An Analysis of Business Potential for Smart Residence Technology System in ASEAN Economic Community: An academic perspective

*Achara Jivacate[1], Wattanapong Rakwichian[1], Prapita Thanarak[2], Watchara Wongpanyo[1], Boonyawat Vichanpol[1] and Chatkaew Chailuecha[1]

***Abstract*— Either in case of CO2 emission reduction aspect or in cases where energy security increase are used for energy management technologies. Smart grid technology serves the main purpose of exactly efficient and sustainable energy management. Smart grid technology including smart meter, smart residence, renewable energy, electrical vehicle, information and communication technology system enables to collectively control small-scale distributed generation of smart grid system. This article deals with the foundations of analysis and synthesis on related information and researches including academic perspectives on ASEAN Economic Community. The preliminary hypotheses demonstrate that although smart grid technology is seen as some significant weaknesses and threats, the advantage of smart residence system business is considered as interesting perspective under global climate change issue. Furthermore, for those people who have purchasing power and demand for this type of residence, this perspective serves for electricity bill payment, environmental concerns, life quality, positive image and national energy security. In similar way, ASEAN Energy Market has potentiality and strength with policy motto "One Vision, One Identity, One Community". The ASEAN region integration is attracted to the investors due to 600 million populations (10% of world population), trillion USD 2.57 GDP and USD 10,700 GDP/capital (PPP / purchasing power parity) in 2014. Additionally, ASEAN has the availability of diverse natural and energy resources, strength in banking system and investment funds as well as policy in the promotion of smart grid technology and capacity building. Therefore, the private sector is certainly the leader who conducts smart residence technology business investment in the future.**

***Index Terms*— smart residence, sustainable smart town, home energy management, home-area network, information and communication technologies**

I. INTRODUCTION

The objective of this article is to analyze business potential for smart residence technology in ASEAN Economic Community (AEC) based on an academic perspective and the experts from the ASEAN energy sector.

[1]School of Energy and Environment, University of Phayao, Thailand, [2]School of Renewable Energy Technology, Naresuan University, Thailand

✉ Achara Jivacate
*acharaJ@ratch.co.th

Received : 3 November 2016
Accepted : 22 December 2016
Published : 31 December 2016

Due to population increase and global warming, the business concept of smart residence system will be applied for home energy management system (HEMS). That is to say that smart residence technology business will be developed from home automation systems, considered as innovative business. According to Global Temperature Report 2015 [1] issued by National Oceanic and Atmospheric Administration (NOAA) of United States, it stated that the annually-averaged temperature of global land and ocean surfaces in 2015 was 0.90 Celsius above the average temperature (13.9 degree Celsius), and higher than 2014's temperature at 0.16 degree Celsius. The 2015 temperature was affected by El Niño phenomenon, the extreme weather which was not only the highest in the calendar year temperature , but also higher than the previous record of the highest temperature for 12-month period on record.

Based on the report of World Population Prospect [2], the 2015 Revision, world population reached 7.3 billion in the middle of 2015. As for the population in the ASEAN Economic Community (AEC), there were around 633 million in 2015 and it was expected that population in this region would increase up to 724 million in 2030. The ten countries in AEC included Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines. Singapore, Thailand and Vietnam, which covered a land area of 4.4 million square kilometer or almost half of the total land area of United States, and included trillion USD 2.57 GDP and 10,700 GDP/capital (PPP / purchasing power parity) [3] in 2014.

Furthermore, ASEAN made the trade agreements with Japan, India and South Korea, leading to economic community in a region nearly equivalent to European Union (EU). With motto "one vision, one identity, one community" [3], the countries in AEC had the same policy of a single market and production base.

EU stated that AEC was a wealthy, fast-growing and large-sized market and an outstanding form of strong economic community as well as its market potential was much bigger than India and China. The AEC moved towards establishing rapid economic growth, having high potential of education, and broadly access to internet [3] [4] [5]. The interesting supporting information can be described in the Table 1 as follows:

Countries	Economy / Energy / Business
Brunei Darussalam Population : 423 thousands GDP (PPP)* : 82,850 USD Internet penetration**: 65.6% Electricity/Capita : 7,470 kWh (Figures 1-4 : country comparison)	natural-resource-based economy, export of oil, gas and related products but the impact of falling oil price on its economy, attempt to conduct petrochemical hub promotion, high purchasing power, retail business, growing transportation, secure politics, inexpensive electricity price, boost for banking and tourism industries whereas the small market and workforce shortage
Cambodia Population : 15,578 thousands GDP (PPP)* : 3,334 USD Internet penetration** : 5.4% Electricity/Capita : 104 kWh (Figures 1-4 : country comparison)	the lowest wage in Asean, foreign investment promotion of road construction, natural resource abundance and diversity whereas the disadvantages ; underdeveloped infrastructure facilities, skilled work force shortage, unreliable banking and financial system, frequent changes on commercial regulations, insufficient electricity and needs to focus on solidifying its national grid, expensive electricity price due to electricity generated from diesel oil, potential in the renewable energy
Indonesia Population : 257,564 thousands GDP (PPP)* : 11,498 USD Internet penetration** : 16.7% Electricity/Capita : 507 kWh (Figures 1-4 : country comparison)	the largest economy in the South East Asian, large market, strong banking system, inexpensive workforce, natural resource abundance and diversity, and being coal exporter, however due to an archipelagic island country microgrid technology is required to reduce fuel transportation, underdeveloped infrastructure facilities, unclarity of laws and regulations
Laos PDR Population : 6,802 thousands GDP (PPP)* : 5,096 USD Internet penetration** : 8.1% Electricity/Capita : 338 kWh (Figures 1-4 : country comparison)	low wage, abundance of biology, energy and natural resources, battery of ASEAN, hydro power plant for base and peak load, underdeveloped infrastructure facilities, instability of the national currency (the kip), unskilled workforce and no exit to the Sea

Countries	Economy / Energy / Business
Vietnam Population : 93,448 thousands GDP (PPP)* : 5,644 USD Internet penetration** : 43.0% Electricity/Capita : 1,103 kWh (Figures 1-4 : country comparison)	low wage, crude oil reserve as the second-highest in the South East Asia-Pacific, with a coastline stretching over 3,200 km, focus on low carbon business and clean energy - wind energy and solar, solar use during daytime and wind use during nighttime, boost for offshore nuclear power plant plan, large number of population, high cost of land and office rental, undeveloped public facilities and unclarity of laws

Countries	Economy / Energy / Business
Malaysia Population : 30,311 thousands GDP (PPP)* : 24,607 USD Internet penetration** : 40.3% Electricity/Capita : 3,215 kWh (Figures 1-4 : country comparison)	the third highest of oil reserves in the Asia-Pacific region, complete infrastructure system, various industries but small markets, high cost of capital, unclear rules and regulations efficiency in Smart Grid leader due to official policy on RE, readiness for solar, wind, and biomass from palm, efficiency in Energy Hub due to close to primary resources such as gas, petrol, coal and RE resources, industrial country and need for peak power during the daytime and good opportunity for PV market
Myanmar Population : 53,897 thousands GDP (PPP)* : 4,923 USD Internet penetration** : 1.2% Electricity/Capita : 85 kWh (Figures 1-4 : country comparison)	Low wage, abundant oil and natural gas resources, border adjacent to China and India, the large sized market, more opportunity for RE, solar having Global Horizontal Irradiation (GHI) levels of between 1,600 and 2,000 kWh/m2/yr and average Direct Normal Irradiation (DNI) levels of about 1,400 kWh/m2/yr, however undeveloped public utilities and insecure politics
Philippines Population : 100,699 thousands GDP (PPP)* : 6,846 USD Internet penetration** : 39.4% Electricity/Capita : 524 kWh (Figures 1-4 : country comparison)	workers having skills in technology and English communication, import of diesel oil like Cambodia, considerable potential in wind and solar energy, but high risk for monsoon, strong labour union, frequent change in rules and regulations and high corruption, undeveloped public utilities, difficult in transportation due to countries with islands, policy of renewable energy, renewable energy mix such as solar, wind, biomass and microgrid to smart grid
Singapore Population : 5,604 thousands GDP (PPP)* : 82,714 USD Internet penetration** : 80.7% Electricity/Capita : 7,695 kWh (Figures 1-4 : country comparison)	high per capita income, maritime and financial hub, readiness for information technology, policy of energy conservation, renewable energy, smart grid, smart devices, considerable potential in the first smart grid country via smart home, smart building, EV, relying on raw material import and low skilled workforce shortage, high operational expenditure
Thailand Population : 67,959 thousands GDP (PPP)* : 14,333 USD Internet penetration** : 28.8% Electricity/Capita : 1,961 kWh (Figures 1-4 : country comparison)	role as hub linking to ASEAN mainland such as Laos, Cambodia, Vietnam, Malaysia, etc., the sea connecting to the Philippines and Brunei, near to all country by air and by sea, major industrial production base of the world, secure financial institutions, official policy with RE, EE and smart grid, middle production technologies, but without strong intellectual property protection, potential for solar and capacity building of technology

Remarks * GDP (PPP : purchasing power parity) and Inflation Rate **(% of population, regular users; internet live status

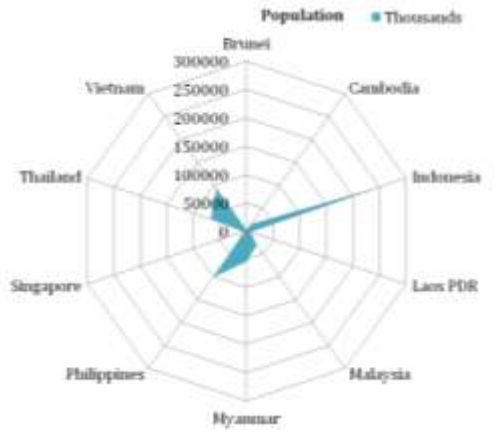

Fig.1. Population Comparison

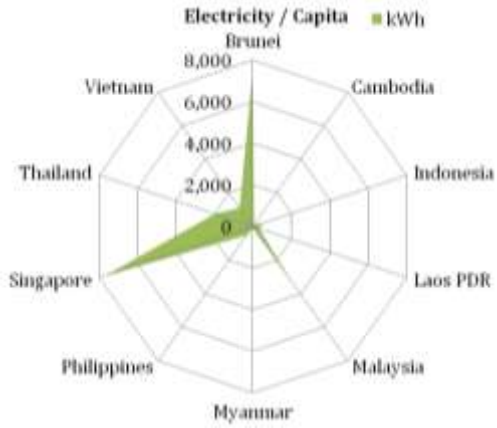

Fig. 4. Electricity / Capita Comparison

Fig. 2. GDP (PPP) Comparison

The rise in population growth and consumption of fossil fuels [6] [7] (Figures 5,6,7) caused pollution and greenhouse gases, which leads to global warming. As a result, trend in global energy consumption for electricity production [6] [7] (Figures 8,9,10) has been changed to rely on renewable energy, or green energy which was considered to be environmentally friendly.

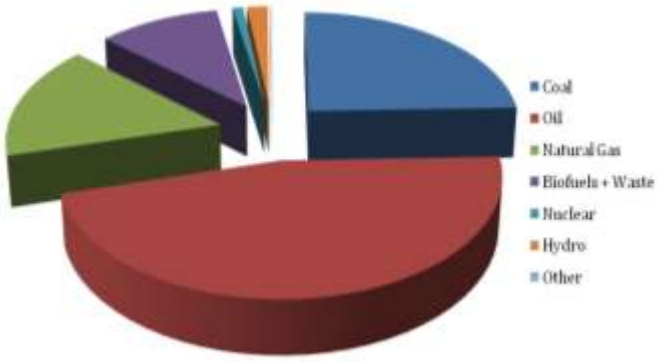

Fig. 5. Total Global Primary Energy Supply Fuel Sharing in 1973

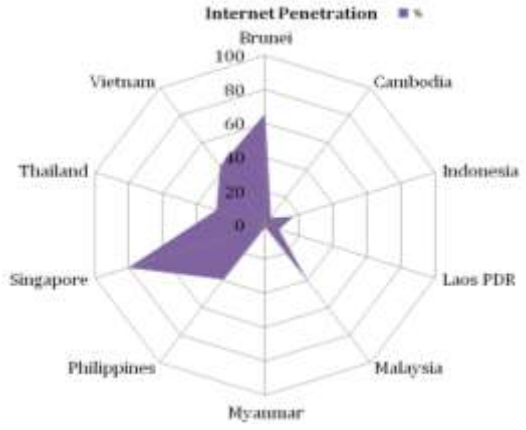

Fig. 3. Internet Penetration Comparison

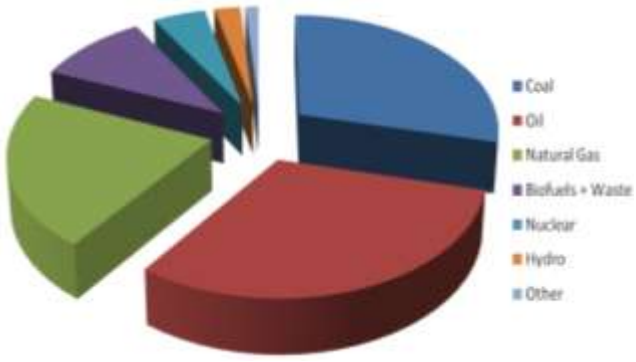

Fig. 6. Total Global Primary Energy Supply Fuel Sharing in 2013

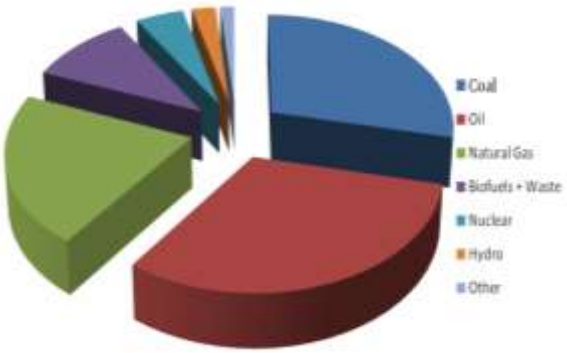

Fig. 7. Total Global Primary Energy Supply Fuel Sharing in 2014

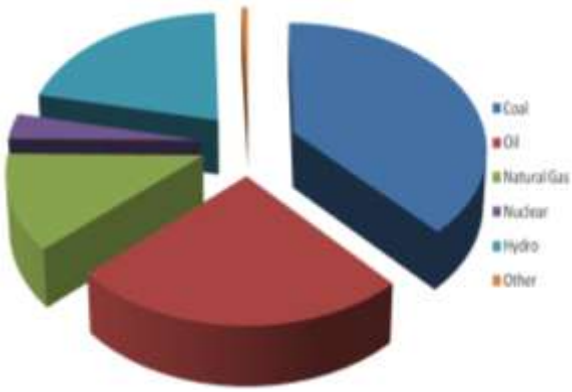

Fig. 8. Total Global Electricity Production in 1973

Fig. 9. Total Global Electricity Production in 2013

Therefore, smart grid has the major role since its advanced technology increases efficiency in electricity / energy management [8]. The transportation of natural gas, oil and coal spread over many areas, directing to power plant. The electricity which was supplied through transmission line system to end users has been changed into the power plant construction at the gas, oil, coal and renewable resources, spreading over various areas. The electricity will be supplied with transmission system and distribution system by means of smart grid system management. The point is that all electric appliances were made from energy conversion and its power delivery was made to end users or electricity consumers. The smart grid management system helps reduction in costs of natural gas, oil, coal and renewable transportation. The renewable energy, green energy boosts electricity generation, leading to pollution / air pollution reduction, carbon emission reduction and global warming solution. Therefore, power plants which are distributed at any energy resource are called "distributed generation to all electric appliances" available for 24 hour power delivery or electricity generation. The amount of electricity production has to be adequate to meet expanded demand for power consumption in different real-time. Therefore, the development shall be made as follows [9]:

- digital smart meter : as computer to record energy usage data (kWh) and process, display and control systems connecting to application for power use and power purchase in real time,
- smart residence (detached house, single house, attached house, commercial building, apartment and condominium) : installation of automatic electricity appliances and energy conservation,
- renewable energy such as solar, green energy : solar power generation system and energy storage system,
- electric vehicle and
- system development of smart information and communication technology (smart ICT) : for two way communication and real time information transfer so that it is ensured that smart grid system helps high efficient power generation, power loss reduction and nation energy security.

In the initial stage, smart grid system is implemented for electricity power management in digital way. Household electricity appliances technology can be used jointly by plug-and-play. Smart residence technology business is new business developed from home automation system.

In the academic term, smart residence system technology (Figure 11) is designed to be not only equipped with intelligent automation systems as usual nowadays but also to monitor, to forecast, to manage and to control efficient and effective energy consumption. Hybrid conventional and renewable energy generation with energy storage, information technology and communication system networks [10] are also considered as innovative / disruptive technology.

Finally, this smart residence system will be connected to the utility grid (microgrid in the level of community grid or national grid) in order that excess energy from renewable generation will be supplied to the grid and/or the grid will cover the energy deficiency for smart residence [11].

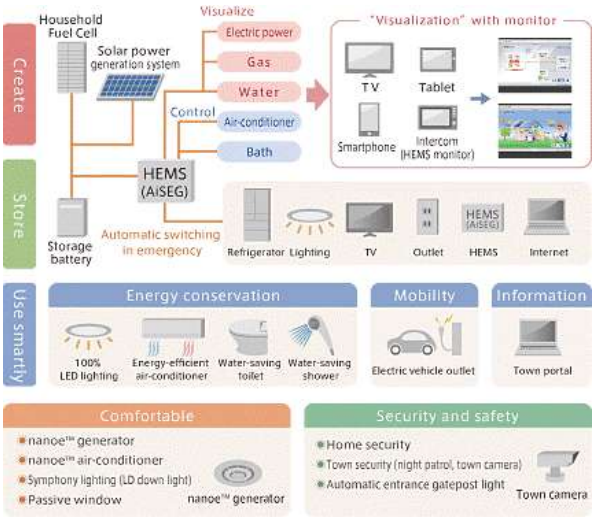

Fig. 11. Smart Residence System
(http://www.globalsmartgridfederation.org)

According to the concept of energy management at the residence level, literature review was conducted for example, "The essence of future smart houses : From embedding ICT to adapting to sustainability principles" [12] which showed data collection on smart houses : The Gator Tech Smart House by University of Florida, Maltilda Smart House by University of Florida, Duke University Smart House, Drexel Smart House, MIT Smart House, Aware Home by Georgia Institute of Technology, CASAS Smart Home by Washington State University, Smart Home Lab by Iowa State University, Toyota Dream House Papi and National Institute of Information and Communication Technology (NICT) Ubiquitous Home.

Especially, the Gator Tech Smart House: a programmable pervasive space [13], University of Florida had attempt to develop Pervasive Computing Systems providing more service-oriented programmable spaces. With the assistance of domain experts, health professional (psychiatrists or gastroenterologists), College of Public Health and Health Professions and Disability and Rehabilitation Research had participation in development of new applications. The clear benefit was to provide accommodation for disabled and elderly people. The final goal of application development was to create “Smart House in the Box”. In other words, the residence was equipped with facility technology or assistive technology. The residents can supply appliances easily and do-it-themselves installation without resorting to engineers.

In conclusion, 10 smart houses were designed to serve different purposes of usages and sizes depending on varying numbers of residents. However, all of these houses focused on the same advantage of harmony, architectural beauty, convenience, privacy, enhanced security, energy efficiency, environment building. ICT system was used for centralized control and remote access. Therefore, the smart residence with ICT system was more developed than the former. This alternative served the development of the residents’ quality of life. They were able to have good health, safety and more conveniences.

Smart Residence System can be designed to develop the residents’ quality of life, leading to Eco & Smart Lifestyle and expanding into the level of community and city for example, Fujisawa sustainable smart town system in Fujisawa City, Kanagawa Prefecture, Japan. As for Fujisawa, the cooperation between Fujisawa City and Panasonic Corporation established the city model for real life living. Advanced technology-base infrastructure, based on actual lifestyles are created for energy conservation. The goal is set for renewable energy usage over 30%, CO2 70% reduction and water consumption 30% reduction [10]. Smart spaces are available for smart lifestyle such as virtual gate town, electric vehicle sharing service and wellness square (healthcare). Town information networks and town energy networks are furnished to monitor privacy data with easy and safety means for personal protection purpose for example, energy consumption, energy savings for own home only, reserve for electric vehicles and shopping assistance service via smart phone, etc.

Smart residence technology is new technology, developed from home automation system. Therefore, the next step for commercial potentiality based on academic perspective and literature reviews showed that of the promotion policy on smart residence was made through financial channel and most of the consumers were interested in and exited with new [14]. However, capacity building based on the proper and reasonable way was required to enable the customers to realize the advantages of smart residence technologies. The examples of individual persuasion were given as follows: easy to use, saving on electricity costs, cost effective investment, safety and security for end users, safety standard on personal data[15] [16] [17]. In addition, sale promotion should be provided for example, free internet information upon installation of smart equipment package (package cost of smart meters and in-home displays) [14]. The customers should be encouraged to be aware of the benefits of smart residence technologies, especially the overview of environmental impact and security of power generation. After all, when the customers understood [18] [19] its benefits and the functions of smart residence technology, they shall agree to use it in the future.

II. METHOD

The information of this paper is based on literature reviews / journals, in-depth interview and questionnaires from purposive 10 and 35 academics at least 7 year experience respectively in AEC energy academic group with SWOT analysis method which is one of the qualitative analysis methods to indicate the most effective business strategies for objective accomplishment [20]. The research process is demonstrated by Figure 12 as follows:

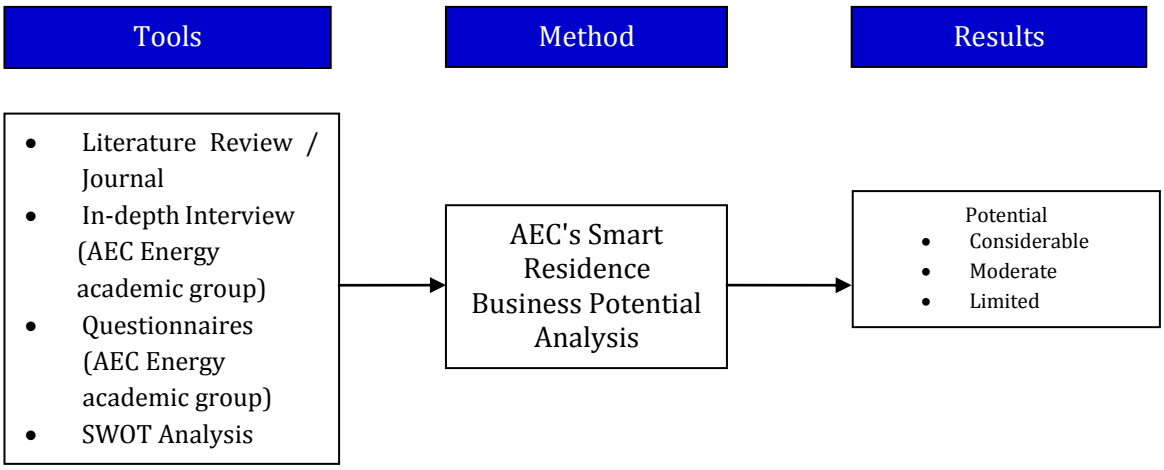

Figure 12. Research Process

This in-depth interview questions are the opinion about investment availability in the business of smart residence system production and installation in AEC such as the policy of each country, first three ranking indication and its reasons as well as key success factors of the business.

As for the questionnaires, the questions are divided into 3 parts: 1. personal data including approximately annual personal income, 2. residence information (type, ownership, location and family member) and 3. technologies (access to internet, electricity consumption sources, smart residence interest, energy saving electric appliances, reasons to use energy efficient electric appliances and average monthly electricity bill payment, etc.)

III. Results and Discussion

Based on information from in–depth interview with AEC energy academic group, this article describes the business potential of smart residence system in AEC and the findings reveal that smart grid technology is a good opportunity for business growth. Every country, for example Singapore, Thailand, Malaysia, Indonesia, Philippines, Vietnam, Brunei Darussalam, Myanmar, Laos PDR and Cambodia, has demonstrated that they are well prepared after considerations of policy, technologies, budget, purchasing power and key players on the business of solar cells, electrical devices, information and communication technologies (ICT).

Singapore shows its leadership in ICT, banking and financial hub, greatest purchasing power, high GDP per capita. In addition, the return on investment is expected in a period of 5 years. Singaporeans and Thais are similar in regard to taste of premium quality product consumption. They are willing to buy for the sake of their own benefit, satisfaction and image no matter how high the price is.

In case of Malaysia, it has diversified economy, business strength, converged infrastructures and modernization. Also, Indonesia has business potential of smart residence system.

It has strengthening economic growth, banking system, capital market, low cost workforce, abundant resources and energy policy promotion. Philippines has considerable knowledge of technologies and the ability to keep up in a rapidly changing world. Especially, Internet speed has to be improved.

Apart from the above-mentioned countries, Vietnam has policy on smart grid. The government promotes renewable energy consisting of solar and hybrid system development for remote areas, high mountain, isolated islands where the national grid system is unreachable. As for Brunei Darussalam, people have purchasing power, lifestyle of luxury shopping, growth in business and transportation but without energy conservation. Myanmar, electrification ratio is lower than other neighboring countries. Electricity distribution in 2015 can be merely supplied up to 34% out of the State's demands although Myanmar has abundant fuel oil and natural gas fields. However, solar energy can be deployed for development since 36% of total areas in the country receive an annual average of solar radiation in the range of 18-19 MJ/m2/day. Laos PDR has abundant renewable energy resources such as biomass, hydro, solar, wind and geothermal energy. The government promotes the development of solar energies, provides lighting services through the installation of solar home systems in rural and remote areas where the national grid system is unreachable. In addition, the government supports the solar energy business development in the country so that the installation of large-scale solar energy system and hybrid system is connected to the nation grid as well as energy services are provided in off-grid areas. The last case, Cambodia has potential in electricity generation from diesel, coal and hydro. The electricity price is found very expensive and has insufficient electricity. The government focuses on solidifying its national grid and shoring up its energy efficiency and transmission lines before expanding into more costly renewable technology. Obviously, renewable technology in the future is great and the opportunity for renewable energy lies in supporting peak load during daytime with solar energy.

According to AEC smart residence technology, data were collected using marketing survey questionnaires from

academic perspective. The findings reveals that the smart residence system in AEC becomes welcome opportunity. Nearly all of the respondents described that sources of electricity consumption were derived from electricity provider only whereas the remaining respondents described that electricity can be provided with electricity provider and self-supply energy by renewables. The home automation systems are installed in the residences, such as lighting system, television and audio, etc. and energy saving electric appliances such as air conditioning system, television, microwave, fridge, etc. Reducing energy use is saving on electricity bills. Furthermore, the energy saving benefits are for environmental concerns, quality of life, nation energy security and positive image. Another point is that 60% of the respondents considered smart residence system very interesting. In conclusion, literature review and academic perspective from in–depth interview and questionnaire were conducted and the preliminary hypotheses have demonstrated that smart residence system business run in AEC becomes a welcome opportunity.

However, the government should provide financial support and promotion for business opportunity. Based on overview survey of the above-mentioned countries, this issue is under consideration of the governments. In the academic term, smart residence system technology is designed to be not only equipped with intelligent automation systems as usual nowadays but also to monitor, to forecast, to manage and to control efficient and effective energy consumption. Hybrid conventional and renewable energy generation with energy storage, information technology and communication system networks are also considered as innovative / disruptive technology like smart grid. Therefore, to conduct business successfully, capacity building or capacity development should be focused on target groups (users and consumers in demand and supply sides) to strengthen their skills and visions. In addition, such target groups should be convinced of the benefits. Apart from these, ICT program design must be renovated or improved in the future to prove the feasibility, usefulness, safety, security in assistive and friendly environments and perceived compatibility. More importantly, ICT program design must be easy to use for the end users [21], especially for the old aged people.

Finally, the most importance is that personal data protection system should be integrated with ICT security standard system to maximize efficiency in home office and ensure workplace security and personal security [17]. All of the benefits serve modern, active and comfortable lifestyle.

REFERENCES

[1] NCEI, (2015), Global Analysis - Annual 2014
[2] United Nations, Department of Economic and Social Affairs, Population Division (2015), World Population Prospects: The 2015 Revision
[3] United Overseas Bank Limited, RSM Chios Lim LLP and Rajah & Tann Singapore LLP, (2016), Doing Business in ASEAN 2 nd edition
[4] Kasikornbank Public Company Limited, (2015), ASEAN+3 Business
[5] Wattanapong Rakwichian and Worajit Setthapun, (2015), New ASEAN Energy Market
[6] International Energy Agency (2015), Key World Energy Statistics 2015
[7] International Energy Agency (2016), Key World Energy Statistics2016
[8] National Energy Technology Laboratory for the U.S. Department of Energy Office of Electricity Delivery and Energy Reliability, (2007), The NETL Modern Grid Initiative Powering our 21st-Century Economy, Modern Grid Benefits
[9] Wattanapong Rakwichian, (2016), Smart Grid : All Electric Appliances
[10] Fujisawa SST Council, Panasonic Corporation, (2014), Fujisawa Sustainable Smart Town
[11] Tropical Renewable Energy Center, (2016), Smart House System
[12] Amir Hosein Ghaffarian Hosein, Nur Dalilah Dahlan, Umberto Berardi, Ali Ghaffarian Hoseini and Nastaran Makaremi, (2013), The essence of future smart houses : From embedding ICT to adapting to sustainability principles
[13] Sumi Helal, William Mann, Hicham El-Zabadani, Jeffrey King, Youssef Kaddoura and Erwin Jansen, (2005), The Gator Tech Smart House: A Programmable Pervasive Space
[14] Linda Dethman – Cadmus and Karen Ehrhardt, PhD, (2010), Consumer Voices : Results of Baseline Focus Groups
[15] Jui-Sheng Choua, Changwan Kimb, Thanh-Khiet Unga, I Gusti Ayu Novi Yutamia, Guo-Tai Lina and Hyojoo Son, (2015), Cross-country review of smart grid adoption in residential buildings
[16] S. Massoud Amin, (2011), Smart Grid : Overview, Issues and Opportunities. Advances and Challenges in Sensing, Modeling, Simulation, Optimization and Control
[17] Layla AlAbdulkarim, Zofia Lukszo and Theo Fens, (2012), Acceptance of Privacy-Sensitive Technologies: Smart Metering Case in The Netherlands
[18] Pedro Ponce, Kenneth Polasko and Arturo Molina, (2016), End User Perceptions toward Smart Grid Technology : Acceptance, Adoption, Risks, and Trust
[19] Chan-KookPark, Hyun-JaeKim and Yang-SooKim, (2014), A study of factors enhancing smart grid consumer engagement
[20] Ekachai Boonyatisatan, (2010), Professional SWOT Analysis Manual (2nd edition)
[21] Everett M. Rogers, (1983), Diffusion of Innovations (3rd edition), the United States of America, A Division of Macmillan Publishing Co., Inc.