Energy and Power Engineering, 2015, 7, 465-476
Published Online September 2015 in SciRes. http://www.scirp.org/journal/epe
http://dx.doi.org/10.4236/epe.2015.710045

Review on People's Lifestyle and Energy Consumption of Asian Communities: Case Study of Indonesia, Thailand, and China

Didit Novianto*, Weijun Gao, Soichiro Kuroki

The University of Kitakyushu, Kitakyushu, Japan
Email: *u3dbb002@eng.kitakyu-u.ac.jp, weijun@kitakyu-u.ac.jp, kuroki@kitakyu-u.ac.jp

Received 10 August 2015; accepted 22 September 2015; published 25 September 2015

Abstract

This paper focuses on the residential housing performance and people's lifestyle in terms of energy use. The research has to be continuously study in order to change the Asian people's lifestyle moving toward the low energy consumption. The research began with collecting data by questionnaires which already distributed to some cities of some countries in Asia. In this paper, we conducted review of energy behavior in housing of three different countries, Indonesia, China, and Thailand. Through questionnaire surveys distributed to more than 600 households, we revealed the housing unit characteristics, household characteristics, ownership of domestic electrical appliances, use of indoor thermal equipment, and monthly energy use. Based on questionnaire results from all households in the seven districts, we conducted statistical analyses to find the major factors influencing the energy use in households. Finally, the research results will be used to indicate the energy use and develop an idea for energy conservation in Asian countries. For further studies, the researchers also try to discover the new way of changing the people's lifestyle in terms of energy consumption.

Keywords

Lifestyle, Housing, Energy Use, Survey, Asia

1. Introduction: Energy Consumption Situation in Each Country

Indonesia: Indonesia is rich in natural resources including the petroleum, natural gas, and coal. About 35% of the petroleum mining products exported to other countries. On the other hand, Indonesia's economic growth af-

*Corresponding author.

How to cite this paper: Novianto, D., Gao, W.J. and Kuroki, S. (2015) Review on People's Lifestyle and Energy Consumption of Asian Communities: Case Study of Indonesia, Thailand, and China. *Energy and Power Engineering*, **7**, 465-476.
http://dx.doi.org/10.4236/epe.2015.710045

fects the increasing of domestic energy demand. However, these energy resources are limited and need hundreds of years of production. From 2000 until 2009, Indonesia's oil export decreased 48% as an impact of oil production decrease [1]. According to the National Energy Outlook of Indonesia, in the period 2000-2009 energy consumption in Indonesia increased from 709.1 million SBM (Barrels of Oil Equivalent/BOE) to 865.4 million SBM, or increased by 2.2% per year. Until the end of 2011, the largest sector of final energy consumption is still dominated by industrial and then followed by household sector and transportation sector, each are 37%, 36%, and 21% [2]. Even so, with the national population booming, there is possibility for the household sector will increase significantly.

China: Energy consumption of China has been increasing rapidly due to the recent economic growth and development. This leads to serious environment problems such as air pollution and acid rains. Meanwhile the building sector accounts for large parts of energy consumption. It is almost 30% of total energy consumption in 2007 [3]. Especially in recent years, people's demand for life quality triggered drastic annual increase of energy consumption on urban areas in China. In order to estimate the future trend of residential indoor environment and energy consumption in China it's necessary to understand the actual conditions of the usage of facilities the indoors thermal conditions and quality in different zones. In China, the space heating energy consumption is about 40% in the urban area on average though there is great difference between the south region where people use individual heating equipment and the north region where district heating is generally used. However, the energy consumption is comparatively large in the villages of China because firewood and crops are used as the energy source.

Thailand: The National statistical office of Thailand has conducted a survey of household energy consumption by 2009 and found out the comparison of the energy cost of the households across the country in 2008 and 2009 has increased from 1568 baht (51 USD) to 1818 baht (60 USD) or increase the percentage of 15.9 per year. Particularly oil, biodiesel and renewable energy, although it is rarely used but has been increased 50%, gas was increased 33.7% and diesel increased by 25.7%. The electric consumption was found increases of 11.6 over the year 2008, which has just in 2.1%. From 2008 to 2009, the monthly energy cost of residential sector has increased 10.6% (from 83 USD to 92 USD) [4].

Responding this issue, some development countries innovate with environmentally hi-technologies, such as wind power, solar panel, and nuclear power plant. The technologies were proven in reducing consumption of oils and coals, but still low in affordability and not a bit of technologies would lead to another disaster like the damage of nuclear power plant in *Fukushima*, Japan, 2011. Rather than just reducing consumption, the technologies were also increase the energy supply, which means people can use it without limits as their needs increase. From these issues, we are thinking about how to change the community towards energy efficient by changing their lifestyle. By using the energy as necessary will significantly able to save the environment and human life, with the combination of the passive technologies.

2. Study of Literature

In response to the issue of increasing energy demand in the housing sector, several studies on residential energy use have been conducted by many researchers in Asian and Western countries. Some researches about trends of energy use and its relationship with households attributes in Japan were reviewed. *Nakagami et al*. [5] reported that the energy demand is expected to increase continuously as well as the increase of housing appliances ownership in Japan. They also surveyed residential energy consumption and its indicators in 18 countries, both developed and developing countries, and revealed that in the Western Countries, household energy consumption shows a trend toward saturation, but in the Asian Countries it is likely that household energy consumption will continue to rise. *Kagajo et al*. [6] analyzed the household energy consumption trends based on the standard models of family pattern, aging society, and its life schedule. *Nomura et al*. [7] conducted a study on the interrelationship between household electricity consumption and family member ages. *Tsurusaki et al*. [8] found that space-heating, space-cooling, lighting and usage of electronic entertainment equipment are the major influences on household energy consumption in the cold climate area, Hokkaido, Japan. *Fong et al*. [9] pointed out the lifestyles in terms of family pattern, employment status; employment sector, gender, and age do have a significant impact on household energy consumption, later the lifestyles were categorized as indirect lifestyles. *Yu et al*. [10] made a questionnaire and simulation in northeast, middle and east of China, and generated an equation to calculate the energy used for district heating of households in Shenyang, Dalian, Beijing, and Luoyang. *Chen et al*.

[11] using Quantification Theory 1, investigated the influential factors on energy consumption in seven big cities of China in the summer time and presented a comparative study of the results. *Lam et al*. [12] also made the research on residential energy consumption with five different building types in Hong Kong, and evaluated the end use values. *Long et al*. [13] conducted an investigation on the electricity use of air conditioners in Shanghai, and got the mean monthly energy consumption values in the air conditioning seasons and transition seasons. *Tso et al*. [14] studied domestic energy structure in Hong Kong and found the breakdown of end use and the daily properties of energy loads by calculations, and finally revealed the influential factors of electricity use in summer and winter. *Yoshino et al*. [15] carried out the investigation to 240 houses during the winter from 1998 to 2000 by means of questionnaire in terms of the space heating and indoor thermal environment of residential buildings in three big cities of China. *Ogawa et al*. [16] carried out research to investigate the characteristics of building energy standard of the residential building in China and classified the climate zones based on thermal environment design, specified new standard of sunlight, lighting, and ventilation. *Wei et al*. [17] analyzed the current condition of urban and rural residential energy consumption of Jilin, China by establishing a model of residential energy demand, which can predict energy demand based on demand types and environmental load until 2020. *Quyang et al*. [18] identify the changes in the occupants' behavior of residential housing in Hangzhou, China, and predicted that residential electricity use will increase continually in the near future due to improved standards of living and a greater dependency on electric appliances, also more than 10% of household electricity use can be conserved by informing occupants of energy-saving measures to improve their behavior. *Hubacek et al*. [19] examined the contribution to CO_2 emissions (I) of population growth (P), affluence (A) (representing different lifestyles and consumption patterns) and CO_2 intensity (T) representing technology. *Kang et al*. [20] developed energy load prediction equations which can be easily used to estimate the energy consumption of multi-residential buildings in Korea by using Orthogonal Array to carry out simulation and investigated the relative importance of each energy factor with ANOVA. *Yoo et al*. [21] identified the changes in occupants' lifestyles using national statistics survey data, and then estimations were made by connecting each occupant activities to the corresponding residential appliances.

In the Western societies, numerous researches about residential energy use and family lifestyle were also reviewed in this paper. *Wood et al*. [22] emphasized the importance of time-series electricity use analysis of each residential appliance in a particular house, in order to reflect the occupant's characteristics and how those characteristics impact electricity use in the UK. *Diamond et al*. [23] characterized the physical environment and identified the forces that would be influential in making implications for the future energy use in US buildings. *Brounen et al*. [24] analyzed the extent to which the use of gas and electricity is determined by technical specification of dwelling as compared to demographic characteristics of the resident in Dutch homes, revealed that the gas consumption is determined principally by structural characteristics, while electricity consumption varies more directly with household composition, income, and family structure. *Haas et al*. [25] investigated the impact of the thermal quality of buildings, consumer behavior, heating degree days, building type (single- or multi-family dwellings) on residential energy demand for spaces heating have been investigated in Austria. *Linde'n et al*. [26] based on a survey of 600 Swedish households, revealed those behavioral patterns that are efficient and those that need to be improved for energy conservation, after that several policy instruments for change were identified in the study and they include combinations of information, economic measures, and administrative measures and more user friendly technology as well as equipment with sufficient esthetic quality. *Olexsak et al*. [27] compiled 274 measurements of observed changes in electricity demand caused by Earth Hour events in 10 countries, the events reduced electricity consumption by 4% on average, with a range of +2% (New Zealand) to −28% (Canada). *Leighty et al*. [28] investigated the changes in behavior and technology induced by a transient crisis which can permanently lower electricity use in Juneau, Alaska by 25% and concluded persistent electricity savings appear to be the result of reduced thermostat settings, continued CFL bulb use, keeping fewer lights on, unplugging appliances when not in use, use of power-saving settings on appliances, and showering behavior (both shorter duration and fewer).

Several studies have obtained the major influential lifestyle factors on household's energy use and proposed some strategies to change the behavior of occupants, but the sample mostly were randomly taken, especially in terms of household's types. In this study, we conducted surveys in Asian big cities: Shanghai (China), Jakarta (Indonesia), and Bangkok (Thailand) to more than a thousand respondents in order to grasp the house energy situation in developing and developed countries. In this paper, we selected some local cities of three countries and targeted the younger nuclear families aging between 20's to 40's (married couples with children, or single

parent with children) as representative for future energy demand. The large number of feedback and unique database are new contribution to this research field, since it is very difficult for researcher to conduct such kinds of questionnaire surveys in different countries and especially in Japan due to privacy issues and strict rule of local government. Furthermore, we also contribute to the discussion on energy use pattern by types of houses and energy sources.

3. Survey on Lifestyle and Housing Energy Consumption

The research framework can be seen in **Figure 1**. The great differences of the climate and architecture characteristics among three countries lead to residential indoor environment and energy usage structures in different countries having their own characteristics. For that reason a survey was carried out for these three countries from August 2011 to December 2012 among more than 4500 households in total of all countries. Questionnaire distribution and collection were done through local cooperative school with their teacher's assistance. Questionnaire has seven parts: building characteristics, family income and outcome, building appliances, family characteristics, life style, interior air quality condition, and effort on energy consumption reduction. The investigated contents are shown in **Table 1**. The types of buildings involved in the survey range from low-rise to high-rise building, the monthly energy consumption data of gas & electricity and field measurement data of humidity & temperature in a year were obtained also.

In Indonesia the survey was conducted from September 2011 to October 2011 among 500 households in the transition time between rainy season and dry season respectively, which were selected in urban area. Almost of the data were collected from three big cities in Java Island, are Jakarta, Bandung, and Semarang City. In China the survey was conducted from September 2011 to December 2011, between summer and autumn, which were selected in Shanghai area, among more than 800 households. In Thailand the survey data was collected from Bangkok City in the same period with Indonesia survey.

3.1. Basic Information

Table 2 shows the building characteristics among all investigated households and its comparison of three different countries. As for the architecture floor area, 32.7% households from Indonesia and 34% households from Japan are between 121 m^2 and 200 m^2, which is the largest one in the country. The 91 m^2 - 120 m^2 is dominating in China, probably is an impact of economic growth in Shanghai, the land also getting higher. While in Indonesia there is 2% households are have less than 15 m^2 of floor area, less than the minimum standard of Indonesian housing, which is 36 m^2. For the building type, in Indonesia, 94% buildings investigated are detached house

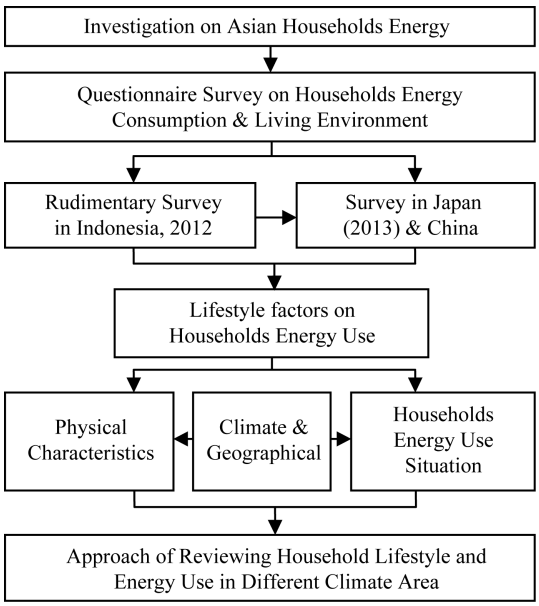

Figure 1. Research framework.

Table 1. Questionnaire contents.

Item	Content
Building characteristics	Housing area, housing type, housing status, housing structure, housing construction year
Family income and outcome	Annual income, electricity bill consumption, water bill consumption, gas bill consumption
Building appliances	Heating and cooling system type, kitchen equipment, entertainment equipment, cleaning & showering equipment, lighting type, transportation type, etc.
Family characteristics	Number of occupants, work type
Life style	Heating & cooling period, heating & cooling time, number of staying persons
Interior air quality condition	Sense of thermal comfort, satisfaction of environment, environmental conditioning method
Effort on energy consumption reduction	Environmental problem, waste management, passive technology usage, etc.

Table 2. Building characteristic.

Building characteristic		Indonesia	Thailand	China
Architecture area (m^2)	<15	2		
	15 - 45	3.3	7	
	46 - 60	5.7	9	3.1
	61 - 90	19.3	11	16.6
	91 - 120	15.7	17	38.8
	121 - 200	32.7	34	25.8
	201 - 250	10	12	8.9
House type	Detached house	94	75	25.8
	Hi-rise apartment	0.7	25	72.2
	Low-cost flat	3.3		
	Shop house	2		2
House floor level	1 F	47.3	27	7.2
	2 F	47	73	16.5
	3 F or more	5.7		76.3
Construct. year (year)	< 5	9		36.6
	5 - 10	30.3	49	35.1
	11 - 20	39	33	19.5
	21 - 30	10.7	16	5.2
	31 - 40	5.7	2	3.4
	41 - 50	2.3		0
	51 - 60	2.7		0.3
	60 >	0.3		
Structure type	Concrete	43.3	90	29.1
	GRC	4.2		66.1
	Brick	26.7	10	3.3
	Steel	0.8		1.2
	Wood	21.7		0
	Bamboo	3.3		0.3
House status	Buy	91	84	29
	Rent	9	16	71

which is the largest one. 3.3% buildings are low cost apartment which received government's subvention. 2% buildings are shop houses; houses with commercial space under it. 0.7% buildings are apartment or mansion without subvention. Thailand situation has similarity on the detached house domination, it is about 75%, but the apartment number is much bigger than Indonesia, about 25%. China situation is different, the house building development growth vertical, 72.2% is hi-rise apartment. As for floor level, there are no significant differences between 1 floor and 2 floors in Indonesia, but in Thailand and China almost of the building are higher than two-storey. In Indonesia most of buildings were built between 1990 and 2000 accounting for 39 %, Thailand is 49% were built around year 2005. The newest building dominate in China, about 36% were built after year 2005. In Indonesia and Thailand, most of buildings use concrete as main structure each is s about 43.3% and 90%. GRC is really popular in China, reach 66.1%, followed by concrete. While about 21.7% and 3.3% are each using wood and bamboo as the main structure which is the traditional building style (*Javanese* and *Sundanese* traditional house) in Indonesia. As for house status, 91% and 84% households in Indonesia and Thailand choose to buy their house. Probably they feel more secure if the families buy the houses also the land price still affordable for most of citizen. Only 9% and 16% households rent the houses. Different with China, more than 70% householder rent their house, as the impact of vertical development.

3.2. Energy Use

Figure 2 shows the electricity and water consumption value comparison between Indonesia and Thailand. All the energy use converted to calorific value in Mega Joules. The gas consumption is difficult to track and make the comparison because householder in the country like Indonesia and Thailand consume gas from the LPG tube which they bought every three weeks or 1 month depend on their need. But in the China, some area already consumes gas from the pipe. From the **Figure 2**, the comparison between Thailand and Indonesia has slightly different in electricity price, but it has similar shape in the respondent number as shown in black parabolic line. Although, there is growth of consumption in Indonesia from point 2000 MJ/year, means there are some household using the electricity bigger than the average (orange parabolic line). In the other hand, China has different consumption graphic pattern, it has wider variation of user's lifestyle makes the average energy consumption is bigger than the other two countries.

3.3. Household Appliances

In order to find an idea of future energy conservation method, the influence factors of residential energy consumption has to be analyzed, also the reasons which result in the differences of energy consumption quantities between high and low energy use family group need a further analysis. Housing appliances user comparison between Indonesia, Thailand, and China can be shown from **Figures 3-9**. The research investigate almost all of the electric equipment in residential housing, but in this paper the only the housing appliances that consume high energy to be described, such as refrigerator, microwave oven, television, computer, and type of stove.

Figure 3 shows that more than 94% China families and about 60% Thailand families have more than 1 unit refrigerator in their house. As **Figure 5**, the microwave oven not really popular in Indonesia and Thailand, but

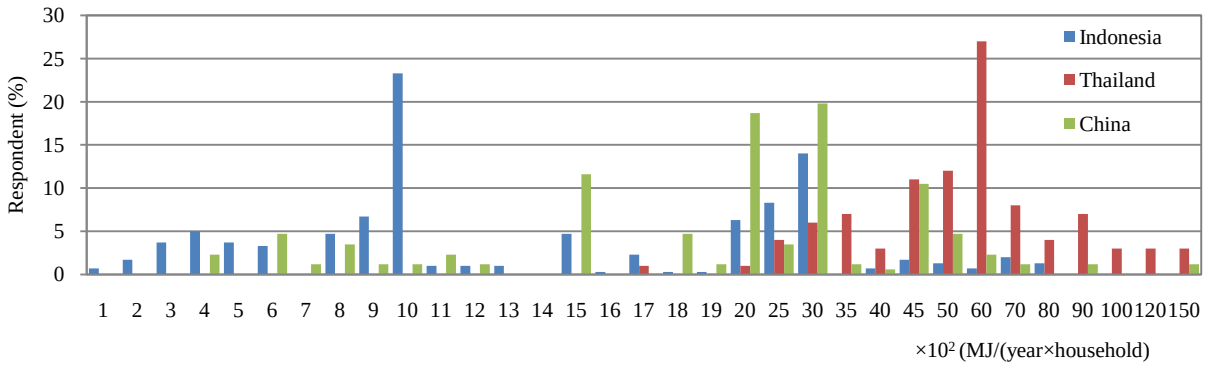

Figure 2. Electricity consumption by countries.

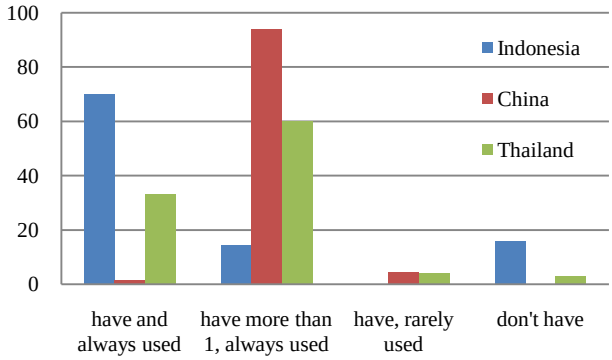

Figure 3. Refrigerator.

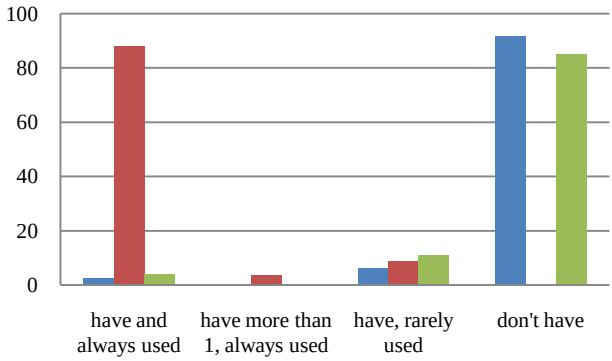

Figure 4. Microwave.

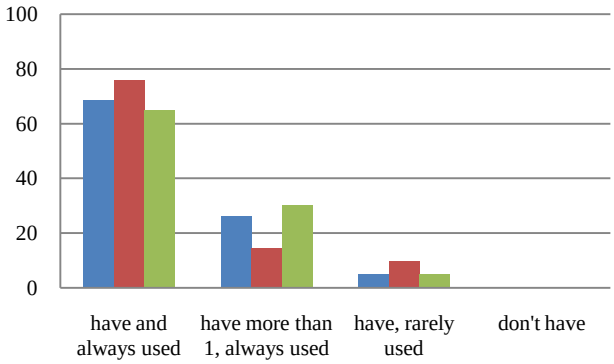

Figure 5. Television.

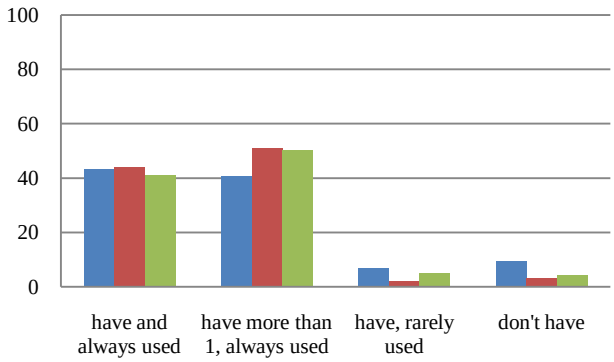

Figure 6. Computer.

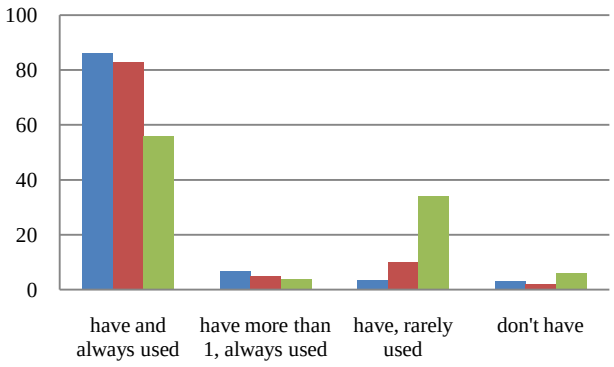

Figure 7. Gas stove.

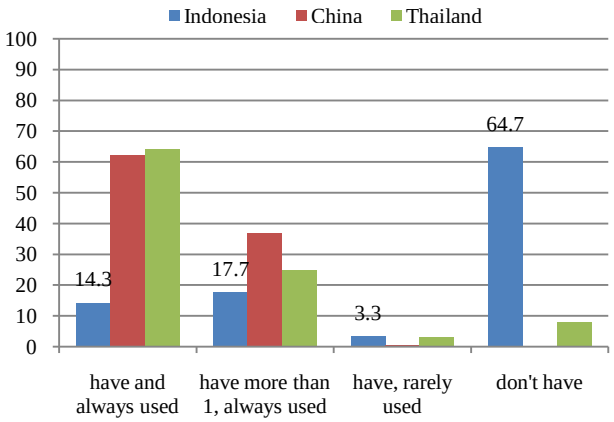

Figure 8. Air conditioner.

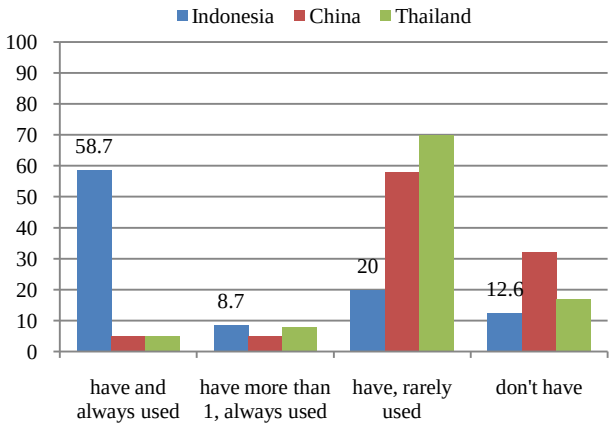

Figure 9. Electric fan.

more than 87% families in China have and always use the microwave. **Figure 5** shows the similarity of the television composition user, until nowadays, televisions are being the primary need of families. Like television, computer and laptop have been modern people lifestyle, shown in **Figure 6**, almost all countries have more than 1 unit computer in the families. **Figure 7** shows the gas stove user composition, Thailand is higher at non-user families in gas stove, probably because the Thai people prefer to buy food rather than cook the food by themselves, different with Indonesian and Chinese who still like to cook for the family.

Indonesia and south part of Thailand are still in the tropical climate zone, mean it only have two main seasons, dry season and rainy season. Even so, the average temperature in Thailand is higher than Indonesia, the result

shows there are more than 60% families who have and always used the air conditioner in their houses. Different with those two countries, China has been divided five architecture thermal zones, the very cold zone, the cold zone, the moderate zone, the hot summer & cold winter zone and the hot summer & warm winter zone, its make the insulation and air conditioning system in China are the important thing to reach the thermal comfort. In the other hand, there are more than 64% of families who did not install the air conditioning system and still comfortable with the use of electric fan. Although, there is growth of air conditioner user in the Jakarta area, it is not only because the Jakarta temperature but also because of the people's lifestyle growth.

4. Influential Factors on Housing Energy Use

Multiple Regression Analysis (MRA) with *Quantification Theory I* was used to weigh the contribution of independent variables (lifestyle types) to the dependent variable (total energy use per households). In this method, the qualitative and quantitative variables of yearly energy use can be introduced into models and be analyzed together. Firstly, the correlation analyses conducted to more than 40 variables and only the factors that have positive correlation were taken for the next stage of analyses. The significant test was taken to judge that to what extent the Partial Correlation Coefficient (PCC) was large enough, the factors will have effect to the energy use. The bigger Significance Probability (SP) has the less PCC. It means the factor has a bigger influence on the housing energy use. In order to get valid results, the regression analysis was conducted on all predicted factors. As a result, 24 factors were revealed with a high correlation score. In this case, there were 24 variables used as independent variables. They were: 1) *House size*, 2) *Family size*, 3) *Household age*, 4) *House type*, 5) *Residential year*, 6) *Electricity current*, 7) *Daily stay hours in home*, 8) *Wakeup/sleep schedule*, 9) *Sleeping hours per day*, 10) *Toilet and kitchen lighting*, 11) *Electric light pattern*, 12) *Bath method*, 13) *Bath length per person*, 14) *Cooking schedule*, 15) *House energy type*, 16) *TV ownership*, 17) *Solar PV ownership*, 18) *Computer ownership* 19) *LED lamp ownership*, 20) *Electric fan ownership*, 21) *AC ownership*, 22) *Oil heater ownership*, 23) *Elec. heater ownership*, 24) *Gas heater ownership*.

Then the regression was conducted once again to include 24 factors above with the filtering method correlation score up to 95%. It means if SP less than 0.05, the factor has big influence on energy use. The score of each variable was used to analyze the influence extent of all the categories of qualitative variables (e.g. housing characteristic, family characteristic, and lifestyle characteristic), and quantitative variables (e.g. appliances ownership) on the dependent variable (yearly energy use).

In the other hand, the data filtering was conducted once again on 600 households. Only data with 100% validity was selected. According to the assumption that significance probability was smaller than 0.05 (or in other words has correlation score bigger than 95%), the factor had a big influence on energy use. As a result, the influence extent of the factors on energy use can be established in the following order in **Table 3**.

Based on the survey results in Indonesia and through the application of Quantification Theory I, households energy use in Indonesia are strongly influenced by the ownership of AC, number of people stay (family member), the ownership of refrigerator, the ownership of electric fan, and the ownership of electric stove, and the ownership of gas stove.

In China, the family member, the yearly income, the land size, the housing floor number, the sleep length of the householder, the ownership of washing machine, and the housing floor size are the major factors influencing the household's energy use.

Table 3. Influential factors on energy use by countries.

Countries	Empirical equation	R^2
Indonesia	$y = -9.29 + 8.06[\text{AC}] + 3.03[\text{people stay}] + 3.24[\text{refrigerator}] - 2.88[\text{fan}] + 5.07[\text{electric stove}] - 2.63[\text{gas stove}]$	0.612
China	$y = 739[\text{Family member}] + 359[\text{income}] + 985[\text{landarea}] - 880[\text{floornumber}] - 1266[\text{sleeplength}] - 513[\text{washingmachine}] - 513[\text{floorarea}] - 820$	0.734
Thailand	$y = 3.82[\text{floorarea}] + 3.47[\text{AC}] + 2.13[\text{residenceperiod}] + 1.98[\text{TV}] + 1.44[\text{electriccurrent}] + 1.28[\text{cookingperiod}] - 16.515$	0.791

While in Thailand, the floor area, residence period of stay, TV ownership, the electricity current contract choices, and daily cooking period have biggest influence on energy use in households.

Figure 10 shows the correlation between surveyed results and predicted energy use from regression models of three countries. The coefficient determination (R^2) was 0.612, 0.734, and 0.791, indicating that the regression model is reasonably well fitted with investigated values. Therefore, the empirical regression equation was found to have a considerable predictive power.

5. Conclusions

The following conclusions can be made through this survey and comparison to the survey conducted from September 2011 to December 2011 among three countries:

1) Indonesian and Thai residential building has a lot of similarity in the physical architecture style and in occupant's behavior, probably because the similarity in the climate condition and economic situation. The slight difference between these two countries is the air conditioner use, 89% of houses installed and always use air conditioner in their houses, while Indonesia only 32% households always use the air conditioner in their house. Compare with Thailand and China, energy consumption cost in Indonesia is lower, it could be the electricity and

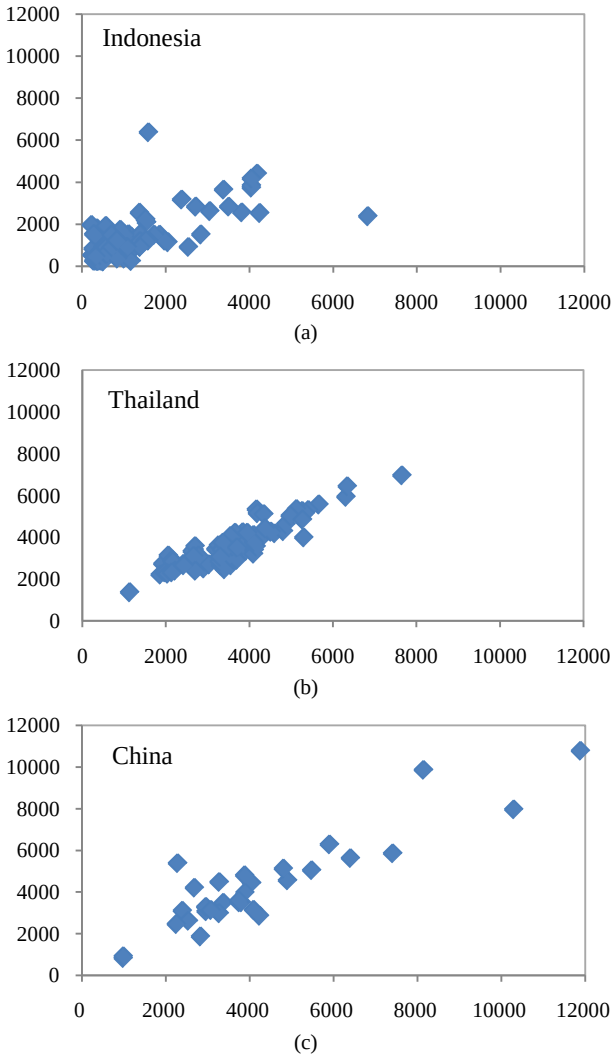

Figure 10. Correlation between x-axis-surveyed value energy use (MJ/household) and y-axis-predicted value (MJ/household).

water tariff also lower in exchange rate. Although there are some families group consume bigger than the average. Even so, the energy consumption per capita is much lower than others, probably there is just little share consumption in space cooling and almost the people don't need the heating system.

2) Beside the climate situation, the housing appliances are very important influence factors on energy consumption in these 3 countries. There is a big possibility of family who doesn't have such kind of appliances now will follow the richer family's life standard. Not only families in one country, but also there is also possibility of country's life standard change follow the developed country. If Indonesian follows the Chinese and Thai lifestyle, it would have bigger energy consumption average because of the human population.

3) The architecture design of the housing building is also an important factor in energy conservation. From the result data, in Thailand and Indonesia, energy consumption increases with the popularity of air conditioners. To prevent the increase of energy consumption, it is necessary to design open spaces between rooms for effective ventilation, to use window openings for night time ventilation, to construct roof insulation and air tightening in rooms with air conditioner. Also, the appropriate structure material choice, building orientation, and space configuration will impact to the occupant's behavior lifestyle to consume less energy. The housing design which can maximize the natural lighting and ventilation or insulation system will reach the indoor thermal comfort without consuming much energy.

Acknowledgements

This research was partly supported and funded by Ministry of Education, Culture, Sports, Science and Technology (MEXT) Japan, under the contract No. 24560724. Authors would also like to thank Mr. Alan Meier, (Energy Efficiency Center, UC Davis) for his advices to improve the quality of this paper. Also thanks to Mr. Ian Jarvis (The University of Kitakyushu) for checking the English.

References

[1] (2009) Ministry of Energy and Mineral Resources of Republic Indonesia. http://www.esdm.go.id

[2] Ning, Y.D., Tonooka, Y. and Zhao, X., *et al*. (2008) Analysis on Trends of Urban Housing Energy Consumption in Shanghai. *Proceedings of the Fifth International Conference on Building Energy and Environment*, Dalian, 412-419.

[3] (2008) The World Fact Book. CIA.

[4] National Statistical Office, The Survey of Household Energy Consumption by 2008-2009, Thailand.

[5] Nakagami, H. (1997) Appliance Standards in Japan. *Energy and Buildings*, **26**, 69-79. http://dx.doi.org/10.1016/S0378-7788(96)01014-6

[6] Kagajo, T. and Nakamura, S. (1997) Analysis of Household Energy Consumption Trends Based on the Standard Models of Family Pattern. *Energy Economics*, 11-29.

[7] Nomura, N. and Ohya, H. (2000) Interrelationship of Household Electricity Consumption and Family Member Ages. *Journal of the Japan Institute of Energy*, **80**, 727-735. http://dx.doi.org/10.3775/jie.80.727

[8] Tsurusaki, T., Murakoshi, C. and Yokoo, M. (2000) Measurement and Analysis of Residential Energy Consumption in Hokkaido. *Proceeding of the Conference on Energy, Economy and Environment*, 417-422.

[9] Fong, W.K., Matsumoto, H., Lun, Y.F. and Kimura, R. (2007) Influences of Indirect Lifestyle Aspects and Climate on Household Energy Consumption. *Journal of Asian Architecture and Building Engineering*, **6**, 395-402.

[10] Yu, L., Watanabe, T., Yoshino, H. and Gao, W. (2008) Research on Energy Consumption of Urban Apartment Buildings in China. *Journal of Environmental Engineering*, **73**, 183-190. http://dx.doi.org/10.3130/aije.73.183

[11] Chen, S., Yoshino, H. and Li, N. (2010) Statistical Analyses on Summer Energy Consumption Characteristics of Residential Buildings in Some Cities of China. *Energy and Buildings*, **42**, 136-146. http://dx.doi.org/10.1016/j.enbuild.2009.07.003

[12] Lam, J.C. (1996) An Analysis of Residential Sector Energy Use in Hongkong. *Energy*, **21**, 1-8. http://dx.doi.org/10.1016/0360-5442(95)00089-5

[13] Long, W.D., Zhong, T. and Zhang, B.H. (2003) Situation and Trends of Residential Building Environment Services in Shanghai. *Proceedings of the* 4*th International Symposium on Heating, Ventilating and Air Conditioning*, Beijing, 9-11 October 2003, 493-498.

[14] Tso, G.K.F. and Yau, K.K.W. (2003) A Study of Domestic Energy Use Pattern in Hongkong. *Energy*, **28**, 1671-1682. http://dx.doi.org/10.1016/S0360-5442(03)00153-1

[15] Yoshino, H. and Lou, H. (2002) Indoor Thermal Environment of Residential Buildings in Three Cities of China. *Jour-*

nal of Asian Architecture and Building Engineering, **1**, 129-136. http://dx.doi.org/10.3130/jaabe.1.129

[16] Ogawa, Y., Gao, W., Zhou, N., Watanabe, T., Yoshino, H. and Ojima, T. (2005) Investigation on the Standard for Energy and Environmental Design of Residential House in China. *Journal of Asian Architecture and Building Engineering*, **4**, 253-258. http://dx.doi.org/10.3130/jaabe.4.253

[17] Wei, X., Xuan, J., Yin, J., Gao, W., Batty, B. and Matsumoto, T. (2006) Prediction of Residential Building Energy Consumption in Jilin Province, China. *Journal of Asian Architecture and Building Engineering*, **5**, 407-412. http://dx.doi.org/10.3130/jaabe.5.407

[18] Quyang, J., Gao, L., Yan, Y., Hokao, K. and Ge, J. (2009) Effects of Improved Consumer Behavior on Energy Conservation in the Urban Residential Sector of Hangzhou, China. *Journal of Asian Architecture and Building Engineering*, **8**, 243-249. http://dx.doi.org/10.3130/jaabe.8.243

[19] Hubacek, K., Feng, K. and Chen, B. (2012) Changing Lifestyles towards a Low Carbon Economy: An IPAT Analysis for China. *Energies*, **5**, 22-31. http://dx.doi.org/10.3390/en5010022

[20] Kang, H.J. and Rhee, E.K. (2012) A Development of Energy Load Prediction Equation for Multi-Residential Buildings in Korea. *Journal of Asian Architecture and Building Engineering*, **11**, 383-389. http://dx.doi.org/10.3130/jaabe.11.383

[21] Yoo, J.H. and Kim, K.H. (2014) Development of Methodology for Estimating Electricity Use in Residential Sectors Using National Statistics Survey Data from South Korea. *Energy and Buildings*, **75**, 402-409. http://dx.doi.org/10.1016/j.enbuild.2014.02.033

[22] Wood, G. and Newborough, M. (2003) Dynamic Energy-Consumption Indicators for Domestic Appliances: Environment, Behavior and Design. *Energy and Buildings*, **35**, 821-841. http://dx.doi.org/10.1016/S0378-7788(02)00241-4

[23] Diamond, R. (2003) A Lifestyle-Based Scenario for US Buildings: Implications for Energy Use. *Energy Policy*, **31**, 1205-1211. http://dx.doi.org/10.1016/S0301-4215(02)00172-6

[24] Brounen, D., Kok, N. and Quigley, J.M. (2012) Residential Energy Use and Conservation: Economics and Demographics. *European Economic Review*, **56**, 931-945. http://dx.doi.org/10.1016/j.euroecorev.2012.02.007

[25] Haas, R., Auer, H. and Biermayr, P. (1998) The Impact of Consumer Behavior on Residential Energy Demand for Space Heating. *Energy and Buildings*, **27**, 195-205. http://dx.doi.org/10.1016/S0378-7788(97)00034-0

[26] Linden, A.L., Kanyama, A.C. and Eriksson, B. (2006) Efficient and Inefficient Aspects of Residential Energy Behavior: What Are the Policy Instruments for Change? *Energy Policy*, **34**, 1918-1927. http://dx.doi.org/10.1016/j.enpol.2005.01.015

[27] Olexsak, S.J. and Meier, A. (2014) The Electricity Impacts of Earth Hour: An International Comparative. *Energy Research & Social Science*, **2**, 159-182. http://dx.doi.org/10.1016/j.erss.2014.04.014

[28] Leighty, W. and Meier, A. (2011) Accelerated Electricity Conservation in Juneau, Alaska: A Study of Household Activities That Reduced Demand 25%. *Energy Policy*, **39**, 2299-2309. http://dx.doi.org/10.1016/j.enpol.2011.01.041