

# **A Knowledge Enhancement about Business Potential for Smart Residence Technology System in Thailand for Communities**

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## **Abstract**

Smart residence is one of advanced technologies, which has been gradually and increasingly recognized nowadays. Smart residence is based on home automation providing the selling points of convenience and image of the resident. The concept of home automation was used in Thailand over the past 20 years. However, nowadays it is likely developed into smart residence. Since Thailand has more global warming awareness caused by increasing amounts of fossil fuel. Smart residence is considered as one alternative to reduce electrical energy generated from fossil fuel. The initial stage to develop smart residence, the first principle approach is that the resident uses electricity produced by electricity providers and self-supply energy supplied with renewable energy. Also, energy storage system and information and communication technologies must be installed. Consequently, smart residence system will be developed to be very desirable residence, home-area network and sustainable smart town. In the future, the complete system will comprise: monitor; forecast; manage and control.

The purpose of this study is to enhance understanding and to address Thailand's readiness to move forward business for smart residence technology system in various aspects. The aspect of policy is to boost renewables, smart grid system, energy storage system, intelligent charging system (V2G). Furthermore, the customers (users), economy and business are highlighted to support business for this smart residence technology system. The up-to-date information of this paper is obtained from literature reviews, purposive in-depth interviews and questionnaires with

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qualitative SWOT analysis method. Some results show Thailand energy policy availability, considerable purchasing power and payment for benefit and satisfaction achievement of Thais. The implications of these findings clearly reflect business potential for smart residence technology system in Thailand.

**Keywords:** energy 4.0, smart residence, electrical vehicles (V2G, G2V), information and communication technologies

## Introduction

The energy plays an essential role to human survival in the modern digital age. In daily life, residence, travel, transport, agriculture, industry, education and communications must inevitably use energy. The energy is, in fact, highly beneficial to us. However, energy conversion affects quality of environment and the health of all living things since most energy sources come from fossil fuel, namely, coal, oil and natural gas, etc. The population growth consequently affects energy and electricity consumption (Office of the National Economics and Social Development Board, 2017) (Department of Alternative Energy Development and Efficiency, 2016), resource grabbing, including lack of environmental awareness due to familiarity of living with comfort and convenience, namely when the switch is turned on, the electricity is promptly used. Therefore, the effects of global warming is increasing every year. Additionally, digital era creates enormous disruption to human lifestyle. Thus smart residence technology system considers suitable for business investment decision because of environment concerns, energy saving, money saving, quality of life as well as nation energy security.

Thailand's GDP (Purchasing Power Parity (PPP)) is equivalent to US Dollars 14,333 ranked as the fourth in ASEAN countries, next to Singapore, Brunei and Malaysia (United Overseas Bank Limited, 2016). In 2015 (Kasikornbank Public Company Limited, 2015) compared with neighboring countries like Singapore, Malaysia and Indonesia, Thailand has an advantage which is key regional connecting points in ASEAN "Thailand the Gateway to ASEAN" and is the world's industrial production base. Also, it has secure financial institution. The civil state policy and investment in AEC (United Overseas Bank Limited, 2016) : Thailand was one of ASEAN Economic Community (AEC). Presently, the government proceed with policy of Public Private Partnerships (PPP), (Office of the National Economics and Social Development Board, 2017) which changed from the previous concept of the private sector seeking for the government support to the new concept of the private sector participation in every stages based on the proportion between 70% of private sector funding and 30% of the government funding

(Office of the National Economics and Social Development Board, 2017).

According to the national strategic plan (Office of the National Economics and Social Development Board, 2017), it showed that research, development, commercial implementation and environment-friendly solutions can support community in the way of creative thinking and of quality society creation. Personnel's knowledge and expert in each of the fields will be used to help the government solve problems. In efforts to create private sector's confidence in political stability and the government's continuous mobilization of policy. Consequently, the economic system stabilizes. Thailand's strategies emphasized 6 aspects 1) security 2) capabilities-based competition 3) development and personnel potential forming 4) equality of opportunity in society 5) improvements in quality of life based on environment-friendly and 6) balanced scorecard for government's management system development.

Thailand has Electricity / Capita equivalent to 1,961 kWh, also ranked as the fourth in ASEAN countries next to Singapore, Brunei and Malaysia (Setthapun, W et al., 2015). In the recent past 2-3 years, e-commerce is a rapidly growing market. The channel of business increases and the e-commerce turnover is forecasted to increase at triple when determining the relative value of an amount of US Dollars 1.4 billion in 2015, and will reach US Dollars 4 billion in 2020 (Kasikornbank Public Company Limited, 2015). It is expected that e-commerce sales via mobile phone will increase to 130% and the government plan that 95% of people have access to high speed internet in 2020, which large budget will be allocated. In this case, National Digital Economy Master Plan is set by the government to promote the channel of e-commerce market sales. According to the 12<sup>th</sup> National Economic and Social Development Plan (NESDP: 2017-2021), the Thailand 4.0 development policy (Office of the National Economics and Social Development Board, 2017)) is set to focus on quality society and people's living through technology in place of human labor and to create disruptive technology and innovation, which will lead to the turning point in leaping development of economy, society and the quality of people's life. In each step of the development process will be based on the state public policy, which is the mutual investment between government and private sector (Public Private Partnership: PPP) in the ratio of 70 for private sector and 30 for state sector. Notwithstanding, private section has to participate in every step starting from the research, innovation development and implementation of research & development outcomes for commercial purpose.

Transition from Thailand 4.0 (smart Thailand) to Thailand Integrated Energy Blueprint: TIEB (2015-2036) is the long-term energy management plan comprising five plans: Power Development Plan (PDP), Energy Efficiency Plan (EEP), Alternative Energy Development Plan (ADEP), Gas Plan, and Oil Plan. Ministry of Energy expected that if the implementation of Energy 4.0 policy (smart energy system) effectively meet the plans, Thailand will reduce the

energy consumption by 30% in 2036, the fossil fuel consumption about one million barrels per day, greenhouse gas emission around 111 million tons per year and the amount of electricity generation approximately 10,000 MW (Department of Alternative Energy Development and Efficiency, 2016)(Ministry of Energy, 2015). Therefore, the policy enhances electricity generation sector as follows:

1. To promote PV rooftop installation and allocate the 200 MW quota in excess of electricity to sell back to the National Grid, which is the starting point of smart residence with two way communication, and for self consumption

2. To promote electricity generation by using energy resources from renewable energy (19,634 MW) and create electricity generation security from renewable energy by entering into power purchase agreement (firm: hybrid renewable energy for electricity generation)

3. To develop electric batteries for electrical vehicles (EVs): vehicle to grid, grid to vehicle (V2G, G2V) to increase long term capacity storage of large amounts of energy

4. To develop plug-in hybrid electrical vehicles (EV) and normal & quick charge stations since it is forecasted that the next 8-9 years from now EV cost in Thailand will be lower than USD 28,000 and will be sold at competitive price with fossil fuel vehicles

5. To develop smart meter system (AMI: Advanced Metering Infrastructure, AMR: Automatic Meter Reading) to monitor and calculate electricity consumption and

6. To develop the system of generation, transmission, distribution, and consumption to reach increased reliability

Energy 4.0 (smart energy system) is a policy of Ministry of Energy. To create smart energy system, information and communication technologies (ICT) system is required for development so that smart energy management will serve to provide monitoring, controlling, forecasting and managing in compliance with electrical system functions.

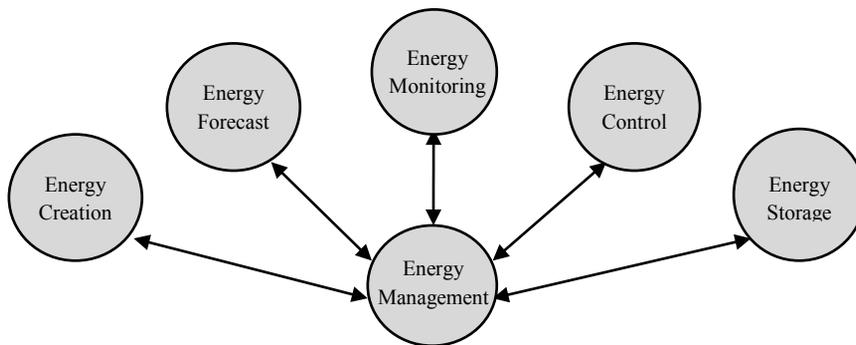
With the above-mentioned opportunities, this paper focuses on the study of business potential with SWOT analysis for smart residence technology system in Thailand.

## **Literature Review**

### **Smart Residence System**

Smart residence technology business is a new business which was developed from home automation system. The definition of smart residence differed from normal residence is the accommodation designed to be into intelligent automation systems with energy consumption

information (Sumi Helal et al., 2005). Also, their functions are to monitor, forecast, manage and control energy consumption Figure 1 (Fujisawa SST Council, Panasonic Corporation, 2014). Furthermore, their device provides energy efficiency and energy savings directives. Household electricity is derived from electricity provider and renewable energy generation with the energy storage system. In general, the findings from the research revealed that the smart residence technologies have the advancement of ICT in various ways. However, all of them is based on integration of architecture, electricity and ICT for services rendered to the improvement in quality of life; good health, safety and more convenience (Sumi Helal et al., 2005) (Amir Hosein Ghaffarian Hosein et al., 2013).



**Figure 1:** Smart Residence Energy System

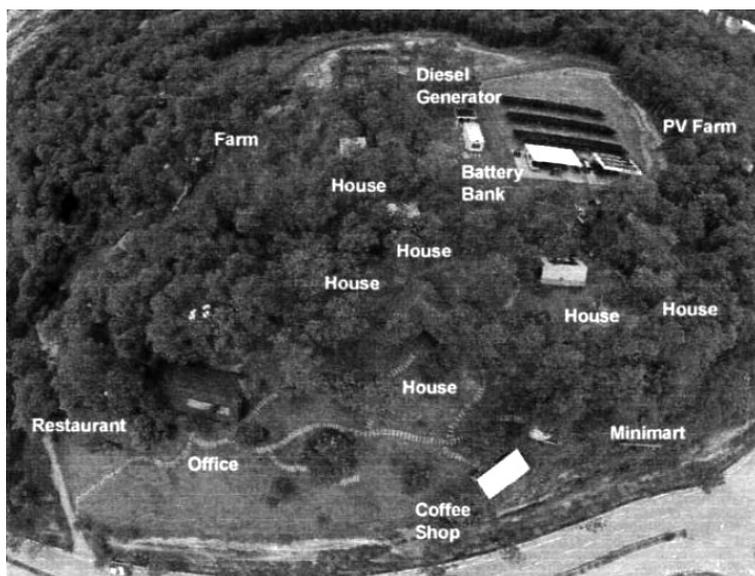
Thailand has “The Nest” which is the ASEAN’s 1st Energy Plus house: the next eco-sustainable technology for home, under research and development (R&D) process, Figure 2.



**Figure 2:** “The Nest”

“The Nest” by SCG living technology (The Siam Cement Group Public Company Limited, 2016) is designed for sustainable home in the future to be smart, eco-friendly and cared with 542 sq.m., 2 floors, 4 bedrooms and 5 bathrooms. The total energy generated from solar cells is equivalent to 16,899 kWh/year, whereas the total energy use (energy saving) is only equivalent to 15,028 kWh/year. Therefore, the energy balance is equivalent to 15,028 kWh/year. The target is set for 24% energy saving (52% from air conditioning system and 22% from lighting system). Moreover, there is the system of Backup Power from Electrolyser Fuel Cell System is installed which makes the home has power supply for necessary points of electrical appliances during Nation Grid’s blackout situation. Also, the water reuse system with active carbon process is prepared for reusing the rain water, grey water and water from condensing unit that makes 59% water saving.

Furthermore, Thailand has “Chiang Mai World Green City Model (CWGC)” at the Asian Development College for Community Economy and Technology (adiCET), Chaing Mai Rajabhat University, Figure 3.



**Figure 3:** Chiang Mai World Green City Model

With 6 small houses, an office, a coffee shop, a minimart, a restaurant and an organic farm, this smart community targeted to accomplish 5 tenable cycles consisting of energy, food, building, economics and environment to grow to be the 1st carbon neutral community in Thailand. The power plant of 55 kWp PV(dc) and 20 kW (dc) biomass gasification for microgrid were

installed for the operation of all electric appliances modified to be available for dc and ac system such as lighting, air conditioner, television, fridge, computer, water heater, etc. to be flexible for power using. All events during system operation including CO<sub>2</sub> balance has been meticulously recorded since the project starting in 2011. After 3.5 years, the findings demonstrated that the net accumulative CO<sub>2</sub> reached -7,505 kgCO<sub>2</sub>e. Also, the trend will continuously decrease to nearly zero as the scenario concept from the year 2013 to the year 2028. Similarly the result pointed out that CWGC could succeed in CO<sub>2</sub> reduction (Prasert Pinngarm et al., 2017) (The integration and transition to a DC based community: A case study of the Smart Community in Chiang Mai World Green City, 2015).

## Consumer Behavior Concept

Apart from the coherent policy promotion of Energy 4.0, the business potential of smart residence technology system mainly depends upon consumer behavior because the consumers are those people who have needs and a need is a consumer's desire for a product. Consumer characteristics may mean that the persons who need to buy and have purchasing power leading to purchasing behavior and using behavior. The marketers have to understand who the consumers are. Lacking of understanding about what the consumers like or dislike, they cannot serve the consumer's satisfaction. It is considered that the primary need is happenings concerning persons, namely need for food, need for water because of thirsty, need for residence and need for comfort, etc. However, the consumers are those people who have purchasing power also. Therefore, analysis on consumer behavior must relate to the consumer's money. Purchasing behavior will occur when the consumers have needs and purchasing power. For example, what criteria for their purchase decision making process and how much they pay (Wongmontha, 1999).

The present concepts and theories of consumer behavior are caused by the effect of outer environment as an essential factor. For example, communication of consumption information motivates consumption decision according to popularity in a society; using expensive luxury car, using expensive and multi functioned mobile, which is considered as an important factor for consumption nowadays and as motivation in consumption decision. The sellers can observe the overt behavior of consumers whether the goods are satisfactory or not for the consumers and including the level of satisfaction. Therefore, they can offer selling directly to the target and appropriately (Kerdrum, 2005).

In conclusion, behavior is a matter of thinking, feeling or expression of persons. People's expression may be different from each other and are changeable depending on circumstances and changing society, which may be caused by outer environment as a key factor.

## Methods

Since smart residence has been increasingly recognized with more global warming awareness, this research aims to study potential of smart residence business in Thailand. The mixed methodology research is based mainly on qualitative research and refers to quantitative research.

The process and method comprises:

### 1. Population and Sample

#### 1.1 Population and Sample in quantitative research

1.1.1 Population studied in the quantitative research is 144 persons who are staying in Thailand.

1.1.2 Samples selected in this study have sample size in accordance with the sampling table in Krejcie and Morgan (Krejcie & Morgan, 1970) at error level .05 with the following formula:

$$n = \frac{X^2 Np (1 - p)}{e^2 (N - 1) + X^2 p(1 - p)}$$

n = sample size

N = population size

e = acceptable error level of sample

X<sup>2</sup> = Chi-Square Test at df = 1 and confidence level at 95% (X<sup>2</sup> = 3.841)

P = Proportion of population characteristics of interest (If unknown, set p = 0.5)

At least 144 sample people are selected to estimate the percentage with no greater than percentage error of 5% at 95 percent confidence level.

Sample selection method used for this study is Non-Probability Sampling. Purposive Sampling is used to achieve the objectives of the study.

#### 1.2 Informants for qualitative research

##### 1.2.1 Key Informants

Key Informants are associated with energy field and business opportunity for smart residence in Thailand. Six people are selected with purposive sampling based on the consideration of key informants' interview in response to objectives and questions of this research.

## 2. Instruments

Instruments used for two groups of samples are Quantitative Research and Qualitative Research. To obtain data covering the full content, data collection tools are used as follows:

### 2.1 Quantitative research part: Questionnaire

Questionnaires present a set of questions to 144 residents in Thailand for the purpose of studying demographic characteristics, household energy consumption behavior and interest in smart residences. The questionnaire is divided into four parts:

Part 1: The questionnaire seeks general information concerning the respondents, consisting of three open-ended and checklist questions: per capita income, right of property and type of residence.

Part 2: The questionnaire is asked about access to internet household, energy consumption behavior, energy saving electric appliances, home automation system and reasons to use efficient electric appliances shown in the checklist.

Part 3: The questionnaire is asked about interest in smart residences, shown in rating scale.

Part 4: Suggestion is asked in the open-ended question form.

### 2.2 Qualitative research part: Interview

Semi-Structure Interview contents included visions, point of views and opinions on energy policy, economic conditions, culture and people's daily life, which reflected the investment potential of smart residence system in Thailand when compared to other countries in AEC.

## 3. Steps for construction and quality test of instruments

### 3.1 Questionnaire

Questionnaire is constructed in the following steps:

3.1.1 Literature review on research documents concerning principles of questionnaire construction and formulation of a conceptual framework

3.1.2 Studying books, articles, research works concerning energy situation, energy market and renewable energy in ASEAN Economics Community – AEC including relevant research works to formulate a set of questions.

3.1.3 Point formulation and scope of questionnaire are made in accordance with objectives, benefits and conceptual framework.

3.1.4 The questionnaire was drafted to test for content validity by six experts with Index of Item-Objective Congruence (IOC) 0.93.

3.1.5 The questionnaire shall be reviewed and revised based on recommendations received by the experts, and therefore the complete questionnaire will be conducted with 144 samples (100%).

### 3.2 Interview

In-depth semi-structure interview is constructed to have a set of questions covering overall context and business potential for smart residence technology in AEC. The instrument validity of the questions was considered and investigated by the six experts.

## 4. Data collection

In primary data collection, the researcher collects the data using the following qualitative and quantitative methods:

4.1 survey questionnaires contain closed-ended questions and open-ended questions, totaled 144 sets.

4.2 in-depth semi-structure interview shall be conducted with 5 key informants experienced at least 7 years and worked for government, state enterprise and private sectors.

## 5. Data analysis and statistics

The statistical package for the social sciences is used for data analysis on questionnaires collected from focus group and data is differentiated and analyzed as follows:

### 5.1 data analysis on questionnaire

The total questionnaires are investigated to test validity and reliability with IOC 0.93. Data processing and analysis using the statistical package for the social sciences is made to compute statistics on the basis of data characteristics, namely percentage, mean and S.D.

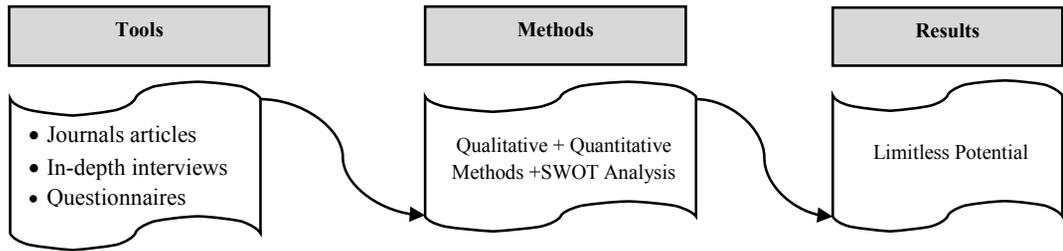
### 5.2 descriptive analysis on interview data

Content analysis by grouping is conducted to provide description of the research findings.

## 6. Presentation (Results)

Descriptive presentation is made in this study.

The method flowchart is demonstrated in Figure 4 and the SWOT analysis results are summarized in Table 10



**Figure 4:** Method Flowchart

## Results

### 1. Questionnaire results

Based on information from questionnaires, the population studied in the quantitative research is 144 residents in Thailand (N = 144). The results are as the following Tables. 1-9 :

**Table 1:** Percentage grouped by total annual personal income (salary, bonuses, investment income, etc.)

Personal Data	Numbers	%
Total annual personal income (USD)		
1. Less than 20,000	85	59.03
2. 20,000 – 39,999	21	14.58
3. 40,000 – 49,999	9	6.25
4. 50,000 – 59,999	8	5.56
5. 60,000 – 69,999	12	8.33
6. 70,000 – 79,999	3	2.08
7. 80,000 – 89,999	0	0.00
8. 90,000 – 99,999	3	2.08
9. N/A	3	2.08
<b>Total</b>	<b>144</b>	<b>100.00</b>

**Table 2:** Percentage grouped by right of property

<b>Personal Data</b>	<b>Numbers</b>	<b>%</b>
<b>Right of property</b>		
1. Holder / Owner	77	53.47
2. Tenant / Rental	17	11.81
3. Resident	44	30.56
4. N/A	6	4.17
<b>Total</b>	<b>144</b>	<b>100.00</b>

**Table 3:** Percentage grouped by type of residence

<b>Personal Data</b>	<b>Numbers</b>	<b>%</b>
<b>Type of residence</b>		
1. Detached house / Single house	103	71.53
2. Attached house	23	15.97
3. Commercial building	6	4.17
4. Apartment / Condominium	9	6.25
5. N/A	3	2.08
<b>Total</b>	<b>144</b>	<b>100.00</b>

**Table 4:** Percentage grouped by access to internet (choose 1 or more multiple options)

<b>Behavior Data</b>	<b>Numbers</b>	<b>%</b>
<b>Access to internet</b>		
1. Office	90	25.42
2. Residence	98	27.68
3. Internet shop	12	1.69
4. Mobile	112	31.64
5. Public wifi	42	11.86
6. Others	0	0.00
<b>Total</b>	<b>354</b>	<b>100.00</b>

**Table 5:** Percentage grouped by sources of electricity consumption (choose 1 or more multiple options)

<b>Behavior Data</b>	<b>Numbers</b>	<b>%</b>
<b>Sources of electricity consumption</b>		
1. Electricity provider	116	74.84
2. Self-supplied energy supply with renewable energy (solar, wind, etc.)	11	7.10
3. Electricity provider + Self-supplied energy supply with renewable energy (solar, wind, etc.)	9	5.81
4. Electricity provider + Self-supplied energy supply with renewable energy (solar, wind, etc.) + national grid connected	3	1.94
5. Others	0	0.00
6. N/A	16	10.32
<b>Total</b>	<b>155</b>	<b>0.00</b>

**Table 6:** Percentage grouped by energy saving electric appliances in the residence (choose 1 or more multiple options)

<b>Behavior Data</b>	<b>Numbers</b>	<b>%</b>
<b>Energy saving electric appliances in the residences</b>		
1. Air conditioning System	117	40.63
2. Microwave	27	9.38
3. Electric cooker	9	3.13
4. Fridge	54	18.75
5. TV	45	15.63
6. Computer	15	5.21
7. Electric iron	21	7.29
8. Others	0	0.00
<b>Total</b>	<b>288</b>	<b>100.00</b>

**Table 7:** Percentage grouped by home automation system in the residences (choose 1 or more multiple options)

Behavior Data	Numbers	%
<b>Home automation system in the residence</b>		
1. Air conditioning System	52	32.70
2. TV	33	20.75
3. Others	0	0.00
4. N/A	74	46.55
<b>Total</b>	<b>159</b>	<b>100.00</b>

**Table 8:** Percentage grouped by reasons to use efficient electric appliances (choose 1 or more multiple options)

Behavior Data	Numbers	%
<b>Reasons to use efficient electric appliances</b>		
1. Environmental concerns	76	23.46
2. Money saving	138	42.59
3. Positive image	21	6.48
4. Quality of life	62	19.14
5. Nation energy security	27	8.33
<b>Total</b>	<b>324</b>	<b>100.00</b>

**Table 9** The average and standa deviation of interest in smart residences

Behavior Data	$\bar{X}$	S.D.	4-Point Scales
Smart Residence Interested	3.14	0.71	Most of the time

The results of the questionnaire show that 75% of the respondents buy power from electricity provider and the remaining (15%) buy power from electricity provider and use renewable energy based on self-supplied energy at home. Their residences have home automation

systems installed, namely, television and air conditioning system. Most people are aware of the importance of saving energy by selecting energy-efficient appliances so that electricity bill can drop significantly and good self-image can be enhanced. An overview of benefits are better quality of life and national energy security. Also, the average of interest in smart residence is equivalent to 3.14 from 4 point scales.

## **2. Interview results**

Based on information from in-depth interview with AEC energy group, Thailand has readiness and potential for smart residence technology, rated one of the three top ranking countries (Singapore, Thailand and Malaysia) of AEC 10 countries. The supporting reason is that Thailand has clear energy policy, that is, energy 4.0 plan set by the government for energy management. Electricity generation sector promoted the development of innovations and new technology, namely, smart grid network of electricity providers, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI) meters, energy storage, Microgrid Energy Management Software (Microgrid EMS), electrical vehicles (EV : V2G, G2V), photovoltaic rooftop installation, and purchasing the excess electricity, etc. All of these things make up infrastructure system and become the business startup of electricity consumption with two way communication until the business growth reaches smart residence system technology finally. However, the complicated regulations for the excess electricity purchasing from PV rooftop should be simplified.

Thailand's advantages are that it is energy hub linking transmission system in ASEAN region and Thai people are more aware of renewable energy than those of other countries due to their familiarity with readily-usable renewable energy. The middle class with high purchasing power reasonably forecasted future 10-year returns, which may take quite a long time but this contributes to a better quality of life. Thai people have the taste in consumption of expensive and high quality products like popular car buying. For most Thai people, consumerism has become the contemporary culture and they have the high purchasing power.

Smart residence technology is modern energy saving products. Technology is advancing at a faster pace than ever before, and model change occurs frequently due to the technologically advanced device functionality. Smartphone as an example is because the design and functionality of cell phones have changed over time and their models are easily changeable. These modern advanced technologies increase consumer satisfaction. The reasons why they bought products are usefulness, modernity and value creation.

In addition, Thai business persons have ability to rapidly adapt to varying environmental conditions. If they can see business opportunities, they can promptly seize such opportunities. They have readiness for investment in smart residence technology. More than 5% returns attract

them to withdraw their savings from a bank and invest in business startup since 5% interest on 10 year deposits may not be worth as much as business investment. However, in the current economic condition, bank loan is not recommended for investment in startup business due to cost of capital associated with high loan interest rates. If the promotion policy of pricing and incentive is not clear, bank loan for investment is not appropriate for this business.

In addition, SWOT data (Boonyatisatan, E., 2010) was gathered and used to identify strengths and weaknesses, which was illustrated in Table 10.

**Table 10:** Brief SWOT Analysis Results

S	O
<p>high purchasing power (4<sup>th</sup> GPP : PPP in ASEAN countries), gateway to ASEAN (United Overseas Bank Limited, 2016) (Kasikornbank Public Company Limited, 2015) (ASEAN Information Center, 2015) (The World Bank, 2017), 1 of 3 tops ranking countries in smart residence technology readiness, energy hub linking transmission system in ASEAN (United Overseas Bank Limited, 2016), renewable energy awareness, familiarity with readily-usable renewable energy, having taste in consumption of expensive and high quality products, businesspersons : ability to rapidly adapt and see business opportunities (excellent vision)</p>	<p>coherent long-term energy policy especially smart grid under Energy 4.0 Policy (smart energy management) (Ministry of Energy. (2015) to create disruptive technology and innovation : PV rooftop system promotion, electricity generation by renewable energy resources, electric battery development for EV, plug-in hybrid EV including normal &amp; quick charge stations, smart meter development (AMR, AMI), electricity generation system development (transmission, distribution and consumption), ICT development, proceeding with Public Private Partnerships (PPP) – funding proportion 70% of private sector and 30% of government sector, effective 6 strategies (security, capabilities-based competition, development and personnel potential forming, equality of opportunity in society, improvements in quality of life based on environment-friendly, balanced scorecard for government’s management system development), rapidly growing e-commerce market (Kasikornbank Public Company Limited, 2015), having high speed internet access plan, high annual personal income, owner : high power of decision making , home automation usage , quite easy accesses to internet, various sources of energy consumption (electricity provider and prosumer with renewable energy), awareness to use efficient electric appliances, interest in smart residences : most of the time</p>

**Table 10:** Brief SWOT Analysis Results (Cont.)

W	T
considerable changes on commercial regulations, some incoherent laws and regulations (United Overseas Bank Limited, 2016) (Kasikornbank Public Company Limited, 2015)	electricity market monopolization, incompletely free PV rooftop market, complicated regulations for grid connected PV rooftop, unsharp focus on residential sector (Kasikornbank Public Company Limited, 2015) (The World Bank, 2017)

## Conclusions and Discussions

Thailand as the “Gateway to ASEAN” has the key advantage for industrial production whatever global warming awareness, reduction on electricity generation from fossil fuel, renewable energy appreciation, and smart energy for smart life (digital 4.0) and e-commerce market growing are in focus. Also, the smart Thailand 4.0 policy attracts digital business investment especially smart residence technology system. Based on information from in-depth interview and questionnaires, the findings are that the electricity market in Thailand has been monopolized so far, but there are high potential business opportunities of smart residence system in Thailand due to the clear policy of Energy 4.0 and the promotion policy of PV rooftop installation and excess electricity selling back to the National Grid. All of these activities will enhance Thai people’s interest in home renewable energy systems. However, the government should promote entirely free market and should not limit 200 MW quota of the self consumption and the excess electric power purchasing from PV rooftop.

The findings of this study reveal that there are many benefits of smart residence system. For example, the specific policies for promotion of Energy 4.0 may indirectly result in the start of smart residence business and the financing channel is enhanced. Also, most consumers are interested in and amazed at the new technologies although smart grid policy has unspecifically focused for residential sector. However, they are the household energy users without knowledge and awareness of the correct energy use. Therefore, capacity building in the use of technologies and improving the knowledge usage are required for the consumers.

In the future, the “prosumer” (producer + consumer) (Gerhardt, W., 2008)), the person producing and consuming the products becomes the trend currently pushed by this smart residence business. This trend is expected to have cost effectiveness of investments in this system. In the mean time, the concerned persons’ demand and supply side must be developed so that they will have correct vision on the benefits of smart residence technology. Furthermore, the technological development of product should be environmentally friendly, namely, the

development of easy-to-use programme in support of the current technologies (Sumi Helal et al., 2005). Technology innovations should offer solutions to help save electricity for home and provide program that displays cost-effective data. The smart technology must provide safety and security to the users, especially elderly people as well as have capability to keep personal information secure (Fujisawa SST Council, Panasonic Corporation, 2014) (Amir Hosein Ghaffarian Hosein et al., 2013).

Apart from the above-mentioned, the sale promotion should be conducted to induce the consumers to purchase service, for example, installed smart equipment package with free internet information (Ehrhardt, L et al., 2010) (package cost of smart meters and free internet). Consumer awareness regarding benefits of smart residence technology should be enhanced. Their benefits are reduction of environmental impact and security of electricity generation system or electricity supply. Finally, when the consumers understand the benefits and the functions of smart residence technology, they will accept and use it. Since smart residence business is providing services, the entrepreneurs must have adequate personnel to meet the needs of the system and serve their consumers. For example, in the case of malfunctioned IT, the call center officers should provide prompt services without delay. In summary, to create smart energy system, information and communication technologies (ICT) system is required for development so that smart energy management will serve to provide monitoring, controlling, forecasting and managing in compliance with electrical system functions (Fujisawa SST Council, Panasonic Corporation, 2014).

It is obvious that the emergence of ICT system in people's daily life proves that it can be integrated with existing electricity system and finally develop into smart city system. Therefore, this innovation policy, close to home, helping residents to use remote control for turning on or off electronic appliances via cell phone at their fingertips even though they are doing activities outside their home. Furthermore, this system has function for data reco of electrical consumption and electricity bills, which can be retrieved from cell phone to remind the user of energy conservation and environmental awareness.

In this regard, private sector and investor can see the broad and outstanding opportunity of promotion policy and participate in investment of smart residence system and smart residence system in industrial estate. Therefore, the boost of government not only enhances the investment in business, but also lead to the economic development and the discovery of innovations useful for further business expansion. Until this modern age, Thailand cannot refuse the emergence of "smart residence" in our daily life. This business is very interesting and enhancing. It is alternative business which serves the quality of life, good health, safety and security including convenience.

Finally, as all above-mentioned results, it cannot deny that a capacity building in “Smart Grid” and “Smart Residence” is an essential element. The course must be created not only short-term training or seminar but also the course syllabus for all science and art students in schools and universities because Thailand has entered the Energy 4.0 (digital) era. Therefore, Thai people have a chance to take the role of “Smart Prosumers”. Though Thailand may come after, it is true for the saying “Better late than never”.

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