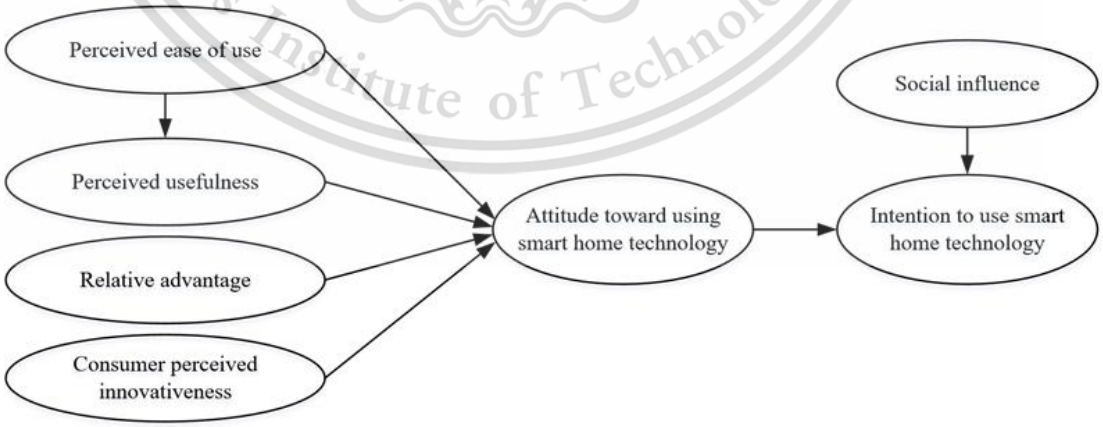


Figure 2.35 Proposed model cited from Nikou (2018)

From the researches mentioned in 2.8.3, the relationship between attitude and the intention to use was identified. Further, there were some researches that found the relationship between perceived usefulness and attitude, as follows.

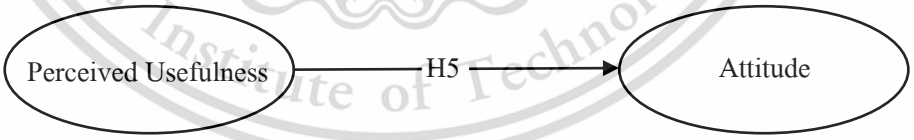
Römer et al. (2015) found from the study of privately-owned houses in Germany that perceived usefulness had a positive and direct influence on attitude towards the use of Electricity Storage Systems (ESS), as shown in Figure 2.26.

Claudy, Peterson and O'Driscoll (2013) found that the positive reasons for the application of renewable energy by people in Ireland had a positive impact on the attitude of the sample group with statistical significance, as shown in the model in Figure 2.24.

Kim et al. (2014) examined the integrated adoption model of solar energy technologies in South Korea and discovered that there were three factors that defined the attitude towards solar energy technology, including perceived benefits, system quality, and perceived trust, as shown in the model in Figure 2.25.

Ahmad et al. (2017) studied public acceptance of residential solar photovoltaic technology in Malaysia. The research results indicated that the perceived ease of use of solar PV technology and the perceived usefulness of solar PV technology influenced the attitude towards using solar PV technology, which also shows a direct impact to the behavioral intention to use solar PV technology in Malaysia, as shown in the model in Figure 2.29.

The above literature review concluded the hypothesis that perceived usefulness had a direct influence on attitude.



2.8.6 Relationship between Perceived Usefulness and Intention to Use

Perceived usefulness was the perception of quality, efficiency, and the result of using certain products and services (Römer et al., 2015). Therefore, marketers should study and understand the needs of consumers and target groups in order to present the products and services that fulfill their needs. This would lead to the sustainable intention to purchase in the future. From

the literature review, there were some important research studies concerning perceived usefulness and the intention to use, as follows.

Hartmann and Apaolaza (2012) studied the consumer attitude and purchase intention towards green energy brands. Brand attitude, environmental concern, utilitarian benefit, self-expressive benefit, and nature experience were the variables. It was discovered that utilitarian benefit and brand attitude had the most direct influence on the intention to purchase among consumers with statistical significance.

Kardooni et al. (2016) investigated the attitude towards using renewable energy and perceived usefulness towards the intention to accept renewable energy technology in Malaysia. They found that perceived usefulness had a direct and positive influence on the intention to use renewable energy.

Zahari and Esa (2016) studied the motivation to adopt renewable energy among Generation Y. Four independent variables include environmental concerns, consumer beliefs, consumer knowledge, and the relative advantages of renewable energy. 200 respondents from a government-linked Malaysian university comprised the sample group. The results indicated that environmental concerns and the relative advantages of the renewable energy had a significant influence on the intention to adopt renewable energy, as shown in the model in Figure 2.36.

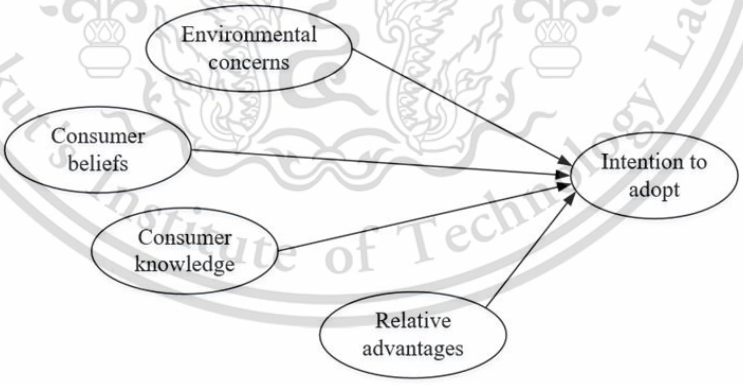


Figure 2.36 Proposed model cited from Zahari and Esa (2016)

Saengsuwan (2017) conducted the research "Thailand smart grid adoption in residential electricity consumer". Smart grid technology is future technology to increase the efficiency of electricity management. Its principle is the combination of information and communication technology integrated with the transmission line, leading to real-time information exchange

between suppliers and consumers. This research adopted the most famous models, called Technology Acceptance Model (TAM) and Value Based Adoption Model (VAM). The results indicated there were 14 factors involved, including the environmental usefulness and feature usefulness affecting the consumers' acceptance and adoption of smart grid technology in Thailand, as shown in Figure 2.37.

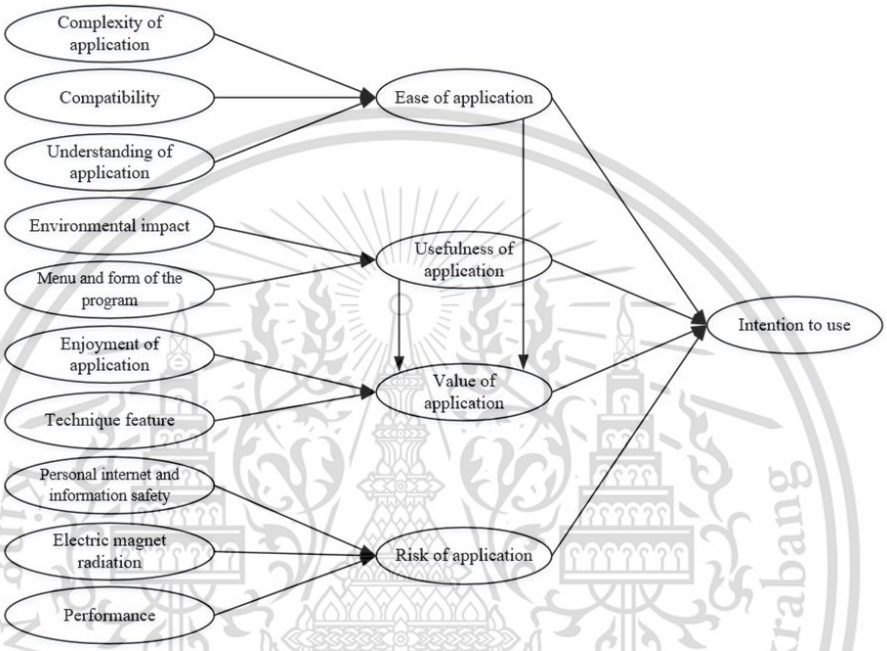


Figure 2.37 Proposed model cited from Saengsuwan (2017)

Wolske et al. (2017) studied the interest in adopting residential solar photovoltaic systems in the United States. The increasing use of household solar power minimizes the release of greenhouse gases and helps reduce the global warming problem. However, the popularity of solar rooftop installation in the United States remains low, even though the cost of solar rooftops has reduced dramatically. This research investigated the psychological and social factors based on three theories: Diffusion of Innovation Theory, Theory of Planned Behavior and Value-belief-norm Theory. The framework was tested using data from 904 homeowners who had never used a solar system. The findings indicated that consumers considered the use of solar power in many aspects, such as the environmental benefits and innovation. Those who trusted in the benefits to themselves were likely to install solar panels on their roofs.

Wang et al. (2018) studied the policy implications for promoting the adoption of electric vehicles. Knowledge, perceived risk, perceived usefulness, attitude, and adoption intention were the variables. The results showed that perceived usefulness had a direct influence on attitude and adoption intention in a positive and significant effect, as shown in Figure 2.38.

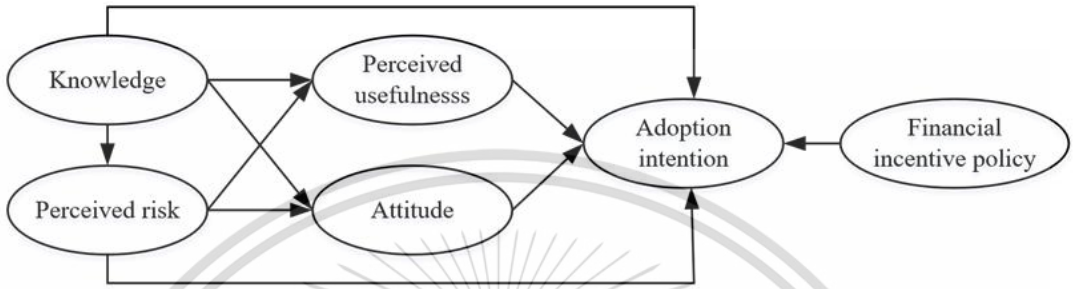


Figure 2.38 Proposed model cited from Wang et al. (2018)

Weng et al. (2018) examined the attitude towards the intention to use multimedia among school teachers. Technology Acceptance Model (TAM) was applied, which involves perceived ease of use, perceived usefulness, attitude towards using multimedia among school teachers, and intention to use. The findings indicated that perceived usefulness positively and directly influenced the attitude towards using multimedia and the intention to use multimedia among school teachers, as shown in Figure 2.39.

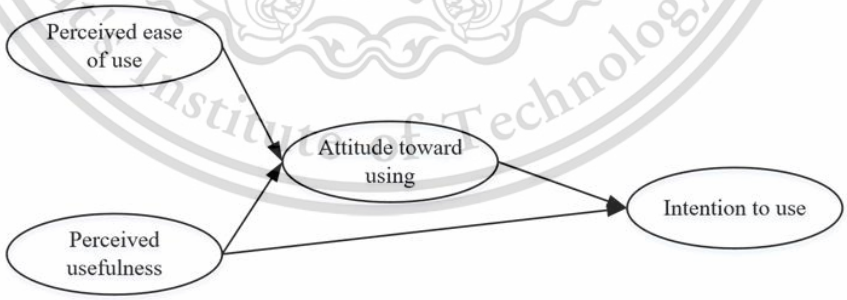
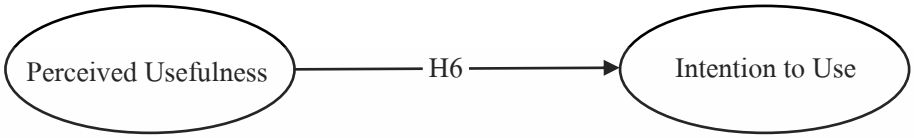


Figure 2.39 Proposed model cited from Weng et al. (2018)

Yun and Lee (2019) investigated the effects of consumers' perceived values on the intention to purchase up-cycled products in the United States. The variables included green value, functional value, emotional value, aesthetic value, social value, and self-expressive value. It was

found that, apart from product attitude, perceived value positively influenced the purchasing behavior for up-cycled products.

Based on the above literature review from the researchers, the hypothesis revealed that perceived usefulness directly influenced the intention to use solar rooftop energy.

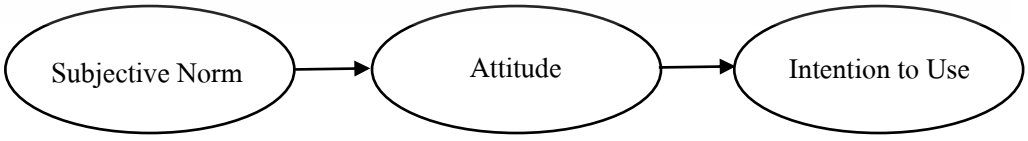


2.8.7 Relationship between Subjective Norm, Attitude and Intention to Use

By reviewing the relationship between subjective norm and intention to use in 2.8.4, it found that these two variables may have an attitude as the mediater latent variable. Fornara et al. (2016) examined the predicting intention to improve household energy efficiency and it was found that the intention to use renewable energy was reflected by the correlation between injunctive norm and attitude. This study is in line with the research by Engelken et al. (2018) that was focused on "Why homeowners strive for energy self-supply and how policy makers can influence them" and the result showed that attitude, subjective norm and perceived behavioral control are important predictors of households' purchase intention of renewable energy system components.

Likewise, Sreen et al. (2018) studied the impact of culture, behavior and gender on green purchase intention. The results indicated that the subjective norm had a direct and positive influence on the attitude towards green purchase intention, as shown in Figure 2.23.

Based on the above literature review from the researchers, the hypothesis revealed that subjective norm may influenced the intention to use solar rooftop energy through attitude.



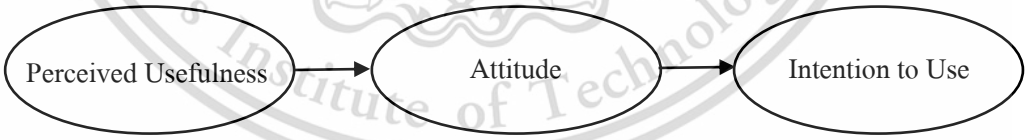
H7: Attitude mediates the relationship between Subjective Norm and Intention to Use.

2.8.8 Relationship between Perceived Usefulness, Attitude, and Intention to Use

By reviewing the relationship between perceived usefulness and intention to use in 2.8.6, it found that these two variables may have an attitude as the mediater latent variable. Hartmann and Apaolaza (2012) examined about the consumer attitude and purchase intention toward green energy brands and it found that the utilitarian benefit affected a brand attitude which will also affect to intention to purchase of the consumer. Korcaj et al. (2015) studied the intention to adopt photovoltaic systems depending on homeowners' expected personal gains and the behavior of peers, as shown in the model in Figure 2.34. The results showed that perceived benefit in preserving environment and perceived economic benefit are the factors of attitude and will affect the intention to install photovoltaic systems.

Nikou (2018) conducted a research about consumers' perceptions on smart home and smart living in Finland. The result showed that perceived usefulness has direct effect to attitude toward using smart home technology and also affect the intention to use smart home technology afterwards, as shown in the model in Figure 2.35. In line with the study by Weng et al. (2018) who examined the attitude towards the intention to use multimedia among school teachers. The research results showed that perceived usefulness is positively influential in attitude towards using multimedia and the intention to use multimedia among school teachers, as shown in Figure 2.39.

Based on the above literature review from the researchers, the hypothesis revealed that perceived usefulness may influenced the intention to use solar rooftop energy through attitude.



H8: Attitude mediates the relationship between Perceived Usefulness and Intention to Use.

The literature review concerning the relationship between the variables can be summarized as shown in Table 2.25.

Table 2.25 Summary of the relationship between the variables, hypothesis, and researches

Hypothesis		Authors/Researchers
H1	Government Policy → Intention to Use	Jiang (2016), Aziz et al. (2017), Wang et al. (2017), Huang and Ge (2019)
H2	Subjective Norm → Attitude	Robinson et al. (2013), Sreen et al. (2018), Abreu et al. (2019), Ali et al. (2019),
H3	Attitude → Intention to Use	Claudy, Peterson and O'Driscoll (2013), Kim et al. (2014), Römer et al. (2015), Yazdanpanah, Komendantova and Ardestani (2015), Chen, Xu and Frey (2016), Mohammad and Baharun (2016), Ahmad et al. (2017), Jeamwittayanukul (2017), Reyes-Mercado and Rajagopal (2017), Yu and Lee (2019)
H4	Subjective Norm → Intention to Use	Yun and Lee (2015), Vassanadumrongdee and Kittipongvises (2017), Engelken et al. (2018), Huang and Ge (2019), Sreen et al. (2018), Chen, Xu and Frey (2016), Reyes-Mercado and Rajagopal (2017)
H5	Perceived Usefulness → Attitude	Korcaj et al. (2015), Nikou (2018), Römer et al. (2015), Claudy, Peterson and O'Driscoll (2013), Kim et al. (2014), Kardooni et al. (2016), Ahmad et al. (2017)
H6	Perceived Usefulness → Intention to Use	Hartmann and Apaolaza (2012), Zahari and Esa (2016), Saengsuwan (2017), Wolske et al. (2017), Wang et al. (2018), Weng et al. (2018),
H7	Subjective Norm → Attitude → Intention to Use	Yun and Lee (2015), Fornara et al. (2016), Engelken et al. (2018), Sreen et al. (2018)
H8	Perceived Usefulness → Attitude → Intention to Use	Hartmann and Apaolaza (2012), Korcaj et al. (2015), Kardooni et al. (2016), Ahmad et al. (2017), Nikou (2018), Weng et al. (2018)

2.9 Conceptual framework

From the research and literature review, the researcher synthesized the relevant concepts and theories and analyzed the relationship between the variables related to the research objectives. As a result, the conceptual framework was obtained, as shown in Figure 2.40.

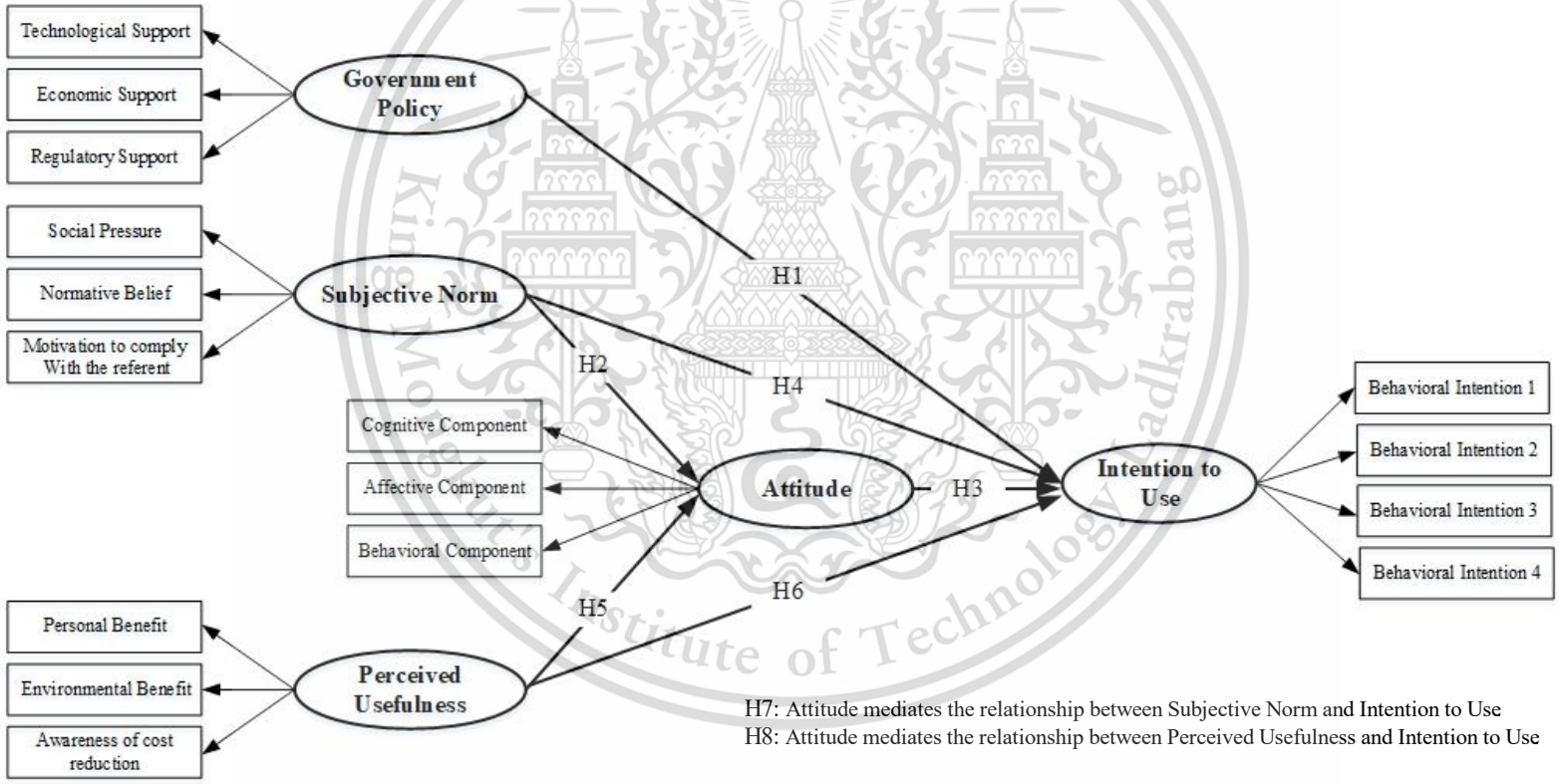


Figure 2.40 Conceptual framework in the research

2.10 Research hypotheses

From Figure 2.40, all research hypotheses can be summarized as follows:

Hypothesis 1 : Government Policy has direct effect to Intention to Use

Hypothesis 2 : Subjective Norm has direct effect to Attitude

Hypothesis 3 : Attitude has direct effect to Intention to Use

Hypothesis 4 : Subjective Norm has direct effect to Intention to Use

Hypothesis 5 : Perceived Usefulness has direct effect to Attitude

Hypothesis 6 : Perceived Usefulness has direct effect to Intention to Use

CHAPTER 3

RESEARCH METHODOLOGY

The research of a Structural Equation Model of Factors Influencing the Intention to Use Solar Rooftop Energy among Households in Thailand" aimed to develop a structural equation model for the factors influencing the intention to use solar rooftop energy by households in Thailand. Mixed methods were used for research implementation. To clarify, questionnaires were used for data collection to find the answers concerning the relevant concepts from the samples of 19,664,165 households (National Statistical Office, 2010). Statistics and the structural equation model (SEM) were used for data analysis. Regarding qualitative research, the researcher relied on secondary data, e.g. books, journals, relevant research papers, and in-depth interviews with 11 experts from companies in the solar energy industry and related government agencies as well as state enterprises and potential users of solar rooftop to confirm and find congruence among the variables, i.e. government policy, attitude, subjective norms, customer knowledge management, and perceived usefulness influencing the intention to use solar rooftop energy by households in Thailand. The research guidelines were demonstrated as follows.

3.1 Quantitative research

3.1.1 Population and samples

3.1.2 Sampling and sample size for quantitative research

3.1.3 Variables in the study

3.1.4 Research instrument and the scales

3.1.5 Quality of the instruments

3.1.6 Data collection method

3.1.7 Data analysis

3.1.8 Statistics for Analysis

3.2 Qualitative research

3.2.1 Sampling and sample size for qualitative research

3.2.2 Instrument for qualitative research

3.2.3 Quality of the interview question

3.2.4 Qualitative data collection

3.2.5 Qualitative data analysis

The development of a structural equation model for the factors influencing the intention to use solar rooftop energy among households in Thailand was based on mixed methodology. First, quantitative research was carried out by studying current data using questionnaires to conduct a survey on the opinions of homeowners or household members. Second, for qualitative research, the researcher relied on in-depth interviews, literature review, and observations from experts in the solar energy industry, executives, and employees of involved government as well as private agencies. This chapter presents the details of the research methodology, which was vital for quality and accurate research implementation in compliance with the theories. The descriptions are clarified as below.

In terms of the literature review for the conceptual framework, it was presented in Chapter 2. Thus, the research focused on the acquisition of the analysis results and quantitative facts to achieve the research objectives. In addition, the research procedures included the following three steps to enhance the quality of the research.

Step 1: Studied the secondary data through a review of relevant literature, concepts, theories, articles, academic papers, research, and online documents. Then, the variables and the relationships among the influential variables in each research published in international journals including national and international dissertations were synthesized. Besides, the researcher also conducted an in-depth interviews with the following executives and academicians to strengthen the conceptual framework from people who know well in this industry in Thailand which is the scope of this study.

1) Dr. Sopitsuda Tongsopit	Energy Policy Analyst at the Policy Institute for Energy, Environment, and the Economy, University of California Davis
2) Asst. Prof. Dr. Kulyos Audomvongseree	Director of Energy Research Institute
3) Asst. Prof. Dr. Surachai Chaitusaney	Department of Electrical Engineering, Faculty of Engineering, Chulalongkorn University

4) Dr. Supachai Sampao	Director of Energy Conservation Standard Group, Department of Alternative Energy Development and Efficiency, Ministry of Energy
5) Mr. Vichan Sripiroj	First Senior Vice President – Renewable Group, Electricity Generating Public Co., Ltd. (EGCO)

Executives and academicians reviewed the variables obtained from the relevant literature and research so as to use the data for setting the design of the conceptual framework and questionnaire. The review led to the variables that could be further studied within the conceptual framework. Therefore, the synthesized theories, research, and knowledge brought about 5 latent variables and 16 observed variables to be used in the research.

Step 2: Conducted quantitative research using a research process, the research instrument, and statistics for data analysis. SEM was used, together with an analysis program called AMOS, to study the structural model of the variables for more precise development and revision of SEM.

Step 3: Conducted qualitative research aimed to confirm the quantitative data for better quality, accuracy, and reliability. The researcher conducted in-depth interviews with experts in the solar energy industry, as well as executives and employees of involved government and private agencies. The structural interview questions were used. Thus, this qualitative research confirmed the enhanced precision of this research. Overall, the 3 steps can be summed up as displayed in Figure 3.1. Step 1 was the study of concepts, theories, articles, academic papers, online documents, and relevant research of latent, mediators/intervening, and observed variables in compliance with the research framework. When large numbers of researches were studied inclusively as set by the framework, the conceptual framework could be set. The population and samples were also set. The research instruments were developed for better quality. Step 2 was the use of the research instrument for quantitative data collection, strengthened by Step 3, the qualitative research. Then, both quantitative and qualitative data was analyzed and concluded. Finally, the results of the research were reported in compliance with international standards.

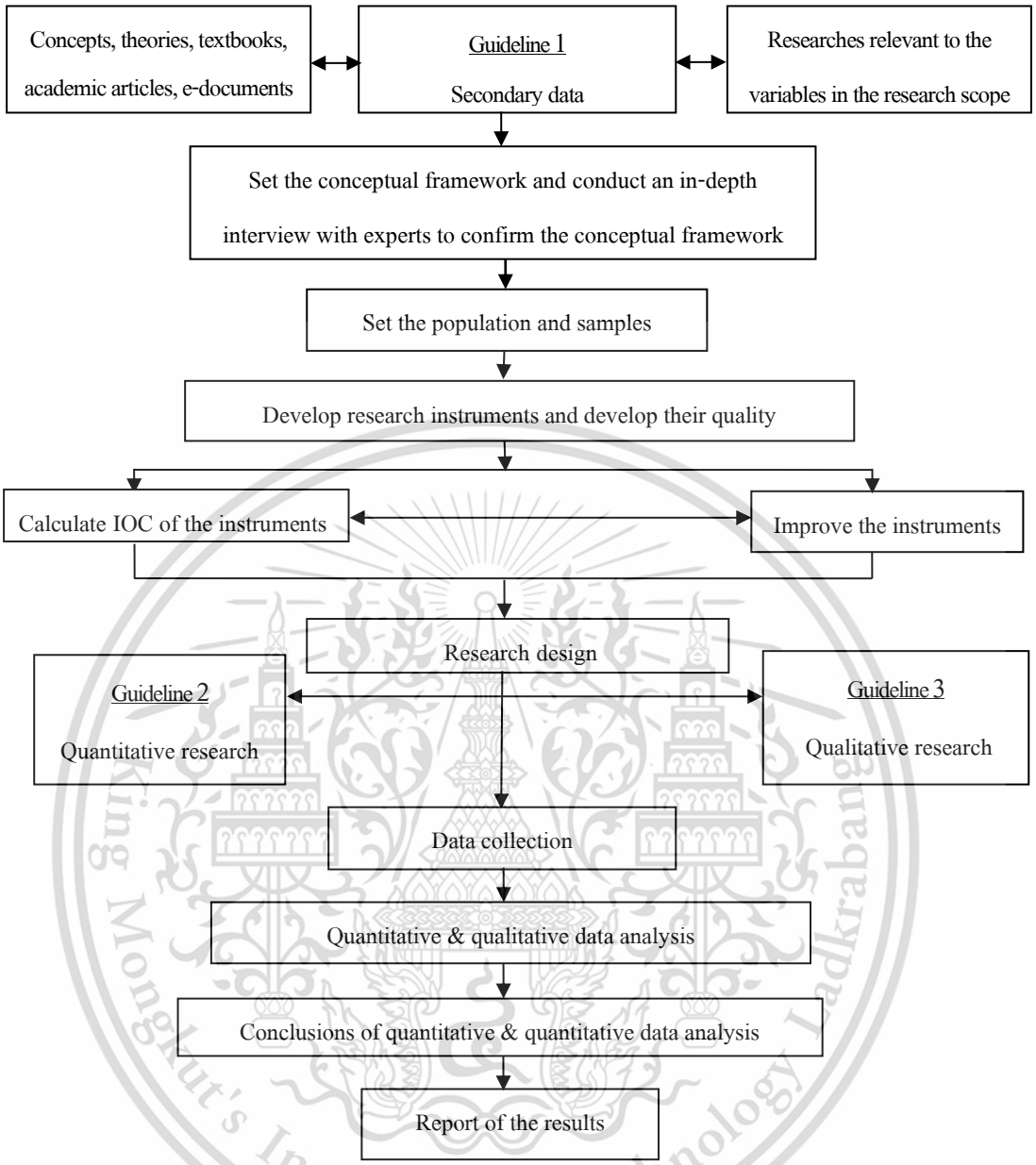


Figure 3.1 Research procedure

3.1 Quantitative research

3.1.1 Population and samples

Population

This research aimed to develop a structural equation model of the factors influencing the intention to use solar rooftop energy in Thailand. The population included homeowners and household members who are in the private dwellings or living places located in environments

exposed to sunlight. There were a total of 19,664,165 households (National Statistical Office, 2010) in the following categories of dwellings:

1) Detached house

2) Townhouse / Duplex / Town home

3) Row house / Shop house

Table 3.1 The number of households classified by regions

No.	Region	Detached house	Townhouse / Duplex / Town home	Row house / Shop house
1	Bangkok	848,859	469,433	476,307
2	Central	3,725,999	754,213	1,136,483
3	North	3,559,296	59,481	248,869
4	Northeast	5,393,889	62,693	268,169
5	South	2,071,204	117,868	471,402
Total		15,599,247	1,463,688	2,601,230
		19,664,165		

Source: National Statistical Office, 2010

3.1.2 Selection of the samples and sample size for quantitative research

This is a study of the intention to use solar rooftop energy among households in Thailand. Table 3.1 displays the numbers of houses spread over the 5 regions in Thailand, totaling 19,664,165 households. The samples were obtained by convenience sampling. The procedure can be summarized into each step as follows.

Part 1: Set the sample size.

Part 2: Divided the population into 5 regions according to the National Statistical Office spread throughout all regions in Thailand.

Part 3: Divided the numbers of the sample size in each particular region based on the portions compared with the population in that region. Besides Bangkok as a region according to the National Statistical Office, other regions are Central, North, Northeast, and South, as seen in Table 3.2.

Part 4: Used convenience sampling to randomize the population from each group. By providing on-line questionnaires that can be sent via mobile phone and by hardcopy questionnaires submitted to people the researcher knew or met by chance. The samples will be compiled by regions until reaching the required specific number. However, some excess samples above 320 samples were collected as some samples were screened out from incomplete data filing such as missing data. Ultimately, a total of 320 samples were received proportionally specified by region as indicated in Table 3.2.

Table 3.2 Selection of the sample size for houses in each region based on proportions, compared with the total population in Thailand

Region	Population* (Household)	Proportion	Samples according to region
Bangkok	1,794,599	9.13%	29
Central	5,616,695	28.56%	91
North	3,867,646	19.67%	63
Northeast	5,724,751	29.11%	93
South	2,660,474	13.53%	44
Total	**19,664,165**	**100.00%**	**320**

Source: National Statistical Office, 2010

For data analysis in this research, the researcher intended to study the development of the structural equation model for the factors influencing the intention to use solar rooftop energy among households in Thailand. AMOS was used to analyze the relationships among the variables, together with SEM or analysis of the structure of causal relationships among the variables. Research of correlations analyzed by advanced statistics with the relationships among the variables was also included. The researcher considered the sample size or the numbers of the population in this research, along with the numbers of the relevant independent variables. Estimation of the studied sample size was set as the rate per number of variables. Stevens J. (1986, p. 147–153) suggested that sample size or population must be considered with estimated independent parameters. The ratio of the studied variables should be 20:1 (20 samples per 1 variable). Schumacker and Lomax (1996, p. 20) suggested that SEM analysis must set a larger sample size than other ways of analysis so that

the estimation will be accurate and can be accurately representative of the population. The ratio criteria of 20 times per the numbers of variables should be used. Likewise, Hair (2006) suggested that a sample size must be large enough for data analysis by SEM and data distribution must be in shown in normal curve. Because this research included 16 observed variables, the required samples included 320 households (20 x 16 = 320). However, the researcher collected more samples to ensure the more reliability of the research study. This sample size was regarded as suitable for AMOS to help in analysis of the relationships among the variables.

3.1.3 Variables in the research

For the variables used in this research, the researcher studied, collected, and reviewed relevant concepts, theories, literature, and research, after which the variables were set as below.

1. Exogenous latent variables

1.1 Government Policy: This consisted of the following 3 observed variables.

1.1.1 Technological Support

1.1.2 Economic Support

1.1.3 Regulatory Support

1.2 Subjective Norm: This consisted of the following 3 observed variables.

1.2.1 Social Pressure

1.2.2 Normative Belief

1.2.3 Motivation to Comply with the Referent

1.3 Perceived Usefulness: This consisted of the following 3 observed variables.

1.3.1 Personal Benefit

1.3.2 Environmental Benefit

1.3.3 Awareness of Cost Reduction

2. Mediator/intervening variable

2.1 Attitude: This consisted of the following 3 observed variables.

2.1.1 Cognitive Component

2.1.2 Affective Component

2.1.3 Behavioral Component

3. Endogenous latent variables

3.1 Intention to Use: This consisted of the following 4 observed variables.

3.1.1 Behavior Intention 1

3.1.2 Behavior Intention 2

3.1.3 Behavior Intention 3

3.1.4 Behavior Intention 4

3.1.4 Research instruments and scale development

The research of the development of structural equation model of factors influencing the intention to use solar rooftop energy among households in Thailand relied on the research instruments as follows.

Quantitative research

A set of questionnaires was used as the instrument to collect data for the variables relevant to the intention to use solar rooftop energy of households in Thailand.

Development procedure for research instrument

1. Collected data from relevant concepts, theories, and research in order to prepare the questionnaire structure.

2. Collected relevant concepts, theories, and research to acknowledge the relationships among endogenous latent, exogenous latent and observed variables. Then, they were developed into the questionnaire structure.

3. Prepared questionnaires in compliance with the studied structure. Then, they were brought to 7 experts, i.e. academicians and executives of the solar energy industry, to find the index of item-objective congruence (IOC) so as to examine congruence among the questions, compared with the research objectives, as well as to observe whether or not they were congruent with the research problems. The values were expected to be between 0.5 – 1.0. If lower than 0.5, the questions had to be improved in order to be congruent with the objectives. (Turner & Carlson, 2003)

4. Revised questionnaires as suggested by the experts.

5. Tested the revised questionnaires on 30 samples before actual use so as to examine the clarity and congruence of the questions in terms of whether or not they went the same way.

6. Took the results of the questionnaires answered by all 30 samples and measured their consistency and reliability with Cronbach's alpha.

7. Revised/improved the tested questionnaires to develop the ones to be actually used to collect data.

The structure of the instrument and questionnaires

A set of questionnaires was used as the research instrument for data collection. The questionnaires were developed based on a review of the relevant concepts, theories, literature, and research in order to set the variables for government policy, attitude, subjective norm, customer knowledge management, and perceived usefulness influencing the intention to use solar rooftop energy among households in Thailand. Questionnaire was first developed in English which is shown in Annex A. However, the it was later converted to Thai as it was the instrument to collect data from Thai people who usually speak Thai as an official language. Thai questionnaire was shown in Annex B which is equally same as a questionnaire in Annex A.

There will be screening questions to get the targeted respondents as follows:

1) A member of an individual household; possibly the owner or a relative of the owner, but not the renter
2) A person who take part in decision-making on house expansion, repairs, and/or buying electrical appliances
3) A person who know or have some knowledge of solar rooftops
4) Type of residence, which is a house located in environments exposed to sunlight and its roof space can be installed the solar panels. They can be in the following types:
    - Detached house
    - Townhouse / Duplex / Town home
    - Row house / Shop house

The screened respondents will be given the questionnaire which was divided into 4 parts as follows:

Part 1: Personal data of the respondent, i.e. gender, age, highest education level, occupation, salary, location of current residence, type of living place, ownership of residence, age of residence, electricity cost per month. Nominal scale and interval scale were used.

Part 2: Questions of the basic knowledge about solar rooftop. The researcher developed questions and evaluated the result by research's own scheme to measure the Customer Knowledge as one of the demographich information of the respondents. Nominal scale and interval scale were used.

Part 3: Questions about the latent variables in the research

3.1) Government policy: This part was developed from previous studies including Chaianong and Pharinon (2015); Long et al. (2017); Sukamongkol (2016); and Yu (2016). An example is demonstrated as below.

The example of the questionnaire about "Government policy"

Instruction: Please answer each question by filling ✓ in the blank that most matches your opinion. The scale was classified into 7 levels as follows.

The variable "Government Policy" refers to the regulations of the government to promote and support the development and installation of solar power systems to become known and accepted by people.

Question	Researcher	Least → Most						
		1	2	3	4	5	6	7
You think a solar rooftop requires high investment and a large space for installation.	Sukamongkol (2016)							
You think a law for renewable energy should be issued and cover the rules as well as promotion measures	Chaianong and Pharinon (2015)							
You think new innovations for solar rooftops will happen if the government offers more support for R&D.	Long et al. (2017)							

3.2) Questions about "Attitude" were developed from the studies of Kim et al. (2014); Lee et al. (2015); Ahmad et al. (2017); Weng et al. (2018); and Teo et al. (2015). An example is demonstrated as below.

The example of the questionnaire about "Attitude"

Instruction: Please answer each question by filling ✓ in the blank that most matches your opinion. The scale was classified into 7 levels as follows.

The variable "Attitude" refers to the level of thought and mental state of the person from knowledge, understanding and the perception of the homeowner towards the solar rooftop in both satisfaction or dissatisfaction, which is the result of experience and the environment that is likely to influence the person to express the reaction to support or deny the matter.

Question	Researcher	Least → Most						
		1	2	3	4	5	6	7
You intend to use solar energy rather than other types of renewable energy for better quality of life.	Kim et al. (2014)							
You believe using solar rooftop energy is worthwhile.	Weng et al. (2018)							
You would like to use solar energy as a source of generating electricity for your living place.	Teo et al. (2015)							

3.3) Questions about "Subjective Norm" were developed from the studies of Abreu et al. (2019); Lynch and Martin (2013); and Ali et al. (2019). An example is demonstrated as below.

The example of the questionnaire about "Subjective Norm"

Instruction: Please answer each question by filling ✓ in the blank that most matches your opinion. The scale was classified into 7 levels as follows.

The variable "Subjective Norm" refers to the belief or pressure received from influential surrounding people on the homeowner for the use of a solar rooftop energy.

Question	Researcher	Least → Most						
		1	2	3	4	5	6	7
Acceptance from neighbors is a key factor for you to choose solar rooftop installation.	Abreu et al. (2019)							
A person whom you trust influences your decision-making on solar rooftop installation.	Lynch and Martin (2013)							
Decision-making by your family member(s) affects your decision-making on solar rooftop installation.	Ali et al. (2019)							

3.4) Questions about "Perceived Usefulness," were developed from the studies of Wang et al. (2018); Ahmad et al. (2017); Akinwale and Adepoju (2019); Kardooni et al. (2016); Korcaj et al. (2015); and Engelken et al. (2018). An example is demonstrated as below.

An example of the questionnaire about "Perceived Usefulness"

Instruction: Please answer each question by filling ✓ in the blank that most matches your opinion. The scale was classified into 7 levels as follows.

The variable "Perceived Usefulness" refers to the awareness of the homeowner in value and benefits gained from using the solar rooftop, which improves efficiency, eco-friendly use, and quality of life.

Question	Researcher	Least → Most						
		1	2	3	4	5	6	7
Using solar energy rooftops creates better quality of life.	Akinwale and Adepoju (2019)							
You think solar rooftop installation for electricity generation is clean and eco-friendly.	Korcaj et al. (2015)							
You think investing in solar rooftop installation is worthwhile for long-term investment.	Engelken et al. (2018)							

3.5) Questions about "Intention to Use," were developed from the studies of Chen (2014); Kim et al. (2014); Sreen et al. (2018); Weng et al. (2018); and Jeamwittayanukul (2017). An

An example of the questionnaire about "Intention to Use"

Instruction: Please answer each question by filling ✓ in the blank that most matches your opinion. The scale was classified into 7 levels as follows.

The variable “Intention to Use” refers to the intention of the homeowner to procure and install a solar rooftop system to utilize the benefits from generated electricity by hiring a contractor to design and install a system on their roof. The homeowner might search for information and have conversations with others about their experiences with solar rooftop systems before making a decision.

Question	Researcher	Least → Most						
		1	2	3	4	5	6	7
You intend to install a solar rooftop on the roof of your house.	Chen (2014)							
You intend to use electricity from solar rooftop rather than electricity from other sources.	Kim et al. (2014)							
You tend to install additional solar rooftops in case you previously installed it.	Weng et al. (2018)							

Part 4: Suggestions of respondents

The questionnaire will be structured as the following table 3.3.

Table 3.3 Questionnaire structure

Variable	Total Questions	Question No.	Form/Scale
Questions for screening targeted respondents	4	-	nominal scale/ interval scale
Part 1: Personal data of the respondents	10	-	
Part 2: Questions of basic knowledge in solar rooftop	15	-	
Part 3: Questions about latent variables			interval scale
3.1 Intention to Use			
3.1.1 Behavior Intention	4	1-4	

Table 3.3 (Continue)

Variable	Total Questions	Question No.	Form/Scale
3.2 Government Policy			
3.2.1 Technological Support	4	5-8	
3.2.2 Economic Support	4	9-12	
3.2.3 Regulatory Support	4	13-16	
3.3 Attitude			
3.3.1 Cognitive Component	4	17-20	
3.3.2 Affective Component	3	21-23	
3.3.3 Behavioral Component	3	24-26	interval scale
3.4 Subjective Norm			
3.4.1 Social Pressure	4	27-30	
3.4.2 Normative Belief	3	31-33	
3.4.3 Motivation to comply with the referent	3	34-36	
3.5 Perceived Usefulness			
3.5.1 Personal Benefit	3	37-39	
3.5.2 Environmental Benefit	4	40-43	
3.5.3 Awareness of Cost Reduction	3	44-46	
Total	46		
Part 4: Suggestions of respondents	-	-	-

Scale development

For the set of questionnaires used as an instrument for quantitative research, it was developed based on different sources in compliance with the conceptual framework. Literature review was also taken into account for validity testing as shown in Table 3.4.

Table 3.4 Development of scale and research questions

Latent Variables	Observed Variables	Development of Research Questions	Number of Question
Intention to Use	1) Behavior Intention	Chen (2014) Sreen et al. (2018) Jeamwittayanukul (2017) Kim et al. (2014) Weng et al. (2018)	4
Government Policy	1) Technological Support 2) Economic Support 3) Regulatory Support	Chaianong and Pharinon (2015) Long et al. (2017) Sukamongkol (2016) Yu (2016)	12
Attitude	1) Cognitive Component 2) Affective Component 3) Behavioral Component	Kim et al. (2014) Lee et al. (2015) Ahmad et al. (2017) Weng et al. (2018) Teo et al. (2015)	10
Subjective Norm	1) Social Pressure 2) Normative Belief 3) Motivation to Comply with the Referent	Abreu et al. (2019) Ali et al. (2019) Lynch and Martin (2013)	10
Perceived Usefulness	1) Personal Benefit 2) Environmental Benefit 3) Awareness of Cost Reduction	Ahmad et al. (2017) Akinwale and Adepoju (2019) Wang et al. (2018) Korcaj et al. (2015) Kardooni et al. (2016) Engelken et al. (2018)	10
Total			46

Next, the obtained data was analyzed and 7-point rating scale (7-point Likert type scale) was set. The questions were developed from some parts of scales by other academicians, along with the collection or arrangement of the studied issues that were obtained from the review of relevant literature.

The researcher chose the 7-point rating scale for questionnaire development, with the scoring criteria of 1-7 points as follows.

"7" points = agree, influential, true, or happened the most.

"6" points = agree, influential, true, or happened a lot.

"5" points = agree, influential, true, or happened quite often.

"4" points = agree, influential, true, or happened moderately.

"3" points = agree, influential, true, or happened infrequently.

"2" points = agree, influential, true, or happened rarely.

"1" point = agree, influential, true, or happened the least.

Because the questions were set as negation, the obtained points were arranged in contrast to those specified above. The interpretation of the variables from this type of scale was based on class interval calculation in compliance with the principle of classification as below.

$$\text{Class interval} = \frac{\text{(Maximum-minimum)}}{\text{The number of classes}}$$

$$= \frac{(7-1)}{7}$$

$$= 0.85$$

According to the calculation, it was found that the distance of each interval = 0.85. Therefore, it was used to set the evaluation criteria of the variables, as displayed in Table 3.5.

The Criteria of variable explanation

Table 3.5 The criteria of variable explanation

Level of Average Point	Influence/behavior	Level of Variable
6.15 - 7.00	Agree, influential, true, or happened the most	Highest
5.29 - 6.14	Agree, influential, true, or happened a lot	High
4.43 - 5.28	Agree, influential, true, or happened quite often	Quite a lot
3.57 - 4.42	Agree, influential, true, or happened moderately	Moderate
2.71 - 3.56	Agree, influential, true, or happened infrequently	Infrequently
1.85 - 2.70	Agree, influential, true, or happened rarely	Rarely
1.00 - 1.84	Agree, influential, true, or happened least	Least

Source: Best and Kahn, 1998

3.1.5 Quality of the instruments

In this research, the quality of the questionnaires and interview questions were examined by 7 experts and academicians in solar energy as follows:

1) Dr. Supachai Sampao	Director of Energy Conservation Standard Group, Department of Alternative Energy Development and Efficiency, Ministry of Energy
2) Mr. Krai Sornjonkul	Senior Engineer, Department of Alternative Energy Development and Efficiency, Ministry of Energy
3) Mr. Weerayut Srithiam	Electrical Engineer, Business Development, Electricity Generating Authority of Thailand (EGAT)
4) Dr. Jakkrapun Kongtana	Project Manager, College of Logistics and Supply Chain, Suan Sunundha Rajabhat University
5) Dr. Kittipong Jeamwittayanukul	Thailand Center of Excellence for Life Sciences (TCELS)
6) Mr. Vichan Sripiroj	First Senior Vice President – Renewable Group, Electricity Generating Public Co., Ltd. (EGCO)
7) Mr. Natthidet Chitkrongtam	Chief Executive Officer, Natural Energy Development Co., Ltd.

The data gathering from these experts and academicians are used for the completeness of the contents, inclusiveness, and language use in terms of whether or not it was easy to understand and hit the points. Then, the instruments were calculated for IOC between each question and variable. The questions with IOC $\geq$ 0.5 were picked up for use. Discrimination power was calculated afterwards by trying out 30 questionnaires on the house owners or household members for the pretest. Discrimination power of each question was calculated by item-total correlation. The questions with discrimination power > 0.20 were regarded as being of good quality. The reliability of the entire questionnaire was calculated by Cronbach's alpha. The questionnaires of the observed variables with reliability > 0.70 were regarded as highly reliable (Vanichbuncha, 2011). The details are described as below.

Calculation formula

$$IOC = \frac{\sum R}{N}$$

R = Congruence value of each question

N = The number of experts

1 = Congruent

0 = Uncertain

-1 = Incongruent

Because IOC was between - 1 to + 1, good questions should be close to 1. The questions with IOC < 0.60 should be revised. Those with IOC < 0.50 should be excluded. (Turner & Carlson, 2003)

+1 = When the experts found that the question was congruent with the content.

0 = When the experts were uncertain if the question was congruent with the content.

-1 = When the experts found that the question was incongruent with the content.

The consideration criteria of IOC:

1. The questions with IOC from 0.5 – 1.00 = Valid and can be used
2. The questions with IOC below 0.5 = Need revision and cannot be used

The reliability testing of the scale in this research relied on the measure of internal consistency, called Cronbach's alpha. This method was developed from a formula (Vanichbuncha,

2009, p. 35) into alpha coefficient so that it could be used to the points which were not in compliance with the scoring system of 0-1, e.g., rating scale. The calculation is demonstrated as below.

$$\alpha = \frac{K}{K-1}\left[1 - \frac{\sum S_i^2}{S_t^2}\right]$$

α	=	Reliability coefficient
K	=	The number of questions for the instrument
S_i^2	=	Variance of score in each question
S_t^2	=	Variance of total score of all respondents

Interpretation of the results: Cronbach's alpha coefficient of 30 tried out questionnaires must be $\geq$ 0.70 so that they could be used for data collection (Cronbach, 1990).

3.1.6 Data collection

Quantitative data collection

The researcher collected data following the procedure below.

3.1.6.1 Primary data

1. Requested the letters of cooperation to collect data. The letters were provided by the head of Ph.D. Program in Industrial Business Administration and from the Vice Dean of Academic and Research Department, who is in charge of graduate degree programs. The purpose for requesting those letters was to ask for permission from some of the respondents in order to carry out data collection for this research.

2. Used the questionnaires to 320 respondents in 5 regions until it was completed as set. Some additional questionnaires were used for spare.

3. Examined the completeness of the questionnaires, followed by data analysis.

3.1.6.2 Secondary data

The researcher collected data from relevant concepts, theories, literature, and national as well as international researches from various sources, e.g. documents, books, journals, internet, and statistical data from both government and private sectors. The data from these sources was used

for analysis and synthesis in order to generate the knowledge used this research and for analysis of the results later on.

3.1.7 Data analysis

Quantitative data analysis

After the return of the questionnaires, they were examined for correct filling and completeness of the data before coding. Then, the basic data was examined for compliance with the analysis agreement. The level of significance or acceptable error (α) for statistical testing was 0.05 ($\alpha = 0.05$). The analysis procedure and statistics used are clarified as follows.

1) Used basic statistical analysis of the samples in order to acknowledge the sample distribution by descriptive statistics, i.e. mean, percentage, and basic statistical analysis of the variables for model development. They basically consisted of 16 observed variables. The analysis was also used to acknowledge the distribution and variation of the observed variables in the study of the development of the structural equation model of factors influencing the intention to use solar rooftop energy among households in Thailand. Descriptive statistics included mean, SD, coefficient of variation, coefficient of variation, skewness, and kurtosis with the use of AMOS.

Regarding the mean, the results of the mean values of the factors were interpreted based on the following criteria of opinion in the research (Best and Kahn, 1998).

Level of mean	Level of the variables
6.15 - 7.00	Highest
5.29 - 6.14	High
4.43 - 5.28	Quite high
3.57 - 4.42	Moderate
2.71 - 3.56	Quite low
1.85 - 2.70	Low
1.00 - 1.84	Lowest

Normal distribution with SK = 0. SK > 0 (positive) referred to right or positive right skew, indicating that data density showed at the low values. SK < 0 (negative) referred to left skew, indicating that data density showed at the high values. KU = 3 (or KU-3 = 0) referred to mesokurtic distribution or moderately high distribution. KU > 3 (positive) referred to leptokurtic distribution or high-kurtosis distribution. KU < 3 (negative) referred to platykurtic distribution or short and flat

distribution. Furthermore, data distribution was also examined to find out whether or not each observed variable was within normal distribution. Kolmogorov-Sminov test from AMOS was used.

2) For analysis of the relationships among the variables, Pearson's correlation coefficient was used, together with AMOS, as basic data for analyzing the structural equation model of factors influencing the intention to use solar rooftop energy among households in Thailand. Table 3.6 displays the consideration criteria of correlation coefficient which should not be high.

Table 3.6 The levels of the relationships of correlation coefficient

Correlation Coefficient (r)	Level of the relationships
$r > 0.8$	Quite high or very high
$0.6 < r < 0.8$	Quite high
$0.4 < r < 0.6$	Moderate
$0.2 < r < 0.4$	Quite low
$r < 0.2$	Low

Source: Taweerat, 1997, p. 144

3) Considered KMO (Kaiser – Meyer – Olkin) for suitability measurement of the data in order to examine whether or not the data was suitable for testing congruence between the conceptual framework and empirical data. Bartlett's test of sphericity was also used for hypothesis testing to examine whether or not the variables related to one another. Both statistics were used for considering the suitability of factor analysis in this research. High KMO (close to 1) referred to the suitability of factor analysis for the available data. KMO < 0.5 referred to unsuitability of factor analysis technique for the available data. Regarding Bartlett's test of sphericity for hypothesis testing, if H was accepted, it referred to no relationship. Thus, factor analysis should not be used (Vanichbuncha, 2011).

4) Examined congruence of the conceptual framework of "The Factors Influencing the Intention to Use Solar Rooftop Energy among Households in Thailand," obtained from the review of relevant literature, concepts, and theories. AMOS was used for the examination.

3.1.8 Statistics for analysis

This research applied the Structural Equation Modeling (SEM), defined by Silpjaru (2012, p. 523) as a model from the combination of 2 types of linear analysis, i.e. path analysis and factor analysis. Hair et al. (2006, p.710) explained that SEM is an analysis technique of multiple variables. It is the combination of factor analysis and multiple regressions, which brought about significant benefits to the researcher because SEM was used to examine the relationships among the variables in the conceptual framework, both directly and indirectly. The well-known statistical program for SEM examination is AMOS.

In this research, AMOS was brought to study the relationships among the latent variables, based on theoretical basis; and to analyze the relationships between the latent and observed variables. The examination was conducted on measurement quality. AMOS increased the opportunity of variance and covariance analysis. This technique was applied with confirmatory factor analysis (CFA) to examine the accuracy of the scale. The objectives of this technique were to test the hypotheses of the relationships between the latent and observed variables and to study the relationships between the exogenous and endogenous latent variables (Praitrattasin, 2008).

Covariance analysis in this research was based on variance analysis of all variables as the overall study in compliance with SEM to confirm accuracy and completeness, or failure of the indicator variables or observed variables for developing theoretical variables. Involved statistics for congruence evaluation between the conceptual framework and the empirical data were also included. The details are displayed in Table 3.7.

Table 3.7 Statistics for congruence evaluation between the conceptual framework and the empirical data

Statistic	Symbol	Objective	Criterion
Chi-square	χ^2	To test and confirm null Hypothesis (The conceptual framework was congruent with the empirical data).	Not significant ($p > .05$)

Table 3.7 (Continue)

Statistic	Symbol	Objective	Criterion
Goodness of Fit Index	GFI	To measure goodness of fit, between 0-1.00.	> .90
Comparative Fit	CFI	To measure comparative goodness of fit, between 0-1.00.	> .95
Adjusted Goodness of Fit Index	AGFI	To measure goodness of fit, between 0-1.00.	> .90
Normal Fit Index	NFI	Relative fit index	> .90
Root Mean Square Error of Approximation	RMSEA	To show errors of the conceptual framework in the form of RMSEA, between 0-100.	< .08

Source: Wheaton et al., 1977; Joreskog and sorbom, 1989; Bentler, 1990; Browne and Cudeck 1993; Chadcham, 2008; Hair et al., 2010; Schumacker and R.G. Lomax, 2010

3.2 Qualitative research

After analyzing the quantitative data obtained from the samples, the data was analyzed further to find congruence and utilization in order to explain and confirm with the qualitative data. The qualitative research process is described as follows.

3.2.1 Sampling and sample size for qualitative research

Pertaining to the sample size for qualitative research, the samples or respondents of key information were selected by considering the results of quantitative research. The respondents of key information were selected for in-depth interviews, in which open-ended questions were used. The interview was based on the depth of problems with significance in the solar energy industry of Thailand towards all 5 variables. The target population included 11 persons who diversified in ages and professions from freelance, senior staff in governmental offices in related energy authorities involved in solar rooftop energy and they are also potential users in solar rooftop.

3.2.2 Instrument for qualitative research

For the instrument in qualitative research, in-depth interviews were used with the samples. The developed questions were from quantitative research relevant to government policy, attitude, subjective norm, customer knowledge management, and perceived usefulness that influence the intention to use solar rooftop energy among households in Thailand. The objectives included finding comments and suggestions from the experts of companies in the solar industry and involved government agencies as well as state enterprises. Another objective was to confirm the congruence of the results of data analysis from qualitative research. These results were adapted to the variables, i.e. government policy, attitude, subjective norm, customer knowledge management, and perceived usefulness influencing the intention to use solar rooftop energy among households in Thailand.

3.2.3 Quality of the interview question

In this research, the in-depth interview form was examined by 11 experts in solar energy to ensure the contents were inclusive enough to be used as a good representative, a good measurement tool, or a tool to help better understanding. Next, the questions for the interview were revised to be more concise and easier to understand, as suggested by the experts in the solar energy industry in Thailand. Moreover, the language used in the interview form was also revised for easier understanding. The revised interview form was actually used for data collection later on.

3.2.4 Qualitative data collection

Different methods were used in order to obtain complete data as the following:

1. Study from documents, i.e. dissertations, relevant researches, concepts, and theories as the guidelines for data collection.

2. Field study with in-depth interviews. The questions about key issues were developed as a guideline on conversation during the interview in a friendly atmosphere which had to be as natural and informal as possible.

The researcher collected the data directly from experts of the companies in the solar industry and involved government agencies as well as state enterprises as they were the respondents of key information. In-depth interviews, along with voice and VDO records, were used. It took around 30-60 minutes to obtain key and complete information in all expected issues within the specific time. Then, the data from the interview was concluded to be used as research evidence and to help data analysis complete and inclusive of all aspects so as to support the quantitative research.

3.2.5 Qualitative data analysis

After data collection from taking notes and voice recording from 11 experts of companies in the solar industry and involved government agencies as well as state enterprises, the data was decoded and grouped into categories for later conclusions, interpretation, and findings from qualitative research in order to confirm its accuracy and congruence. Lastly, the findings and suggestions were brought for presenting the results of the research. The findings must be described in compliance with the conceptual framework according to the model and the empirical data of government policy, attitude, subjective norms, customer knowledge management, and perceived usefulness influencing the intention to use solar rooftop energy among households in Thailand.

3.3 Conclusion

The research was implemented by mixed methods, i.e. (1) quantitative research, in which data was collected by using the questionnaires to find the answers about the relevant concepts from the samples of 320 households. Then, the collected data was analyzed by statistics and SEM. (2) Qualitative research was based on sources of secondary data, e.g. relevant books, journals, researches, and in-depth interviews from 11 experts in companies in the solar industry, involved government agencies, and state enterprises. Then, the obtained data was analyzed by descriptive statistics.

CHAPTER 4

RESULTS

The research aimed to develop the structural equation model (SEM) of factors influencing the intention to use solar rooftop energy of households in Thailand. Mixed methods were used, i.e., quantitative research and qualitative research. The quantitative research consisted of a set of questionnaires that was designed based on the literature review and then examined by 7 experts, which are academicians and executives of the solar energy industry for the index of item-objective congruence (IOC). After that, the questionnaires were piloted with 30 participants to check the reliability before conducting the actual collection of the data. The obtained data was analyzed for SEM. The qualitative research was based on the secondary sources, e.g., books, journals, related researches and the in-depth interview by the executives of companies in the solar industry as well as the involved government agencies and state enterprises to confirm and find congruence among government policy, attitude, subjective norm and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand. The researcher set the variables as displayed in Table 4.1.

Table 4.1 Variable settings for analysis

Latent Variable	Observed Variable	Variable Setting
Intention to Use	1) Behavioral Intention	Intention 1 Intention 2 Intention 3 Intention 4
Government Policy	1) Technological Support 2) Economic Support 3) Regulatory Support	Technological Economic Regulatory

Table 4.1 (Continue)

Latent Variable	Observed Variable	Variable Setting
Attitude	1) Cognitive Component	Cognitive
	2) Affective Component	Affective
	3) Behavioral Component	Behavioral
Subjective Norm	1) Social Pressure	Social
	2) Normative Belief	Belief
	3) Motivation to Comply with the Referent	Motivation
Perceived Usefulness	1) Personal Benefit	Personal
	2) Environmental Benefit	Environmental
	3) Awareness of Cost Reduction	Awareness

4.1 Validity and reliability analysis

The researcher used questionnaires as the instrument for collecting the data. The questions were designed based on the review of the related concepts, theories, literature, and research to set the variables, i.e., government policy, attitude, subjective norm, and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand. Then, the obtained data were analyzed and used to design the questionnaires with a seven-point Likert type scale (Likert, 1970). The population included homeowner and household members in residence in a type of detached houses, townhouses, duplexes, townhomes, row houses, or shop houses which has the roof space exposed to sunlight. Next, the questionnaires were tested by using different statistics to confirm their quality in compliance with the statistical testing standards (Hair et al., 2010). The quality of the questionnaires was tested and the data were analyzed as follows.

4.1.1 Content validity

The validity of the content was examined to find the inclusion of the contents and language used for the validity of the questionnaires. The examination was conducted by 7 related experts, i.e., academicians and executives involved in the solar industry to assess the questionnaires. Then, the questionnaires were evaluated for the IOC (Bollen,1989) based on the scoring criteria between 0.5 – 1.0. If the value obtained was below 0.5, the item must be revised to be congruent with the objectives (IOC) (Turner and Carlson, 2003). The assessment results found that 51 items

passed the criteria (IOC > 0.5). Then, the language and texts were revised according to the suggestions from the experts. The researcher used 30 sets of the revised questionnaires to pilot with the samples and to examine the reliability by using Cronbach's alpha.

4.1.2 Reliability analysis

The researcher used 30 questionnaires and attempted to collect data from the homeowners or their relatives who are living in the residence for the pretest. Then, those questionnaires were analyzed to find the discriminatory power (D). Every correlation coefficient or corrected item-total correlation (CITC) should be 0.2 or over (Ferguson, 1981), and the reliability analyzed by Cronbach's alpha must be over 0.7 (Cronbach, 1990). The analysis results are displayed in Table 4.2.

Table 4.2 Reliability analysis

Variable	Observed Variable	Corrected Item-Total Correlation	Cronbach's Alpha
Intention to Use	Intention 1	.742	.870
	Intention 2	.757	
	Intention 3	.803	
	Intention 4	.599	
Government Policy	Technological Support	.919	.954
	Economic Support	.949	
	Regulatory Support	.918	
Attitude	Cognitive Component	.865	.926
	Affective Component	.812	
	Behavioral Component	.863	
Subjective Norm	Social Pressure	.777	.889
	Normative Belief	.746	
	Motivation to Comply with the Referent	.707	
Perceived Usefulness	Personal Benefit	.798	.903
	Environmental Benefit	.907	
	Awareness of the Cost Reduction	.829	

As can be seen in Table 4.2, the analysis results of the discriminatory power (D) to analyze the CITC found that the knowledge level had a CITC between 0.837-0.929 and Cronbach's alpha = 0.957. The intention to use had a CITC between 0.599-0.803 and Cronbach's Alpha is 0.870. Government policy had a CITC between 0.918-0.949 and Cronbach's Alpha = 0.954. Attitude had a CITC between 0.812-0.865 and Cronbach's alpha is 0.926. Subjective norm had a CITC between 0.707-0.777 and Cronbach's alpha is 0.889. Perceived usefulness had a CITC between 0.798-0.907 and Cronbach's alpha is 0.903. Therefore, every factor displayed a CITC over 0.2 (Ferguson, 1981) and reliability over 0.7 (Cronbach, 1990). Likewise, the analysis result of the total Cronbach's alpha is 0.950, which implied that the scale of reliability was very high.

The questionnaires were then used to collect data from 320 samples and analyzed for the correlation coefficient or CITC between each item in order to find whether or not it is related to each other in the entire questionnaire. For the items to be taken into consideration, they had to be over or equal 0.2. The negative items and those below 0.2 had to be considered for revision or be removed (Ferguson, 1981). The analysis results are displayed in Table 4.3.

Table 4.3 Analysis results of the CITC

Item	Corrected Item-Total Correlation	Interpretation
Intention to Use		
Behavioral Intention		
1. Currently, you are interested in installing a solar rooftop at your house.	.625	Passed
2. If you bought or built a new house, you would be interested in installing a solar rooftop.	.643	Passed
3. You intend to install a solar rooftop on your house although it is not widely used.	.640	Passed
4. You have an idea to install a solar rooftop at your house in the near future.	.468	Passed

Table 4.3 (Continue)

Government Policy		
Technological Support		
5. You now think that the government sector supports R&D in solar rooftops more than before.	.412	Passed
6. You now think that the government sector continually initiates new innovations of solar rooftops through serious R&D support.	.472	Passed
7. You now think that the government sector promotes the exchange of knowledge about a solar rooftop in order to develop innovations.	.430	Passed
8. You now think that the government sector clearly promotes educating each local area on the ability to develop itself a solar rooftop.	.448	Passed
Economic Support		
9. You now think that the government sector has a policy to help investment for your cost reduction to use a solar rooftop.	.425	Passed
10. Now the government sector has measures to provide sufficient financial assistance and support so that you can use a solar rooftop.	.418	Passed
11. Up until now, you have been satisfied with the assistance supported by the government sector, and this has partly made you feel interested in using a solar rooftop.	.407	Passed
12. You now think that the government sector provides financial support and investment for the development of sample projects in your area to use a solar rooftop in order to make local inhabitants realize its usefulness and be interested in using solar rooftop.	.435	Passed

Table 4.3 (Continue)

Regulatory Support		
13. You now think that the government sector issues renewable energy laws that seriously support using a solar rooftop.	.353	Passed
14. You now think that the government sector issues concrete, clear, and simple rules and regulations to use a solar rooftop in order to promote it to be used widely.	.435	Passed
15. You think that the current policy of the government sector on using a solar rooftop clearly include regulations for both service providers and service users.	.447	Passed
16. You think that the current policy of the government sector on using a solar rooftop focuses on seriously developing it as a national source of renewable energy with stability and sustainability.	.476	Passed
Attitude		
Cognitive Component		
17. You agree that if a solar rooftop works, it would be good, and we should use it as much as possible to reduce household costs.	.577	Passed
18. You agree to use a solar rooftop for generating electricity in households in order to use solar energy, which is free and already available in nature.	.555	Passed
19. You agree that the current situation is the most appropriate time to start using a solar rooftop.	.587	Passed
20. You believe that using electricity from a solar rooftop is worthwhile.	.605	Passed

Table 4.3 (Continue)

Affective Component		
21. You think a solar rooftop is interesting.	.618	Passed
22. If a solar rooftop is installed at your house, it would facilitate your better living standard.	.675	Passed
23. You would feel impressed and proud if a solar rooftop was used at your house.	.682	Passed
Behavioral Component		
24. You intend to use a solar rooftop to produce electricity from solar energy than other types of renewable energy; such as, wind energy or waste energy for a better quality of life.	.644	Passed
25. You intend to use a solar rooftop at your house parallel to the power transmitted from the electricity authorities as usual.	.740	Passed
26. If you were free to choose electricity from any sources, you would choose to use a solar rooftop at your house to generate electricity.	.713	Passed
Subjective Norm		
Social Pressure		
27. Acceptance from neighboring houses is a key factor influencing you to choose a solar rooftop.	.498	Passed
28. Acceptance from friends is a key factor influencing you to choose a solar rooftop.	.476	Passed
29. Acceptance from family members is a key factor influencing you to choose a solar rooftop.	.564	Passed
30. Solar rooftop ads through the media, e.g., TV, magazines, or social networks would make you interested in using a solar rooftop.	.571	Passed

Table 4.3 (Continue)

Normative Belief		
31. You give priority to the decision-making from family members on using a solar rooftop.	.521	Passed
32. You give priority to decision-making from friends on using a solar rooftop.	.493	Passed
33. You would use a solar rooftop as suggested by influential persons in your life.	.555	Passed

Table 4.3 (Cont.)

Motivation to Comply with the Referent		
34. If your family members wanted you to install a solar rooftop, you would do so accordingly.	.611	Passed
35. If your friends convinced you to install a solar rooftop, you would do so accordingly.	.614	Passed
36. If your favorite persons, e.g., successful businessmen or artists installed a solar rooftop, you would follow them.	.538	Passed
Perceived Usefulness		
Personal Benefit		
37. You think using a solar rooftop could fulfill your need of daily electricity.	.673	Passed
38. You would use a solar rooftop for generating electricity if it facilitated your life more.	.592	Passed
39. You would use a solar rooftop for generating electricity if it gave you a better and easier quality of life.	.621	Passed

Table 4.3 (Continue)

Environmental Benefit		
40. You think a solar rooftop helps reduce air pollution because the Thais are generating electricity. It is mostly caused by the combustion of coal and natural gas.	.510	Passed
41. You think a solar rooftop uses clean and eco-friendly energy.	.554	Passed
42. You believe that using a solar rooftop helps reduce environmental pollution and global warming problem.	.515	Passed
43. You believe a solar rooftop could be used as a source of electricity in the future.	.553	Passed

Table 4.3 (Cont.)

Awareness of Cost Reduction		
44. You believe using a solar rooftop helps reduce your electricity costs.	.553	Passed
45. For you, using a solar rooftop is a valued investment despite the high capital of investment and long period of return.	.616	Passed
46. You believe a solar rooftop installation is a good form of financial investment to reduce your household costs.	.666	Passed

According to Table 4.3, the analysis results of the CITC of the knowledge level found that the reliability was acceptable. The total CITC of the variables had a total scale score between 0.231-0.325; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was quite low.

For the behavioral intention, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.468-0.643; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate to high.

For technological support, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.412-0.472; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

For economic support, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.407-0.435; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

For regulatory support, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.353-0.476; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was quite low to moderate.

For cognitive component, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.555-0.605; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

For affective component, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.618-0.682; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

For the behavioral component, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.644-0.740; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate to high.

For social pressure, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.476-0.571; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

For normative belief, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.493-0.555; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

For the motivation to comply with the reference, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.538-0.614; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

For personal benefit, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.592-0.673; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

For the environmental benefit, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.510-0.554; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

For awareness of the cost reduction, the scale reliability was acceptable. According to the CITC test of the variables, the total scale score was between 0.553-0.666; which is $\geq$ 0.2. Therefore, all of the items passed the criteria. The scale reliability was moderate.

4.2 Analysis of the general data

After the questionnaires had been returned, the data were examined for correctness and completeness. Then, the data of all 320 sets of the questionnaires were encoded. The data and scale were analyzed, and it was found that the data were reliable. Therefore, the data were brought for basic statistical analysis of the samples to acknowledge the sample distribution by descriptive statistics, i.e., frequency and percentage. From the general data of the respondents, Part 1 was classified based on gender, age, highest educational level, occupation, monthly income, house location, type of residence, ownership status of the residence, age of the residence, and monthly electricity cost. Then, the general data of the respondents were analyzed for frequency and percentage (Table 4.4).

Table 4.4 General data of the respondents

General Data		Frequency (n=320)	Percentage
Gender	Male	146	45.63
	Female	174	54.37
Age (years)	≤ 20	13	4.06
	21 – 30	71	22.19
	31 - 40	89	27.75

Table 4.4 (Continue)

General Data		Frequency	Percentage
	41 - 50	74	23.13
	51 - 60	62	19.38
	> 60	11	3.49
Highest Educational Level	Below bachelor's degree	61	19.06
	Bachelor's degree	139	43.44
	Higher than a bachelor's degree	120	37.50
Occupation	Business entrepreneur	57	17.81
	Corporate employee	174	54.38
	Government officer	44	13.75
	State enterprise officer	16	5.00
	Unemployed / retired	12	3.75
	Others	17	5.31
Monthly Income (Baht)	≤ 35,000	127	39.69
	35,001 – 70,000	87	27.19
	70,001 – 100,000	40	12.50
	> 100,000	66	20.63
Location of the Main House	Bangkok		
	- Lak Si	9	2.81
	- Taling Chan	1	0.31
	- Chatuchak	2	0.63
	- Bang Na	1	0.31
	- Ratchathewi	1	0.31
	- Sathon	1	0.31
	- Thawi Watthana	1	0.31
	- Don Mueang	1	0.31
	- Lat Phrao	1	0.31

Table 4.4 (Continue)

General Data		Frequency	Percentage
	- Bang Wa	1	0.31
	- Suan Luang	2	0.63
	- Prawet	1	0.31
	- Wang Thonglang	1	0.31
	- Sai Mai	3	0.94
	- Bang Kho Laem	1	0.31
	- Phra Khanong	1	0.31
	- Thon Buri	1	0.31
	Central	91	28.56
	North	63	19.67
	Northeast	93	29.11
	South	44	13.53
Type of residence	Detached house	235	73.44
	Duplex	14	4.38
	Townhouse	47	14.69
	Commercial building/Row house	23	7.19
	Shop house	1	0.31
Ownership Status of the Residence	Homeowner	158	49.38
	Household member	162	50.63
Age of the Residence (years)	≤ 1	10	3.13
	1 - 4	42	13.13
	5 - 10	84	26.25
	> 10	184	57.49
Average Monthly Electricity Cost (Baht)	≤ 1,000	88	27.50
	1,001 – 3,000	142	44.38
	3,001 – 5,000	62	19.38
	> 5,000	28	8.75

The general data of the respondents in Table 4.4 displayed that 174 or a little over half of the total number of participants were female (54.38%) while 146 were male (45.63%). The highest number of respondents were aged between 31-40 years (89; 27.81%), followed by those aged 41-50 years (74; 23.13%), then those aged between 21-30 years (71; 22.19%), those aged between 51-60 years (62; 19.38%), those aged ≤ 20 years (13; 4.06%), and those aged > 60 years (11; 3.44%), respectively. About half of the total number of respondents had graduated with a bachelor's degree (139; 43.44%), followed by higher degrees (120; 37.50%), and lower education than a bachelor's degree (61; 19.06%). A little over half of the total number of respondents were corporate employees (174; 54.38%), followed by business entrepreneurs (57; 17.81%), government officers (44; 13.75%), other occupations, e.g., freelancers, general workers, and housemaids (17; 5.31%), state enterprise officers (16; 5%), and unemployed/retired respondents (12; 3.75%), respectively. About one third of the total number of respondents received a monthly income of ≤ 35,000 Baht (127; 39.69%), followed by those who received between 35,001-70,000 Baht (897; 27.19%), those who received 100,000 Baht (66; 20.63%), and those who received between 70,001 – 100,000 Baht (40; 12.50%), respectively.

For the location of the main house, the highest number of respondents lived in Northeast (93; 29.11%), followed by Central (91; 28.56%), North (63; 19.67%), South (44; 13.53%) and Bangkok (29; 9.13); i.e., Lak Si (9; 2.81%), Sai Mai (3; 0.94%), Chatuchak (2; 0.63%), and Suan Luang (2; 0.63%). Other than these, each of the remaining respondents lived in Taling Chan, Bang Na, Ratchathewi, Sathon, Thawi Watthana, Don Mueang, Lat Phrao, Bang Wa, Prawet, Wang Thonglang, Bang Kho Laem, Phra Khanong, and Thon Buri (4.03%), respectively.

Most of the respondents lived in detached houses (235; 73.44%), followed by townhouses (47; 14.69%), commercial building or row houses (23; 7.19%), duplexes (14; 4.38%), and condomeniums (1; 0.31%), respectively. Furthermore at least half of the total number of respondents were household members (162; 50.63%), followed by homeowners (158; 49.38%). A little over half of the total number of respondents lived in houses aged > 10 years (184; 57.50%), followed by houses aged between 5 - 10 years (84; 26.25%), houses aged between 1 - 4 year(s) (42; 13.13%), and houses aged ≤ 1 year (10; 3.13%), respectively. Nearly half of the total number

of respondents paid a monthly electricity cost between 1,001 – 3,000 Baht (142; 44.38%), followed by ≤ 1,000 Baht (88; 27.50%), between 3,001 – 5,000 Baht (62; 19.38%), and > 5,000 baht (28; 8.75%), respectively.

For the survey on the general data of the respondents, Part 2 assessed their knowledge and was divided into two sections, i.e., general knowledge of a solar rooftop to which a nominal scale was used to find the frequency and percentage (Table 4.5), and the assessment of the knowledge level in five fields of knowledge about a solar rooftop to which an interval scale was used to find the mean, standard deviation (SD), skewness, and kurtosis (Table 4.5).

Table 4.5 General data about a solar rooftop

Knowledge of the Respondents		Frequency (n=320)	Percentage
1. A solar rooftop basically consists of solar cells. What material is used for generating electricity?	Semiconductor	272	85.00
	Steel	16	5.00
	Plastic	7	2.19
	Lead	25	7.81
2. What material is used for the surface of the solar panels?	Transparent plastic	25	7.81
	Fiber	80	25.00
	Metal	27	8.44
	Glass	188	58.75
3. What is the electricity generating process of a solar rooftop?	Heat	145	45.31
	Excitation via electric charge	131	40.94
	Electromagnetic induction	30	9.38
	Chemical reaction	14	4.38
4. What type of electricity is produced by solar panels?	Direct current (AC)	210	65.63
	Alternating current (DC)	35	10.94
	Both AC & DC	52	16.25
	Electrostatics	23	7.19

Table 4.5 (Continue)

Knowledge of the Respondents		Frequency (n=320)	Percentage
5. What is the indispensable equipment for a solar rooftop?	Inverter	175	54.69
	Fuse	24	7.50
	Transformer	72	22.50
	Insulator	49	15.31
6. Currently, how many watts of each solar panel is used for a solar rooftop?	10 watts	58	18.13
	100 watts	118	36.88
	300 watts	123	38.44
	500 watts	21	6.56
7. At present, what is the tariff (Baht/kWh) of excessive electricity from a solar rooftop that can be transmitted to the grid system of an electricity authority?	0.55 Baht	69	21.56
	1.25 Baht	105	32.81
	1.68 Baht	120	37.50
	2.53 Baht	26	8.13
8. What is the best direction for solar panels to be exposed to sunlight?	North	21	6.56
	South	109	34.06
	East	146	45.63
	West	44	13.75
9. What is the most suitable angle of inclination for solar panel installation?	Lay it on the ground	6	1.88
	≤ 5 degrees	24	7.50
	10 – 15 degrees	233	72.81
	> 30 degrees	57	17.81
10. What are the benefits of a solar rooftop?	Do not use fuels for generation.	31	9.69
	Reduce global warming.	21	6.56
	Cool house.	2	.63
	All are correct.	266	83.13

As displayed in Table 4.5, the analysis results from the answered questionnaires on the general data of a solar rooftop found that for knowledge about solar panels under the question "What material is used for generating electricity?", most of the respondents thought of a semiconductor (272; 85.00%), followed by lead (25; 7.81%), steel (16; 5.00%), and plastic (7; 2.19%), respectively.

For knowledge on a solar rooftop under the question "What material is used for the surface of the solar panels?", a little more than half of the total number of respondents thought of glass (188; 58.75%), followed by fiber (80; 25.00%), metal (27; 8.44%), and transparent plastic (25; 7.81%), respectively.

For knowledge on a solar rooftop under the question "What is the electricity generating process of a solar rooftop?", just under half of the total number of respondents thought of heat (145; 45.31%), followed by excitation via electric charge (131; 40.94%), electromagnetic induction (30; 9.38%), and chemical reaction (14; 4.38%), respectively.

For knowledge under the question "What type of electricity is produced from solar panels?", nearly two thirds of the total number of respondents thought of DC (210; 65.63%), followed by both DC and AC (52; 16.25%), AC (35; 10.94%), and electrostatics (23; 7.19%), respectively.

For knowledge under the question "What is the indispensable equipment for a solar rooftop?", a little more than half of the total number of respondents thought of an inverter (175; 54.69%), followed by a transformer (72; 22.50%), insulator (49; 15.31%), and fuse (24; 7.50%), respectively.

For knowledge under the question "Currently, how many watts of each solar panel is used for a solar rooftop?", quite a few of the respondents thought of 300 watts (123; 38.44%), followed by 100 watts (118; 36.88%), 10 watts (58; 18.13%), and 500 watts (21; 6.56%), respectively.

For knowledge under the question "At present, what is the tariff (Baht/kWh) of excessive electricity from a solar rooftop that can be transmitted to the grid system of an electricity authority?", quite a few of the respondents thought of 1.68 Baht (120; 37.50%), followed by 1.25 Baht (105; 32.81%), 55 Satang (69; 21.56%), and 2.53 Baht (26; 8.13%), respectively.

For knowledge under the question “What is the best direction for solar panels to be exposed to sunlight?”, just under half of the total number of respondents thought of east (146; 45.63%), followed by south (109; 34.06%), west (44; 13.75%), and north (21; 6.56%), respectively.

For knowledge under the question “What is the most suitable angle of inclination for solar panel installation?”, most of the respondents thought of between $10 - 15$ degrees (233; 72.81%), followed by > 30 degrees (57; 17.81%), ≤ 5 degrees (24; 7.50%), and laying on the ground (6; 1.88%), respectively.

For knowledge under the question “What are the benefits of a solar rooftop?”, most of the respondents thought all choices were correct (266; 83.13%), followed by no use of fuels for electricity generation (31; 9.69%), reduction of global warming (21; 6.56%), and cooling the house (21; 0.63%), respectively.

For the assessment of the knowledge on the general data of a solar rooftop by 10 questions, the results of the analysis are concluded in Table 4.6.

Table 4.6 The assessment of the general knowledge on a solar rooftop

Number of Correct Items	Number of Respondents (n=320)	Percentage
10	24	7.50%
9	25	7.81%
8	33	10.30%
7	32	10.00%
6	40	12.50%
5	53	16.56%
4	54	16.88%
3	42	13.13%
2	12	3.75%
1	3	0.94%
0	2	0.63%

The survey on the general data of the respondents in the assessment of the level of the knowledge on a solar rooftop shows the classification of respondents' knowledge in Table 4.7. Most of the respondents have fair level of knowledge at 55.94%. 82 respondents or 25.61% have good level of knowledge, while the rest of 18.45% have poor level of knowledge.

Table 4.7 Classification of respondents' level of general knowledge in solar rooftop

Number of Correct Items	Number of Respondents	Percentage	Level of knowledge
8 - 10	82	25.61%	Good
4 - 7	179	55.94%	Fair
1 - 3	59	18.45%	Poor

As mentioned in 3.1.7, criteria of the mean interpretation are based on the following criteria of opinion in the research (Best and Kahn, 1998).

Level of mean	Level of the variables
6.15 - 7.00	Highest
5.29 - 6.14	High
4.43 - 5.28	Quite high
3.57 - 4.42	Moderate
2.71 - 3.56	Quite low
1.85 - 2.70	Low
1.00 - 1.84	Lowest

Table 4.8 Level of knowledge about a solar rooftop

Knowledge Level Assessment	$\bar{X}$	SD.	Skewness	Kurtosis	Opinion Level
1. What is the level of your knowledge on the technical aspect and standards of a solar rooftop?	2.89	1.618	.446	-.798	Quite low
2. What is the level of your knowledge on the data of the investment capital for a solar rooftop?	2.87	1.634	.555	-.549	Quite low
3. What is the level of your knowledge on the rules and regulations from the government sector related to a solar rooftop?	2.65	1.572	.797	-.089	Low
4. What is the level of your knowledge on the efficiency and quality of equipment of a solar rooftop?	2.86	1.662	.601	-.588	Quite low
5. What is the level of your knowledge on the products and brands of the equipment of a solar rooftop?	2.55	1.616	.839	-.287	Low
Total	2.77	1.512	.640	-.471	Quite low

According to Table 4.8, the results of the assessment of the level of knowledge about a solar rooftop found that the respondents had an overall opinion ($\bar{X}$) = 2.77; SD = 1.512. When considering each item, the item with the highest mean was "What is the level of your knowledge on the technical aspect and standards of a solar rooftop?" ($\bar{X}$ = 2.89; SD = 1.618), followed by "What is the level of your knowledge on the data of the investment capital for a solar rooftop?" ($\bar{X}$ = 2.87; SD = 1.634), and the lowest item was "What is the level of your knowledge on the products and brands of the equipment of a solar rooftop?" ($\bar{X}$ = 2.55; SD = 1.616), respectively. Moreover, according to the normality examination from the analysis of all items to find the skewness and kurtosis, it was found that the data was with normality with skewness close to 1 and kurtosis ≤ 3 (Vanichbuncha, 2011). When considering all of the items, they met the required criteria.

4.3 Basic statistics of the variables

The questionnaires were used as the instrument to collect data of the indicators in the structural equation of factors influencing the intention to use solar rooftop energy of households in Thailand from the homeowners and their household members of 320 houses in five regions in the country. The data were collected in full as expected. The respondents' opinions were analyzed and presented by basic statistics, i.e., mean, SD, skewness, and kurtosis of the endogenous latent variable (intention to use), the mediator/intervening variable (attitude), and the exogenous latent variables (government policy, subjective norm, and perceived usefulness). A seven-point rating scale was used (Likert, 1972), and the mean values of the factors were interpreted (Tables 4.9-4.13).

4.3.1 Basic statistics of Intention to Use

The data in this research were collected and analyzed for the basic factors by finding the mean, SD, skewness, and kurtosis of the intention to use with the behavioral intention as the observed variable (Table 4.9).

Table 4.9 Basic statistics of Intention to Use

Intention to Use	$\overline{X}$	SD	Skewness	Kurtosis	Opinion Level
Behavioral Intention					
1. You are interested in installing a solar rooftop.	3.94	1.792	.000	-.873	Moderate
2. If you bought or built a new house, you would be interested in installing a solar rooftop.	4.59	1.815	-.346	-.930	Quite high
3. You intend to install solar rooftop on your house although it is not widely used.	4.07	1.859	-.034	-1.037	Moderate
4. You have an idea to install a solar rooftop in the near future.	3.62	1.549	.131	-.730	Moderate
Total	4.05	1.406	-.190	-.835	Moderate

From the results of Table 4.9, it could be implied that the respondents had opinions for the intention to use = 4.05; SD = 1.406. The mean of the scale was moderate or medium intention to use.

4.3.2 Basic statistics of Government Policy

The data in this research were collected and analyzed for the basic factors by finding the mean, SD, skewness, and kurtosis of the government policy with the three observed variables, i.e., 1) technological support, 2) economic support, and 3) regulatory support (Table 4.10).

Table 4.10 Basic statistics of Government Policy

Government Policy	$\overline{X}$	SD	Skewness	Kurtosis	Opinion Level
Technological Support	3.57	1.324	.101	-.655	Moderate
You now think that the government sector supports R&D in solar rooftops more than before.	3.66	1.573	.182	-.628	Moderate
You now think that the government sector continually initiates new innovations of solar rooftops through serious R&D support.	3.67	1.499	.083	-.567	Moderate
You now think that the government sector supports the knowledge exchange of solar rooftops for better development of such innovations.	3.60	1.400	.103	-.497	Moderate
You now think that the government sector clearly promotes educating each local area on the ability to a develop solar rooftop.	3.41	1.420	.184	-.620	Quite low

Table 4.10 (Continue)

Government Policy	$\bar{x}$	SD	Skewness	Kurtosis	Opinion Level
Economic Support	2.84	1.267	.495	-.159	Quite low
You now think that the government sector has a policy to help investment for your cost reduction to use a solar rooftop.	3.12	1.492	.487	-.193	Quite low
Now the government sector has measures to provide sufficient financial assistance and support so that you can use a solar rooftop.	2.82	1.384	.538	-.146	Quite low
Up until now, you have been satisfied with the assistance supported by the government sector, and this has partly made you feel interested in using a solar rooftop.	2.67	1.424	.796	.095	Low
You now think the government sector provide financial support and investment for the development of sample projects in your area to use a solar rooftop in order to make local inhabitants realize its usefulness and be interested in using one.	2.74	1.365	.529	-.173	Quite low
Regulatory Support	3.07	1.348	.331	-.524	Quite low
You now think that the government sector issues renewable energy laws that seriously support using a solar rooftop.	3.13	1.532	.397	-.507	Quite low

Table 4.10 (Continue)

Government Policy	$\bar{X}$	SD	Skewness	Kurtosis	Opinion Level
You now think the government sector issues concrete, clear, and simple rules and regulations to use a solar rooftop in order to promote it to be used widely.	3.00	1.400	.354	-.509	Quite low
You think that the current policy of the government sector on using a solar rooftop clearly includes inclusive regulations for both service providers and service users.	3.00	1.431	.398	-.395	Quite low
You think that the current policy of the government sector on using a solar rooftop focuses on seriously developing it as a national source of renewable energy with stability and sustainability.	3.14	1.551	.461	-.536	Quite low
Total	3.16	1.197	.301	-.344	Quite low

As can be seen in Table 4.10, the respondents had quite low opinions for government policy as a factor influencing the intention to use solar rooftop energy of households in Thailand ($\bar{X}$ = 3.16; SD = 1.197). When considering the components of the observed respectively, it was found that technological support had the highest mean ($\bar{X}$ = 3.57; SD = 1.324). The mean of the scale was moderate, followed by regulatory support ($\bar{X}$ = 3.07; SD = 1.348) with a mean of the scale being quite low. The last one was economic support ($\bar{X}$ = 2.84; SD = 1.267), and the mean of the scale was also quite low or they think there is low support by the government.

4.3.3 Basic statistics of Attitude

The data in this research was collected and analyzed for the basic factors by finding the mean, SD, skewness, and kurtosis of attitude with the three observed variables, i.e., 1) cognitive component, 2) affective component, and 3) behavioral component (Table 4.11).

Table 4.11 Basic statistics of Attitude

Attitude	$\overline{X}$	SD	Skewness	Kurtosis	Opinion Level
Cognitive Component	5.38	1.328	-.675	-.154	High
You agree that if a solar rooftop works, it would be good, and we should use it as much as possible to reduce household costs.	5.53	1.478	-.856	-.062	High
You agree to bring a solar rooftop for electricity generating in households in order to use solar energy, which is already available in nature.	5.61	1.488	-1.016	.419	High
In current situations, you think it is a suitable time to start using a solar rooftop.	5.08	1.506	-.415	-.522	Quite high
You believe using solar rooftop is a valuable form of energy consumption.	5.29	1.505	-.650	-.225	High
Affective Component	5.30	1.366	-.663	.019	High
You think a solar rooftop is interesting.	5.65	1.404	-.863	.105	High
If a solar rooftop is installed at your house, it would facilitate your better living.	5.04	1.514	-.551	-.197	Quite high

Table 4.11 (Continue)

Attitude	$\bar{X}$	SD	Skewness	Kurtosis	Opinion Level
You would feel impressed and proud if solar rooftop were used at your house.	5.21	1.622	-.711	-.268	Quite high
Behavioral Component	5.15	1.500	-.771	.181	Quite high
You intend to use a solar rooftop rather than other types of renewable energy, e.g., wind energy or waste energy, etc. for a better quality of life.	5.13	1.673	-.714	-.163	Quite high
You intend to use a solar rooftop at your house parallel to the power transmitted from the electricity authorities as usual.	5.08	1.641	-.701	-.202	Quite high
If you were free to choose electricity from any sources, you would choose to use a solar rooftop at your house.	5.24	1.642	-.802	.091	Quite high
Total	5.28	1.299	-.678	-.029	Quite high

Table 4.11 implied that the respondents had quite high opinions for attitude as a factor influencing the intention to use solar rooftop energy of households in Thailand ($\bar{X}$ = 5.28; SD = 1.299). When considering the components of the observed variables respectively, it was found that cognitive component had the highest mean ($\bar{X}$ = 5.38; SD = 1.328) with a high mean of the scale. This was followed by affective component ($\bar{X}$ = 5.30; SD = 1.366), which also had a high mean of the scale, and the last one was behavioral component ($\bar{X}$ = 5.15; SD = 1.500) with a mean of the scale that was quite high or they feel high interest in using solar rooftop.

4.3.4 Basic statistics of Subjective Norm

The data in this research was collected and analyzed for the basic factors by finding the mean, SD, skewness, and kurtosis of subjective norm with the three observed variables, i.e., 1) social pressure, 2) normative belief, and 3) motivation to comply with the referent (Table 4.12).

Table 4.12 Basic statistics of Subjective Norm

Subjective Norm	$\overline{X}$	SD	Skewness	Kurtosis	Opinion Level
Social Pressure	4.11	1.430	-.140	-.434	Moderate
Acceptance from neighboring houses is a key factor influencing you to choose a solar rooftop.	3.79	1.851	-.052	-1.061	Moderate
Acceptance from friends is a key factor influencing you to choose a solar rooftop.	3.55	1.823	.189	-.985	Quite low
Acceptance from family members is a key factor influencing you to choose a solar rooftop.	4.80	1.665	-.572	-.401	Quite high
Solar rooftop ads through media, e.g., TV, magazines, or social networks would make you interested in using a solar rooftop.	4.30	1.743	-.324	-.823	Moderate
Normative Belief	4.35	1.413	-.374	-.208	Moderate
You give priority to decision-making from family members on using a solar rooftop.	4.98	1.606	-.606	-.151	Quite high
You give priority to decision-making from friends on using a solar rooftop.	3.70	1.764	.072	-.944	Moderate
You would use a solar rooftop as suggested by influential persons in your life.	4.37	1.691	-.371	-.587	Moderate

Table 4.12 (Continue)

Subjective Norm	$\bar{X}$	SD	Skewness	Kurtosis	Opinion Level
Motivation to Comply with the Referent	4.09	1.417	-.258	-.351	Moderate
If your family members wanted you to install a solar rooftop, you would do so accordingly.	4.85	1.621	-.602	-.216	Quite high
If your friends convinced you to install a solar rooftop, you would do so accordingly.	4.00	1.759	-.112	-.883	Moderate
If your favorite persons, e.g., successful businessmen or artists installed a solar rooftop, you would follow them.	3.42	1.678	.154	-.825	Quite low
Total	4.18	1.305	-.351	-.150	Moderate

According to Table 4.12, it implied that the respondents had moderate opinions for subjective norm as a factor influencing the intention to use solar rooftop energy of households in Thailand ($\bar{X}$ = 4.18; SD = 1.305). When considering the components of the observed variables respectively, it was found that normative belief had the highest mean ($\bar{X}$ = 4.35; SD = 1.413) with a moderate mean of the scale. This was followed by social pressure ($\bar{X}$ = 4.11; SD = 1.430) and then motivation to comply with the referent ($\bar{X}$ = 4.09; SD = 1.417), which both also had a moderate mean of the scale or their tendency to follow other people are medium.

4.3.5 Basic statistics of Perceived Usefulness

The data in this research was collected and analyzed for the basic factors by finding the mean, SD, skewness, and kurtosis of perceived usefulness with the three observed variables, i.e., 1) personal benefit, 2) environmental benefit, and 3) awareness of the cost reduction (Table 4.13).

Table 4.13 Basic statistics of Perceived Usefulness

Perceived Usefulness	$\bar{x}$	SD	Skewness	Kurtosis	Opinion Level
Personal Benefit	4.94	1.403	-.444	-.260	Quite high
You think using a solar rooftop could fulfill your need of daily electricity.	4.78	1.541	-.396	-.484	Quite high
You would use a solar rooftop for generating electricity if it facilitated your life more.	5.00	1.535	-.463	-.404	Quite high
You would use a solar rooftop for generating electricity if it gave you a better quality of life.	5.04	1.558	-.517	-.424	Quite high
Environmental Benefit	5.61	1.253	-.844	.217	High
You think a solar rooftop helps reduce air pollution due to that Thais are generating electricity. It is mostly caused by the combustion of coal and natural gas.	5.55	1.439	-.923	.323	High
You think a solar rooftop is clean and eco-friendly energy.	5.66	1.386	-.952	.317	High
You believe using s solar rooftop helps reduce environmental pollution and global warming.	5.61	1.338	-.959	.687	High
You believe a solar rooftop could be used as a source of electricity in the future.	5.61	1.391	-1.042	.809	High

Table 4.13 (Continue)

Perceived Usefulness	$\bar{X}$	SD	Skewness	Kurtosis	Opinion Level
Awareness of the Cost Reduction	4.98	1.407	-.500	-.181	Quite high
You believe using a solar rooftop helps reduce your electricity cost.	5.45	1.510	-.848	.186	High
For you, using a solar rooftop is a valued investment despite the high capital of investment and long period of return.	4.68	1.626	-.371	-.480	Quite high
You believe solar rooftop installation is a good form of financial investment to reduce your household costs.	4.82	1.579	-.490	-.228	Quite high
Total	5.18	1.188	-.550	-.039	Quite high

As seen from the results in Table 4.13, the respondents had quite high opinions for perceived usefulness as a factor influencing the intention to use solar rooftop energy of households in Thailand ($\bar{X}$ = 5.18; SD = 1.188). When considering the components of the observed variables respectively, it was found that environmental benefit had the highest mean ($\bar{X}$ = 5.61; SD = 1.253) with a high mean of the scale. This was followed by awareness of the cost reduction ($\bar{X}$ = 4.98; SD = 1.407) and personal benefit ($\bar{X}$ = 4.94; SD = 1.403), which both had quite a high mean of the scale or they believe that the benefits from solar rooftop are an important factor for them to use solar rooftop.

According to the factor analysis, i.e., government policy, subjective norm, perceived usefulness, attitude, and intention to use by finding the mean, SD, and normality examination of the data from 320 samples, as well as the data analysis of all items to find the skewness and kurtosis, it was found that the data were with good normality with skewness close to 1 and kurtosis ≤ 3 (Vanichbuncha, 2011). When considering all of the items, it was found that they were under the required criteria.

In addition, the respondents made some additional comments as follows:

The government sector should provide information support and promote low-priced tools as well as equipment with a good and reasonable energy storage system. The power distribution and transmission system should also be developed for more stability because several countries with increasing renewable energy are having stability problems from intermittency from renewable energy.

The government sector should drive or support campaigns of using electricity from solar rooftop in households more seriously. For example, announcing public relations campaigns or advertisements to the people for their acknowledgement, holding activities of promoting basic knowledge on solar rooftops to the general public, promoting campaigns of solar rooftop utilization, showing the motivation of the government sector to purchase electricity from solar rooftop users, and setting taxation measures and compulsory measures such as to use a solar rooftop for new buildings.

However, using renewable energy, particularly solar energy, is advantageous because it reduces burning fossil fuel to generate electricity and global warning, as well as increases income for solar rooftop users. In general, the lifetime of solar panels will last for 20-25 years, which can make it feasible for investment. However, in long term, the deterioration of the equipment would cause more industrial waste, e.g., toxic waste from expired solar panels, batteries and accessories. Therefore, precaution measures and good planning are necessary to be prepared in advance together with development of innovation for more efficient equipment and safer disposal.

4.4 Analysis of the relationship between the variables

The analysis of the relationship between the variables was conducted by analyzing Pearson's correlation (Pearson's Product-Moment Correlation Coefficient: PPMCC) between the factors in order to find their relationship and to consider the possible problems that might occur due to excessive multicollinearity.

4.4.1 Correlation

According to the correlation analysis or bivariate correlation analysis of the factors mentioned in the model (Table 4.14), it was found that the correlation was between -0.006 and 0.843. When considering each pair of the relationship, there were two pairs with high correlation between regulatory support and economic support (0.827), and between affective component

behavioral component (0.843). Nevertheless, as this relationship of both pairs was the observed variable of the same latent variable, there was no problems of multicollinearity. For other indicators, there was no high relationships with each other (Puangrat, 1997).

Table 4.14 Correlation

	GP1	GP2	GP3	AT1	AT2	AT3	PU1	PU2	PU3	SN1	SN2	SN3	IT
Technological (GP1)	1												
Economic (GP2)	.723**	1											
Regulatory (GP3)	.689**	.827**	1										
Cognitive (AT1)	.091	.022	.029	1									
Affective (AT2)	.099	.049	.046	.799**	1								
Behavioral (AT3)	.139*	.120	.096	.743**	.843**	1							
Personal (PU1)	.108	.064	.049	.652**	.706**	.714**	1						
Environmental (PU2)	.040	-.039	-.006	.735**	.625**	.659**	.603**	1					
Awareness (PU3)	.098	.087	.045	.644**	.708**	.697**	.717**	.634**	1				
Social (SN1)	.227**	.244**	.192**	.350**	.513**	.542**	.475**	.343**	.487**	1			
Belief (SN2)	.182**	.223**	.197**	.349**	.440**	.490**	.502**	.366**	.457**	.776**	1		
Motivation (SN3)	.181**	.181**	.195**	.425**	.548**	.604**	.595**	.427**	.580**	.733**	.791**	1	
Intention (IT)	.442**	.326**	.334**	.558**	.631**	.609**	.562**	.432**	.536**	.350**	.393**	.468**	1

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

4.4.2 KMO and Bartlett's Test

The Kaiser – Meyer – Olkin (KMO) test is a statistic to measure whether or not the data should be examined for the congruence between the conceptual framework and the empirical data. Bartlett's test of sphericity is a statistic for testing the hypothesis on the relationship between the variables. If the KMO is close to 1, it means the factor analysis is suitable for the available data. Bartlett's test of sphericity is significant when $p \leq 0.05$ (Vanichbuncha, 2011). According to the analysis results (Table 4.15), it was found that the KMO = 0.875 and Bartlett's test of sphericity was significant (Sig. = .000; which is less than 0.05). This inferred that the factors suited the data and were not related to each other.

Table 4.15 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.875
Bartlett's Test of Sphericity	Approx. Chi-Square	3620.817
	df	120
	Sig.	.000

4.5 Confirmatory factor analysis

In this research, the researcher reviewed the related literature to develop a conceptual framework, which was further developed into a model and displayed the relationship between the variables. The data were collected to assess the empirical data and the measurement model based on the theories from the literature review. Specifically, measurement model analysis by confirmatory factor analysis (CFA) was conducted to test the relationship between the latent and observed variables, as well as between the exogenous latent and endogenous latent variables (Praitrattasin, 2008). This was congruent with the conceptual framework. The model fit was examined by maximum likelihood estimation (MLE) in the measurement model analysis of each factor in order to examine if the studied factors could be measured by many observed variables. The researcher applied reflective analysis to the factors. The goodness of fit measure (GFM) was brought for examination based on the consideration of the standard criteria (Table 4.16).

Table 4.16 Statistics for the goodness of fit measure

Statistic	Symbol	Criterion
Chi-square	χ^2	Not significant (p > .05)
Relative Chi-square	χ^2 /df	χ^2 /df < 2.00
Goodness of Fit Index	GFI	>.90
Comparative Fit Index	CFI	>.95
Adjusted Goodness of Fit Index	AGFI	>.90
Normal Fit Index	NFI	>.90
Root Mean Square Error of Approximation	RMSEA	<.08

Source: Hair et al., 2010; Joreskog and Sorbom, 1989; Schumacker and Lomax, 2010.

First order confirmatory factor analysis and composite reliability

The research tested indicators or observed variable of each factor by confirmatory factor analysis. It was found that all indicators are suitable. Then the researcher tested the goodness of fit by using first order confirmatory factor analysis to analyze the relationship between exogenous latent variables and endogenous latent variables. The first order confirmatory factor analysis to test the construct validity and construct reliability of Government Policy is consisted of Technological Support, Economic Support, Regulatory Support. For Subjective Norm, the analysis is consisted of Social Pressure, Normative Belief, Motivation to comply with the referent. For Attitude, the analysis is consisted of Cognitive Component, Affective Component, Behavioral Component. For Perceived Usefulness, the analysis is consisted of Personal Benefit, Environmental Benefit, Awareness of cost reduction. The criteria of the test are the following:

1. Standard Regression Weight should be more than 0.4 (λ>0.4) statistically significance. (Fornell & Larcker, 1981, Hair et al., 2010)
2. Average Variable Extracted: AVE (ρ_v) is more than 0.5. (ρ_v>0.5)
3. Composite Reliability: CR (ρ_c) is more than 0.6. (ρ_c>0.6)

The researcher then analyzed all observed variables and latent variables with the result as shown in Table 4.17 and Figure 4.1-4.2.

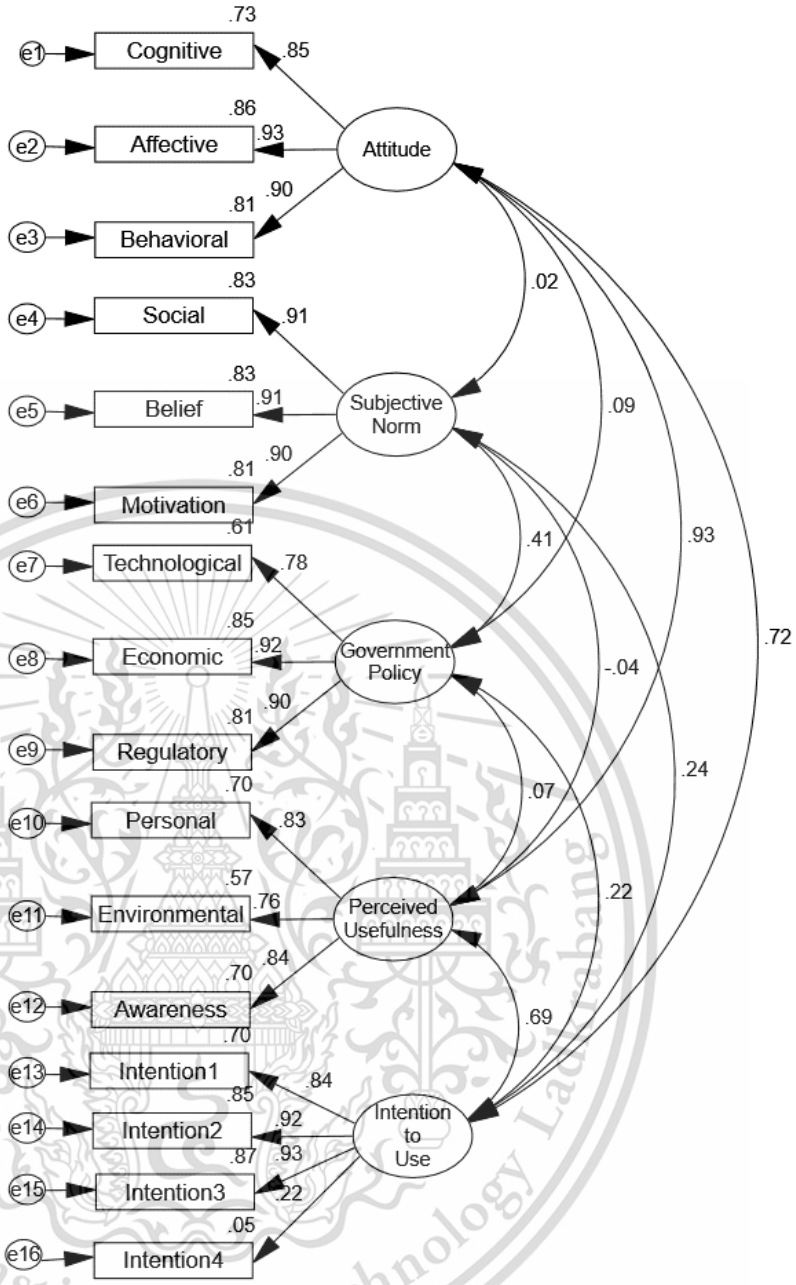
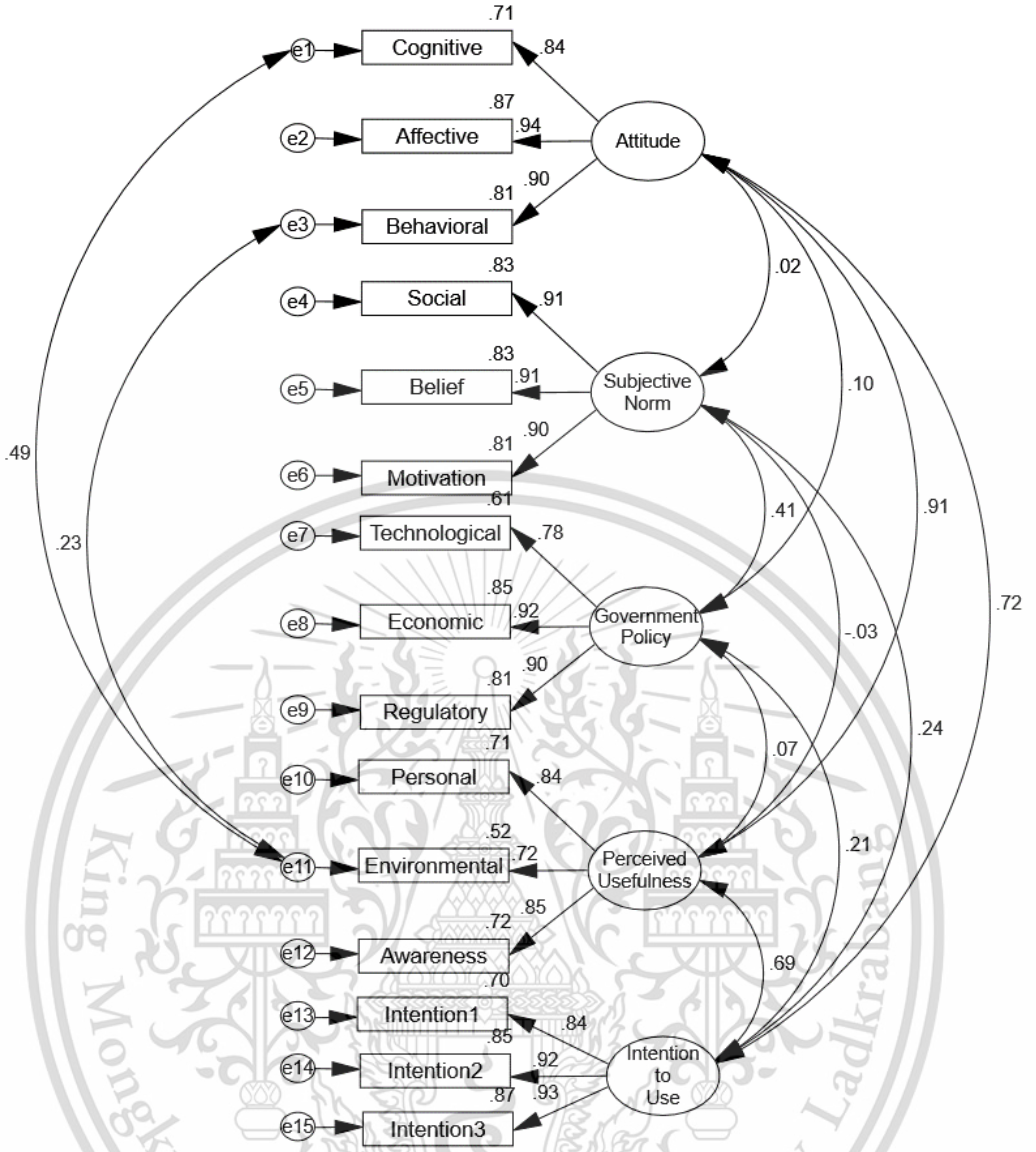


Figure 4.1 First order confirmatory factor analysis – before adjustment

According to Figure 4.1, the analysis results shows that the standard regression weight of intention 4 is 0.22, which is lower than the standard (λ>0.4) and R^2 <0.2. therefore, the researcher removed Intention 4 (Hair et al., 2010) and adjusted the model (Table 4.17 and Figure 4.2).

Table 4.17 Composite Reliability

Observed variables	Standard Regression Weight (λ)	Average Variable Extracted (AVE or ρ_v)	Composite Reliability (CR or ρ_c)
Intention to Use		0.808	0.926
- Intention 1	0.838		
- Intention 2	0.921		
- Intention 3	0.934		
Government Policy		0.753	0.901
- Technological	0.780		
- Economic	0.920		
- Regulatory	0.897		
Attitude		0.798	0.922
- Cognitive	0.843		
- Affective	0.935		
- Behavioral	0.899		
Subjective Norm		0.825	0.934
- Social	0.909		
- Belief	0.914		
- Motivation	0.902		
Perceived Usefulness		0.652	0.849
- Personal	0.844		
- Environmental	0.724		
- Awareness	0.849		



Chi-square (χ^2) =96.871, df = 78, CMIN/DF (χ^2 /df) = 1.242, GFI=.951, CFI=.994, AGFI=.925, NFI=.970, and RMSEA= .031

Figure 4.2 First order confirmatory factor analysis – after adjustment

As can be seen from Table 4.17, the examination result found that the standard regression weight of Intention to Use was between 0.838-0.934 which met criteria (λ>0.4). AVE or ρ_v was 0.808 which met criteria (ρ_v>0.5) and CR or ρ_c was 0.926 which suitable as it is more than 0.6 (ρ_c>0.6). Therefore, it could be concluded that Intention 1, Intention 2, and Intention 3 passed the first order confirmatory factor analysis and composite reliability test.

The examination result found that the standard regression weight of Government Policy was between 0.780-0.920 which met criteria (λ>0.4). AVE or ρ_v was 0.753 which met criteria

(ρ_v>0.5) and CR or ρ_c was 0.901 which suitable as it is more than 0.6 (ρ_c>0.6). Therefore, it could be concluded that Technological Support, Economic Support, and Regulatory Support passed the first order confirmatory factor analysis and composite reliability test.

The examination result found that the standard regression weight of Attitude was between 0.843-0.935 which met criteria (λ>0.4). AVE or ρ_v was 0.798 which met criteria (ρ_v>0.5) and CR or ρ_c was 0.922 which suitable as it is more than 0.6 (ρ_c>0.6). Therefore, it could be concluded that Cognitive Component, Affective Component, Behavioral Component passed the first order confirmatory factor analysis and composite reliability test.

The examination result found that the standard regression weight of Subjective Norm was between 0.902-0.914 which met criteria (λ>0.4). AVE or ρ_v was 0.825 which met criteria (ρ_v>0.5) and CR or ρ_c was 0.934 which suitable as it is more than 0.6 (ρ_c>0.6). Therefore, it could be concluded that Social Pressure, Normative Belief, Motivation to Comply with the Referent passed the first order confirmatory factor analysis and composite reliability test.

The examination result found that the standard regression weight of Perceived Usefulness was between 0.724-0.849 which met criteria (λ>0.4). AVE or ρ_v was 0.652 which met criteria (ρ_v>0.5) and CR or ρ_c was 0.849 which suitable as it is more than 0.6 (ρ_c>0.6). Therefore, it could be concluded that Personal Benefit, Environmental Benefit, Awareness of Cost Reduction passed the first order confirmatory factor analysis and composite reliability test.

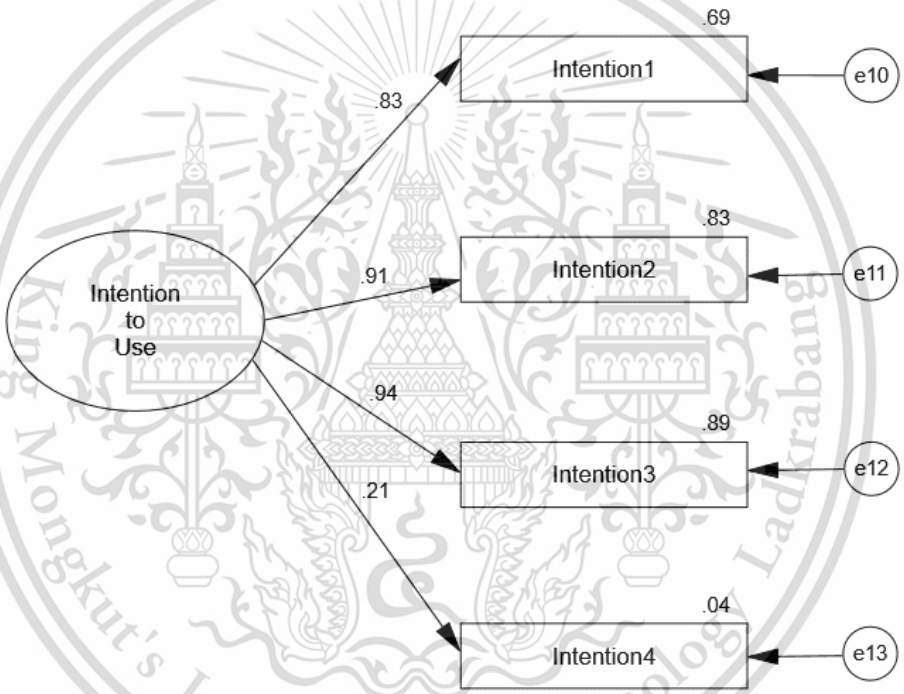
Then the research analyzed the measurement model by Confirmatory Factor Analysis (CFA) to test the relationship between the latent variables and observed variable.

4.5.1 Intention to Use

Intention to Use consisted of the behavioral intention as an observed variable. The scale included four items that were analyzed to examine if all of the items could measure the Intention to Use. The analysis results are displayed in Table 4.18 and Figure 4.3.

Table 4.18 Analysis of the Intention to Use Model

Measurement Model			Standard Regression Weight	S.E.	Squared Multiple Correlation	C.R.	p
Intention1	<---	Intention to Use	.832	.044	.692	19.179	***
Intention2	<---	Intention to Use	.914	.040	.835	23.388	***
Intention3	<---	Intention to Use	.944		.891		
Intention4	<---	Intention to Use	.205	.057	.042	3.196	.001



Chi-square(χ^2) = 1.918, df = 2, CMIN/DF(χ^2 /df) = .959, p =.383, GFI = .996, CFI = 1.000, AGFI = .981, NFI = .997, and RMSEA = .000.

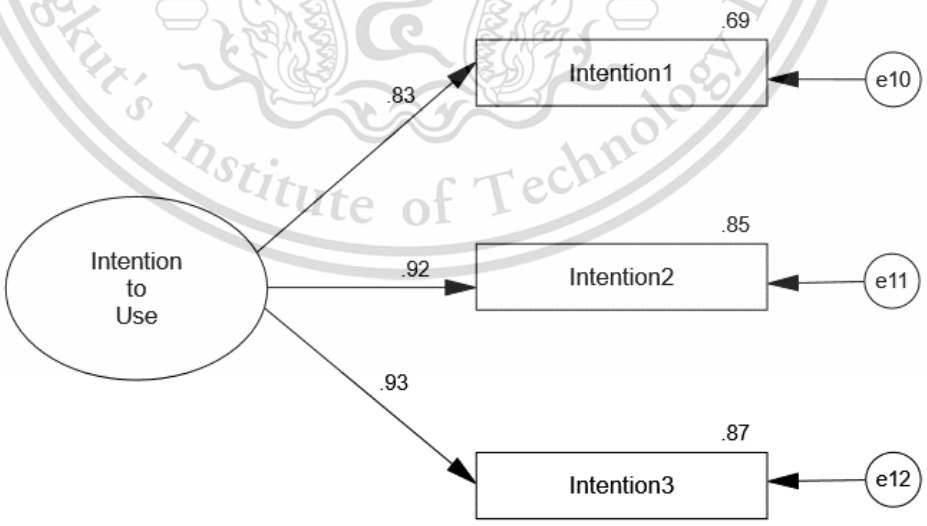
Figure 4.3 Confirmatory factor analysis of the Intention to Use

As seen in Table 4.18 and Figure 4.3, the analysis results of the Intention to Use model found that the Chi-square(χ^2) = 1.918, df = 2, CMIN/DF(χ^2 /df) = .959, p =.383, GFI = .996, CFI = 1.000, AGFI = .981, NFI = .997, and RMSEA = .000 with a model fit. For the weight test, 1) Intention 1 had a standard regression weight = 0.832 and R^2 (Squared Multiple Correlations) =

0.692. 2) Intention 2 had a standard regression weight = 0.914 and R^2 = 0.835. 3) Intention 3 had a standard regression weight = 0.944 and R^2 = 0.891. 4) Intention 4 had a standard regression weight = 0.205 and R^2 = 0.042. The CR of all factors showed | t | $\geq$ 1.96, but Intention 4 had a low standard regression weight and R^2 < 0.2. Therefore, the researcher removed Intention 4 (Hair et al., 2010) and adjusted the model (Table 4.19 and Figure 4.4). The analysis results of the adjusted Intention to Use Model found that the Chi-square (χ^2) = 1.737, df = 1, CMIN/DF(χ^2 /df) = 1.737, p = .188, GFI = .995, CFI = .999, AGFI = .972, NFI = .997, and RMSEA = .054 with a model fit. For the weight test, 1) Intention 1 had a standard regression weight = 0.832 and R^2 = 0.692. 2) Intention 2 had a standard regression weight = 0.925 and R^2 = 0.855. 3) Intention 3 had a standard regression weight = 0.934 and R^2 = 0.872. The CR of all factors showed | t | $\geq$ 1.96. Therefore, it could be concluded that Intention 1, Intention 2, and Intention 3 had suitable reliability (Hair et al., 2010).

Table 4.19 Adjusted Intention to Use Model

Measurement Model			Standard Regression Weight	S.E.	Squared Multiple Correlation	C.R.	p
Intention1	<---	Intention to Use	.832	.042	.692	20.620	***
Intention2	<---	Intention to Use	.925		.855		
Intention3	<---	Intention to Use	.934		.872		



Chi-square(χ^2) = 1.737, df = 1, CMIN/DF(χ^2 /df) = 1.737, p = .188, GFI = .995, CFI = .999, AGFI = .972, NFI = .997, and RMSEA = .054.

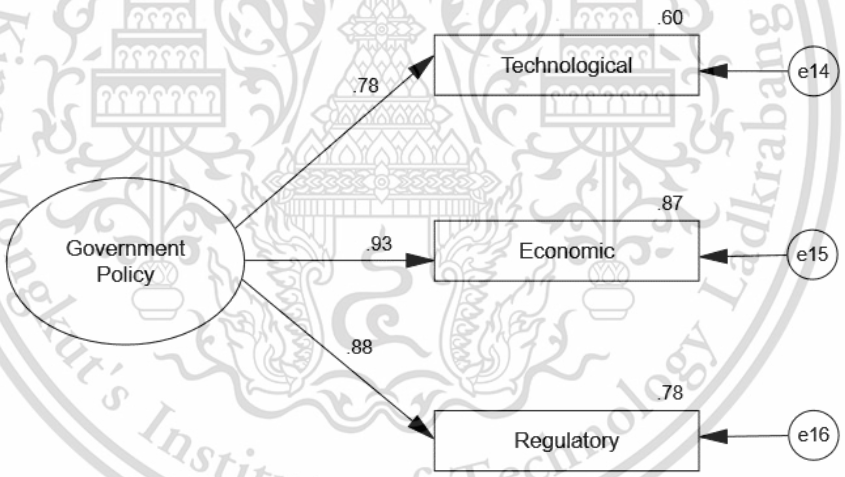
Figure 4.4 Adjusted Intention to Use Model

4.5.2 Government Policy

The Government Policy consisted of the three observed variables, i.e., 1) technological support, 2) economic support, and 3) regulatory support. These variables were analyzed to examine if all of them could measure the Government Policy. The analysis results are displayed in Table 4.20 and Figure 4.5.

Table 4.20 Analysis of the Government Policy Model

Measurement Model	Standard Regression Weight	S.E.	Squared Multiple Correlation	C.R.	p
Technological <-- Government Policy	.776	.051	.602	16.839	***
Economic <-- Government Policy	.934		.873		
Regulatory <-- Government Policy	.884		.781		



Chi-square(χ^2) = .056, df = 1, CMIN/DF(χ^2 /df) = .056, p = .813, GFI = 1.000, CFI = 1.000, AGFI = .999, NFI = 1.000 and RMSEA = .000.

Figure 4.5 Confirmatory factor analysis of Government Policy

As shown in Table 4.20 and Figure 4.5, the analysis results of the Government Policy found that the Chi-square(χ^2) = .056, df = 1, CMIN/DF(χ^2 /df) = .056, p = .813, GFI = 1.000, CFI = 1.000, AGFI = .999, NFI = 1.000, and RMSEA = .000 with a model fit. For the weight test,

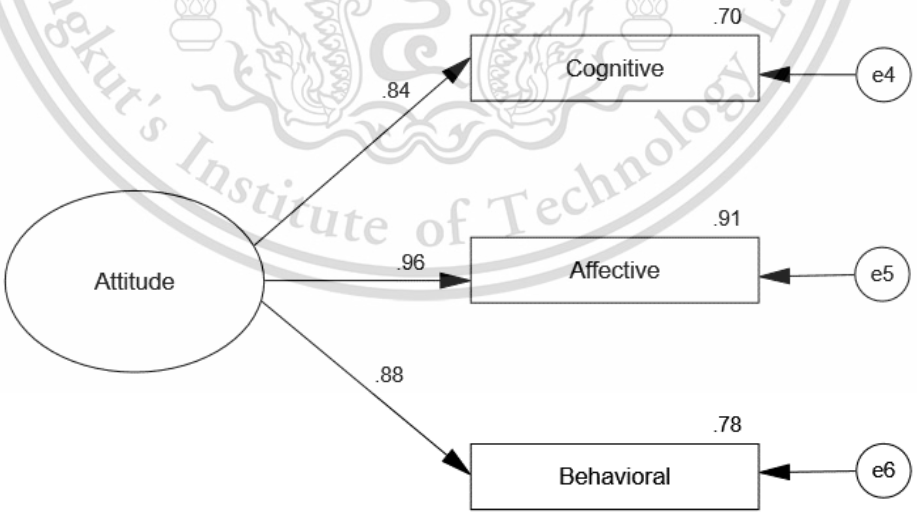
1) Technological Support had a standard regression weight = 0.776 and R^2 = 0.602. 2) Economic Support had a standard regression weight = 0.934 and R^2 = 0.873. 3) Regulatory Support had a standard regression weight = 0.884 and R^2 = 0.781. The CR of all factors showed $|t| \geq 1.96$. Therefore, it could be concluded that Technological Support, Economic Support, and Regulatory Support had suitable reliability (Hair et al., 2010).

4.5.3 Attitude

Attitude consisted of the three observed variables, i.e., 1) Cognitive Component, 2) Affective Component, and 3) Behavioral Component. These variables were analyzed to examine if all of them could measure Attitude. The analysis results are displayed in Table 4.21 and Figure 4.6.

Table 4.21 Analysis of the Attitude Model

Measurement Model	Standard Regression Weight	S.E.	Squared Multiple Correlation	C.R.	p
Behavioral <--- Attitude	.881		.776		
Cognitive <--- Attitude	.837	.041	.701	20.684	***
Affective <--- Attitude	.955		.913		



Chi-square(χ^2) =.209, df = 1, CMIN/DF(χ^2 /df) = .209, p = .648, GFI = .999, CFI = 1.000, AGFI = .997, NFI = 1.000, and RMSEA = .000.

Figure 4.6 Confirmatory factor analysis of Attitude

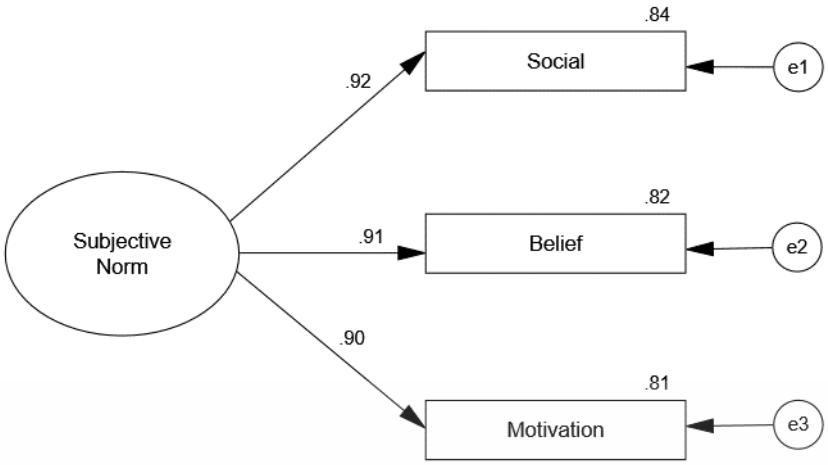
According to Table 4.21 and Figure 4.6, the analysis results of attitude found that the Chi-square(χ^2) =.209, df = 1, CMIN/DF(χ^2 /df) = .209, p = .648, GFI = .999, CFI = 1.000, AGFI = .997, NFI = 1.000, and RMSEA = .000 with a model fit. For the weight test, 1) Cognitive Component had a standard regression weight = 0.837 and R^2 = 0.701. 2) Affective Component had a standard regression weight = 0.955 and R^2 = 0.913. 3) Behavioral Component had a standard regression weight = 0.881 and R^2 = 0.776. The CR of all factors showed $|t| \geq 1.96$. Therefore, it could be concluded that Cognitive Component, Affective Component, and Behavioral Component had suitable reliability (Hair et al., 2010).

4.5.4 Subjective Norm

Subjective norm consisted of the three observed variables, i.e., 1) Social Pressure, 2) Normative Belief, and 3) Motivation to Comply with the Referent. These variables were analyzed to examine if all of them could measure Subjective Norm. The analysis results are displayed in Table 4.22 and Figure 4.7.

Table 4.22 Analysis of the Subjective Norm Model

Measurement Model			Standard Regression Weight	S.E.	Squared Multiple Correlation	C.R.	p
Social	<---	Subjective Norm	.918		.842		
Belief	<---	Subjective Norm	.908		.825		
Motivation	<---	Subjective Norm	.899	.039	.808	24.920	***



Chi-square(χ^2) = .090, df = 1 CMIN/DF(χ^2 /df) = .090, p = .764, GFI = 1.000, CFI = 1.000, AGFI = .999, NFI = 1.000, and RMSEA = .000.

Figure 4.7 Confirmatory factor analysis of Subjective Norm

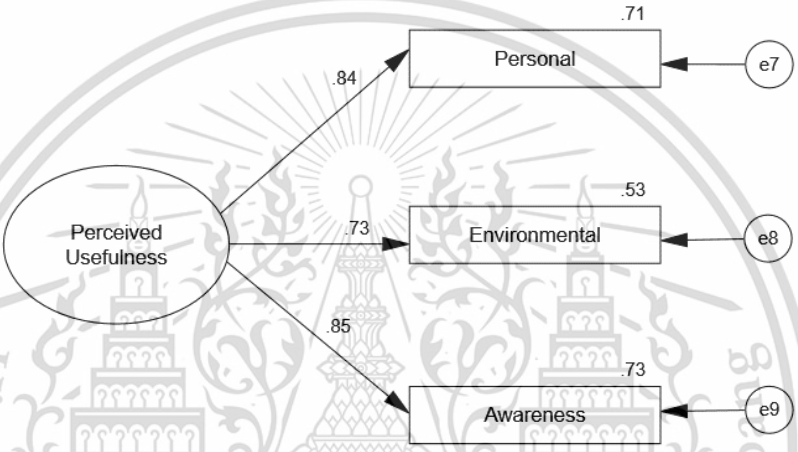
As can be seen in Table 4.22 and Figure 4.7, the analysis results of the Subjective Norm found that the Chi-square(χ^2) =.090, df = 1 CMIN/DF(χ^2 /df) =.090, p = .764, GFI = 1.000, CFI = 1.000, AGFI = .999, NFI = 1.000, and RMSEA = .000 with a model fit. For the weight test, 1) Social Pressure had a standard regression weight = 0.918 and R^2 = 0.842. 2) Normative Belief had a standard regression weight = 0.908 and R^2 = 0.825. 3) Motivation to Comply with the Referent had a standard regression weight = 0.899 and R^2 = 0.808. The CR of all factors showed $|t| \geq 1.96$. Therefore, it could be concluded that Social Pressure, Normative Belief, and Motivation to Comply with the Referent had suitable reliability (Hair et al., 2010).

4.5.5 Perceived Usefulness

Perceived Usefulness consisted of three observed variables, i.e., 1) Personal Benefit, 2) Environmental Benefit, and 3) Awareness of the Cost Reduction. These variables were analyzed to examine if all of them could measure Perceived Usefulness. The analysis results are displayed in Table 4.23 and Figure 4.8.

Table 4.23 Analysis of the Perceived Usefulness Model

Measurement Model		Standard Regression Weight	S.E.	Squared Multiple Correlation	C.R.	p
Awareness	<-- Perceived Usefulness	.855		.730		
Personal	<-- Perceived Usefulness	.840		.705		
Environmental	<-- Perceived Usefulness	.731	.058	.534	13.365	***



Chi-square(χ^2) = .489, df = 1, CMIN/DF(χ^2 /df) = .489, p = .484, GFI = .999, CFI = 1.000, AGFI = .992, NFI = .999, and RMSEA = .000.

Figure 4.8 Confirmatory factor analysis of Perceived Usefulness

According to Table 4.23 and Figure 4.8, the analysis results of Perceived Usefulness found that the Chi-square(χ^2) =.489, df = 1, CMIN/DF(χ^2 /df) = .489, p = .484, GFI = .999, CFI = 1.000, AGFI = .992, NFI = .999, and RMSEA = .000 with a model fit. For the weight test, 1) Personal Benefit had a standard regression weight = 0.840 and R^2 = 0.705. 2) Environmental Benefit had a standard regression weight = 0.731 and R^2 = 0.534. 3) Awareness of the Cost Reduction had a standard regression weight = 0.855 and R^2 = 0.730. The CR of all factors showed $|t| \geq 1.96$. Therefore, it could be concluded that Personal Benefit, Environmental Benefit, and Awareness of the Cost Reduction had suitable reliability (Hair et al., 2010).

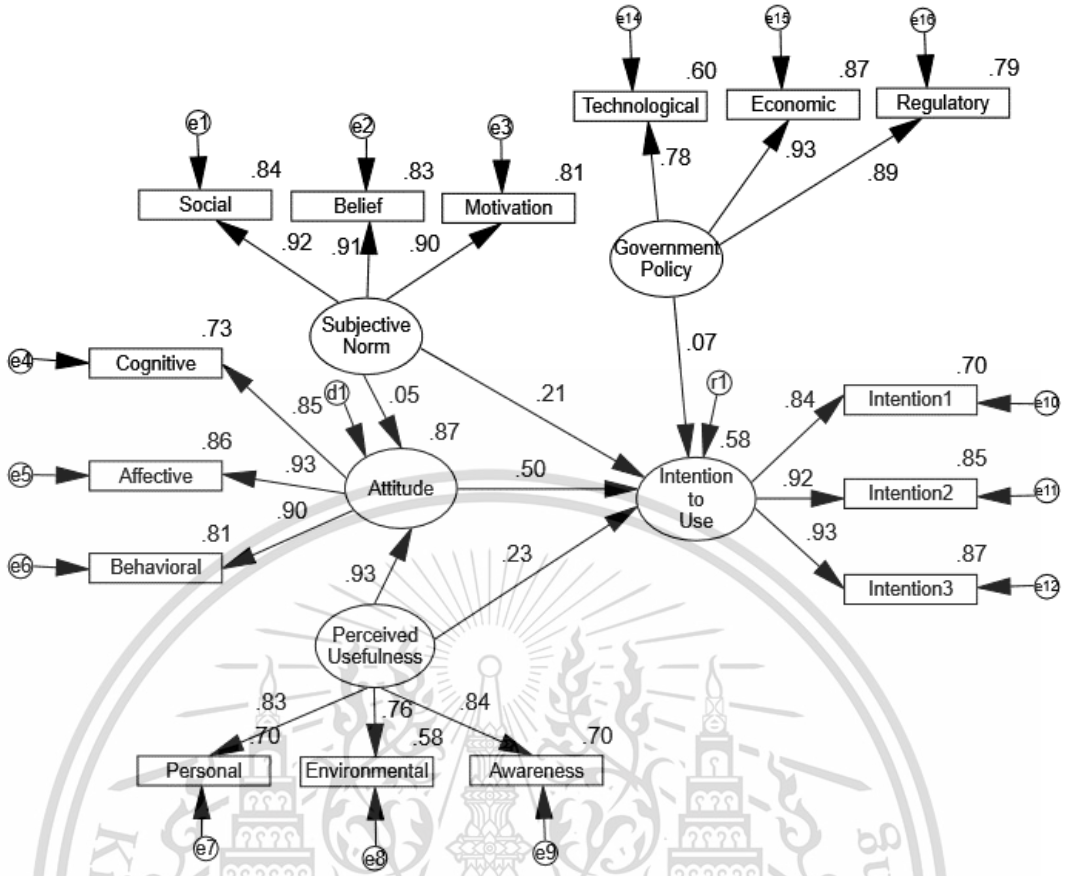
4.6 Analysis of the Structural Equation Model

The researcher analyzed and tested the structural equation of the factors influencing the intention to use solar rooftop energy of households in Thailand in order to test the model according to the set conceptual framework based on the literature review. The structural equation model (SEM) was analyzed by the model fit examination, in which the empirical data was collected from the samples of homeowners and household members in houses exposed to sunlight. The relationship of the endogenous latent variable was also examined, i.e., intention to use, which consisted of the behavioral intention as an observed variable. There were three items of the indicators. Attitude, the mediator/intervening variable, consisted of three observed variables, i.e., 1) cognitive component, 2) affective component, and 3) behavioral component. Government policy, an exogenous latent variable, consisted of three observed variables, i.e., 1) technological support, 2) economic support, and 3) regulatory support. Subjective norm, an exogenous latent variable, consisted of three observed variables, i.e., 1) social pressure, 2) normative belief, and 3) motivation to comply with the referent. Last of all, perceived usefulness, an exogenous latent variable, consisted of three observed variables, i.e., 1) personal benefit, 2) environmental benefit, and 3) awareness of the cost reduction. The analysis was also to find the standardized regression coefficient, hypothesis test, and effect size of the factors influencing the intention to use solar rooftop energy of households in Thailand. This was implemented as follows:

1. The relationship between the variables obtained from the literature review was connected. Then, the data of the structural equation was analyzed, followed by the hypothesis test, and finding the effect size by using the statistical programs.

2. After the data analysis, the results were considered by standard regression weight, which should be ≥ 0.5 (Fornell and Larcker, 1981). If less than the required weight, that observed variable was removed and analyzed again. Then, the CR was examined and $|t| \geq 1.96$ (Hair et al., 2010) showing significance and that model fit met the standard criteria (Table 4.15).

3. The model fit was examined. If not in compliance with the standard criteria, the modification index must be considered as suggested by the program. Then, the analysis was repeated until the model fit met the standard criteria before concluding its suitability.



Chi-square(χ^2) = 185.143, df = 84, CMIN/DF(χ^2 /df) = 2.204, p = .000, GFI = .914, CFI = .968, AGFI = .877, NFI = .943, and RMSEA = .070.

Figure 4.9 Analysis results of the model before adjustment

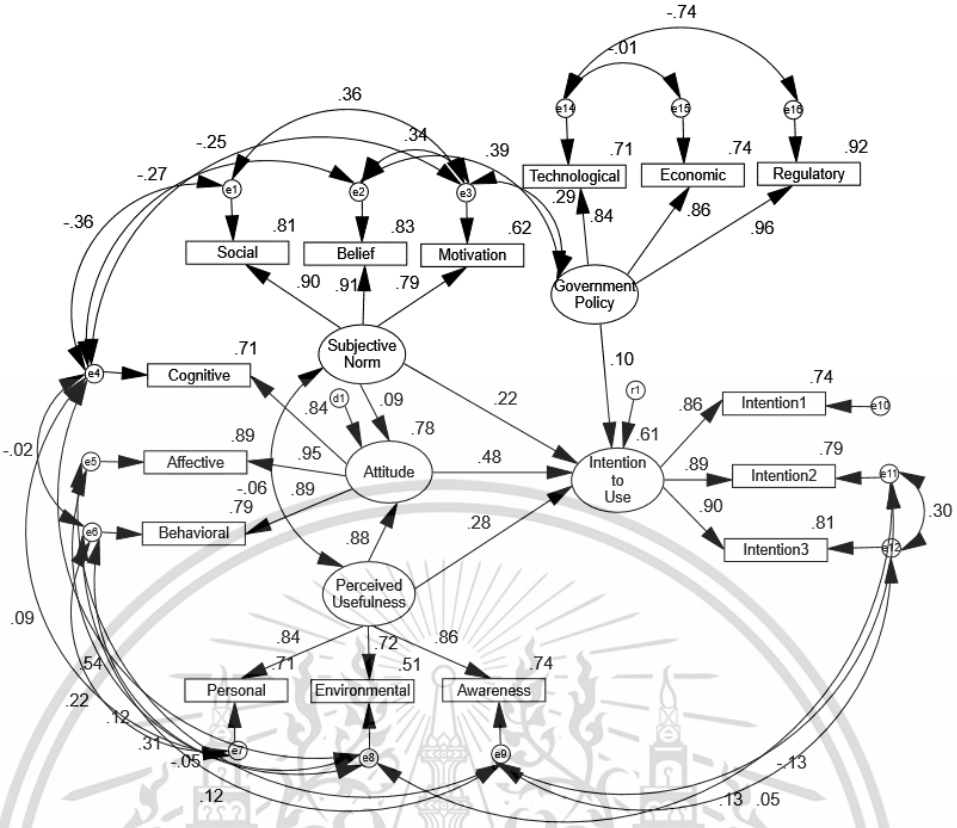
According to Figure 4.9, the analysis results of the model fit found that the Chi-square (χ^2) = 185.143, df = 84, CMIN/DF(χ^2 /df) = 2.204, p = .000, GFI = .914, CFI = .968, AGFI = .877, NFI = .943, and RMSEA = .070. No significance (0.05) was found for the model (Table 4.24). When considering the standard regression weight and variance rate (R^2 or Squared Multiple Correlation), they met the standard criteria (Fornell and Larcker, 1981). Therefore, the observed variables were not removed. Due to the large size of the model, the modification index was considered later.

Table 4.24 Comparison between the Goodness of Fit (GF) test and standard criteria before the model adjustment

Related Statistics	Symbol	Criterion	Value	Interpretation
Chi-square	χ^2	Ns. (p > .05)	185.143 (p= 0.000)	Failed
Relative Chi-square	χ^2 /df	χ^2 /df < 2.00	2.204	Failed
Goodness of Fit Index	GFI	>.90	.914	Passed
Comparative Fit Index	CFI	>.95	.968	Passed
Normal Fit Index	NFI	>.90	.943	Passed
Adjusted Goodness of Fit Index	AGFI	>.90	.877	Failed
Root Mean Square Error of Approximation	RMSEA	<.08	.070	Passed

Source: Hair et al., 2010; Joreskog and Sorbom, 1989; Kline, 1998; Schumacker and Lomax, 2010.

According to the consideration, adjustment, and reanalyzing of the modification index as suggested in order to find the standardized regression coefficient, hypothesis test, and effect size of the factors influencing the intention to use solar rooftop energy of households in Thailand (Figure 4.10), the model fit was found from the test results with the Chi-square (χ^2) = 80.705, df = 63, CMIN/DF (χ^2 /df) = 1.302, p = .055, GFI = .960, CFI = .994, AGFI = .922, NFI = .975, and RMSEA = .035. For the GF after the model adjustment (Table 4.24), it was found that all tested values passed the standard criteria with the model fit. When considering the relationship between the variables of the adjusted model, with the value not being high, it could be concluded that the variables did not have a too high relationship (Hair et al., 2010; Joreskog and Sorbom, 1989; Kline, 1998; Schumacker and Lomax, 2010).



Chi-square (χ^2) = 80.705, df = 63, CMIN/DF (χ^2 /df) = 1.302, p = .055, GFI = .960, CFI = .994, AGFI = .922, NFI = .975, and RMSEA = .035.

Figure 4.10 Analysis results after the model adjustment

Table 4.25 Comparison between the GF test and standard criteria after the model adjustment

Related Statistics	Symbol	Criterion	Value	Interpretation
Chi-square	χ^2	Ns. (p > .05)	80.705 (p = .055)	Passed
Relative Chi-square	χ^2 /df	χ^2 /df < 2.00	1.302	Passed
Goodness of Fit Index	GFI	>.90	.960	Passed
Comparative Fit Index	CFI	>.95	.994	Passed
Normal Fit Index	NFI	>.90	.975	Passed
Adjusted Goodness of Fit Index	AGFI	>.90	.922	Passed
Root Mean Square Error of Approximation	RMSEA	<.08	.035	Passed

Source: Hair et al., 2010; Joreskog and Sorbom, 1989; Kline, 1998; Schumacker and Lomax, 2010.

Table 4.26 Comparison of the GF test statistics

Related Statistics	Symbol	Criterion	Before Adjustment	After Adjustment
Chi-square	χ^2	Ns. (p > .05)	185.143 (p = .000)	80.705 (p = .055)
Relative Chi-square	χ^2 /df	χ^2 /df < 2.00	2.204	1.302
Goodness of Fit Index	GFI	>.90	.914	.960
Comparative Fit Index	CFI	>.95	.968	.994
Normal Fit Index	NFI	>.90	.943	.975
Adjusted Goodness of Fit Index	AGFI	>.90	.877	.922
Root Mean Square Error of Approximation	RMSEA	<.08	.070	.035

Source: Hair et al., 2010; Joreskog and Sorbom,1989; Kline, 1998; Schumacker and Lomax, 2010.

As can be seen in Table 4.26, the examination results of the Goodness of Fit (GF) both before and after adjustment found that the GF statistics as per the standard criteria had suitable values with a model fit. Therefore, it could be concluded that after the model adjustment of the factors influencing the intention to use solar rooftop energy of households in Thailand, a model fit could be found (Hair et al., 2010; Joreskog and Sorbom, 1989; Kline, 1998; Schumacker and Lomax, 2010). Then, the standard regression weights were considered. The analysis results were displayed in CR; $|t| \geq 1.96$, showing significance.

Table 4.27 Analysis of the relationship between the factors in SEM

Relationship of the Variables			Standard Regression Weight	S.E.	R^2	C.R.	p
Attitude	<---	Perceived Usefulness	.884	.100	.780	12.770	***
Attitude	<---	Subjective Norm	.085	.038		2.050	.040
Intention to Use	<---	Subjective Norm	.217	.065	.608	3.883	***
Intention to Use	<---	Perceived Usefulness	.280	.256		2.028	.043
Intention to Use	<---	Attitude	.484	.165		3.767	***
Intention to Use	<---	Government Policy	.101	.076		2.003	.045
Intention1	<---	Intention to Use	.861	.057	.741	16.058	***
Intention2	<---	Intention to Use	.889	.040	.790	24.402	***
Intention3	<---	Intention to Use	.899		.809		
Cognitive	<---	Attitude	.844	.047	.713	18.479	***
Affective	<---	Attitude	.946		.894		
Behavioral	<---	Attitude	.891	.051	.794	20.256	***
Social	<---	Subjective Norm	.899	.138	.809	7.306	***
Belief	<---	Subjective Norm	.909		.826		
Motivation	<---	Subjective Norm	.787	.134	.619	6.330	***
Personal	<---	Perceived Usefulness	.842	.110	.708	11.999	***
Environmental	<---	Perceived Usefulness	.718		.515		
Awareness	<---	Perceived Usefulness	.862	.110	.743	12.441	***
Technological	<---	Government Policy	.840	.158	.705	6.435	***
Economic	<---	Government Policy	.863		.745		
Regulatory	<---	Government Policy	.958	.141	.917	8.378	***

Note: *** Significance level of .01.

As displayed in Table 4.27, the analysis results found a model fit with standard regression weights and R^2 as follows:

Intention to Use consisted of three observed variables as follows:

1) Behavioral Intention 1 had a standard regression weight = 0.861 and R^2 = 0.741.

2) Behavioral Intention 2 had a standard regression weight = 0.889 and R^2 = 0.790.

3) Behavioral Intention 3 had a standard regression weight = 0.899 and R^2 = 0.809.

Government Policy consisted of three observed variables as follows:

1) Technological Support had a standard regression weight = 0.840 and R^2 = 0.705.

2) Economic Support had a standard regression weight = 0.863 and R^2 = 0.745.

3) Regulatory Support had a standard regression weight = 0.958 and R^2 = 0.917.

Subjective Norm consisted of three observed variables as follows:

1) Social Pressure had a standard regression weight = 0.899 and R^2 = 0.809.

2) Normative Belief had a standard regression weight = 0.909 and R^2 = 0.826.

3) Motivation to Comply with the Referent had a standard regression weight = 0.787 and R^2 = 0.619.

Perceived Usefulness consisted of three observed variables as follows:

1) Personal Benefit had a standard regression weight = 0.842 and R^2 = 0.708.

2) Environmental Benefit had a standard regression weight = 0.718 and R^2 = 0.515.

3) Awareness of Cost Reduction had a standard regression weight = 0.862 and R^2 = 0.743.

Attitude consisted of three observed variables as follows:

1) Cognitive Component had a standard regression weight = 0.844 and R^2 = 0.713.

2) Affective Component had a standard regression weight = 0.946 and R^2 = 0.894.

3) Behavioral Component had a standard regression weight = 0.891 and R^2 = 0.794.

According to the analysis results as displayed in Figure 4.8, the equations were developed as follows:

$$\text{Attitude} = 0.88\text{Perceived Usefulness} + 0.09\text{Subjective Norm}, \quad R^2 = 0.78 \quad (4.1)$$

$$\text{Intention to Use} = 0.48\text{Attitude} + 0.28\text{Perceived Usefulness} + 0.22\text{Subjective Norm} + 0.10\text{Government Policy}, \quad R^2 = 0.61 \quad (4.2)$$

According to Equation 4.1, it was found that attitude was positively and significantly affected by perceived usefulness and subjective norm. The variance of attitude could be explained as 78% ($R^2 = 0.78$). The remainder were affected by other factors.

According to Equation 4.2, it was found that intention to use was positively and significantly affected by perceived usefulness, subjective norm, and government policy. Intention to use could be explained as 61% ($R^2 = 0.61$). The remainder were affected by other factors.

4.7 Hypothesis test results

The analysis of the factors influencing the intention to use solar rooftop energy of households in Thailand was to find the relationship of the factors in pairs between the independent and dependent factors, as well as to find the effect size of the factors obtained from the standardized regression coefficient. The predictive factors were attitude, perceived usefulness, subjective norm, and government policy. The endogenous latent variable was intention to use. Maximum Likelihood (ML)was used together with the hypothesis test. CR (t-test) and p-value were considered (Table 4.26 and Figure 4.11) with the standardized regression coefficient of each path of the relationship according to the hypotheses and with significant CR. In this research, the CR of all values showed $|t| \geq 1.96$. Therefore, it could be concluded that the analysis results supported all hypotheses with the analysis results of the effect size (Table 4.28).

Table 4.28 Hypothesis test results

Hypothesis	coef.	C.R.	p	Interpretation
H1: Government policy directly affects the intention to use.	.101	2.003	.045	Supported
H2: Subjective norm directly affects attitude.	.085	2.050	.040	Supported
H3: Attitude directly affects the intention to use.	.484	3.767	***	Supported
H4: Subjective norm directly affects the intention to use.	.217	3.883	***	Supported
H5: Perceived usefulness directly affects attitude.	.884	12.770	***	Supported
H6: Perceived usefulness directly affects the intention to use.	.280	2.028	.043	Supported

Note: *** Significance level of .01.

4.7.1 Direct effect

"H1: Government policy directly affects the intention to use." The hypothesis test results found that the standardized regression coefficient = 0.101 (p=.045) showing significance. Therefore, H1 was true and accepted.

"H2: Subjective norm directly affects attitude." The hypothesis test results found that the standardized regression coefficient = 0.085 (p=.040) showing significance. Therefore, H2 was true and accepted.

"H3: Attitude directly affects the intention to use." The hypothesis test results found that the standardized regression coefficient = 0.484 (p < .01) showing significance. Therefore, H3 was true and accepted.

"H4: Subjective norm directly affects the intention to use." The hypothesis test results found that the standardized regression coefficient = 0.217 (p<.01) showing significance. Therefore, H4 was true and accepted.

"H5: Perceived usefulness directly affects attitude." The hypothesis test results found that the standardized regression coefficient = 0.884 (p < .01) showing significance. Therefore, H5 was true and accepted.

"H6: Perceived usefulness directly affects the intention to use." The hypothesis test results found that the standardized regression coefficient = 0.280 (p=.043) showing significance. Therefore, H6 was true and accepted.

Table 4.29 Analysis results of the effect size

Dependent Variable	R^2	Effect	Independent Variable			
			Government Policy	Subjective Norm	Perceived Usefulness	Attitude
Attitude	.78	DE	.000	.085	.884	.000
		IE	.000	.000	.000	.000
		TE	.000	.085	.884	.000
Intention to Use	.61	DE	.101	.217	.280	.484
		IE	.000	.042	.428	.000
		TE	.101	.259	.708	.484

Note: Direct Effect (DE), Indirect Effect (IE), and Total Effect (TE).

4.7.2 Indirect effect

After the data analysis for the hypothesis test and model fit examination, the researcher considered the analysis results and presented that the predictive factors indirectly and significantly affected the dependent factors through the mediator variable (Hair et al., 2010) as follows:

1) Subjective norm indirectly and positively affected the intention to use through attitude.

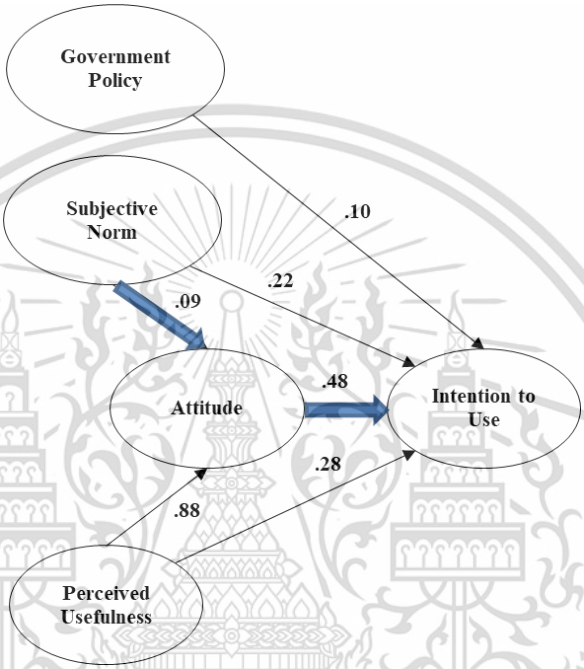


Figure 4.11 Subjective Norm indirectly affected Intention to Use

Subjective Norm → Attitude → Intention to Use = (0.085)(0.484) = 0.042

Therefore, it could be concluded that subjective norm indirectly and positively affected the intention to use through attitude = 0.042.

2) Perceived usefulness indirectly and positively affected the intention to use through attitude.

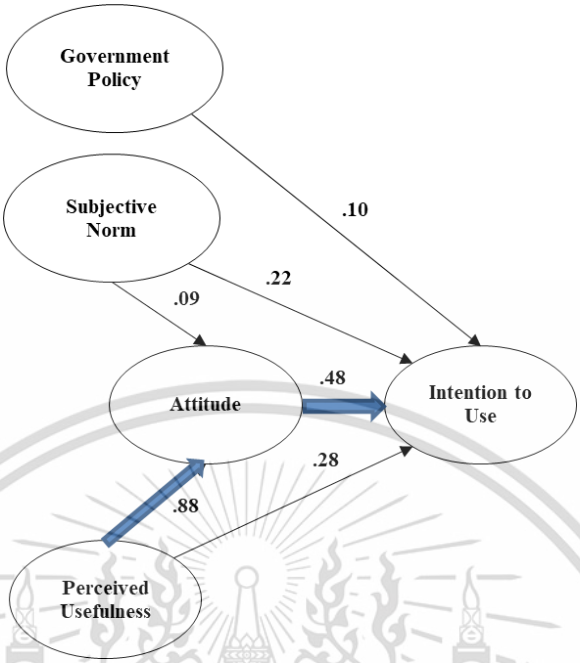


Figure 4.12 Perceived Usefulness indirectly affected Intention to Use

Perceived Usefulness → Attitude → Intention to Use = (0.884)(0.484) = 0.428.

Therefore, it could be concluded that perceived usefulness indirectly and positively affected the intention to use through attitude = 0.428.

4.7.3 Total effect

1) Subjective norm had a total positive effect on the intention to use as follows:

Direct effect = 0.217

Indirect effect = 0.042

Total effect = 0.259

2) Perceived usefulness had total positive effect on the intention to use as follows:

Direct effect = 0.280

Indirect effect = 0.428

Total effect = 0.708

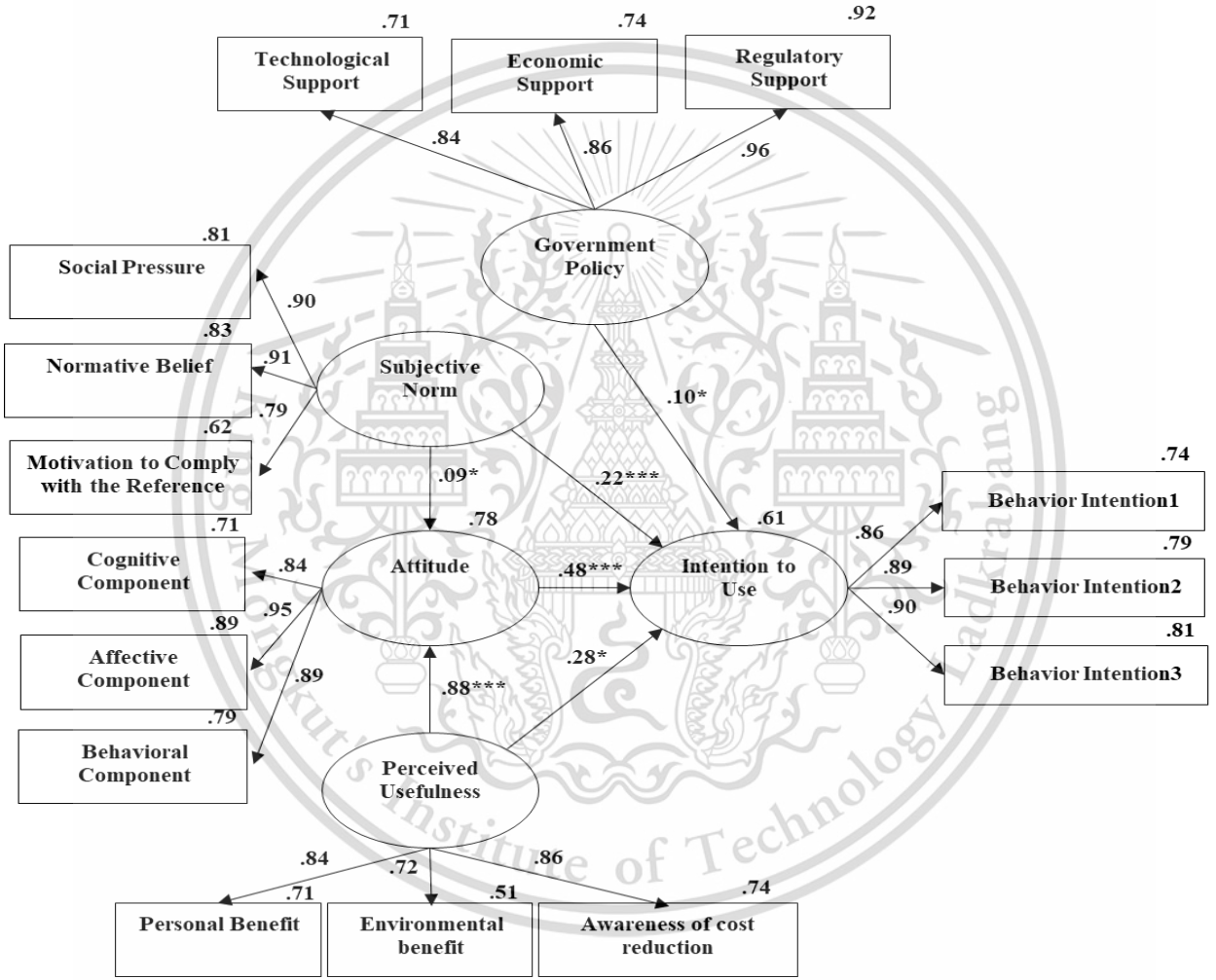


Figure 4.13 Model of the factors influencing the intention to use solar rooftop energy of households in Thailand

4.8 Qualitative results

For the implementation of the research, mixed methods were used, i.e., quantitative and qualitative research. After the quantitative data was analyzed, it was used for answering the research questions, objectives, and hypotheses. Then, the final model from the analysis results and the data collected from the secondary sources as well as literature review was developed into an interview form to collect the qualitative data from the related persons, experts and executives in solar industries, users of solar rooftop energy of households, as well as others involved in solar rooftop energy in order to bring the data obtained from the qualitative research to confirm the quantitative results for more reliability. In this qualitative research, an in-depth interview was applied. The data was recorded in the open-ended interview form with structured open-ended questions. To collect data from the interview, it was conducted by purposive sampling. The interviewees comprised 11 persons who are the experts, executives, users, and senior officers from related energy authorities involved in solar rooftop energy. They were selected by different ages and professions which were varied from private companies to governmental institutes. The interview was conducted one by one and continued until result of the ideas and opinions from interviewees got saturated. Then the interview was completed and the summary was made.

Therefore, the interview results had to be finally consistent without any new issues (Nastasi and Schensul, 2005). The interviewees were as follows:

1) Interviewee #1	Business development manager from a property company
2) Interviewee #2	Industrial engineer
3) Interviewee #3	Environmental & public senior office from a renewable energy company
4) Interviewee #4	Community relation manager from a private power producer
5) Interviewee #5	Gynecologist
6) Interviewee #6	General manager at a solar energy company
7) Interviewee #7	Risk management manager from a private power producer
8) Interviewee #8	Senior professional officer from a governmental sector
9) Interviewee #9	Alternative energy manager from Provincial Electricity Authority
10) Interviewee #10	Researcher at the Faculty of Medicine
11) Interviewee #11	Freelance lecturer

4.8.1 Qualitative data collection

In this qualitative research, an open-ended interview form was used as the instrument to collect the data from an in-depth interview with experts, users, executives, or others involved in solar rooftop energy. The interviewees were notified beforehand that the data would be recorded by writing and voice recording for systematic implementation. The interview results collected from the experts were used to confirm the analyzed quantitative results, or the significant aspects of the five latent factors, i.e., 1) government policy, 2) subjective norm, 3) perceived usefulness, 4) attitude, and 5) intention to use. This was congruent with the conceptual framework. Then, the quantitative results were compared with the qualitative ones. The process of the qualitative research was implemented as follows (Chai, 2009):

1) The interview form to collect the qualitative data was developed as an open-ended format with structured open-ended questions developed from the qualitative research congruent with the quantitative results.

2) Appointments with experts, users, executives, or others involved in solar rooftop energy were made. Then, the developed interview form was used to collect the qualitative data. Next, the data were recorded by writing and voice recording for systematic collection of correct and interesting content.

3) The data were synthesized systematically and presented in a descriptive form with the connection between the interview data and the conceptual framework. Then, the data were analyzed with the studied issues.

4) The in-depth interview results from the interviewees were concluded before the resolutions, interpretation, and correctness examination of the qualitative results. Conclusions, interpretation of the findings from the research, and interest were also explored to confirm the objectives and the conceptual framework.

The issues for the interview were described as follows:

Issue 1: Do you think the indicators of the government policy consist of the following?

1) technological support

2) economic support

3) regulatory support

Are there any other indicators? (If yes), what are they? Please comment.

Issue 2: Do you think the indicators of subjective norm consist of the following?

1) social pressure

2) normative belief

3) motivation to comply with the referent

Are there any other indicators? (If yes), what are they? Please comment.

Issue 3: Do you think the indicators of perceived usefulness consist of the following?

1) personal benefit

2) environmental benefit

3) awareness of the cost reduction

Are there any other indicators? (If yes), what are they? Please comment.

Issue 4: Do you think the indicators of attitude consist of the following?

1) cognitive component

2) affective component

3) behavioral component

Are there any other indicators? (If yes), what are they? Please comment.

Issue 5: Do you think the intention to use consists of behavioral intention?

Are there any other indicators? (If yes), what are they? Please comment.

Issue 6: Do you think government policy directly affects the intention to use and how? Please comment.

Issue 7: Do you think subjective norm directly affects attitude and how? Please comment.

Issue 8: Do you think attitude directly affects the intention to use and how? Please comment.

Issue 9: Do you think subjective norm directly affects the intention to use and how? Please comment.

Issue 10: Do you think perceived usefulness directly affects attitude and how? Please comment.

Issue 11: Do you think perceived usefulness directly affects the intention to use and how? Please comment.

Issue 12: Do you think subjective norm indirectly affects the intention to use through attitude and how? Please comment.

Issue 13: Do you think perceived usefulness indirectly affects the intention to use through attitude and how? Please comment.

Issue 14: Which variable do you think affects the intention to use the most? Please rank the variables from most to least effect and please comment.

After the interview with the experts, users, executives, or others involved in solar rooftop energy, the issues in each item and interesting data were extracted. Then, the obtained data were concluded and synthesized by considering the same interview results without any new issues. In other words, if the data were collected further, no new issues would be found except for the same data (Strauss and Corbin, 1998). This is called theoretical saturation. Then, the data's correctness was examined and presented in theoretical conclusions. At this step, the interview was completed, and the data were concluded.

4.8.2 Qualitative results

The interview results were collected from 11 experts, users, executives, or others involved in solar rooftop energy. Then, they were presented by extracting interesting issues for conclusion and synthesis based on the same results. The issues of each factor and the findings from the interview were concluded to confirm the qualitative results and to compare the quantitative and qualitative results (Table 4.30).

4.8.2.1 Government policy

Government policy directly affected the intention to use a solar rooftop. This was congruent with the interview results from the interviewees. They agreed with the indicators of government policy, which consisted of 1) technological support, 2) economic support, and 3) regulatory support. They viewed government policy as a key factor affecting the intention to use solar rooftop energy of households in Thailand. Most of them viewed that "*government policy is definitely relevant to the intention to use solar rooftop*". All interviewees also agreed that "*all three indicators in this study were the key factors of government policy that helped to promote the greater use of a solar rooftop*". Overall, the people sector actually need a solar rooftop more than before; however, there are several limitations. For example, a solar rooftop cannot be used at night without supporting technology or extra accessories. Using batteries or new technology requires more innovative systems. There should be support for the lower prices of batteries or energy storage system. Other limitations included installation, requesting permission, and government regulations to request for a solar rooftop. Therefore, it could be regarded that regulation support is necessary for the intention to use a solar rooftop. Still, if the regulations were not flexible, there might be only a few solar rooftop users. Thus, it could be said that regulations hugely affected the people's decision-making about installing a solar rooftop. At present, the structure of purchasing electricity in Thailand is an enhanced single-buyer model, with the Electricity Generating Authority of Thailand (EGAT) as the sole buyer. This top-down structure has created one current problem and obstacle. Therefore, rules and regulations must be unlocked to facilitate more peer-to-peer energy trading. This would imply that government support in terms of regulations must be the first priority to be implemented.

In addition, there are some interviewees suggested that "*government support should include education and the development of learning sources/centers to provide knowledge for the public sector or for technical knowledge*". Because there have been only a few measures in this aspect so far, more knowledge on solar rooftops should be supported. Technological knowledge and understanding are also necessary, as they are the indicators that could continually affect the decision-making about installing a solar rooftop.

Previous government measures of announcement to purchase the excess of electricity produced from solar rooftop on houses have not been satisfied by the people. Most of the interviewees agreed that "*the previous program of solar rooftop by the government is not successful. It seems that a government is not fully supported at all*". In 2019, the government

announced the Residential Solar Rooftop program and set the maximum installed capacity and purchasing prices, but there are still some unclear issues regarding pricing, which have not been fully promoted. In other words, the purchasing prices might not be persuasive enough to motivate people to use a solar rooftop. This issue would be a key driver to motivate people to participate in generating solar energy from a solar rooftop.

4.8.2.2 Subjective norm

Subjective norm directly affected the intention to use solar rooftop energy of households in Thailand. To clarify, it directly affected the attitude and then the intention to use solar rooftop energy of households in Thailand through attitude. This was congruent with the interview results from the related executives, experts and users. They agreed with the indicators of subjective norm, which consisted of social pressure, 2) normative belief, and 3) the motivation to comply with the referent. At present, a society of a solar rooftop is necessary to enhance users' image, i.e., environmental protection or be the leading users of renewable energy. This also enhances the views of consumer goods being used because of their modernity, or when people see their favorite persons or celebrities using a solar rooftop, they would acknowledge those people with a positive attitude. In addition, today's social networks facilitate easier and greater access to social media. Some interviewees though that "*People nowadays search for more information, including searching for information from well-informed people or having easier interpersonal communication*". This would imply that society is a key factor affecting subjective norm. Even so, despite people's subjective norm following social networks, they would finally make a decision based on a self-reference the most for installing a solar rooftop. The experts viewed that the self-reliance of the people sector was another key factor that should be studied further. This is because now most people use social networks more and search for more knowledge on their own. Therefore, information and technology are perceived and understood. Then, these aspects would be further developed from understanding to creating professionalism with advanced skills. This would lead to self-decision-making, which is another key factor.

Moreover, normative belief is a personal belief that a solar rooftop is useful. This would encourage people to search for more information about installing a solar rooftop. Thus, this would be a key factor affecting the decision-making whether or not to install a solar rooftop if an individual already has the motivation to install it. Therefore, the related agencies need to find references or search for information required by consumers in order to support the decision-making on installing a solar rooftop, or to create consumer confidence and motivation to install a solar

rooftop. Nonetheless, social pressure is not a key factor totally affecting the decision-making on this subject. Those with the intention to use would still have to search for more information about a solar rooftop in detail. As such, at present, installers tend to pay more attention to investment returns, installation costs, and the break-even point than the subjective norm. This would affect their attitude to search for knowledge and to develop using solar rooftop. Such attitude would finally lead to the intention to install a solar rooftop afterwards.

Nevertheless, there is still a difference in the generation of users. To clarify, the new generation usually has their own beliefs and do not always follow the subjective norm. As there was one opinion raised from a young interviewee who is in generation Z that "*I don't really think I'll follow neighbors if they install solar rooftop on their roof. They are not effect to me at all. If I install a solar rooftop, it will come from my own decision after my search for more information.*". Additionally, the majority of people in Thai society live as an extended family. Therefore, the family are mixed with various generations of members in the same house. This type of family is a key factor that would differently affect the intention to use a solar rooftop. This would be because the extended family might have different ideas leading to different decision-making. As a result, subjective norm toward the intention to use a solar rooftop would occur.

4.8.2.3 Perceived usefulness

Perceived usefulness directly affected the intention to use solar rooftop energy of households in Thailand. To clarify, it directly affected attitude and then the intention to use solar rooftop energy of households in Thailand through the attitude. This was congruent with the interview results from the related executives, experts, and users. All interviewees agreed that "*perceived benefits are crucial factors to install the solar rooftop system and agreed that personal benefit, environmental benefit, and awareness of the cost reduction are key reasons to use solar rooftop by Thai*". That was because most people do not want to generate electricity from a solar rooftop for sales but wanted it for daily use. Therefore, perceived usefulness or what would be obtained from solar energy is what people would be mainly concerned about. Alternatively, they could be educated regarding this to make sure that solar rooftop system would be easy and convenient to use, that they could be actually utilized, and would be really useful for daily consumption. Nonetheless, most people would basically focus on personal benefit first in installing a solar rooftop as can be noted from some interviewees that "*I don't think I will invest solar rooftop just to help the world while my salary is not high*". Despite the quite high cost and investment capital, they would be aware that it could reduce electricity costs. This would be followed by

perceived environmental benefit and personal benefit in terms of imagining themselves as leading users of renewable energy, maintaining the world's resources, reducing global warming problem, helping to save energy, reducing imports of oil, reducing environmental degradation, and caring for the national economic interest.

Furthermore, seeing others using a solar rooftop would lead to imitation because users would perceive the real benefits from using one by their own. Therefore, they would develop their personal benefit, or they might see the cost reduction as being tangible. Environmental protection is the second necessary factor that would make consumers focus on using less energy for even better environmental conditions. The experts also viewed that the indicators of social benefit were necessary too, e.g., educating and training people. At present, there are a great number of people who make a social benefit, educate others, and act as role models of the installation of a solar rooftop. Then, they transfer the obtained knowledge to the people and communities in terms of using a solar rooftop and its benefits. With perceived benefits, the people would be able to continually extend what they had gained. This is an example of generating a good connection for society and reducing energy consumption.

In the past, people did not perceive benefits from the government sector, or users might not have realized the genuine benefits, values, cost reduction, and environmental protection. However, now these issues are being promoted, supported, and educated to consumers. As a result, they have a greater positive attitude toward a solar rooftop because of such promotion and support that can reduce costs and protect the environment. This is useful for individuals themselves, and it is necessary for consumers with high electricity consumption, e.g., large businesses and industries. These groups need knowledge or desire to know about the costs for the business benefit or for personal benefit resulting in more intention to use. Sometimes, high investment capital can make consumers think twice about usability, the capability to reduce costs, and then value of investment. The long life of a solar rooftop and more efficient cost reduction are also what people take into consideration. Many interviewees think that "*a government should pay more for giving information of solar rooftop and its benefits to the society. Currently people know very little about solar rooftop as the government does not care much for it*".

4.8.2.4 Attitude

Attitude directly affected the intention to use a solar rooftop. This was congruent with the interview results from the related executives, experts, and users. They agreed with the indicators of the attitude, which consisted of 1) cognitive component, 2) affective component, and 3) behavioral component. This also included internal and external consumer attitudes arising from perceived information, news, knowledge, and new technology. Another necessity of attitude is personal belief because it could lead to a change in attitude toward a certain thing apart from intellect, emotion, feeling, and behavior. If consumers believe in something, they will do anything just to change their behavior for it. However, many interviewees think that "*attitude from Thai people to solar rooftop is very poor as there is no much information about it. Even though there is some program from a government related to solar rooftop, the process in practice is contradicted and it is too complicated to follow. A government should be aware and be more supportive to build good attitude for the people*." Furthermore, the attitude of people who want to become influencers or leading users of a solar rooftop has risen from social media and social networks in daily life. Nevertheless, most consumers pay attention to the benefits, lower electricity costs, and cost reduction. As such, they examine the high cost and long break-even point despite the long life of a solar rooftop. Thus, a positive consumer attitude would affect the intention to use when people perceive the high benefits and clarity of a solar rooftop. That is why attitude would finally affect the intention to use a solar rooftop.

4.8.2.5 Intention to use

The intention to use solar rooftop energy of households in Thailand was congruent with the interview results from the related executives, experts, and users. They agreed with the indicator of the intention to use, which consisted of behavioral intention. At present, consumers need knowledge called "consumer knowledge" because they intend to use a solar rooftop. Searching for knowledge on such matters can simply be accessed. This lets us know about consumers who have the intention to use a solar rooftop, and the implication of their intention to use. This is further substantiated by the higher electricity consumption at present; consumers thus want to change their mind about using a solar rooftop. Currently, the government sector has not yet issued any compulsory regulations of using a solar rooftop in households. People are only convinced of using solar rooftop and motivated by obtaining some income in return from selling excess of electricity from internal energy consumption at home. Additionally, installing a solar rooftop now has a lower installation cost; therefore, as people have more knowledge about it, they

would compare the payment of the electricity costs and the information about the investment on the installation, which would result in lower electricity costs, or the effect from the economics of force. This is the knowledge of those with the intention to use, including the factors in terms of price, the environmental concept, and safety. These are the key issues reflecting their higher intention to use. Another key issue is the driver in terms of the image or concept among those with the intention to use a solar rooftop. This group of people do not focus mainly on price; thus, it reflects their environmental-concerned intention, i.e., environmental protection and global warming prevention. Some interviewees spoke that "*I want to install it even though its payback period is long or its return is low as I want to be part of a good citizen to help protect environment*." In their opinion, a solar rooftop must be easy to use with functional convenience and simple maintenance methods. In addition, quality acceptance is also necessary and should be added to the intention to use the solar rooftop products or services. However, at present, a solar rooftop has a mixture of good and poor quality depending on the brands and suppliers. Therefore, quality is a key factor leading to the intention to use a solar rooftop, and it must be congruent with a reasonable price. Good quality products usually lead to the intention to use because users do not worry about the maintenance, repairs, or replacement of parts and equipment.

For campaigning to promote more use of a solar rooftop, it is necessary to educate and inform consumers to visit the project sites and to campaign for greater use of a solar rooftop, to promote or campaign for more use of renewable energy, and to support research on using materials with a high capacity of energy storage for the installation of a solar rooftop. Most of the interviewees agreed that "*battery or energy storage system will be a key success of solar rooftop. Once its cost is cheap and people can afford it. The use of solar rooftop will be very popular."* To some extent, the government policy supporting electricity produced by the people has still not been clarified, which is why a solar rooftop has not really been used. In addition, the business sector, who mostly focus on solar rooftop design and installation, is a direct key electricity generator and provider of information. It promotes knowledge to the people and persuades them to use a solar rooftop, e.g., setting promotions and informing people about the benefits of solar energy. To clarify, information is provided through activities or seminars, the benefits of cost reduction, environmental protection, or corporate social responsibility (CSR) activities to hospitals, schools, or any locations that have the shortage of electricity.

The findings from the interview were concluded to confirm the qualitative results and to compare the quantitative and qualitative results as shown in Table 4.30.

Table 4.30 Comparison between the quantitative and qualitative results

Factor	Quantitative	Qualitative	Concluded Congruence
Government policy consisted of the following scales. 1) Technological Support 2) Economic Support 3) Regulatory Support	Government policy directly affected the intention to use solar rooftop energy of households in Thailand. This was congruent with the interview results from the related executives, experts, and users. They agreed with the indicators of the government policy, which consisted of the following scales. 1) Technological support: standard regression weight = 0.840 and R^2 = 0.705. 2) Economic support: standard regression weight = 00.863 and R^2 = 0.745. 3) Regulatory support: standard regression weight = 0.958 and R^2 = 0.917.	According to the interview results from related executives, experts, and users, they viewed that government policy directly affected the intention to use solar rooftop energy of households in Thailand. This was congruent with the quantitative results. For the government policy and promoting greater use of a solar rooftop, it could be concluded that installation, requesting permission, and government regulations were necessary and affected the intention to use. The government sector has still not clarified and fully supported the purchasing price. Moreover, it should develop learning centers and knowledge sharing that could educate people or inform about technical knowledge.	According to the analysis of the quantitative and qualitative results, they were found to be congruent.

Table 4.30 (Continue)

Factor	Quantitative	Qualitative	Concluded Congruence
Subjective norm consisted of the following three observed variables: 1) Social Pressure 2) Normative Belief 3) Motivation to Comply with the Referent	Subjective norm directly and indirectly affected the intention to use solar rooftop energy of households in Thailand and directly affected attitude. This was congruent with the interview results from the related executives, experts, and users. They agreed with the indicators of subjective norm, which consisted of the following three observed variables. 1) Social pressure: standard regression weight = 0.899 and R^2 = 0.809. 2) Normative belief: standard regression weight = 0.909 and R^2 = 0.826. 3) Motivation to comply with the reference: standard regression weight = 0.787 and R2 = 0.619.	According to the interview results from the related executives, experts, and users, they viewed that subjective norm directly and indirectly affected the intention to use solar rooftop energy of households in Thailand and directly affected attitude. This was congruent with the quantitative results. Today's social networks facilitate easier and greater access to social media. People search for more information and use big data, or easier interpersonal communication. This implies that society is a key factor affecting subjective norm, including self-reliance in terms of understanding until it has finally achieved professionalism with advanced skills. This has led to self-decision-making on the installation of a solar rooftop of households in Thailand.	According to the analysis of the quantitative and qualitative results, they were found to be congruent.

Table 4.30 (Continue)

Factor	Quantitative	Qualitative	Concluded Congruence
Perceived usefulness consisted of the following three observed variables: 1) Personal Benefit 2) Environmental benefit 3) Awareness of the Cost Reduction	Perceived usefulness directly and indirectly affected intention to use solar rooftop energy of households in Thailand and directly affected attitude. This was congruent with the interview results from the related executives, experts, and users. They agreed with the indicators of perceived usefulness, which consisted of the following three observed variables. 1) Personal benefit: standard regression weight = 0.842 and R2 = 0.708. 2) Environmental benefit: standard regression weight = 0.718 and R2 = 0.515. 3) Awareness of the cost reduction: standard regression weight = 0.862 and R2 = 0.743.	According to the interview results from the related executives, experts, and users, they viewed that perceived usefulness directly and indirectly affected the intention to use solar rooftop energy of households in Thailand and directly affected attitude. This was congruent with the quantitative results. People perceive usefulness or what they would obtain from solar energy; that it is easy and convenient to use, and it could be used in daily life. They also perceive personal benefit in terms of imagining themselves as being leading users of renewable energy, maintaining the world's resources, helping save energy, reducing imports of fossil fuels, reducing environmental degradation, and caring for the national economic interest.	According to the analysis of the quantitative and qualitative results, they were found to be congruent.

Table 4.30 (Continue)

Factor	Quantitative	Qualitative	Concluded Congruence
Attitude consisted of the following three observed variables: 1) Cognitive Component 2) Affective Component 3) Behavioral Component	Attitude directly affected the intention to use solar rooftop energy of households in Thailand. This was congruent with the interview results from the related executives, experts, and users. They agreed with the indicators of attitude, which consisted of the following three observed variables. 1) Cognitive component: standard regression weight = 0.844 and R2 = 0.713. 2) Affective component: standard regression weight = 0.946 and R2 = 0.894. 3) Behavioral component: standard regression weight = 0.891 and R2 = 0.794.	According to the interview results from the related executives, experts, and users, they viewed that attitude directly affected the intention to use solar rooftop energy of households in Thailand. This was congruent with the quantitative results. The internal and external consumer attitudes arose from perceived information, news, knowledge, and new technology. Another necessity of attitude is personal belief because it can lead to a change in attitude toward a certain aspect apart from intellect, emotion, feeling, and behavior. If consumers believe in something, they will do anything to change their behavior for it. A positive consumer attitude affects the intention to use a solar rooftop.	According to the analysis of the quantitative and qualitative results, they were found to be congruent.

Table 4.30 (Continue)

Factor	Quantitative	Qualitative	Concluded Congruence
Intention to use consisted of the following three observed variables: 1) Behavioral Intention 1 2) Behavioral Intention 2 3) Behavioral Intention 3	The intention to use solar rooftop energy of households in Thailand was congruent with the interview results from the related executives, experts, and users. They agreed with the indicators of the intention to use, which consisted of the following three observed variables. 1) Behavioral Intention 1: standard regression weight = 0.861 and R2 = 0.741. 2) Behavioral Intention 2: standard regression weight = 0.889 and R2 = 0.790. 3) Behavioral Intention 3: standard regression weight = 0.899 and R2 = 0.809.	According to the interview results from the related executives, experts, and users, they viewed that government policy directly affected the intention to use solar rooftop energy of households in Thailand. This was congruent with the quantitative results. Currently, consumers always find knowledge on a solar rooftop by themselves. Searching for more knowledge on such matters will lead people to use a solar rooftop. Another key issue is the driver in terms of image when using a solar rooftop without focusing on the cost. This reflects their environmental-concerned intention, i.e., environmental protection and global warming prevention.	According to the analysis of the quantitative and qualitative results, they were found to be congruent.

CHAPTER 5

CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

The research on "Factors Influencing the Intention to Use Solar Rooftop Energy of Households in Thailand" aimed to develop the model of the government policy, attitude, the subjective norm, and perceived usefulness influencing the intention to use by utilizing mixed methods, i.e., quantitative research and qualitative research. The quantitative data was analyzed by descriptive statistics, confirmatory factor analysis (CFA), and structural equation model (SEM) analysis to examine the goodness of fit. The qualitative data and in-depth interview with the executives of companies in the solar industry as well as the involved government agencies and state enterprises. In this chapter, the researcher has provided the conclusions, discussion, and recommendations.

5.1 Conclusions

5.1.1 Conclusions of the quantitative results

This research was based on secondary sources, e.g., books, journals, and related researches to develop the conceptual framework of setting the variables, i.e., the government policy, attitude, subjective norm, and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand. Then, questionnaires were developed for the data collection and analysis. The analysis results were then concluded. For the general data of the respondents, 174 or a little over half of the total number of participants were female (54.38%). The highest number of respondents were aged between 31-40 years (89; 27.81%). About half of the total number of respondents had graduated with a bachelor's degree (139; 43.44%). A little over half of the total number of respondents were corporate employees (174; 54.38%). About one third of the total number of respondents received a monthly income of $\leq$ 35,000 Baht (127; 39.69%). The highest number of respondents lived in Nakhon Ratchasima (38; 11.88%). Most of the respondents lived in detached houses (235; 73.44%). At least half of the total number of respondents were house members (162; 50.63%). A little over half of the total number of respondents lived in houses aged

> 10 years (184; 57.50%). Nearly half of the total number of respondents paid a monthly electricity cost between 1,001 - 3,000 Thai Baht (142; 44.38%).

According to the survey by asking questions of general knowledge about solar rooftop, it was found that 82 respondents or 25.61% have good level of knowledge, 179 respondents or 55.94% have fair level of knowledge, and 59 respondents or 18.45% have poor level of knowledge. It shows that most respondents have fair level of knowledge in solar rooftop.

According to the analysis results of the level of the factors, it was found that attitude had the highest mean ($\overline{X}$ = 5.28; SD = 1.299) with a quite high mean of the scale. Next was perceived usefulness ($\overline{X}$ = 5.18; SD = 1.188) with quite a high mean of the scale. The subjective norm had $\overline{X}$ = 4.18; SD = 1.305 with a moderate mean of the scale. The intention to use had $\overline{X}$ = 4.05; SD = 1.406 with a moderate mean of the scale. The government policy had $\overline{X}$ = 3.16; SD = 1.197 with quite a low mean of the scale.

According to the correlation analysis, it was found that the correlation was between -0.006 and 0.843. When considering each pair of the relationship, there were two pairs with a very high correlation, i.e., between regulatory support and economic support (0.827), and between the affective component behavioral component (0.843). Because the relationship of both pairs was the observed variable of the same latent variable, there were no problems of multicollinearity. Other indicators did not have very high relationships with each other (Puangrat, 1997). According to the Kaiser-Meyer-Olkin (KMO) analysis, it was found that the KMO = 0.875 and Bartlett's test of sphericity was significant (Sig. = .000 which is less than 0.05). This inferred that the factors were appropriate for the data and were not related to each other.

According to the results of the CFA, the analysis results of the intention to use model found that Intention 4 had a low standard regression weight with $R^2 < 0.2$. Therefore, the researcher removed Intention 4 (Hair et al., 2010) and adjusted the model. The analysis results of the adjusted intention to use model found that the Chi-square(χ^2) = 1.737, df = 1, CMIN/DF(χ^2/df) = 1.737, p = .188, GFI = .995, CFI = .999, AGFI = .972, NFI = .997, and RMSEA = .054 with a model fit. The standard regression weights were high, and the CR of all factors showed $|t| \geq 1.96$, representing suitable reliability (Hair et al., 2010).

The analysis results of the government policy found that the Chi-square(χ^2) = .056, df = 1, CMIN/DF(χ^2/df) = .056, p = .813, GFI = 1.000, CFI = 1.000, AGFI = .999, NFI = 1.000, and

RMSEA = .000 with a model fit. The standard regression weights were high, and the CR of all factors showed | t | $\geq$ 1.96, representing suitable reliability (Hair et al., 2010).

The analysis results of attitude found that the Chi-square(χ^2) = .209, df = 1, CMIN/DF (χ^2 /df) = .209, p = .648, GFI = .999, CFI = 1.000, AGFI = .997, NFI = 1.000, and RMSEA = .000 with a model fit. The standard regression weights were high, and the CR of all factors showed | t | $\geq$ 1.96, representing suitable reliability (Hair et al., 2010).

The analysis results of the subjective norm found that the Chi-square(χ^2) =.090, df = 1 CMIN/DF(χ^2 /df) =.090, p = .764, GFI = 1.000, CFI = 1.000, AGFI = .999, NFI = 1.000, and RMSEA = .000 with a model fit. The standard regression weights were high, and the CR of all factors showed | t | $\geq$ 1.96, representing suitable reliability (Hair et al., 2010).

The analysis results of perceived usefulness found that the Chi-square(χ^2) = .489, df = 1, CMIN/DF(χ^2 /df) = .489, p = .484, GFI = .999, CFI = 1.000, AGFI = .992, NFI = .999, and RMSEA = .000 with a model fit. The standard regression weights were high, and the CR of all factors showed | t | $\geq$ 1.96, representing suitable reliability (Hair et al., 2010).

Then, the SEM was analyzed and the goodness of fit was examined. However, a model fit was not found. Therefore, the modification index was considered and applied. Later, the model fit was found from the test results with the Chi-square(χ^2) = 80.705, df = 63, CMIN/DF (χ^2 /df) = 1.302, p = .055, GFI = .960, CFI = .994, AGFI = .922, NFI = .975, and RMSEA = .035. For the GF after the model adjustment, it was found that all tested values passed the standard criteria with the GF (Table 5.1). When considering the relationship between the variables of the adjusted model, with the value not being high, it could be concluded that the variables did not have a too high relationship (Hair et al., 2010; Joreskog and Sorbom, 1989; Kline, 1998; Schumacker and Lomax, 2010).

Table 5.1 Concluded statistics for the GF test

Related Statistics	Symbol	Criterion	After Adjustment
Chi-square	χ^2	Ns. (p > .05)	80.705 (p = .055)
Relative Chi-square	χ^2 /df	χ^2 /df < 2.00	1.302
Goodness of Fit Index	GFI	>.90	.960
Comparative Fit Index	CFI	>.95	.994
Normal Fit Index	NFI	>.90	.975

Table 5.1 (Continue)

Related Statistics	Symbol	Criterion	After Adjustment
Adjusted Goodness of Fit Index	AGFI	>.90	.922
Root Mean Square Error of Approximation	RMSEA	<.08	.035

5.1.2 Conclusions of the qualitative results

According to the results of the interview with 11 experts, executives, users and senior officers from related energy authorities involved in solar rooftop energy of households in Thailand, the key issues were concluded. The government policy was viewed as a key indicator in terms that it helped promote the use of a solar rooftop. Overall, the people sector actually now needs a solar rooftop more than before. Still, if the regulations are not flexible, there might be only a few solar rooftop users. Therefore, the regulations affected the people's decision-making on installing a solar rooftop. Furthermore, government support of educating, technical learning centers, and announcements to purchase excess electricity from internal use in households were also a key driver for the people's decision-making on using a solar rooftop.

At present, the society of a solar rooftop is necessary to enhance users' image and environmental protection which enhance the good attitude to the users of solar rooftop. In addition, today's social networks facilitate easier and greater access to social media. People search for more information and use big data. A personal belief that a solar rooftop is useful is also a key factor affecting the decision-making whether or not to install a solar rooftop. Most people basically focus on personal benefit first and cost reduction in installing a solar rooftop before perceived environmental benefit. Perceived personal benefit also includes imagining themselves as leading users of renewable energy, maintaining the world's resources, helping to save energy, reducing environmental degradation, and social benefit in terms of educating and training people. A positive consumer attitude would also affect the intention to use when people perceive the high benefits and the clear government policy of a solar rooftop. That is why this would finally affect the intention to use a solar rooftop.

5.1.3 Conclusions following the research questions

1) How did the model of the government policy, attitude, subjective norm and perceived usefulness influencing the intention to use solar rooftop energy of households in Thailand relate to one another and congruent with the empirical data?

According to the result of the CFA of the government policy, attitude, the subjective norm, perceived usefulness, and the intention to use, a model fit was found. This could be concluded that the measurement model was congruent with the empirical data with validity. All factors reflected the intention to use in terms of the behavioral intention of the study on the factors influencing the intention to use solar rooftop energy of households in Thailand. The model fit was found from the test results with the Chi-square (χ^2) = 80.705, df = 63, CMIN/DF (χ^2 /df) = 1.302, p = .055, GFI = .960, CFI = .994, AGFI = .922, NFI = .975, and RMSEA = .035. The model showed a significance level of 0.05 of which the equation could be developed as follows:

Intention to Use = 0.48Attitude + 0.28Perceived Usefulness + 0.22Subjective Norm + 0.10Government Policy, $R^2 = 0.61$

The intention to use was positively and significantly affected by perceived usefulness, the subjective norm, and the government policy. The variance of the intention to use could be explained as 61% ($R^2 = 0.61$). The remainder were affected by other factors. The government policy, attitude, the subjective norm, and perceived usefulness were the current key factors in building users' confidence and provided positive results to the behavioral intention to use a solar rooftop. It can be seen that attitude plays the most influential motivation to the intention to use, following by perceived usefulness and subjective norm, respectively. When people have good or positive attitude in solar rooftop and they acknowledged the benefits received from solar rooftop, it will be easy to convince them to install and use the solar rooftop. We should then create good attitude to the people by providing them knowledge and good benefits in all aspects to them. If they are aware of such benefits and the positive attitude was built, they are very potential to become the users of solar rooftop. Likewise, perceived usefulness and subjective norm also significantly affect to the willing to use solar rooftop. These two factors are almost equally impact to the intention to use and are two factors that the government can provide information of benefits and may show advertisement of powerful people or celebrities using solar rooftop so that more people will become the user of solar rooftop. Regarding the factor of government policy, when people perceive rules/regulations and values arising from the use solar energy or reference groups by using a solar rooftop on their own house, plants, or buildings or by selling solar energy to the grid of the electricity authorities, this would generate a positive attitude toward the use and to the intention to use a solar rooftop.

2) Which factors contain the direct, indirect, and total effects on the intention to use solar rooftop energy of households in Thailand?

According to the data analysis for the model fit examination by direct effect analysis, all hypotheses were found to be significant. The predictive factors indirectly and significantly affected the dependent factors through the mediator. They also totally affected the intention to use solar rooftop energy of households in Thailand (Table 5.2).

Table 5.2 Direct effect, indirect effect, and total effect

Dependent Variable	R^2	Effect	Independent Variable			
			Government Policy	Subjective Norm	Perceived Usefulness	Attitude
Attitude	.78	DE	.000	.085	.884	.000
		IE	.000	.000	.000	.000
		TE	.000	.085	.884	.000
Intention to Use	.61	DE	.101	.217	.280	.484
		IE	.000	.042	.428	.000
		TE	.101	.259	.708	.484

Note: Direct Effect (DE), Indirect Effect (IE), and Total Effect (TE)

According to the results, it was found that the exogenous latent variables, i.e., the government policy, subjective norm, and perceived usefulness, and the mediator/intervening variable, i.e., attitude affecting the endogenous latent variable demonstrated the intention to use solar rooftop energy of households in Thailand. The quantitative results were congruent with the empirical data confirming that the government policy directly affected the intention to use (DE = 0.101), and that attitude directly affected the intention to use (DE = 0.484).

The subjective norm directly affected the intention to use (DE = 0.217) and directly affected attitude (DE = 0.085). The subjective norm indirectly affected the intention to use solar rooftop energy of households in Thailand through the mediator/intervening variable, i.e., attitude (IE = 0.042). Additionally, it totally affected the intention to use solar rooftop energy of households in Thailand (TE = 0.259).

Perceived usefulness directly affected the intention to use (DE = 0.280) and directly affected attitude (DE = 0.884). Perceived usefulness indirectly affected the intention to use through the mediator/intervening variable, i.e., attitude (IE = 0.428). Furthermore, it totally affected the intention to use solar rooftop energy of households in Thailand (TE = 0.708).

5.1.4 Concluded Findings

According to the analysis results of the research, it was found that the government policy directly affected the intention to use solar rooftop energy of households in Thailand the least (coef. = 0.101). Regulatory support had the highest regression weight, followed by economic support and technological support. At present, the rules and regulations issued from a government are still ambiguous in terms of promoting the use of a solar rooftop and renewable energy that would seriously support the use of a solar rooftop, including measures to provide sufficient financial assistance and support so that people would be satisfied with the assistance and public relations from the government to make people interested in a solar rooftop. Alternatively, the government sector should provide financial support and investment for the development of sample projects in local areas to use a solar rooftop in order to make the local inhabitants realize its usefulness. This could be done in the form of any newly created innovations of solar rooftops through serious research and development (R&D) support, knowledge exchange of solar rooftops for the better development of such innovation, or education to each local area on the ability to develop a solar rooftop. This was congruent with the interview results of the interviewees' opinions that previous government measures to announce rules and regulations were still not serious and supportive enough. Previous government measures of announcements to purchase excess electricity had still not yet been clarified due to some ambiguous issues. In other words, the tariff and procedure to purchase electricity from solar rooftop were not convincing enough to motivate people to use a solar rooftop. This issue is a key driver in motivating the people to participate in the generation of solar energy from a solar rooftop.

Additionally, attitude directly affected the intention to use solar rooftop energy of households in Thailand the most (coef. = 0.484). The affective component had the highest regression weight, followed by the behavioral component and cognitive component. People used emotion and feelings for decision-making, and they viewed a solar rooftop as an interesting item. They felt more impressed and proud to use a solar rooftop than other types of renewable energy,

as using a solar rooftop at their house was parallel to the normal power transmitted and distributed by the electricity authorities. Thus, this provided them with the independence of selecting electricity from various sources. They also viewed that the electricity can be generated from solar rooftop and it will bring direct benefits for the users as it is available in nature. As such, this would be a good alternative that solar rooftop should be used as much as possible for the reduction of household costs. They also believed using a solar rooftop was a valuable form of energy consumption. Moreover, the users showed their intention to use in case they bought or built a new house although it was not widely used because they intended and were still interested to install a solar rooftop. This was congruent with the interview results that the internal and external consumer attitudes arose from perceived information, news, knowledge, and new technology. Another necessity of attitude was personal belief because this could lead to a change in attitude toward a certain aspect apart from intellect, emotion, feeling, and behavior. If consumers believed in something, they would do anything to change their behavior for it.

Perceived usefulness directly affected the intention to use solar rooftop energy of households in Thailand (coef. = 0.280), and indirectly affected the intention to use it (coef. = 0.428). Therefore, perceived usefulness totally affected the intention to use solar rooftop energy of households in Thailand (TE = 0.708). However, when considering the indirect effect and total effect on the intention to use solar rooftop energy of households in Thailand, it was found that the intention was higher. This was congruent with the interview results from the interviewees, who thought that perceived usefulness is the most necessary factor affecting the intention to use a solar rooftop. That is because most people did not want to generate electricity from a solar rooftop for sale but for their own personal daily use. Therefore, perceived usefulness or what would be obtained from solar energy would be what people would be mainly concerned about. Alternatively, they could be educated regarding this issue to make sure that solar rooftop system was easy and convenient to use, that they could be actually utilized, and were really useful for daily consumption. Now these issues are being promoted, supported, and educated to consumers. As a result, consumers now have a greater positive attitude toward a solar rooftop because of such promotion and support that could reduce costs and protect the environment leading to a greater intention to use a solar rooftop.

5.2 Discussion

After the quantitative and qualitative data analysis based on the conceptual framework, the hypothesis test with the significance level of 0.05, and interviews with experts, executives, users and others involved in the factors influencing the intention to use solar rooftop energy of households in Thailand to confirm the congruence with the quantitative results, the researcher synthesized the results to discuss the issues congruent with the related literature. The discussion was presented according to the hypothesis test results as follows:

"H1: Government policy directly affects the intention to use."

According to the hypothesis test, it was found that government policy directly and significantly affected the intention to use (coef. = 0.101; p =.045). Therefore, H1 was true and accepted. The hypothesis was about the renewable energy promotion and support by the government, so that it would be recognized and accepted by the people (Cardenas et al., 2017). The government policy should focus mainly on strict announcements of regulations and conditions related to a solar rooftop installation, educating consumers, R&D support, and financial support by the government (Child et al., 2017). The quantitative results found that the government policy consisted of the three observed variables with the standard regression weights and R^2 as follows: (1) technological support had the standard regression weight = 0.840 and R^2 = 0.705. Because solar rooftop technology has been advanced and become very popular, solar rooftop equipment was hastily manufactured in large numbers. Therefore, modern manufacturing technological support from the government for quality and standard products would be indispensable. This was congruent with Sukamongkol (2016), who suggested that there should be technological support and personnel support for better knowledge and expertise in R&D as well as a solar rooftop. Chaianong and Pharinon (2015) stated that the government should support knowledge development, manufacturing experience, and modern equipment or technological supply for manufacturing. Likewise, Potisat et al. (2017) mentioned that the support of the ability and efficiency development of product manufacturing and R&D would help innovative product manufacturing. (2) Economic support had the standard regression weight = 0.863 and R^2 = 0.745. This was congruent with Tongsopit et al. (2016), who commented that despite the quite high cost of a solar rooftop investment, it was worth investing when compared with the rate of return. Potisat et al. (2017) indicated that economic support from the government in terms of investment could attract consumers to install a solar

rooftop. (3) Regulatory support had the standard regression weight = 0.958 and R^2 = 0.917. This was a key factor representing the responsibility and guidance on coping with regulations by the government for clarity, for reducing the redundancy of outdated laws used, and for reducing the overuse of strict regulations of any implementations of a solar rooftop. This was congruent with Potisat et al. (2017), who suggested that the government should set the rules and regulations, or have a clear policy about the public utility from an electricity authority. A policy of contracts or agreements between the government and households for using products or services from renewable energy should also be considered (Chaianong and Pharinon, 2015). Furthermore, Tongsopit et al. (2016) mentioned that the government sector should set solutions for ambiguity, uncertainty, and redundancy in their units regarding the enforcement of government rules and regulations to support renewable energy installation. This was congruent with the qualitative result from the interview from the experts, executives, users, and others involved in solar rooftop energy of households in Thailand. Regulation support is necessary for the intention to use a solar rooftop. Still, if the regulations are not flexible, then there might be only a few solar rooftop users. Thus, it can be said that regulations hugely affected the people's decision-making about installing a solar rooftop. This would imply that government support in terms of regulations must be the first priority to be implemented. Experts also mentioned that the application and licensing process nowadays are too complicated and it is a big problem in making people comply and follow. Similarly, Jiang (2016) studied the purchase intention for electric vehicles (EVs) in China from a customer-value perspective and found that the factors influencing the intention to buy EVs were environmental awareness and the government policy of which environmental care measures in China were required. Moreover, Aziz et al. (2017) investigated the factors influencing Malaysian consumers' intention to purchase solar panels. Questionnaires were used for the collection of the data from Malaysian non-solar panel users. The theory of reasoned action (TRA) was used as the basis of their investigation. The results found that perceived government policy, solar panel esthetics, environmental concern, and demographic factors (education and income level) were significantly related to the purchase intention. These findings were congruent with Huang and Ge (2019), who conducted research on EVs development in Beijing, China in 2018. A total of 502 survey responses from potential clients in Beijing were obtained, and the SEM was used for the empirical analysis of the factors influencing the EVs purchasing intention. Based on the theory of planned behavior (TPB), the results showed that monetary incentive policy measures as well as other factors; such as

attitude and cognitive status positively and significantly affected consumers' intention to purchase EVs in Beijing. However, non-monetary incentive policy measures did not have any significant impact on the purchasing intention.

"H2: Subjective norm directly affects attitude."

According to the hypothesis test, it was found that the subjective norm directly and significantly affected attitude (coef. = 0.085; p=.040). Therefore, H2 was true and accepted. Listening to family members, relatives, close friends, experienced persons, and celebrities or experts about a certain topic was a key factor influencing the purchase behavior and usage. This also depended on any individuals influencing the consumers' attitude, decision-making, and behavioral change by using convincing words to make listeners follow emotions and feelings of the speakers until their attitude or viewpoints changed as the speakers expected (Kotler, Armstrong and Opresni, 2016). This was congruent with Ajzen (1991), who stated that the perception of personages or the important persons was influential. If an individual perceives the behavior of a personage, or that the personage expects him/her to behave in a certain way, the individual would tend to defer and follow. Ajzen (1985) explained further that before an intention to behave would occur, the subjective norm would occur first. This would influence the attitude or behavior, thus affecting the intention to behave. Zhang (2018) also stated that believing in other's ideas without any doubts could affect either having a positive or negative attitude. The quantitative results also found that the subjective norm consisted of the three observed variables with the standard regression weights and R^2 as follows: (1) social pressure had the standard regression weight = 0.899 and R^2 = 0.809. This was congruent with Ajzen and Fishbein (1980), who found that an individual would behave by following the personages and the society that they lived in. Like Bommer et al. (1987), he stated that an individual would behave with an attitude influenced by a personage. (2) Normative belief had the standard regression weight = 0.909 and R^2 = 0.826. This was congruent with Kruse et al. (2018), who discovered that the attitude and behavior of an individual arose from the personages in their life, i.e., family, relatives, and close friends. Personal beliefs and behavior arose from intimates (Reyes-Mercado and Rajagopal, 2017) and beliefs arose from media, social networks, and advertising exposure (Bhattacherjee, 2000). (3) The motivation to comply with the reference had the standard regression weight = 0.787 and R^2 = 0.619. This was congruent with Ajzen and Fishbein (1980), who stated that an individual behaves following a motivation deferring to the

expectation of a reference group. Likewise, Mascherek et al. (2014) mentioned that an individual's behavior was based on the belief in people with greater maturity, including any beliefs arising from listening to guest speakers (Sun et al., 2015). This was congruent with the qualitative result from the interview from the experts, executives, users and others involved in solar rooftop energy of households in Thailand. Using solar rooftop can show a good image to the house owner particularly in preserving environment and being the pioneer in renewable energy in the community. If the people in that community see success for the pioneer, they will follow to install solar rooftop. According to their viewpoints, today's social networks facilitate easier and greater access to social media. People search for more information and use big data, or easier interpersonal communication. This implies that society is a key factor affecting the subjective norm. Even so, despite people's subjective norm following social networks, they would finally make a decision based on a self-reference the most for installing a solar rooftop. In addition, Thai family currently is a group of many members living together. It is consisted of many generations in a family. There is perhaps different opinions on something; however, they usually listen to the majority in doing something. This was congruent with Sreen et al. (2018), who conducted research on the impact of culture, behavior and gender on the green purchase intention in which the variables consisted of the subjective norm, perceived behavioral control, attitude toward green products, and gender. The population of the study comprised educated urban consumers in India with their need to use eco-friendly materials. The TPB was applied, and the results found that the subjective norm directly and positively affected the attitude toward green products. In the same way, Ali et al. (2019) conducted research consisting of independent variables, i.e., attitude, the subjective norm, and perceived behavioral control of Pakistanis purchasing energy-saving products. The results found that the subjective norm directly and positively affected the attitude of their purchasing behavior. In addition, Abreu et al. (2019) studied new trends in using solar energy in which the results found that the subjective norm directly and positively affected the attitude toward the adoption of rooftop PV system on buildings in the United States.

"H3: Attitude directly affects the intention to use."

According to the hypothesis test, it was found that attitude directly and significantly affected the intention to use (coef. = 0.484; $p < .01$). Therefore, H3 was true and accepted. Kotler (1997) stated that attitude is a learned likelihood to behave following the satisfaction or

dissatisfaction toward a certain item. Therefore, attitude is necessary for consumer behavior (Huang et al., 2004). This was congruent with the TRA and TPB that used attitude as a key concept to predict human behavioral intention (Ajzen, 1985; Ajzen and Fishbein, 1980). Like Reyes-Mercado and Rajagopal (2017), Korcaj et al. (2015) studied the intention of adopting photovoltaic systems by homeowners, whereas Engelken et al. (2018) examined the reasons that homeowners wanted self-supply energy and how policymakers could influence them. The quantitative results found that attitude consisted of the three observed variables with the standard regression weights and R^2 as follows: (1) the cognitive component had the standard regression weight = 0.844 and R^2 = 0.713. This was congruent with Chowdhury and Salam (2015), who discovered that knowledge and idea processing through perception from different sources led to beliefs. Moreover, Kim et al. (2014) suggested that the perceived information about quality, properties, values, and significance of products or services led to beliefs. (2) The affective component had the standard regression weight = 0.946 and R^2 = 0.894. Emotional attitude and feelings of consumers basically arose from their experiences based on the preference or impression toward a certain item. This was congruent with Weng et al. (2018), who found that emotions and feelings of an individual arose from the product or service consumption that resulted in an expected impression. In addition, Chowdhury and Salam (2015) stated that positive or negative feelings of each individual toward products or services affected attitude. (3) The behavioral component had the standard regression weight = 0.891 and R^2 = 0.794. This was congruent with Kim et al. (2014), who indicated that behavior was expressed from emotions and feelings according to the decision-making process and behavioral intention to choose the most suitable item in order to fulfill the emotions or feelings toward products or services (Chowdhury and Salam, 2015). This was congruent with the qualitative result from the interview from the experts, executives, users and others involved in solar rooftop energy of households in Thailand. They suggested that apart from intellect, emotion, feeling, and behavior, if consumers believed in something, they would do anything just to change their attitude toward that thing as well as behavior. This was congruent with Claudy, Peterson and O'Driscoll (2013), who investigated a renewable energy system being applied as an alternative for people in Ireland. The results found that attitude positively affected the intention to use the system. Yu and Lee's study (2019) also found that green value, functional value, emotional value, esthetic value, social value, and self-expressive value positively affected product attitude, the mediator/intervening variable. In addition, it directly and positively affected the intention to buy upcycled products of Americans.

Yazdanpanah, Komendantova and Ardestani (2015) studied the structural model of the factors influencing public acceptance and willingness to use renewable energy sources in Iran. The results found that attitude and perceived behavioral control positively affected the intention to use renewable energy (Ahmad et al., 2017; Jeamwittayanukul, 2017; Mohammad and Baharun, 2016). Additionally, Römer et al. (2015) conducted an empirical analysis of the adoption of IS-enhanced energy storage systems. The data from the survey was gathered from 339 decision-makers for modifications of privately-owned houses in Germany. The conceptual framework consisted of the perceived ease of use, perceived usefulness, attitude, and the intention to use. The results found that attitude positively affected the intention to use an energy storage system (ESS). Kim et al. (2014) conducted a survey on the factors significantly affecting people's intention to use solar energy technology in South Korea. They found that attitude positively affected the Koreans' intention to use this kind of technology. Chen, Xu and Frey (2016) assessed the social-psychological predictors of adoption intention and policy support in China by using renewable energy technology, e.g., solar water heaters and alternative fuel vehicles. The results found that environmental attitudes positively and hugely affected the adoption intention and policy support of the aforementioned items.

"H4: Subjective norm directly affects the intention to use."

According to the hypothesis test, it was found that the subjective norm directly and significantly affected the intention to use (coef. = 0.217; $p < .01$). Therefore, H4 was true and accepted. This was congruent with Ajzen (1991), who mentioned that the perception of personages affected behavior that tended to defer and follow. This was also congruent with the qualitative result from the interview from the experts, executives, users and others involved in solar rooftop energy of households in Thailand by specifying that the driver from peers, relatives, family, or trusted people can influence the decision to use solar rooftop. This group of people is not primarily concerned with cost but they pay attention on the intention to protect environment. Yun and Lee (2015) studied the SEM of the factors determining societal readiness toward renewable energy system adoption. The results found that attitude, subjective norm, and perceived behavioral control positively affected the intention to use renewable energy. This was congruent with Vassanadumrongdee and Kittipongvises' study (2017) of the factors influencing the source separation intention and willingness to pay for improving waste management in Bangkok, Thailand. As most developing countries including Thailand have faced a lack of recycling facilities and low

level of source separation practice, by extending the TPB and employing 1,076 questionnaire surveys, both the subjective norm and knowledge on the municipal solid waste situation were found to have a positive correlation with Bangkokians' source separation intention and willingness to pay. Engelken et al. (2018) also studied the reasons homeowners wanted self-supply energy and how policymakers could influence them. This was because the subsidies from the German government reduced households' behavioral motivations that had changed by starting to adopt various technologies to supply themselves with energy. The data of this study included 20 qualitative interviews and 395 quantitative surveys among homeowners of houses and apartments in Germany. In addition to attitude, the subjective norm and perceived behavioral control were important predictors of households' purchase intention of renewable energy system components. Huang and Ge (2019) found that subjective norm had some impact on the purchasing intention of EVs in Beijing, China. This was congruent with Chen, Xu and Frey (2016), who studied the need for solar water heaters and alternative fuel vehicles in China in which the model of TPB was used. The factors consisted of the attitude toward renewable energy, perceived behavioral control, subjective and descriptive norms, and knowledge on renewable energy affecting the intention to use solar water heaters and alternative fuel vehicles. The results found that the subjective norm positively affected the intention to support the use of solar water heaters and alternative fuel vehicles (Reyes-Mercado and Rajagopal, 2017; Sreen et al., 2018).

"H5: Perceived usefulness directly affects attitude."

According to the hypothesis test, it was found that perceived usefulness directly and significantly affected attitude (coef. = 0.884; $p < .01$). Therefore, H5 was true and accepted. If a business could offer quality products and services fulfilling consumers' needs, it could lead to the intention to use those products or services in the future with sustainability when perceived usefulness occurred in terms of quality, efficiency, and outcomes of using them (Römer et al., 2015). Teo et al. (2015) stated that perceived usefulness toward innovation and technology was absolutely different based on attitude and personal beliefs (Davis, 1989; Wang et al., 2018). This was congruent with Davis (1989), who suggested using TAM in which perceived usefulness and perceived ease of use were studied. He found that these factors affected attitude, influenced the intention to use, as well as the actual use of technological products. This was also congruent with the studies by Kim et al. (2014) on an integrated adoption model of solar energy technologies in

South Korea and Saengsuwa (2017) on smart grid adoption by Thai consumers in which TAM was used. The quantitative results found that perceived usefulness consisted of the three observed variables with the standard regression weights and R^2 as follows: (1) personal benefit had the standard regression weight = 0.842 and R^2 = 0.708. Consumers were aware of the outcomes obtained from consumption, including facilitation in life (Weng et al., 2018), responsiveness (Ahmad et al., 2017), and better quality of life (Wang et al., 2018). (2) Environmental benefit had the standard regression weight = 0.718 and R^2 = 0.515. Environmental awareness brought energy-saving products or services to consumers (Römer et al., 2015). Those products or services were also eco-friendly (Ertz et al., 2016) with electricity storage capacity for future use (Ahmad et al., 2017). Nonetheless, the products had to be safe with no electrical short circuits (Wang et al., 2018). (3) Awareness of cost reduction had the standard regression weight = 0.862 and R^2 = 0.743. Consumers were also aware of other costs of the products or services in terms of repair, maintenance, electricity cost reduction (ASIC, 2012; Wang et al., 2018), reasonability, and worthiness (Römer et al., 2015).

This was congruent with the qualitative result of the interview from the experts, executives, users and others involved in solar rooftop energy of households in Thailand. They viewed perceived usefulness as the most necessary factor affecting the intention to use a solar rooftop. This was because most people did not want to generate electricity from a solar rooftop for sale but for their own personal daily use. Therefore, perceived usefulness or what would be obtained from solar energy would be what people would be mainly concerned about. Alternatively, they could be educated regarding this issue to make sure that solar rooftop system was easy and convenient to use, that they could be actually utilized, and were really useful for daily consumption. However, most people basically focused on personal benefit first and cost reduction in installing a solar rooftop before perceived environmental benefit. This was congruent with Nikou (2018) who conducted a study on smart homes and smart living of households in Finland. The independent variables consisted of perceived usefulness, perceived ease of use, relative advantage, and consumer perceived innovativeness. These variables directly and positively affected the attitude toward using smart home technology; and also affected the intention to use smart home technology in that country. Additionally, Korcaj et al. (2015) studied the adoption of photovoltaic systems by homeowners and found that the very first factor affecting consumers' attitude was the willingness to install solar PV systems, which were perceived as an environmental benefit. The overall cost of

PV systems was worth a one-time investment because they could be used for the long term. Similarly, Ahmad et al. (2017) studied the acceptance of residential solar photovoltaic technology in Malaysia and found that the perceived ease of use and perceived usefulness of solar PV technology affected the attitude toward this kind of technology and influenced the behavioral intention to use it. Römer et al. (2015) found that perceived usefulness directly and positively affected the attitude in terms of accepting to use Energy Storage System (ESS). The study from privately owned houses in Germany was congruent with the study of Kim et al. (2014). It was found that perceived benefits, system quality, and perceived trust were the key factors determining the attitude toward solar energy technology.

"H6: Perceived usefulness directly affects the intention to use."

According to the hypothesis test, it was found that perceived usefulness directly and significantly affected the intention to use (coef. = 0.280; p=.043). Therefore, H6 was true and accepted. Awareness of consumers' needs, feelings, and perceived values from consumption was a key factor leading to the sustainable intention to use or purchase. Kotler, Armstrong and Opresni (2016) stated that actual purchase initially arises from awareness, knowledge, liking, preference, and conviction. These factors basically affect the behavioral intention to use renewable energy. This would occur naturally starting when consumers believed that renewable energy was clean and eco-friendly, and that it could be reused unlimitedly (Akinwale et al., 2014). The results also found that the intention to use consisted of the three observed variables with the standard regression weights and R^2 as follows: (1) behavioral intention 1 had the standard regression weight = 0.861 and R^2 = 0.741, (2) behavioral Intention 2 had the standard regression weight = 0.889 and R^2 = 0.790, and (3) behavioral intention 3 had the standard regression weight = 0.899 and R^2 = 0.809. This was congruent with Ahmed and Sathish (2017), who found that the intention to use brought behavior that led to the acceptance of a certain item, or to responsiveness, or to emotional decision-making on a certain product at a certain time (Bigne et al., 2001). This consumer behavior arose from the influence of personal interest (Ananda and Herath, 2008) leading to the purchase intention based on consumers' satisfaction toward that particular business (Thirumalai and Sinha, 2011). This was congruent with the qualitative result from the interview from the experts, executives, users and others involved in solar rooftop energy of households in Thailand. At present, consumers need knowledge called "consumer knowledge" because they intend to use a solar rooftop. Searching for

knowledge on such matters can simply be accessed. This would let the related stakeholders in the solar rooftop industry know about the consumers who have the intention to use a solar rooftop. Therefore, as people have more knowledge about this product, they could compare the payment of the electricity costs and the information about the investment on the installation resulting in lower electricity costs, or the effect from the economics of force. This would be the knowledge of those with the intention to use, including the factors in terms of price, environmental concept, and health concept (safety). These key issues would reflect their higher intention to use. Another key issue would be the driver in terms of the image or concept among those with the intention to use a solar rooftop. This group of people would not focus mainly on price; thus, this would reflect their environmental-concerned intention, i.e., environmental protection, and global warming prevention. In their opinion, a solar rooftop must be easy to use with functional convenience and simple maintenance methods. This was congruent with Kardooni et al. (2016) who studied the goodness of fit of attitude toward using renewable energy and perceived usefulness on the intention to accept renewable energy technology in Malaysia. The results found that perceived usefulness directly and positively affected the intention to use renewable energy (Hartmann and Apaolaza, 2012). Saengsuwan (2017) also studied the adoption of a smart grid adoption by Thai consumers. This researcher viewed smart grid technology as a technology of the future to increase the efficiency of electricity management. The principle of the smart grid is the combination of information and communication technology integrated with the transmission line leading to information exchange in real time between a supplier and a consumer. TAM was applied to the research. The results found that there were 14 factors, including environmental usefulness and feature usefulness affecting the consumers' acceptance and adoption of smart grid technology in Thailand. Wang et al. (2018) studied the adoption of EVs. The variables in the research consisted of knowledge, perceived risk, perceived usefulness, attitude, and adoption intention. The results found that perceived usefulness directly and positively affected attitude and adoption intention (Yun and Lee, 2019). This was congruent with Weng et al. (2018), who conducted a study on the use of multimedia by teachers in which TAM was used. The variables in the research comprised the perceived ease of use, perceived usefulness, attitude toward using multimedia, and the intention to use. It was found that perceived usefulness directly and positively affected the attitude and intention to use multimedia by school teachers (Hartmann and Apaolaza, 2012; Korcaj et al., 2015; Nikou, 2018).

5.3 Recommendations

This research study collected the empirical data, both quantitative and qualitative, then analyzed and interpreted the data. Because the results were very useful, the researcher would like to present the following recommendations.

5.3.1 Recommendations for the government sector

1. As a study shows that attitude and perceived usefulness are the most key factors for people to use solar rooftop, a government should emphasize the process and way to inform and educate people the benefits from using solar rooftop in their daily life. Annual budget and promotional program by responsible energy institutes can help make the benefits public to the people effectively.

2. As subjective norm is a factor that is effect to the intention to use solar rooftop, a government should drive or support campaigns of using a solar rooftop in households more seriously by setting an advertisement program by inviting the influential people or the celebrities as the successful samples in using solar rooftop. Some samples that can be conducted are announcing public relations campaigns or advertisements to the people for their acknowledgement, holding activities of promoting basic knowledge on solar rooftops to the general public, promoting campaigns of solar rooftop utilization, and showing the motivation of the government sector to purchase electricity from solar rooftop users.

3. Some people may think that those benefits are far from them as it seems that solar rooftop system is high in terms of personal investment. However, comparing to the benefits will prove that it is worthwhile for investment even though it will take many years for payback. A government may help reduce their investment by many forms such as the purchase of excess electricity from households' roofs or the subsidy to help people install solar rooftop. The government should seriously support using solar rooftop energy as part of people's daily life. Investment on this should also be supported. That is because the installation of a solar rooftop currently requires very high investment capital and takes a long time to achieve the break-even point. As a result, people who want to use a solar rooftop do not have sufficient investment capital; therefore, such support from the government is required.

4. Regulation support should be regarded by the government, as it is necessary for the intention to use a solar rooftop. Clear rules and regulations must be provided, as they hugely affect the people's decision-making about installing a solar rooftop. At present, the structure of purchasing

electricity in Thailand is an enhanced single-buyer model (ESB) with the Electricity Generating Authority of Thailand (EGAT) as the sole buyer. This top-down structure has created one current problem and obstacle. Therefore, rules and regulations must be unlocked to facilitate more peer-to-peer energy trade. Installed capacity of solar panels and purchasing prices must be clarified or be able to motivate people to install a solar rooftop, including setting taxation measures and compulsory measures to use a solar rooftop for new big houses and buildings. Some rules and regulations have to be changed to facilitate people to use solar rooftop. The convenience and simple process are important to make people feel easy to follow.

5. The government sector should remove any obstacles of solar rooftop acceptance, i.e., conflicts of laws and regulations with any complicated and ambiguous procedures, and the lengthy period of time to request for approval. Therefore, these conflicts must be solved by reviewing and amending those laws and regulations in order to increase the growth of solar rooftop energy.

6. The government sector should provide the budget for R&D support, along with information support and promote low-priced tools as well as equipment with a good and low-priced electricity storage system for better power stability. The battery should contain more capacity with a longer lifetime.

5.3.2 Recommendations for academics

The result of this research pointed out that the perceived usefulness is a key factor to attitude and the intention to use solar rooftop energy of households in Thailand. It showed that people who intend to install a solar rooftop expect to receive benefits before making a decision to install the solar rooftop system on their house roofs. On the other hand, when the homeowners are aware of the benefits, it will result in a better attitude and more confidence in the intention to use of solar rooftop. The result of this study is in line with a study in Malaysia by Thong et al. (2017) who found that perceived benefit has a positive and significant effect on attitudes toward residential solar power systems. Moreover, attitudes toward residential solar power systems are also having positive influence on intention to use residential solar power systems in Malaysia. Moreover, it is consistent with the qualitative results in that all interviewees strongly agreed that the perceived benefit affects the intention of using solar rooftop by Thai people. The result is also consistent with Technology Acceptance Model (TAM) by Davis (1986), explaining that the intention to use of new technology was influential by perceived usefulness and perceived ease of use. This study shows

that the perceived usefulness is the most influential factor of Thai people to the acceptance and intention to use of solar rooftop of household in Thailand. Therefore, to encourage Thai people to use more solar rooftop, we can apply the concept from TAM theory by informing Thai people for the benefits and usefulness in installing a solar rooftop system.

5.3.3 Recommendations for solar industry professionals

1. Good design and reasonable cost of solar rooftop system should be well controlled so that people who installs solar rooftop will get real benefits from solar energy. Word of mouth is powerful and it will make others who are not yet install solar rooftop to become interested in trying to use it or study more by themselves which is finally the use of solar rooftop.

2. Conduct public relations campaigns and promote educating the people sector for their acknowledgement of the installation of a solar rooftop and its circuits lasting up to 20 years, the break-even point, expected benefits, cost saving, and environmental protection.

3. Safety is one of the major concerns from people. The power transmission system should be developed for more stability and safety. The battery system should also be developed for longer electricity storage generating a more stable solar rooftop system. Such knowledge should be transferred widely, too.

4. Involved agencies should conduct marketing plans with systematic implementation or create them into packages. They could also set promotions combined with engineering jobs, request for approval of the installation of a solar rooftop, break-even point analysis, installation, finding investment capital, and making contracts with homeowners in the form of an engineering, procurement and construction (EPC) project to facilitate the owners who want to install a solar rooftop but without any information nor knowledge, and are unable to install it on their own.

5. Promotion is necessary at this stage and it may come together with the real estate buying program. A new house with solar rooftop is effective as its cost of solar rooftop is combined to the house and the financial institutes can provide loan to both house and solar rooftop system as it is the accessory to the house.

6. Materials used for solar rooftop manufacturing should be developed to last for 20-25 years, which would make it a valuable investment. Waste and deteriorated equipment should be planned or managed, or methods for guidance and plans to remove such waste should be provided, or for repairs/replacements.

5.3.4 Recommendations for future research

1. Further studies on more factors of consumer innovation and public image influencing the intention to use solar rooftop energy of households in Thailand should be conducted. It is recommended that Exploratory Factor Analysis (EFA) is carried out prior to running the Confirmatory Factor Analysis (CFA) to identify the underlying relationships between observed variables and to identify the structure of the relationship between the variables and the respondent.

2. Comparative studies on the installation of a solar rooftop among users of different generations should be undertaken in order to examine the differences and similarities of opinions between the new and old generations.

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APPENDIX

APPENDIX A

QUESTIONNAIRE

Factors Influencing the Homeowners' Intention to Use Solar Rooftop Energy in Thailand

This questionnaire is a part of the research of the Doctor of Philosophy Program in Industrial Business Administration, Faculty of Administration and Management, King Mongkut's Institute of Technology Ladkrabang. All data obtained from this questionnaire would be compiled with data from other sets of questionnaires and processed as a statistical report regardless of the specific name of the agency or the individual.

There are 4 parts in the questionnaire.

Part 1: Personal Data of the Respondent

Part 2: Questions of the basic knowledge about solar rooftop

Part 3: Questions about the latent variables in the research

Definition of the 7-point Scale:

"7" Point: Completely agree, influence, true, or correspond to you.

"6" Point: Mostly agree, influence, true, or correspond to you.

"5" Point: Somewhat agree, influence, true, or somewhat correspond to you.

"4" Point: Moderately agree, influence, true, or correspond to you.

"3" Point: Slightly agree, influence, true, or correspond to you.

"2" Point: Insignificantly agree, influence, true, or correspond to you.

"1" Point: Mildly agree, influence, true, or correspond to you.

Part 4: Suggestions of respondents

Part 1: Personal Data of the Respondent

1. Gender

☐ male ☐ female

2. Age

☐ Under 20 years ☐ 21 - 30 years

☐ 31 - 40 years ☐ 41 - 50 years

☐ 51 - 60 years ☐ Older than 60 years

3. Highest education

☐ Under a bachelor's degree

☐ Bachelor's degree

☐ Higher than a bachelor's degree

4. Occupation

☐ Self-employed ☐ Company employee

☐ Government officer ☐ State enterprise employee

☐ Unemployed/Retired ☐ Other (please state): _____

5. Salary per month

☐ Not more than 35,000 Baht ☐ 35,001 – 70,000 Baht

☐ 70,001 – 100,000 Baht ☐ More than 100,000 Baht

6. Location of <u>current residence</u> (current residence is the house where you are living regularly)

☐ Bangkok (please state the district) _____

☐ Province (please state the province) _____

7. Type of your current residence

☐ Detached house ☐ Duplex house
☐ Townhouse ☐ Row house / building
☐ Condominium ☐ Other (please state): _____

8. Ownership of your current residence

☐ Owner ☐ Resident ☐ Other (please state): _____

9. Age of your current residence

☐ Under 1 year ☐ 1-4 years
☐ 5-10 years ☐ More than 10 years

10. Electricity cost per month of your current residence

☐ Not more than 1,000 Baht ☐ 1,001 – 3,000 Baht
☐ 3,001 – 5,000 Baht ☐ More than 5,000 Baht

Part 2: Questions of the basic knowledge about solar rooftop

2.1 General knowledge of solar rooftop system

1. What is the material in the solar panel that produce electricity?

☐ semiconductor ☐ steel ☐ plastic ☐ lead

2. What is the material used in the surface of solar panel?

☐ transparent plastic ☐ fiber ☐ metal ☐ glass

3. What is the process how electricity produced from solar panel?

☐ thermal ☐ exciting by electrons
☐ magnetic induction ☐ chemical reaction

4. What is the type of electricity produced from solar panel?

☐ direct current ☐ alternating current
☐ both direct and alternating current ☐ static current

5. Which equipment is needed and indispensable for solar rooftop system?

☐ Inverter ☐ fuse ☐ transformer ☐ insulator

6. At present, what is the approximated size (watt) of each solar panel available?

☐ 10 watt ☐ 100 watt ☐ 300 watt ☐ 500 watt

7. Currently Electricity Authorities allow the homeowners to sell electricity to the grid. How much is the unit price?

☐ 0.55 Baht ☐ 1.25 Baht ☐ 1.68 Baht ☐ 2.53 Baht

8. Which direction is best for facting the solar panel?

☐ North ☐ south ☐ east ☐ west

9. What is the best inclination of solar panel?

☐ Laydown on the roof ☐ less than 5 degree

☐ 10 – 15 degree ☐ more than 30 degree

10. which is the benefits from solar rooftop system?

☐ don't need the fuel ☐ reduce the problem of global warming

☐ cool the house ☐ all are correct

2.2 Self-evaluation of respondents

Question	Least ◄ ► Most						
	1	2	3	4	5	6	7
1. What is your knowledge level about the **techniques and standards** of a solar rooftop?							
2. What is your knowledge level about the **investment information** of a solar rooftop?							
3. What is your knowledge level about the **rules and regulations** about a solar rooftop?							
4. What is your knowledge level about **the efficiency and quality of equipment** of a solar rooftop system?							
5. What is your knowledge level about the **products and equipment brand** of a solar rooftop system?							

Part 3: Questions about the latent variables in the research

Please mark in the box that corresponds to your opinion.

Question	Least ◄——► Most						
	1	2	3	4	5	6	7
Intention to Use							
Behavior Intention							
1. Currently, you are interested in installing a solar rooftop at your house.							
2. If you bought or built a new house, you would be interested in installing a solar rooftop.							
3. You intend to install a solar rooftop on your house although it is not widely used.							
4. You have an idea to install a solar rooftop at your house in the near future.							
Government Policy							
Technological Support							
5. You now think that the government sector supports research and development (R&D) in solar rooftops more than before.							
6. You now think that the government sector continually initiates new innovations of solar rooftops through intensive R&D support.							
7. You now think that the government sector promotes the exchange of knowledge about a solar rooftop in order to develop innovations.							

Question	Least ◄——► Most						
	1	2	3	4	5	6	7
8. You now think that the government sector clearly promotes educating each local area on the ability to develop itself a solar rooftop.							
Economic Support							
9. You now think that the government sector has a policy to help investment for your cost reduction to use a solar rooftop.							
10. Currently, the government sector has measures to provide sufficient financial assistance and support so that you can use a solar rooftop.							
11. Up until now, you have been satisfied with the assistance supported by the government sector, and this has partly made you feel interested in using a solar rooftop.							
12. You now think that the government sector provides financial support and investment for the development of sample projects in your area to use a solar rooftop in order to make local inhabitants realize its usefulness and be interested in using solar rooftop.							
Regulatory Support							
13. You now think that the government sector issues renewable energy laws							

Question	Least ◄——► Most						
	1	2	3	4	5	6	7
that seriously support using a solar rooftop.							
14. You now think that the government sector issues concrete, clear, and simple rules and regulations to use a solar rooftop in order to promote it to be used widely.							
15. You think that the current policy of the government sector on using a solar rooftop clearly include regulations for both service providers and service users.							
16. You think that the current policy of the government sector on using a solar rooftop focuses on seriously developing it as a national source of renewable energy with stability and sustainability.							
Attitude							
Cognitive Component							
17. You agree that if a solar rooftop works, it would be good, and we should use it as much as possible to reduce household costs.							
18. You agree to use a solar rooftop for generating electricity in households in order to use solar energy, which is already available in nature.							

Question	Least ◄——► Most						
	1	2	3	4	5	6	7
19. You agree that the current situation is the most appropriate time to start using a solar rooftop.							
20. You believe that using electricity from a solar rooftop is worthwhile.							
Affective Component							
21. You think a solar rooftop is interesting.							
22. If a solar rooftop is installed at your house, it would facilitate your better living standard.							
23. You would feel impressed and proud if a solar rooftop was used at your house.							
Behavioral Component							
24. You intend to use a solar rooftop to produce electricity from solar energy than other types of renewable energy; such as, wind energy or waste energy for a better quality of life.							
25. You intend to use a solar rooftop at your house parallel to the power transmitted from the electricity authorities as usual.							
26. If you were free to choose electricity from any sources, you would choose to use a solar rooftop at your house to generate electricity.							
Subjective Norm							
Social Pressure							

Question	Least ◄——► Most						
	1	2	3	4	5	6	7
27. Acceptance from neighboring houses is a key factor influencing you to choose a solar rooftop.							
28. Acceptance from friends is a key factor influencing you to choose a solar rooftop.							
29. Acceptance from family members is a key factor influencing you to choose a solar rooftop.							
30. Media and advertisements about a solar rooftop; such as, TV, magazines and social networks make you interest in using a solar rooftop.							
Normative Belief							
31. You give priority to the decision-making from family members on using a solar rooftop.							
32. You give priority to decision-making from friends on using a solar rooftop.							
33. You would use a solar rooftop as suggested by influential persons in your life.							
Motivation to Comply with the Reference							
34. If your family members wanted you to install a solar rooftop, you would do so accordingly.							
35. If your friends convinced you to install a solar rooftop, you would do so accordingly.							

Question	Least ◄——► Most						
	1	2	3	4	5	6	7
36. If your favorite person; such as, a successful businessperson, actor or actress installed a solar rooftop, you would follow them.							
Personal Benefit							
37. You think using a solar rooftop could fulfill your need of daily electricity.							
38. You would use a solar rooftop if it would facilitate your life.							
39. You would use a solar rooftop if it gave you a better quality of life							
Environmental benefit							
40. You think that a solar rooftop would resolve the air pollution caused by electricity generation in Thailand, which comes mostly from combustion of coal and natural gas.							
41. You think that solar rooftop installation is to use clean energy, which is eco-friendly.							
42. You think that using electricity generated from a solar rooftop reduces the environmental problem and global warming.							
43. You believe that using electricity generated from a solar rooftop would be the electricity source in the future.							
Awareness of Cost Reduction							

Question	Least ◄——► Most						
	1	2	3	4	5	6	7
44. You believe using a solar rooftop helps reduce your electricity costs.							
45. For you, using a solar rooftop is a valued investment despite the high capital of investment and long period of return.							
46. You believe that installing a solar rooftop is one of the financial investments that could reduce household expenses.							

Part 4: Suggestions of respondents

Thank you very much for your information

If there is any suggestion, please contact 087-400-4040 or pongsapat@gmail.com

APPENDIX B

QUESTIONNAIRE (IN THAI)

แบบสอบถามงานวิจัย

ปัจจัยที่มีผลต่อความตั้งใจใช้พลังงานแสงอาทิตย์แบบติดตั้งบนหลังคารัวเรือนในประเทศไทย

แบบสอบถามนี้เป็นส่วนหนึ่งของงานวิจัยในหลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาบริหารธุรกิจอุตสาหกรรม คณะการบริหารและจัดการ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง ข้อมูลที่ได้จากแบบสอบถามชุดนี้ จะถูกนำไปใช้ร่วมกับข้อมูลที่ได้รับจากแบบสอบถามชุดอื่นโดยประมวลผลออกมาเป็นรายงานทางสถิติ จะไม่มีการอ้างอิงชื่อหน่วยงานใดหรือบุคคลใดเป็นการเฉพาะเจาะจง

แบบสอบถามนี้แบ่งออกเป็น 4 ส่วน ประกอบด้วย

ส่วนที่ 1 ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม (จำนวน 10 ข้อ)

ส่วนที่ 2 ความรู้ของผู้ตอบแบบสอบถาม (จำนวน 15 ข้อ)

ส่วนที่ 3 ข้อมูลเกี่ยวกับตัวแปร (จำนวน 46 ข้อ)

คำอธิบาย แบบสอบถามจะใช้ Scale 7 point ดังนี้

"7" คะแนน หมายถึง เป็นสิ่งที่ท่านเห็นด้วย มีอิทธิพล เป็นจริง หรือเกิดขึ้นตรงกับท่านมากที่สุด

"6" คะแนน หมายถึง เป็นสิ่งที่ท่านเห็นด้วย มีอิทธิพล เป็นจริง หรือเกิดขึ้นตรงกับท่านมาก

"5" คะแนน หมายถึง เป็นสิ่งที่ท่านเห็นด้วย มีอิทธิพล เป็นจริง หรือเกิดขึ้นตรงกับท่านค่อนข้างมาก

"4" คะแนน หมายถึง เป็นสิ่งที่ท่านเห็นด้วย มีอิทธิพล เป็นจริง หรือเกิดขึ้นตรงกับท่านปานกลาง

"3" คะแนน หมายถึง เป็นสิ่งที่ท่านเห็นด้วย มีอิทธิพล เป็นจริง หรือเกิดขึ้นตรงกับท่านค่อนข้างน้อย

"2" คะแนน หมายถึง เป็นสิ่งที่ท่านเห็นด้วย มีอิทธิพล เป็นจริง หรือเกิดขึ้นตรงกับท่านน้อย

"1" คะแนน หมายถึง เป็นสิ่งที่ท่านเห็นด้วย มีอิทธิพล เป็นจริง หรือเกิดขึ้นตรงกับท่านน้อยที่สุด

ส่วนที่ 4 ข้อเสนอแนะจากผู้ตอบแบบสอบถาม

ส่วนที่ 1 ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม (มีทั้งหมด 10 ข้อ)

11. เพศ

☐ ชาย ☐ หญิง

12. อายุ

☐ ไม่เกิน 20 ปี ☐ 21 - 30 ปี

☐ 31 - 40 ปี ☐ 41 - 50 ปี

☐ 51 - 60 ปี ☐ มากกว่า 60 ปี

13. ระดับการศึกษาสูงสุด

☐ ต่ำกว่าปริญญาตรี

☐ ปริญญาตรี

☐ สูงกว่าปริญญาตรี

14. อาชีพ

☐ ธุรกิจส่วนตัว ☐ พนักงานบริษัท

☐ รับราชการ ☐ พนักงานรัฐวิสาหกิจ

☐ ไม่ได้ทำงาน / เกษียณ ☐ อื่นๆ โปรดระบุ _____

15. รายได้เฉลี่ยต่อเดือน

☐ ไม่เกิน 35,000 บาท ☐ 35,001 – 70,000 บาท

☐ 70,001 – 100,000 บาท ☐ มากกว่า 100,000 บาท

16. สถานที่ตั้งของ<u>บ้านพักอาศัยหลัก</u>ของท่าน (บ้านพักอาศัยหลัก คือบ้านพักที่ท่านอาศัยอยู่เป็นประจำที่สุด)

☐ กรุงเทพมหานคร โปรดระบุเขต _____

☐ ต่างจังหวัด โปรดระบุจังหวัด _____

17. ประเภทของบ้านพักอาศัยหลักของท่าน

☐ บ้านเดี่ยว ☐ บ้านแฝด

☐ ทาวน์เฮาส์ ☐ อาคารพาณิชย์ / ตึกแถว

☐ คอนโด / อาคารชุด ☐ อื่นๆ โปรดระบุ _____

18. สถานภาพความเป็นเจ้าของ บ้านพักอาศัยหลักที่ท่านอาศัยอยู่

☐ เจ้าของบ้าน ☐ สมาชิกในบ้าน ☐ อื่นๆ โปรดระบุ _____

19. อายุของบ้านพักอาศัยหลักของท่าน ประมาณกี่ปี

☐ ไม่เกิน 1 ปี ☐ 1 - 4 ปี

☐ 5 - 10 ปี ☐ มากกว่า 10 ปี

20. ค่าไฟฟ้าเฉลี่ยต่อเดือน ของบ้านพักอาศัยหลักของท่าน

☐ ไม่เกิน 1,000 บาท ☐ 1,001 – 3,000 บาท

☐ 3,001 – 5,000 บาท ☐ มากกว่า 5,000 บาท

ส่วนที่ 2 วัดความรู้ของผู้ตอบแบบสอบถาม (มีทั้งหมด 15 ข้อ)

2.1 ความรู้ทั่วไปเกี่ยวกับระบบผลิตไฟฟ้าจากแสงอาทิตย์บนหลังคาบ้าน (Solar rooftop)

10. ระบบ Solar rooftop ประกอบไปด้วยแผงโซลาร์เซลล์ ซึ่งแผงนี้ใช้วัสดุอะไรในการทำให้เกิดกระแสไฟฟ้า

☐ สารกึ่งตัวนำ ☐ เหล็ก ☐ พลาสติก ☐ ตะกั่ว

11. แผงโซลาร์เซลล์ มีผิวหน้ารับแสงเป็นวัสดุอะไร

☐ พลาสติกใส ☐ ไฟเบอร์ ☐ โลหะ ☐ กระจก

12. ไฟฟ้าจากพลังงานแสงอาทิตย์ผลิตจากแผงโซลาร์เซลล์บนหลังคาบ้าน เกิดได้ด้วยกระบวนการใด

☐ ความร้อน ☐ กระตุ้นทางประจุไฟฟ้า
☐ เหนี่ยวนำทางสนามแม่เหล็ก ☐ ปฏิกิริยาทางเคมี

13. ไฟฟ้าที่ผลิตได้จากแผงโซลาร์เซลล์เป็นกระแสไฟฟ้าประเภทใด

☐ ไฟฟ้ากระแสตรง ☐ ไฟฟ้ากระแสสลับ
☐ เป็นได้ทั้งไฟฟ้ากระแสตรงและสลับ ☐ ไฟฟ้าสถิต

14. อุปกรณ์ใดจำเป็นในระบบ Solar rooftop บนหลังคาบ้าน

☐ อินเวอร์เตอร์ ☐ ฟิวส์ตัดไฟ ☐ หม้อแปลงไฟฟ้า ☐ ฉนวนไฟฟ้า

15. แผงโซลาร์เซลล์ที่ใช้ บนหลังคาบ้านในปัจจุบัน มีขนาดแผงละประมาณกี่วัตต์ (Watt)

☐ 10 วัตต์ ☐ 100 วัตต์ ☐ 300 วัตต์ ☐ 500 วัตต์

16. ปัจจุบัน การไฟฟ้าฯอนุญาตให้สามารถจ่ายไฟฟ้าจาก Solar rooftop บนบ้านพักอาศัย ส่วนที่เหลือใช้ เข้าระบบของการไฟฟ้าฯ ได้หน่วยละเท่าไร

☐ 55 สตางค์ ☐ 1.25 บาท ☐ 1.68 บาท ☐ 2.53 บาท

17. ควรตั้งแผงโซลาร์เซลล์หันรับแสงทิศใด ดีที่สุด

☐ ทิศเหนือ ☐ ทิศใต้ ☐ ทิศตะวันออก ☐ ทิศตะวันตก

18. การติดตั้งแผงโซลาร์เซลล์ ควรอยู่ในมุมเอียงเท่าใดจึงเหมาะสมที่สุด

☐ วางนอนกับพื้น ☐ ไม่เกิน 5 องศา
☐ 10 – 15 องศา ☐ มากกว่า 30 องศา

10. ข้อใดเป็นประโยชน์จากระบบ Solar rooftop บนหลังคาบ้าน

☐ ไม่ใช้เชื้อเพลิงในการผลิตไฟฟ้า ☐ ช่วยลดสภาวะโลกร้อน
☐ ช่วยให้บ้านเย็น ☐ ถูกทุกข้อ

2.2 การประเมินระดับความรู้เกี่ยวกับระบบผลิตไฟฟ้าจากแสงอาทิตย์บนหลังคาบ้าน (Solar rooftop)

ข้อคำถาม	ระดับความคิดเห็นของท่าน น้อยที่สุด ◄——► มากที่สุด						
	1	2	3	4	5	6	7
6. ท่านคิดว่าระดับความรู้ของท่าน**ด้านเทคนิคและมาตรฐานต่างๆ**ในระบบ Solar rooftop อยู่ระดับใด							
7. ท่านคิดว่าระดับความรู้ของท่าน**ด้านข้อมูลเงินทุน**ที่เกี่ยวกับระบบ Solar rooftop อยู่ระดับใด							
8. ท่านคิดว่าระดับความรู้ของท่าน**ด้านกฎระเบียบกฎเกณฑ์ ข้อบังคับจากภาครัฐ**ที่เกี่ยวกับ Solar rooftop อยู่ระดับใด							
9. ท่านคิดว่าระดับความรู้ของท่าน**ด้านประสิทธิภาพและคุณภาพของอุปกรณ์**ในระบบ Solar rooftop อยู่ระดับใด							
10. ท่านคิดว่าระดับความรู้ของท่าน**ด้านผลิตภัณฑ์และยี่ห้อของอุปกรณ์**ในระบบ Solar rooftop อยู่ระดับใด							

ส่วนที่ 3 ข้อมูลเกี่ยวกับตัวแปรที่มีอิทธิพลต่อความตั้งใจใช้พลังงานแสงอาทิตย์แบบติดตั้งบนหลังคาครัวเรือนในประเทศไทย (มีทั้งหมด 46 ข้อ)

โปรดทำเครื่องหมาย / ในช่องที่ตรงกับความคิดเห็นของท่าน

ข้อคำถาม	ระดับความคิดเห็นของท่าน น้อยที่สุด ◄——► มากที่สุด						
	1	2	3	4	5	6	7
การตั้งใจใช้ (Intention to Use)							
พฤติกรรมการตั้งใจบริโภค (Behavior Intention)							
47. ในปัจจุบันนี้ ท่านมีความสนใจที่จะติดตั้งระบบผลิตไฟฟ้าจากแสงอาทิตย์บนหลังคาบ้าน (Solar rooftop) ของท่าน							
48. หากท่านซื้อบ้านใหม่หรือสร้างบ้านใหม่ ท่านสนใจที่จะติดตั้งระบบ Solar rooftop บนหลังคาบ้านของท่าน							
49. ท่านตั้งใจที่จะติดตั้งระบบ Solar rooftop ที่บ้านของท่าน แม้ว่ายังไม่มีการใช้กันอย่างแพร่หลายก็ตาม							
50. ท่านมีแนวคิดที่จะติดตั้งระบบ Solar rooftop ที่บ้านของท่าน ในอนาคตอันใกล้นี้							
นโยบายของรัฐบาล (Government Policy)							
การสนับสนุนด้านเทคโนโลยี (Technological Support)							
51. ท่านคิดว่าในปัจจุบันภาครัฐมีการสนับสนุนการวิจัยและพัฒนา (R&D) เกี่ยวกับระบบ Solar rooftop มากกว่าที่ผ่านมา							
52. ท่านคิดว่าในปัจจุบันภาครัฐมีการคิดนวัตกรรมใหม่ๆเกิดขึ้นได้อย่างต่อเนื่องเกี่ยวกับระบบ Solar rooftop จากการ							

ข้อคำถาม	ระดับความคิดเห็นของท่าน น้อยที่สุด ◄——► มากที่สุด						
	1	2	3	4	5	6	7
สนับสนุนให้มีการวิจัยและพัฒนา (R&D) อย่างจริงจัง							
53. ท่านเห็นว่าในปัจจุบันภาครัฐมีการสนับสนุนให้มีการแลกเปลี่ยนองค์ความรู้ระหว่างกันเกี่ยวกับระบบ Solar rooftop เพื่อช่วยพัฒนานวัตกรรมด้านนี้ให้ดีขึ้น							
54. ท่านคิดว่าในปัจจุบันภาครัฐมีการส่งเสริมอย่างชัดเจนในด้านการให้ความรู้ในแต่ละท้องที่ให้สามารถพัฒนาระบบ Solar rooftop ได้เอง							
การสนับสนุนด้านการลงทุน (Economic Support)							
55. ท่านคิดว่าในปัจจุบันภาครัฐมีนโยบายช่วยเหลือด้านการลงทุนเพื่อลดค่าใช้จ่ายท่านในการใช้ระบบ Solar rooftop							
56. ปัจจุบันภาครัฐมีมาตรการให้ความช่วยเหลือและสนับสนุนด้านการเงินอย่างเพียงพอ เพื่อช่วยให้ท่านสามารถใช้ระบบ Solar rooftop							
57. ที่ผ่านมาท่านพอใจในความช่วยเหลือที่ภาครัฐมีการสนับสนุน และมีส่วนทำให้ท่านสนใจเลือกใช้ระบบ Solar rooftop							
58. ท่านเห็นว่าในปัจจุบันภาครัฐได้ส่งเสริมด้านการเงินและการลงทุนให้มีการพัฒนาโครงการตัวอย่างในพื้นที่ของท่านให้มีการใช้ระบบ Solar rooftop เพื่อให้คนในท้องที่นั้นๆเห็นประโยชน์และสนใจใช้ระบบ Solar rooftop							

ข้อคำถาม	ระดับความคิดเห็นของท่าน น้อยที่สุด ◄——► มากที่สุด						
	1	2	3	4	5	6	7
การสนับสนุนด้านกฎระเบียบ ข้อบังคับ (Regulatory Support)							
59. ท่านเห็นว่าในปัจจุบันภาครัฐมีการออกกฎหมายเกี่ยวกับพลังงานทดแทน ที่สนับสนุนการใช้ระบบ Solar rooftop อย่างจริงจัง							
60. ท่านคิดว่าในปัจจุบันภาครัฐมีการออกกฎระเบียบที่เป็นรูปธรรม ชัดเจน และง่ายต่อการใช้ระบบ Solar rooftop เพื่อส่งเสริมให้ประชาชนใช้กันอย่างแพร่หลาย							
61. ท่านคิดว่าการจัดทำนโยบายของภาครัฐในปัจจุบันเกี่ยวกับการใช้ Solar rooftop มีข้อกำหนดที่ครอบคลุมทั้งผู้ให้บริการและผู้ใช้บริการอย่างชัดเจน							
62. ท่านคิดว่าการจัดทำนโยบายของภาครัฐในปัจจุบันเกี่ยวกับการใช้ Solar rooftop มีการเน้นในเรื่องการพัฒนาให้เป็นแหล่งพลังงานที่มั่นคงและยั่งยืนของประเทศอย่างจริงจัง							
ตัวแปรทัศนคติ (Attitude)							
องค์ประกอบด้านปัญญา (Cognitive Component)							
63. ท่านเห็นด้วยว่าหากสามารถผลิตไฟฟ้าจากระบบผลิตไฟฟ้าจากแสงอาทิตย์บนหลังคาบ้าน (Solar rooftop) ได้จริง จะเป็นสิ่งดีที่เราควรนำมาใช้กันให้มากที่สุดเพื่อลดค่าใช้จ่ายในครัวเรือน							
64. ท่านเห็นด้วยกับการนำระบบ Solar rooftop มาผลิตไฟฟ้าใช้ในบ้าน เพื่อใช้							

ข้อคำถาม	ระดับความคิดเห็นของท่าน น้อยที่สุด ◄——► มากที่สุด						
	1	2	3	4	5	6	7
พลังงานแสงอาทิตย์ที่มีอยู่แล้วจากธรรมชาติ							
65. ในสถานการณ์ปัจจุบัน ท่านคิดว่าเป็นช่วงเวลาที่เหมาะสมแล้วในการเริ่มใช้ระบบ Solar rooftop							
66. ท่านเชื่อว่าการใช้ไฟฟ้าจากระบบ Solar rooftop เป็นการใช้พลังงานที่คุ้มค่า							
องค์ประกอบด้านอารมณ์และความรู้สึก (Affective Component)							
67. ท่านคิดว่าระบบผลิตไฟฟ้าจากแสงอาทิตย์บนหลังคาบ้าน (Solar rooftop) เป็นสิ่งที่น่าสนใจ							
68. หากบ้านของท่านมีการติดตั้งระบบ Solar rooftop จะมีส่วนช่วยให้การดำเนินชีวิตของท่านดีขึ้น							
69. ท่านจะรู้สึกประทับใจและภูมิใจ ถ้าบ้านของท่านมีการนำระบบ Solar rooftop มาใช้							
องค์ประกอบด้านพฤติกรรม (Behavioral Component)							
70. ท่านตั้งใจที่จะใช้ระบบ Solar rooftop ในการผลิตไฟฟ้าจากพลังงานแสงอาทิตย์มากกว่าจากพลังงานทดแทนชนิดอื่น เช่น พลังงานลม พลังงานจากขยะ ฯลฯ เพื่อคุณภาพชีวิตที่ดีขึ้น							
71. ท่านตั้งใจจะใช้ระบบ Solar rooftop ในการผลิตไฟฟ้ามาใช้ในบ้านของท่านเพื่อเสริมกับไฟฟ้าที่ส่งมาจากระบบของการไฟฟ้าตามปกติ							

ข้อคำถาม	ระดับความคิดเห็นของท่าน น้อยที่สุด ◄——► มากที่สุด						
	1	2	3	4	5	6	7
72. หากท่านมีอิสระในการเลือกใช้ไฟฟ้าจากแหล่งต่างๆ ท่านจะเลือกใช้ระบบ Solar rooftop ในการผลิตไฟฟ้าใช้ในบ้านของท่าน							
การคล้อยตามกลุ่มอ้างอิง (Subjective Norm)							
แรงกดดันจากสังคมรอบข้าง (Social Pressure)							
73. การได้รับการยอมรับจากบ้านข้างเคียงเป็นปัจจัยสำคัญให้ท่านเลือกใช้ระบบผลิตไฟฟ้าจากแสงอาทิตย์บนหลังคาบ้าน (Solar rooftop)							
74. การได้รับการยอมรับจากเพื่อนเป็นปัจจัยสำคัญให้ท่านเลือกใช้ระบบผลิตไฟฟ้าจากแสงอาทิตย์บนหลังคาบ้าน (Solar rooftop)							
75. การได้รับความเห็นด้วยจากสมาชิกในครอบครัว เป็นสิ่งสำคัญที่ทำให้ท่านเลือกใช้ระบบ Solar rooftop							
76. สื่อโฆษณาเกี่ยวกับระบบ Solar rooftop เช่น ทางทีวี วารสาร หรือโซเชียลเน็ตเวิร์ก ทำให้ท่านมีความสนใจใช้ระบบ Solar rooftop							
ความเชื่อเกี่ยวกับกลุ่มอ้างอิง (Normative Belief)							
77. ท่านให้ความสำคัญกับการตัดสินใจของสมาชิกในครอบครัวที่มีต่อการใช้ระบบ Solar rooftop							
78. ท่านให้ความสำคัญกับการตัดสินใจของเพื่อนที่มีต่อการใช้ระบบ Solar rooftop							

ข้อคำถาม	ระดับความคิดเห็นของท่าน น้อยที่สุด ◄——► มากที่สุด						
	1	2	3	4	5	6	7
79. ท่านจะใช้ระบบ Solar rooftop ตามคำแนะนำของบุคคลที่มีความสำคัญในชีวิตท่าน							
ความต้องการทำตามกลุ่มอ้างอิง (Motivation to Comply with the Reference)							
80. ถ้าสมาชิกในครอบครัวของท่านต้องการให้ท่านติดตั้งระบบ Solar rooftop ท่านจะปฏิบัติตามความเห็นของบุคคลในครอบครัว							
81. ถ้าเพื่อนรอบตัวท่าน ชวนให้ท่านติดตั้งระบบ Solar rooftop ท่านจะปฏิบัติตามความเห็นของเพื่อนท่าน							
82. ถ้าบุคคลที่ท่านชื่นชอบ เช่น นักธุรกิจที่ประสบความสำเร็จ หรือดารานักแสดงติดตั้งระบบ Solar rooftop ท่านจะปฏิบัติตาม							
การรับรู้ผลประโยชน์ (Perceived Usefulness)							
ผลประโยชน์ต่อตนเอง (Personal Benefit)							
83. ท่านคิดว่าการใช้ระบบผลิตไฟฟ้าจากแสงอาทิตย์บนหลังคาบ้าน (Solar rooftop) สามารถตอบสนองความต้องการของท่านในการใช้ไฟฟ้าในชีวิตประจำวันได้							
84. ท่านจะใช้ระบบ Solar rooftop เพื่อผลิตไฟฟ้าจากแสงอาทิตย์ ถ้าการใช้นั้นทำให้ชีวิตท่านสะดวกสบายขึ้น							
85. ท่านจะใช้ระบบ Solar rooftop เพื่อผลิตไฟฟ้าจากแสงอาทิตย์ ถ้าการใช้นั้นทำให้คุณภาพชีวิตของท่านดีขึ้น							

ข้อคำถาม	ระดับความคิดเห็นของท่าน น้อยที่สุด ◄——► มากที่สุด						
	1	2	3	4	5	6	7
ผลประโยชน์ต่อสิ่งแวดล้อม (Environmental benefit)							
86. ท่านคิดว่าระบบผลิตไฟฟ้าจาก Solar rooftop จะช่วยลดปัญหามลภาวะทางอากาศจากการผลิตไฟฟ้าของไทยที่ปัจจุบันส่วนใหญ่มาจากการเผาไหม้ของถ่านหินและก๊าซธรรมชาติ							
87. ท่านคิดว่าการติดตั้งเพื่อใช้ Solar Rooftop ผลิตกระแสไฟฟ้า เป็นการใช้พลังงานสะอาดและเป็นมิตรต่อสิ่งแวดล้อม							
88. ท่านเชื่อว่าการใช้ไฟฟ้าจาก Solar Rooftop ช่วยลดมลภาวะทางด้านสิ่งแวดล้อมและช่วยลดปัญหาโลกร้อนได้							
89. ท่านมีความเชื่อมั่นว่าการใช้ไฟฟ้าจาก Solar Rooftop จะสามารถใช้เป็นแหล่งพลังงานไฟฟ้าในอนาคตได้							
การรับรู้เกี่ยวกับค่าใช้จ่ายที่ลดลง (Awareness of Cost Reduction)							
90. ท่านเชื่อว่าการใช้ระบบ Solar Rooftop จะช่วยลดภาระค่าไฟฟ้าที่บ้านของท่านได้							
91. สำหรับท่าน การใช้ระบบ Solar rooftop ในการผลิตไฟฟ้ามีความคุ้มค่าในการลงทุนมากที่สุด แม้ว่าจะมีการลงทุนสูงและมีระยะเวลาในการคืนทุนค่อนข้างนานก็ตาม							
92. ท่านเชื่อว่าการติดตั้งระบบ Solar rooftop เป็นหนึ่งในรูปแบบการลงทุนทาง							

ข้อคำถาม	ระดับความคิดเห็นของท่าน น้อยที่สุด ◄——► มากที่สุด						
	1	2	3	4	5	6	7
การเงินของท่านที่ดีรูปแบบหนึ่งในการช่วยลดค่าใช้จ่ายในครัวเรือนของท่าน							

ส่วนที่ 4 ข้อเสนอแนะของผู้ตอบแบบสอบถาม

ขอขอบคุณที่ท่านได้กรุณาให้ความร่วมมือในการตอบแบบสอบถามอย่างสมบูรณ์

หากมีข้อแนะนำเพิ่มเติมประการใด กรุณาติดต่อเบอร์ 087-400-4040 หรือ pongsapat@gmail.com

APPENDIX C

IN-DEPTH INTERVIEW

To collect data from the interview, it was conducted by purposive sampling. The interview was conducted to gather the significant aspects of the five latent factors, i.e., 1) government policy, 2) subjective norm, 3) perceived usefulness, 4) attitude, and 5) intention to use. The data were synthesized systematically and presented in a descriptive form with the connection between the interview data and the conceptual framework.

The interviewees comprised 11 persons who are the experts, executives, users, and senior officers from related energy authorities involved in solar rooftop energy. They were listed as follows:

1) Interviewee #1	Business development manager from a property company
2) Interviewee #2	Industrial engineer
3) Interviewee #3	Environmental & public senior office from a renewable energy company
4) Interviewee #4	Community relation manager from a private power producer
5) Interviewee #5	Gynecologist
6) Interviewee #6	General manager at a solar energy company
7) Interviewee #7	Risk management manager from a private power producer
8) Interviewee #8	Senior professional officer from a governmental sector
9) Interviewee #9	Alternative energy manager from Provincial Electricity Authority
10) Interviewee #10	Researcher at the Faculty of Medicine
11) Interviewee #11	Freelance lecturer

Issues in the in-depth interview

Issue 1	Do you think the indicators of the government policy consist of the following? 1) technological support 2) economic support 3) regulatory support Are there any other indicators? (If yes), what are they? Please comment.
Interviewee 1	Agree. Support the idea that the government sector should purchase electricity from solar rooftop generated from the house because usually the electricity cannot be sold to government by individuals.
Interviewee 2	Agree. Government should more support renewable energy, to support knowledge sharing to remote communities such as hospitals, schools, temples, etc.
Interviewee 3	Agree. The government should add measures or policies that persuade people to get involved and to provide information and knowledge to people regarding benefits to them.
Interviewee 4	Agree. The government should support the price of the battery to be cheaper and being able to store electricity for longer period. There should also be more innovative device for solar rooftop for more efficiency.
Interviewee 5	Agree. The government should support the price of installation to be cheaper because consumers do not want to produce electricity from solar rooftop for sales but they want to produce for use in daily life
Interviewee 6	Agree. Consumers are increasingly demanding solar panels but the permission to install solar rooftop is a big obstacle at the moment.
Interviewee 7	Agree. The government should support the learning centers that provide knowledge to the public or technical sharing (knowledge sharing).
Interviewee 8	Agree. Knowledge and understanding of people are important, especially in technology. Nowadays, in the power purchase structure, one of the problems and obstacles is the regulation, which should be unlocked to allow peer-to-peer energy trading.
Interviewee 9	Agree with the policy that will be very important in make people become a user of solar power rooftop.

Interviewee 10	Agree. The government should help support the purchase of electricity and tax-reduction measures for positive support.
Interviewee 11	Agree. The government must create a clear atmosphere of support. With a concrete expression, there should be good communication and the procedure is possible in practice.

Issue 2	Do you think the indicators of subjective norm consist of the following? 1) social pressure 2) normative belief 3) motivation to comply with the referent Are there any other indicators? (If yes), what are they? Please comment.
Interviewee 1	Agree. From easy access to social media, it makes people can more easily search for information, find information from educators, experts, and other people who like it. There is easier communication between users.
Interviewee 2	Agree. Families today are different in generation. People in new generation will have their own ideas more than follow the others. Therefore, it is not always necessary to conform to the referring person.
Interviewee 3	Agree. Consumers are environmentally conscious. It is their intention to actually use it and can make decisions by themselves.
Interviewee 4	Agree. Consumers see that in the future, or the trend of the global society, the use of renewable energy is something that should be done more.
Interviewee 5	Agree. Needs or attitudes of intention to use modern things or seeing people whom they like lead to the good attitude to follow.
Interviewee 6	Agree. Consumers want to be leaders by themselves, not by others.
Interviewee 7	Agree. The characteristics of the self-reliance of the people is another important factor that should be studied. More access to social media and more self-knowledge is a nature of people nowadays.
Interviewee 8	Agree. Access and use of big data increases. Easy communication makes people more inclined to refer to other people whom they like or respect.
Interviewee 9	Agree. Consumers usually have already the intention to install solar roof already. Therefore, consumers will go to find a reference group or search for

	information that needs to be used to support the decision to install solar rooftop or build confidence.
Interviewee 10	Agree. The fact that people believe that the use of solar power installed on a house roof is useful causes people to search for more information about solar rooftop.
Interviewee 11	Agree. Confidence leads to more motivation for solar rooftop or being difference makes the leader in using solar energy.

Issue 3	Do you think the indicators of perceived usefulness consist of…? 1) personal benefit 2) environmental benefit 3) awareness of the cost reduction Are there any other indicators? (If yes), what are they? Please comment.
Interviewee 1	Agree. The use of renewable energy helps save energy and reduce the import of oil.
Interviewee 2	Agree. Using renewable energy helps reduce fossil fuel import which will benefit the economy of the country.
Interviewee 3	Agree. Awareness of self-benefits in being a leader in the use of renewable energy to take part in saving energy and finally to protect the environment.
Interviewee 4	Agree. Currently, there is a promotion to support the use of solar energy that can reduce costs and protect the environment. This will be beneficial for the consumers and can generate income.
Interviewee 5	Agree. In the past, the government or users themselves have not seen the true benefits of solar rooftop, but at present there is a promotion and support to increase this knowledge; thus, giving consumers a positive attitude.
Interviewee 6	Agree. Most consumers think that using renewable energy is beneficial to individual.
Interviewee 7	Agree. At present, consumers in business get a lot of benefits by using solar power.

Interviewee 8	Agree. When user see other people being installed and make them see that there is a real benefit, then such user will install solar rooftop system for his own benefit.
Interviewee 9	Agree. In most cases, the public will mainly look at their own interests in installing a solar rooftop. The awareness of the environment is later.
Interviewee 10	Agree. Consumers look first at benefits for themselves, reduce costs and indirectly benefit to environment by reducing small dust or PM2.5.
Interviewee 11	Agree. Although the installation cost of solar rooftop is high, consumers are aware that it is worthwhile in reducing electricity bills in the long run.

Issue 4	Do you think the indicators of attitude consist of the following? 1) cognitive component 2) affective component 3) behavioral component Are there any other indicators? (If yes), what are they? Please comment.
Interviewee 1	Agree. Consumer's attitudes come from both an internal factor (the habit of doing things regularly) and an external factor (receiving information, news, and technology).
Interviewee 2	Agree. Consumers are interested in cheaper electricity bills without considering at high investment, long break-even point, and long service life.
Interviewee 3	Agree. Consumers intend to use when they know the obvious benefits; resulting in a positive attitude towards usage.
Interviewee 4	Agree. Some consumers want to be an influencer because nowadays they use more social media; therefore, they want to use solar rooftop before anyone else.
Interviewee 5	Agree. Apart from the intelligence, emotion, and behavior if consumers have a certain belief, they can follow everything.
Interviewee 6	Agree. Person's belief can make a change in his/her attitude.
Interviewee 7	Agree. When consumers begin to have knowledge, the cost data was compared, i.e. electric cost and investment information for installation including the pros and cons of installation.

Interviewee 8	Agree. Personal beliefs can cause changes in attitudes, aside from the intelligence, emotions, feelings and behaviors that occur.
Interviewee 9	Agree. Promoting or campaigning to use more renewable energy by installing solar energy system on the house roof makes consumers a good attitude towards using solar rooftop.
Interviewee 10	Agree. Consumers have recently changed their attitude towards the use of renewable energy by use of materials that can store energy for longer time, has a long service life, be environmentally friendly, and be easily disposed.
Interviewee 11	Agree. Consumers have behaviors that require simple operation, convenience, and easy maintenance.

Issue 5	Do you think the intention to use consists of behavioral intention? Are there any other indicators? (If yes), what are they? Please comment.
Interviewee 1	Agree. Individuals who learn that solar rooftop helps reduce electricity cost can guide them to have the intention to use more of solar rooftop.
Interviewee 2	Agree. Economic, price, environment, and safety are important issues that reflect higher consumers' intentions.
Interviewee 3	Agree. The government sector is providing concrete compensation; resulting in the intention to use solar rooftop by consumers.
Interviewee 4	Agree. The image is a driver or concept of some people without considering the cost of solar rooftop.
Interviewee 5	Agree. Because in the future, the electricity tariff will be higher, causing the electricity cost to increase too. The intention to use of solar rooftop should be more from the public.
Interviewee 6	Agree. Searching more information by consumers these days leads to higher intentions.
Interviewee 7	Agree. People usually compare electricity cost and installation cost to decide about the intention to use.
Interviewee 8	Agree. In particular, the acceptance of the quality of a product is something that should be added to the behavior of the intention to use of solar rooftop.

Interviewee 9	Agree. Intentional behavior means that buyers don't have to worry about maintenance, repairs, or equipment replacement.
Interviewee 10	Agree. When the general public are able to sell electric power to the government, it causes the general public to have more behavior intention to use solar energy.
Interviewee 11	Agree. Collaboration between the government and the private sector will make the people more knowledgeable and have more behavior intention to use solar rooftop.

Issue 6	Do you think government policy directly affects the intention to use and how? Please comment.
Interviewee 1	Yes. If the government policy promotes knowledge in technology and investment, it should affect the intention to use.
Interviewee 2	Yes. Regulations are what will make people decide to install or not install solar roof on the house.
Interviewee 3	Yes. When the government has supported, invited to create incentives for reducing household expenses and and provided concrete compensation, it will result in consumers' willingness to use more.
Interviewee 4	Yes. The promotion of the government that allows private sector to participate in providing knowledge to the public sector, deregulate solar power installation and electricity is increasingly being purchased from the public sector
Interviewee 5	Yes. Establishing the government policies that use appropriate amount and form of renewable energy will make consumers more willingness to switch to install solar rooftop.
Interviewee 6	Yes. The announcement of electricity purchase program from the public sector has not yet been satisfied to the public sector. Therefore, the government policy is an important driving force for intention to use.
Interviewee 7	Yes. Regulation Support is very important when it comes to roof-top solar power. In addition, if the rules are too weak, it is likely that those who intend to use solar rooftop are less likely to decide to invest in the installation.

Interviewee 8	Yes. Knowledge in solar technology is very important, resulting in the decision to install solar panels. Regarding the regulations, if it is not clear, it will cause consumers to use less. Therefore, regulations are important in order to make people decide to install solar panels.
Interviewee 9	Yes. The government's regulatory policies help support the use and installation of solar rooftop.
Interviewee 10	Yes. Government supports such as electricity purchase, tax deduction measures, knowledge support will be the incentives to increase installation.
Interviewee 11	Yes. The increase in measures from the government and communication to the public must be clear, resulting in more intention to use solar rooftop from the people.

Issue 7	Do you think subjective norm directly affects attitude and how? Please comment.
Interviewee 1	Yes. Due to the social characteristics of Thai family that is large, conforming to those close to them is an important factor greatly affecting the attitudes of use.
Interviewee 2	Yes but little influence because new generation usually thinks differently from older generation. They may not always conform to other people but they will decide by themselves.
Interviewee 3	Yes. Demand for leadership in the society of renewable energy use helps promote a positive attitude to consumers because such consumers see that the use of solar rooftop is the modern leadership.
Interviewee 4	Yes. Social attitudes towards the use of solar rooftop can change from their favorite people.
Interviewee 5	Yes. Analysis of data by consumers and knowledge gained from the reference group and the desire to be a leader in new technology results in a change in attitude towards use of solar rooftop.
Interviewee 6	Yes. Reference groups are another matter that most consumers have to look at but consumers have to look at many aspect before making a decision to use solar rooftop.

Interviewee 7	Yes. Generation diversity that lives in the same place leads to diverse opinions. Compliance with the reference group is therefore an important factor in changing attitudes.
Interviewee 8	Yes. Getting more social makes consumers to receive information from people in the society, which is easier to communicate. Therefore, the subjective norm is considered an important factor that will make people likely to follow with their references.
Interviewee 9	Yes but social conformity tends to be somewhat less than normative belief. If a person believes in searching for information about installing a solar rooftop, it will directly affect the attitude to install a solar rooftop system.
Interviewee 10	Yes. Nowadays, people are more self-reliant by seeking more information from social media. This causes awareness, understanding, and more skills which is important for changing attitudes towards using electricity from solar rooftop.
Interviewee 11	Yes. Reference groups or from the search for information help support the decision to install solar rooftop or build confidence. This will create motivation to make a positive attitude.

Issue 8	Do you think attitude directly affects the intention to use and how? Please comment.
Interviewee 1	Yes. Consumers have a good attitude towards renewable energy, which consequently affects the intention to use when consumers recognize many benefits.
Interviewee 2	Yes. If consumers are already interested in certain things, their attitudes will change accordingly.
Interviewee 3	Yes. User's attitude is the result of receiving information from social media and having positive thoughts. It will then make a user intend to use in daily life.
Interviewee 4	Yes. Consumers may change their attitude if they get better information which is different from the previous knowledge.

Interviewee 5	Yes. Changes in new technology resulting in changes in personal attitudes and beliefs. This will be a good effect to the intention to use of solar rooftop.
Interviewee 6	Yes. Preserving the environment by using renewable energy will help promote a positive attitude towards consumers towards the use of solar rooftop.
Interviewee 7	Yes. Being able to search for information easily makes a positive attitude towards the use of solar rooftop.
Interviewee 8	Yes. Beliefs are what consumers think that if they believe in something, such consumers will follow what they believe and it will change their behavior.
Interviewee 9	Yes. The internal thrust of consumers is the attitudes towards that matter, giving consumers the willingness to use or install alternative energy.
Interviewee 10	Yes. Consumers who are aware of the benefit of renewable energy to the environment will have a positive attitude towards the solar rooftop and will then affect their intention to use.
Interviewee 11	Yes. The consumer's attitude is the driving force of his willingness to use. When consumers have received clear information and understand, they will turn to a good attitude.

Issue 9	Do you think subjective norm directly affects the intention to use and how? Please comment.
Interviewee 1	Yes. In today's society, conformity with favorite people is easy as it causes as they want to be like a leader. This reflects the intention to use as a leader.
Interviewee 2	Yes. The diverse groups of people have different opinions. Especially the younger generation who have their own ideas and will not easily conform to others when making decisions. Usually they decide by themselves.
Interviewee 3	Yes. As society uses more solar rooftop, it is important to enhance the image of users as the ones who help preserve the environment or be a leader. Then, there will be the intention to use solar rooftop afterwards.
Interviewee 4	Yes. Modernization or seeing other people who like to use things that are up-to-date will result in intention to use.

Interviewee 5	Yes. Social media is easily accessible cause the public to search for information from people who know more. Therefore, society causes some users to follow to the reference group accordingly.
Interviewee 6	Yes. Some users follow from on-line social reference groups and then decide based on themselves in decision to install the solar rooftop.
Interviewee 7	Yes. Entering the online community of consumers through education will cause awareness and information Understanding the rapidly changing technology, some users may want to follow, resulting in the intention to use accordingly.
Interviewee 8	Yes. When consumers have beliefs from the surrounding society, they can follow others. Some consumers may follow from the study by themselves. There will be learning by doing until understanding and affecting the intention to use.
Interviewee 9	Yes. The influencing factors of the reference group play a role in making people more willing to use solar rooftop. However, it does not play a role in all decisions, because investment is more important for decision making. If external pressure comes in, the consumers need to have more detailed studies, particularly in technical issues.
Interviewee 10	Yes but little effect, as consumers are not only looking at others but also in other aspects such as investment, technical issues and necessity.
Interviewee 11	Yes. Experts can be a reference group play a major role in stimulating the consumers to have intention to use solar rooftop.

Issue 10	Do you think perceived usefulness directly affects attitude and how? Please comment.
Interviewee 1	Yes. When consumers recognize the benefits received in terms of costs and environment preservation, it will then affect the positive attitude towards the use of renewable energy.
Interviewee 2	Yes. When users clearly see that the use of solar rooftop is easy to use and useful in daily life, it will then change the users' attitude.

Interviewee 3	Yes. Benefits that consumers are aware of can result in changes of consumers' attitude.
Interviewee 4	Yes. In the past, most consumers still did not see or imagine the benefits from solar rooftop. But nowadays, consumers are able to realize their benefits more easily even before installation; this therefore have more positive attitude towards using solar rooftop.
Interviewee 5	Yes. Investing in a solar rooftop is a big issue for consumers, but when seeing the obvious benefits, it has a positive attitude to install it.
Interviewee 6	Yes. Using renewable energy helps save household energy and reduce the destruction of the environment is something that consumers already know and affect to their good attitude towards using renewable energy.
Interviewee 7	Yes. Behavior in following or imitating the consumers comes from the perceived benefits. Therefore, those consumers have a good attitude and want to follow for their own benefit.
Interviewee 8	Yes. Motivation that arises with consumers is important. When consumers have more knowledge, which is caused by finding more knowledge from self-reliance and being aware of the benefits, it has a positive attitude towards using renewable energy.
Interviewee 9	Yes. Consumers are able to perceive benefits for themselves and aware of expense reduction, resulting in changing attitudes of consumers both directly and indirectly.
Interviewee 10	Yes. As for the perceived benefits, it is the factor that directly affects the consumers' attitude. When consumers recognize the benefits, they have a positive attitude towards that thing.
Interviewee 11	Yes. Consumers will mainly consider their own benefits, which will result in a better attitude.

Issue 11	Do you think perceived usefulness directly affects the intention to use and how? Please comment.
Interviewee 1	Yes. When consumers see the benefits to themselves or their organization, it will affect their intention to use without looking at other issues.

Interviewee 2	Yes. When seeing concrete benefits from solar rooftop, consumers have therefore developed into their own interests with the intention to use it.
Interviewee 3	Yes. Installation cost and the reduced expenses resulting in more installation which eventually results in higher willingness to use.
Interviewee 4	Yes. The fact that consumers themselves can create benefits to society is important to their own interests. This will make others intend to use solar rooftop as benefits to the community continues to spread widely.
Interviewee 5	Yes. Reduced electricity bills are tangible benefit together with the reduction of fossil fuels for combustion to produce electricity as well as improving the environment are reasons why people intend to widely use solar rooftop.
Interviewee 6	Yes. The fact that consumers have high electricity costs and can see the benefits that solar rooftop can reduce electricity bills. This will affect the intention to use renewable energy although sometimes consumers may not yet have any knowledge about solar rooftop.
Interviewee 7	Yes. Consumers may not look at the short-term break-even point but looking at the benefits that can greatly affect the intended use of solar rooftop.
Interviewee 8	Yes. When consumers perceive that it is truly useful, they intend to use immediately.
Interviewee 9	Yes. The perception of the benefits of consumers, especially in terms of their own benefits and the perceived cost reduction is what consumers want or is the intention that consumers want.
Interviewee 10	Yes. The perceived benefits have a direct effect on the willingness to use renewable energy for sure.
Interviewee 11	Yes. Consumers will take advantage of their own. When they perceive their own benefits, consumers will intend to use solar rooftop.

Issue 12	Do you think subjective norm indirectly affects the intention to use through attitude and how? Please comment.
Interviewee 1	Yes. The driving forces resulting from the changing society enable consumers to change their attitude both positively and negatively. When the surrounding society reflects good things, it will result in the intention to use accordingly.

Interviewee 2	Yes. Environmental campaigns for using clean energy, such as solar energy, are a priority for consumers when information is provided by experts to encourage incentives for intention to use of renewable energy.
Interviewee 3	Yes. Some groups of consumers do not think primarily about cost but they sometimes look at the preference of the person who is the leader or a person whom they respect. This will reflect the intention to use solar rooftop accordingly.
Interviewee 4	Yes. Consumers accept and follow people who have expertise in providing information about the solar roof. This will make the belief that is important to their behavior of intention to use.
Interviewee 5	Yes. In the past, consumers are worried about complicated instruction to install/use and lack of data to support their decisions. But nowadays, the behavior or attitude of consumers has changed when seeing other people using solar rooftop and then consumers are willing to use it.
Interviewee 6	Yes. When consumers see groups of people who are closed to the consumers get benefit from the use of solar rooftop, there is a good tendency to consumers to use too.
Interviewee 7	Yes. Support of knowledge by experts will make people interested in using solar energy because educating people about the installation of solar rooftop that are useful, reduces costs and helps protect the environment has made a positive change in consumers' attitude.
Interviewee 8	Yes. The direct impact of beliefs arising from social pressure; resulting in an attitude to the use of solar rooftop.
Interviewee 9	Yes. When consumers are under social pressure from a reference group, it then creates an attitude that enhances what consumers have intended to do or helps build consumer confidence resulting in a willingness to use solar rooftop.
Interviewee 10	Yes. Following with reliable reference groups can change a consumer's attitude in intention to use solar rooftop.

Interviewee 11	Yes. Human behavior is changable to the reference groups of the surrounding society and it can then change a positive attitude towards the use of solar energy.

Issue 13	Do you think perceived usefulness indirectly affects the intention to use through attitude and how? Please comment.
Interviewee 1	Yes. Safety measures and the benefits that consumers can receive from solar rooftop will be able to change their attitudes and become more willing to use solar rooftop.
Interviewee 2	Yes. Benefits from using clean renewable energy will change consumers' attitude to install solar rooftop.
Interviewee 3	Yes. People are aware of benefits to themselves and to environment, resulting in a positive attitude towards the intention of using solar energy.
Interviewee 4	Yes. Nowadays, electricity usage has increased, resulting in higher household expenses. Consumers therefore changed their mind to use solar energy from solar rooftop on their house roof because they know they can reduce costs and not damage the environment.
Interviewee 5	Yes. People who know some about solar energy and are aware of its benefits, resulting in a changing attitude to the use of solar rooftop.
Interviewee 6	Yes. When consumers perceive the benefits to themselves and they know that they can sell excess electricity from solar rooftop, it makes such consumers have a positive attitude, resulting in the intention to use solar rooftop accordingly.
Interviewee 7	Yes. Most people don't want to install solar rooftop for sale but for production of electricity for daily usage because these people are aware of the reduced cost, causing the behavior to change and want to use more solar energy.
Interviewee 8	Yes. Consumers can actually see value of solar rooftop and make awareness of its benefits, which positively affects the attitude towards solar energy.
Interviewee 9	Yes. The benefits that consumers are aware of are definitely both direct and indirect. When consumers realize the benefits that are in line with what they already thought, it will strengthen them to use the solar rooftop. Even though

	if consumers have a bad attitude to solar rooftop, once real benefits are realized, consumers can change their attitudes and intention to use solar rooftop.
Interviewee 10	Yes. When consumers are aware of the benefits of using solar energy and household electricity bills can be reduced. It will result in a good view, affecting the willingness to use solar energy.
Interviewee 11	Yes. Consumers mainly want benefits for themselves, while their benefits are something that can be learned later. This affects consumers to change their opinions to a positive attitude and then intention to use solar rooftop afterwards.

Issue 14	Which variable do you think affects the intention to use the most? Please rank the variables from most to least effect and please comment.
Interviewee 1	Perceived Usefulness, Government Policy, Attitude, Subjective Norm
Interviewee 2	Perceived Usefulness, Government Policy, Attitude, Subjective Norm
Interviewee 3	Perceived Usefulness, Government Policy, Subjective Norm, Attitude
Interviewee 4	Perceived Usefulness, Government Policy, Attitude, Subjective Norm
Interviewee 5	Perceived Usefulness, Government Policy, Attitude, Subjective Norm
Interviewee 6	Perceived Usefulness, Government Policy, Attitude, Subjective Norm
Interviewee 7	Perceived Usefulness, Government Policy, Attitude, Subjective Norm
Interviewee 8	Government Policy, Perceived Usefulness, Subjective Norm, Attitude
Interviewee 9	Perceived Usefulness, Government Policy, Attitude, Subjective Norm
Interviewee 10	Government Policy, Perceived Usefulness, Attitude, Subjective Norm
Interviewee 11	Perceived Usefulness, Attitude, Government Policy, Subjective Norm

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