

A REVIEW OF CROSS-CULTURAL ANALYSIS ON ENERGY BEHAVIOUR CONSUMPTION IN RESIDENTIAL BUILDING BETWEEN MALAYSIA AND JAPAN

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ABSTRACT

Energy saving behaviour is unique and complex. The role of culture in shaping energy usage patterns in Japanese and Malaysian households is focused in this review study. The Japanese is much better in terms of energy savings behaviour in order to decrease the emission of the country. It will help to sort out energy usage patterns that are rooted in the Japanese culture and thus resistant to rapid changes in technological aspect of buying household appliances. The Japanese daily use of appliances is more effective and efficient than Malaysians who make up one-third of the Japanese population. The impact of occupant behaviour on energy consumption is therefore crucial to be investigated. The findings from this investigation can develop an improved green technology usage for sustainable development in Malaysia.

Keywords - energy behaviour, energy usage habits, energy buying pattern, green energy technology

1. INTRODUCTION

Energy used in the home is invisible. Our energy consuming behaviours are based on our routine and habit. We turn the lights on, leave televisions on standby without having to think about how these actions are carried out, where the energy comes from or what the environmental consequences are [1-5]. The impact of energy misuse behaviour resulting in supply difficulties, exhaustion of energy resources and impact on the environment such as climate change, global warming and ozone layer depletion [6-9]. Energy misuse in residential sector is influenced by very diverse factors such as energy saving awareness socio-demographic factors, building characteristics, and energy prices [4, 10-12].

The rapid development of Malaysia as a developing country is unavoidably consuming huge amounts of energy that contribute to urban heat island and global warming. The energy use prediction for built environment is the efficient way to solve the global warming issue[13]. This is in line with the 10th Malaysia Plan on the widespread availability and recognition of green technology in terms of products, appliances, equipment, and systems in the local market through standards, rating and labelling programs [14-17].

In 2011, Malaysia residential sector consumed 6.5 Mtoe per year. In addition, 1.2 Mtoe LPG consumed as cooking gas [14]. Although Malaysia is a developing country which also

a net exporter of natural gas, oil reserves are expected to be adequate for the continuity up to 20 years. Nonetheless, natural gas for 38 years demand of energy use in Malaysia is increasing until 2015 [18]. This trend implies to most of the household electrical appliances such as television, refrigerator, fan, iron, washing machine, etc.[19-21]. According to a study done in Malaysia, energy consumption of air-conditioner are estimated to increase from 9471 MWh in 2000 to 19.153 GWh by 2010 [16]. Considering these circumstances, effective strategies of energy saving in residential sectors are strongly needed from social science as well as engineering perspective.

Meanwhile, the investigation of Japanese's behaviour and perception towards energy saving seems fruitful for Malaysia. In comparison to Japan, Malaysia by far has a greater number of oil and natural gas reserves, which is the reason why Japan energy production of oil is only 60% and the rest is nuclear-generated power[22]. Japan relies more on natural gas and coal as substitute to nuclear power, as energy conservation measures are enforced for the benefit of the larger sector[23, 24]. EIA assumed that the Japanese oil consumption will continue to decline until 2015 with support from nuclear power for its energy needs [23].

Indeed, Japan is a developed country with 127.1 million people [25], yet it has invested in energy-efficient technologies which majority of it have been successfully developed to promote energy saving essentially for domestic applications. A lot of these accomplishments are attributed to the well-received concept of "Mottainai".

The comparison of attitudes towards energy use in Japan is very necessary to Malaysia in order to decrease the energy consumption in residential sector that Japan had successfully managed to implement the "Mottainai" [26]. This comparison is very interesting because both has same pattern of material culture, but different cultural traditions. As we shall indicate, the findings of the comparison from two countries shows cross-national differences in the use of electricity, gas cooking, heating, air conditioner and lighting [26]. It is very important to analyse the habits of energy use at home [27]. It is helpful to take a pattern rooted in culture and thereby resistant against changes the fast and the elastic more. This research we will be able to find out more about the Japanese culture and their lifestyle. The database of energy use behaviour in Malaysia is still insufficient and needs to be obtained by investigating the energy use pattern.

2. WORLD ENERGY CONSUMPTION

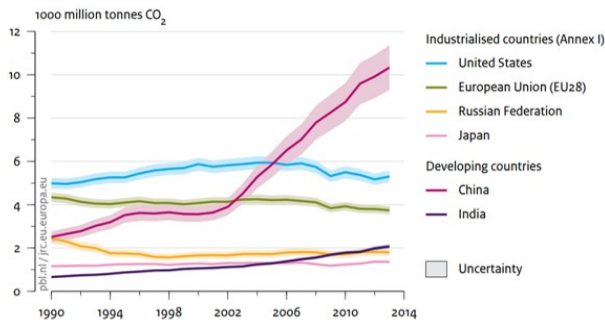


Figure 1: Global carbon dioxide (CO₂) emissions from 1990–2014 [24].

Energy behaviour is significant untapped potential to increase end-user energy efficiency in buildings. Although the behaviour of energy use is the main determinant of energy use in buildings, the potential energy savings because the behaviour is usually ignored, although the so-called high as those of technology solutions [9, 29, 30]. Aware of behavioural habits and provide feedback in a context that is important to empower individuals to take control of the residential electricity consumption [31]. Energy consumption in the residential sector is one major part of the total energy consumption in most countries. In order to promote energy conservation in the housing sector and to predict the CO₂ emissions, it is important to check the energy consumption of housing in various countries, and to exchange information on residential energy consumption so that policy makers and energy experts in various countries can learn from each other in policy making energy standard housing[16, 30, 32]. In terms of energy consumption in residential sector [as shown in Figure 1], among the developed and developing countries studied [33], Japan is the only country that the household size impacts positive and decline on total energy requirement.

In terms of household size, among the five countries studied (Australia, Brazil, Denmark, India, and Japan), showed that only in Japan that the household size impacts positively on total energy requirement[33]. Japan started to reduce CO₂ emissions to 1055.0 million tons starting in 2008. The reduction target of 6% seems to be practical given the fact that Japan is one of the most advanced countries in the world, and consists of citizens with a high public awareness on the subject of environmental conservation[23]. In fact, civil awareness of Japanese citizens is in proportion to the citizens in European countries about this. This can also be reflected in the ratio of CO₂ emissions to gross domestic product (GDP) of Japan. The data shows that for every 1% of GDP, Japan emits less CO₂ than other developed countries in the world[34]. In addition to examine the global and regional trends, the study of household energy consumption also includes the analysis of national trends in a number of selected countries. While most global and

regional shows movement towards or away from sustainability in connection with global issues, national case studies are very important to examine the impact of the policy on the trend.

3. MALAYSIA ENERGY CONSUMPTIONS IN RESIDENTIAL SECTOR

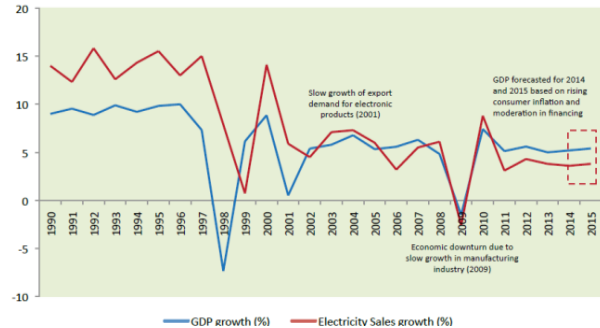


Figure 2: Malaysia relative growth rates comparison - GDP and electricity sales[18].

Malaysia is a developing country with increasing population from 25.7 million in 2009 to 30.1 million by the end of 2014 [25]. Malaysia energy consumption has recorded increasing as well as gross domestic product (GDP). It forecasted that relative growth rates comparison - GDP and electricity sales for 2014 and 2015 based on rising consumer inflation in financing will also increase [as shown in Figure 2]. Apart from that, Malaysia electricity consumption per capita has increased from 1,101kWh per person in 1990 to 3,902kWh per person in 2012 with compounded growth of 5.9% over the period of 22 years. As the nation's becoming more electrified as a result of economic growth, higher income, and technological innovations, demand for energy has increased to almost four times since 1990. Going by the recent trends, the energy demand is still growing, therefore it requires timely supply infrastructure upgrades [28].

The rapid development of Malaysia as a developing country is unavoidably consuming huge amounts of energy that contribute to urban heat island and global warming. The energy use prediction for built environment is the efficient way to solve the global warming issue. This is in line with the 10th Malaysia Plan on the widespread availability and recognition of green technology in terms of products, appliances, equipment, and systems in the local market through standards, rating and labelling programs [14].

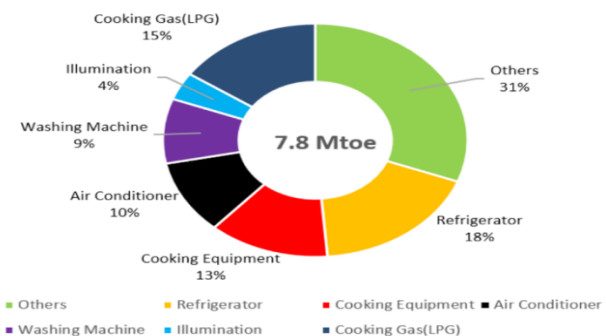


Figure 3: The structure of residential energy consumption in Malaysia in 2011[14].

In 2011 [as shown in Figure 3], Malaysia residential sector consumed 6.5 Mtoe per year. In addition, 1.2 Mtoe LPG consumed as cooking gas [14]. Although Malaysia is a developing country which also a net exporter of natural gas, oil reserves are expected to be adequate for the continuity up to 20 years. Nonetheless, natural gas for 38 years demand of energy use in Malaysia is increasing until 2015 [18]. This trend implies to most of the household appliances such as television, refrigerator, fan, iron, washing machine, etc. According to a study done in Malaysia, energy consumption of air-conditioner are estimated to increase from 9471 GWh in 2000 to 19.153 GWh by 2010 [16].

4. JAPAN ENERGY CONSUMPTION IN RESIDENTIAL SECTOR

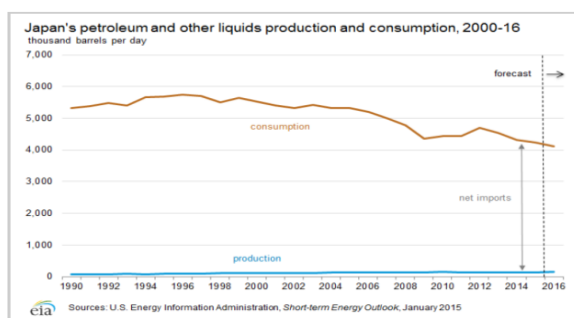


Figure 4: Japan Petroleum Energy consumption [23].

Meanwhile, the investigation of Japanese’s behaviour and perception towards energy saving seems fruitful for Malaysia. In comparison to Japan, Malaysia by far has a greater number of oil and natural gas reserves, which is the reason why Japan energy production of oil is only 60% and the rest is nuclear-generated power [13]. Japan relies more on natural gas and coal as substitute to nuclear power, as energy conservation measures are enforced for the benefit of the larger sector. EIA assumed [as shown in Figure 4] that the Japanese oil consumption will continue to decline until 2015 with support from nuclear power for its energy needs [23].

Indeed, Japan is a developed country with 127.1 million people [25], yet it has invested in energy-efficient technologies which majority of it have been successfully developed to promote energy saving essentially for domestic applications.

Japanese household energy demand are in an unusual situation. The increase of demand for heating and cooling cannot be avoided, and the future demand for lighting and motive power should be controlled [35].

While in Japan, the home-nation to the Kyoto Protocol [15, 34], explain that it has an important role to play in reducing greenhouse gases. In 2004, Japan is the fourth largest CO2 emitter in the world after the United States (22.1%), China (18.1%) and Russia (6.0%). Japan CO2 emissions account for 4.8% of total global CO2 emissions, amounting to 1.2734 billion tonnes of CO2. Under the Kyoto Protocol, Japan is committed to reducing CO2 emissions by 6%

during the first commitment period from 2008 to 2012, with 1990 as the base year for 1.1223 billion tons emitted [34]. Therefore, Japan will be required to reduce CO2 emissions to 1055.0 million tons starting in 2008. The reduction target of 6% seems to be practical given the fact that Japan is one of the most advanced countries in the world, and consists of citizens with a high public awareness on the subject of environmental conservation. This can also be reflected in the ratio of CO2 emissions to gross domestic product (GDP) of Japan. The data shows that for every 1% of GDP, Japan emits less CO2 than other developed countries in the world [34].

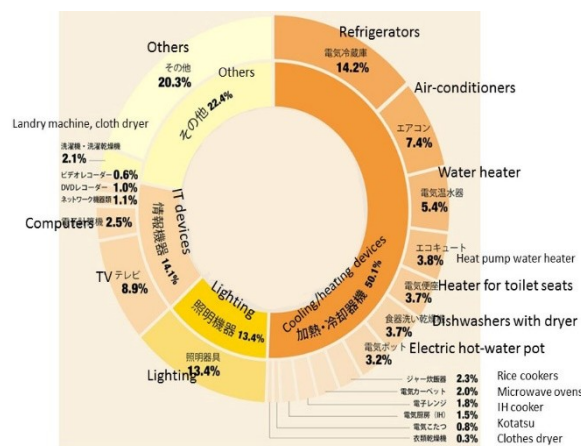


Figure 5: Breakdown of energy consumption of household at Japan in 2009 [24].

Most of the household appliances such as television, refrigerator, fan, iron, washing machine [as shown in Figure 5] used in Japanese residences are similar to Malaysian residences. The concept of “*Mottanai*” that generally means wasteful is widely-known as one of characteristics of Japanese behaviour and attitude in daily life. It is well-known to the world by “Reduce, Reuse, Recycle” [36]. This concept emphasizes on consuming resources wisely and not wasting or misusing the resources. It will give us something effective to countermeasure environmental issues in Malaysia.

Japanese household energy demand are in an unusual situation where the increase in demand in the future to a standard of living remains for heating and cooling cannot be avoided, and the future demand for lighting and motive power, which has reached a high standard, should be controlled.

5. ENERGY SAVING CONSERVATION IN JAPAN

Energy conservation [13, 21, 23, 37] is a lifestyle change, which is the transition from luxury consumption (household area residents in high-income levels are too large) for saving consumption (reduction in the use of AC as soon as possible), private cars in the country of high gasoline consumption and emissions for lower gasoline consumption and the emission of high-power appliances for the energy conservation and environmental protection [8, 11, 27, 30, 35]. Japan has recorded a remarkable development in the field of energy conservation, as the fruit of the cooperation

of the community and the government since the First Oil Crisis (1973). When the oil crisis hit, Japan's dependence on oil in primary energy consumption is about 80 percent. Although the surge in oil prices are very high when it made the Japanese economy was devastated, the government took the momentum to organize the structure of energy consumption (energy mix) are strictly Japanese. Diversification of energy on the supply side (supply) is done by replacing the use of oil with natural gas and nuclear power. Natural gas in the form of imported LNG from Indonesia and among them nuclear power plants built to suppress the dependence on petroleum [39]. Energy conservation is applied on the side of consumption (demand) of energy, especially on the activities in the residential sector [7, 27, 30, 32, 35, 38, 40].

Energy savings or energy conservation is the act of reducing the amount of energy use. Energy savings can be achieved by efficient energy use where the same benefits obtained by using less energy, or by reducing consumption and activities that use energy [7, 11, 41–43].

Energy saving is an important element of an energy policy. The energy savings to lower energy consumption and energy demand per capita, so it can close the growing need for energy due to population growth. This reduces the rise in energy costs, and can reduce the need for energy generation or energy imports. Reduced energy demand can provide flexibility in choosing the method of energy production[30, 42–44].

Based on historical, 1978 Second Oil Crisis. Japan Energy Conservation Centre was established to expand Japan's efforts to conserve energy that had previously been performed tirelessly. Energy Conservation Law of Japan first published in 1979 has gone through improvements [23].

In addition, by reducing emissions, saving energy is an important part of preventing or mitigating climate change. Energy savings also facilitate the replacement of resources cannot be renewed by the sources that can be renewed. Energy savings are often the most economical way in the face of lack of energy, and is a more environmentally friendly way than by increasing energy production to support effective energy conservation programs in Malaysia one of which can be achieved by motion like community awareness in the area about the importance of energy housing, energy regulation, energy and information as well as the adverse impact of the waste of energy that should be known by the society [41]. to support effective energy conservation programs in Malaysia one of which can be achieved by motion like community awareness in the area about the importance of energy housing, energy regulation, energy and information as well as the adverse impact of the waste of energy that should be known by the society[45].

6. COMPARATIVE STUDIES AND RECOMMENDATION

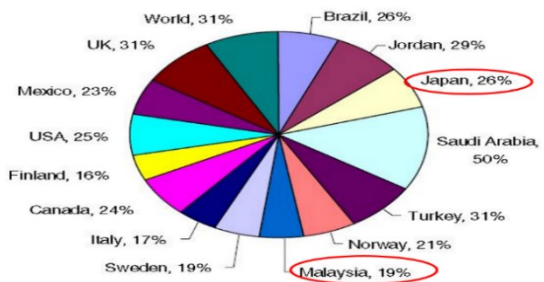


Figure 6: Worldwide residential energy consumption [46].

Malaysia is a developing country with increasing population from 25.7 million in 2009 to 30.1 million by the end of 2014. Apart from that, Malaysia's per capita electricity consumption has increased from 1,101kWh per person in 1990 to 3,902kWh per person in 2012 with compounded growth of 5.9% over the period of 22 years[25].

Japan is a developed country with 127.1 million people [25] and has invested in energy-efficient technologies majority of the which have been successfully developed to promote energy saving at domestic Essentially applications[36, 47].

As shown on Figure 6, a cross-cultural analysis between the Japanese in residential with 26% and Malaysians 19% will further develop the scope of this research. The comparison of citizens' lifestyles in countries to be identified significant factors on their energy use behaviour that having gap only 7 % although Japan has population three times higher than Malaysia. Not only the social science of human behaviour can be studied and its scope can be expanded to understanding the Japanese culture, their energy-saving practices can be learned and applied in Malaysia also. it is necessary for an investigation and a study for Malaysia to find out more in a pattern of habits of Japanese people against the use of a Japanese home electric appliance to be applied in Malaysia to reduce the amount of emissions which produced by Malaysia. Many Japanese culture plays an important lesson for Malaysia and other countries in the world can learn from successful programs and policies of Japan in reducing CO2 emissions in the field of energy saving and consumption patterns in the residential sector [46, 48]. It will be interesting for Malaysia to find out more in a pattern of habits of Japanese people against the use of a Japanese home electric appliance to be applied in Malaysia to reduce the amount of emissions which produced by Malaysia.

However, Malaysia as a country which has reserves of oil and gas resources is less abundant with emission as that of the Japanese state. We can see from the price of electricity tariffs that electricity tariffs Malaysia is 25.8 cents / kWh [49] while electricity tariffs 23:38 Japanese yen / kWh (71 cents / kWh) in 1999 will be reduced from about 7000 yen to 3660 yen by using the electricity generated by the PV solar panels to households [50]. This situation forced the Japanese did the pattern of saving lives on the use of electricity. Factor is very useful and contribute positively to all the programs and policies by the Japanese government aimed to reduce energy consumption and reduce CO2 consumption. it is necessary for an investigation and a study for Malaysia to find out more in a pattern of habits of Japanese people against the use of a Japanese home electric appliance to be applied in Malaysia to reduce the amount of

emissions which produced by Malaysian. Many Japanese culture plays an important lesson for Malaysia and other countries in the world can learn from successful programs and policies of Japan in reducing CO₂ emissions in the field of energy saving and consumption patterns in the housing.

7. CONCLUSION

Research projects on studying human behaviour on energy consumption in Malaysia are yet to be done. The closest scope of study done so far is only on energy consumption of several Malaysian households. There are number of research projects implemented to observe and study energy use behaviour of inhabitants in other countries. These researches are used as references to this present study in order to effectively carry out a cross-cultural analysis between Malaysia and Japan. It will help to sort out which patterns are rooted in the culture, and thus resistant to rapid change, and more elastic in technological aspect of buying a appliances at home and daily use of those appliances more effective and efficient rather than Malaysia who have less population compared Japan 3 times higher. This review also attempts to provide a detailed explanation on the impact of occupant behaviour in decreasing energy consumption in Malaysia.

In a nutshell, energy usage behaviour is unique and very complex, shaped by many factors individuals as well as contextual. Because of this complexity, these are usually studied using fragmented studies and disciplines of the various thematic areas such as psychology, sociology, economics and engineering. The social sciences focus on understanding and explaining behaviour of energy use whereas engineering and technology focus on calculating the energy consumption as the support for the decision and policy making. However, each approach is limited by its own assumptions but important for completely studying the energy behaviour. Therefore, the study of the behaviour of energy requires discipline integration through direct observation of people in Japan and Malaysia to be compared through investigation and interview in field. It is important to investigate how much energy is consumed at homes, appliances are used daily after purchase in two countries. The study of interdisciplinary approaches, in particular, by bringing together engineering and social sciences to see how far they are using the appliances and saving the energy. This will be very beneficial in the future to evaluate the user's behaviour of using electrical appliances in housing sector in Malaysia and Japan. The behaviour of electrical appliance usage need to be investigated depending on preferences and cultural habits of energy savings of users in both countries.

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