

ENERGY CONSERVATION OF RESIDENTIAL SECTOR IN MALAYSIA (PENJIMATAN TENAGA BAGI SEKTOR KEDIAMAN DI MALAYSIA)

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Abstract: This article discusses the trends in residential sector's growth and energy consumption pattern in Malaysia. Residential sector has been regarded by researchers as an important target group for energy conservation. In Malaysia, energy use of the residential sector accounts for about 15% of that consumed by all sectors. Although it is ranked at the fourth place after other major sectors such as industrial, transport and non-energy, energy consumption in the household sector has become important because the increase of energy consumption in household sector is portrayed as a major threat to the sustainability where it will increase the CO₂, and will generate major global problems like greenhouse gas effect, ozone layer depletion and acid rain. For this reason, reducing the inefficiency of household energy consumption can be effective means of decreasing global energy use and associated undesirable environmental impacts. Therefore, this study aims to analyse on the past trends in residential sector's growth and energy consumption pattern in order to understand the key issues and challenges faces for residential sector in Malaysia. The paper will also discuss the policy and strategic options aimed towards energy conservation in Malaysia.

Keywords: Conservation, household, sustainable development, energy consumption.

Abstrak: Artikel ini membincangkan trend dalam pertumbuhan dan corak penggunaan tenaga bagi sektor kediaman di Malaysia. Sektor kediaman telah dianggap sebagai kumpulan sasaran terpenting bagi penjimatan tenaga. Di Malaysia, penggunaan tenaga di sektor kediaman mencakupi kira-kira 15% daripada penggunaan oleh semua sektor. Berada di tangga keempat berbanding sektor-sektor utama lain seperti industri, pengangkutan dan bukan tenaga, penjimatan tenaga dalam sektor isi rumah adalah penting kerana ia dianggap sebagai ancaman kepada kemapanan yang dapat meningkatkan CO₂ dan menghasilkan masalah global lain seperti kesan gas rumah hijau, penipisan lapisan ozon dan hujan asid. Justeru, dengan mengurangkan ketidakcekapan penggunaan tenaga isi rumah boleh menjadi satu cara yang berkesan untuk mengurangkan penggunaan tenaga global dan kesan-kesan yang tidak diingini terhadap alam sekitar. Justeru, kajian ini bertujuan untuk menganalisis trend terdahulu dalam perkembangan sektor kediaman dan corak penggunaan tenaga bagi memahami isu dan permasalahan penting dalam sektor isi rumah di Malaysia. Kertas ini juga membincangkan polisi dan pelan strategik dalam menuju matlamat ke arah penjimatan tenaga di Malaysia.

Kata kunci: Penjimatan, isi rumah, pembangunan, mapan, penggunaan tenaga.

Introduction

In this age of growing world energy demand, fossil fuel depletion and emission excesses, efficient energy use and energy conservation are becoming more and more important. With a heightened focus on mitigating climate change, both scientist and policy makers agree that the most drastic reduction in world energy consumption is extremely vital to put into action. For this reason, energy conservation had been identified as a significant element of energy policies addressing the above problems.

Energy conservation refers to effort made to reduce energy consumption and is one of today's most prominent issues in energy markets. It involves a reduction in energy consumption with a change in consumer's behaviour and the reduction in energy consumption can be achieved in conjunction with increment use of energy efficient (Oikonomou *et al.*, (2009). During 1970s, in the aftermath of the energy crisis, concerns about a possible depletion of fossil fuels and increasing oil and gas prices triggered the energy conservation research. At

present, renewed interest to energy conservation is motivated by concerns about environmental problems such as climate change, greenhouse gases, global warming and threats to biodiversity (Abrahamse *et al.*, 2005, Gardner & Stern, 2002).

As one of the most advanced developing countries in the Association of Southeast Asian Nation (ASEAN), Malaysia has experienced tremendous economic achievement in the last three decades. In line with Malaysia's rapid economic development, energy consumption in Malaysia has been reported to increase higher growth rates. According to National Energy Balance (NEB), final energy consumption grew at an average rate of 6.7% per annum since 1971 until 2011 (NEB, 2012). In the future, total energy consumption in Malaysia is expected to increase and this is corresponding with the estimation of the International Energy Agency (IEA), where energy consumption in Asia is forecasted to increase by 2.2 times in 2008-2035 (EIA, 2011). The increasing energy consumption which is parallel to the extensive modes of development have posed more and more pressure on the sustainable development of economy and environmental protection. With the increasing consumption for energy, the carbon dioxide (CO₂) emissions has increased dramatically for the last few years. As shown in Figure 1, there is a positive correlation between

energy consumption and carbon dioxide emission of Malaysia for the period 1975 to 2011 (World Bank, 2014). Figure 1 also indicates that from 1975 to 2011, Malaysia's total energy consumption rose from 7,159 to 68,309 kt of oil equivalent. In the meantime, Malaysia's CO₂ emissions also showed a rapid growth, whose total amount has increased substantially from 19,446 to 203,262 kt. This significant amount of CO₂ emissions may be resulted from the increasing energy consumption. Therefore, to combat green house gases (GHG) emissions, concerted efforts to promote and encourage the efficient use of energy, which ultimate goal is to lower the demand for energy is of vital importance.

Carbon dioxide emissions from the residential sector are also responsible for a great amount of CO₂ emissions. According to IPCC (2005), carbon dioxide emission arise from a number of sources, mainly fossil fuel combustion in the power generation, industrial, residential and transportation sectors. It is released into the atmosphere mainly by the combustion of fossil fuels such as coal, oil or natural gas, and renewable fuels like biomass. As shown in Figure 2, from 1970 to 2013, Malaysia's CO₂ from residential building rose from 0.45 to 5.1 million metric tons, with the rate of change is about 1033%.

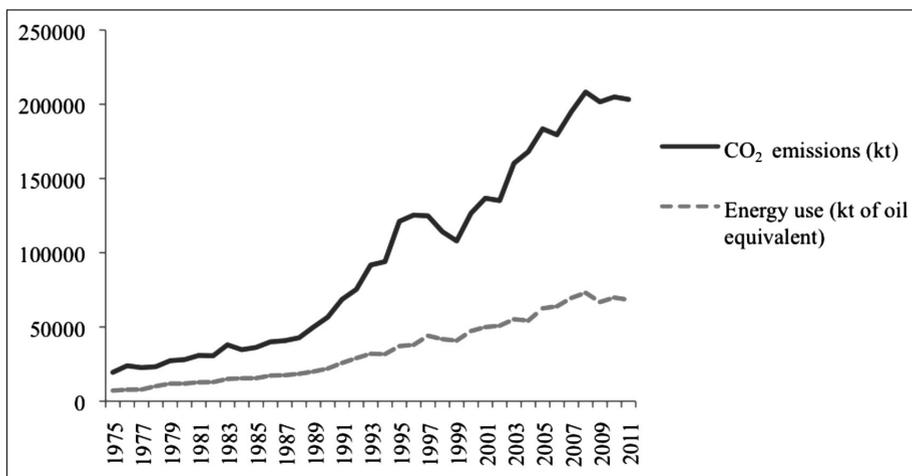


Figure 1: Energy consumption and CO₂ emissions for Malaysia between 1975 and 2011

Source: World Bank, 2014

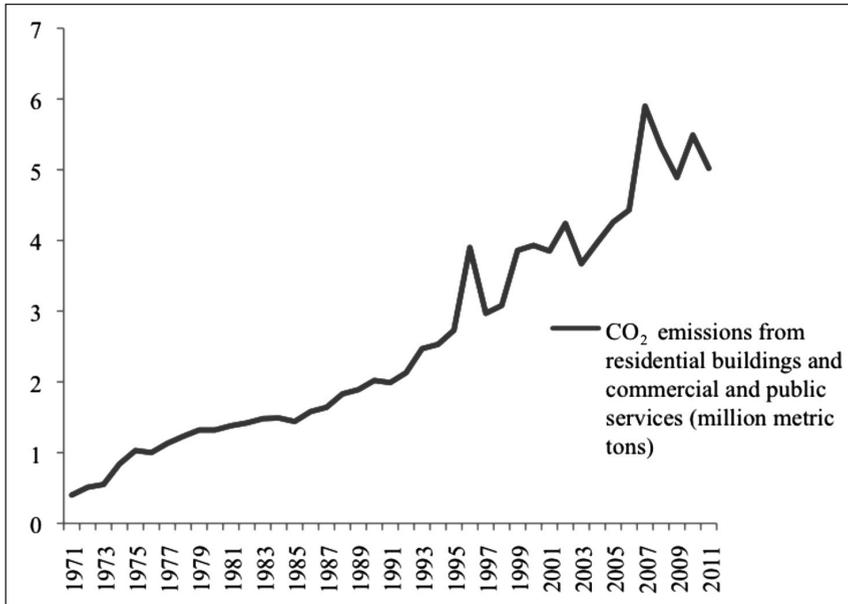


Figure 2: CO₂ emissions from residential buildings and commercial and public services (million metric tons), 1970-2013

Source: World Bank, 2014

Therefore, one way of reducing energy consumption could be assisted to the reduction of CO₂ emissions in residential sector. Since households are run by individual and not obliged to take particular actions through regulatory means as compared to other sector such as industry or transportation, it is difficult to control household energy use. Hence, a vital challenge facing policy makers is to encourage household energy consumption behavior towards energy saving actions. Finding novel ways to reduce energy consumption has triggered the attention of policymakers, academic and the industry itself. Thus, to what extent this increasing focus on energy conservation is understand and supported by the households that consume the energy in their residential, is still vague.

Given the lack of research on energy conservation of households in Malaysia, this study attempts to identify the current situation of household energy conservation in Malaysia. In this paper, we analyse on the past trends in residential sector's growth and energy consumption pattern in order to understand the key issues and challenges faced for residential

in Malaysia. The paper will also discuss the policy and strategic options aimed towards energy efficient in Malaysia. The paper is based on the assessment of energy consumption and CO₂ emissions in residential sector from 1970 to 2011 in Malaysia. The remainder of this paper is structured as follows. Section 2 reviews the relevant literature. Section 3 assesses the trends in residential sector's growth and energy consumption pattern and Section 4 deals with some important findings. Finally, in Section 5 the policy implications are discussed and the analysis are summarized.

A Review of Literature

Households have been recognized by researchers as an important target group for energy conservation (Andreassi *et al.*, 2009; Yamaguchi *et al.*, 2007 and Brounen *et al.*, 2012). Wang *et al.*, (2011), Abrahamse and Steg (2009) & Barr *et al.*, (2005) have also stressed that households play an important role in the use and conservation of energy. In the developed countries such as the US and UK, households

account for 25% and 30% respectively, of the total energy consumption (Drukman & Jackson, 2008). As reported by Saidur *et al.*, (2007), the household account for 26% in Japan and 50% in Saudi Arabia. In 2007, households' electricity consumption accounts for 15.8% of the total consumption in China (Wang, *et al.*, 2011).

In contrast to other sectors such as industrial sector, energy consumption by households is more difficult to control through regulations or laws that applied to other sectors. This is because, households made up of individuals and quite difficult to force them to comply with regulations relating to energy consumption (Hori *et al.*, 2013). Thus, efficient resource management in the household need to be addressed to ensure adequate energy needs to the country in the future.

There are several key factors influencing the behaviour of household with regards to residential energy conservation. Among these factors are socio-economic, demographics, housing/dwelling and household attitudes. Socio-demographic factors are a crucial determinant of energy conservation. Studies investigating the determinants of energy conservation have recognized the importance of several variables may contribute to energy conservation of households. For example, income, age, gender, educational level, family size and employment.

Carlsson-Kanyama & Linden (2007) recognized the importance dual role of income as not only for consuming energy but also for the evaluation of the effectiveness of an economic policy instrument aimed to motivate conservation. Most studies found that income was positively related to energy consumption. Brandon & Lewis (1999), Biesiot & Noorman (1999) and Sardianou (2007) results confirmed that households with higher incomes consume more energy sources. According to Dillman *et al.*, (1983), conservation actions are developed by people who have higher income that can be used for energy conservation. Long (1993) econometric analysis confirmed that higher income households were positively

and statistically related to larger conservation investments. A survey of household in Brazil, conducted by Cohen *et al.*, (2005), also found that household expenditure related to energy conservation increases with income level.

Demographic factors are able to influence the behavior of households in energy saving. Wang *et al.*, (2011) found that older people tend to have a positive attitude towards energy conservation. In contrast with the study done by Sardianou (2007) and Linden *et al.*, (2006) they found that age factor negatively related to energy savings. Sardianou (2007) in his studies of Greek households also found that demographic variables such as family size and residential characteristics such as type of home affect energy conservation. Ek & Söderholm (2010) found that individuals with different socio-economic backgrounds such as education level, income, age and gender have a significant impact on the ability to reduce consumption of electricity in Sweden. In contrast, Sardianou (2007) identified that variables such as gender, education level and marital status does not affect household choice relating to the actions taken for energy conservation in the case of Greece.

According to Wang *et al.*, (2011), attitude refers to the degree of people's awareness of performing electricity saving behavior, which largely depends on the evaluation of preference to electricity saving and the information the individual holds towards such a behavior. As Samuelson (1990) conformed, environment awareness is an important factor in energy use and conversation. This view has been supported by Ek & Söderholm (2010) and Zografakis *et al.*, (2010) research. Ek & Söderholm (2010) found that electricity saving activities can be affected by resident's attitude towards environment. Zografakis *et al.*, (2010) argued that people with more information regarding energy saving and stronger awareness for climate change are more likely to purchase renewable energy and participate energy-saving activities. A recent study of households in Netherlands, conducted by Abrahamse & Steg (2011) supported the view that household behavior is positively

related to attitudes toward energy conservation. Respondents with a high level of awareness and with more responsible attitudes towards energy sources are found to have high awareness to reduce energy consumption.

Studies conducted by Brounen *et al.*, (2012) found that there is a strong relationship between dwellings and energy consumption. With reference to the demographic of the households, they found that families with children consume more energy than single households or couples. In addition, they also reported that residential energy consumption is determined by income and family composition.

Information also has an important role in influencing energy savings among households. The studies by Hori *et al.*, (2013), Ek & Söderholm (2010), Sardianou (2007), Linden *et al.*, (2006) and Boardman (2004) found that these two factors are positively related. Wang *et al.*, (2011) also noted that households with information and knowledge of the energy savings are able to increase electricity savings in China. They also found that Beijing residents have a high awareness of issues related to environmental burden and lack of resources. Chong & Dubois (2009) found that information was the main determinant of energy conservation. Extensive knowledge related to energy and energy saving measures can be obtained via the internet. Mass media such as television programs, magazines and newspapers are the main channels that provide information to the public on the issue of energy conservation. Ma *et al.*, (2011) highlighted that government policy and propaganda also can provide significant contributions towards public attitudes and awareness of households.

In Malaysia, the residential sector is the third largest energy user in the economy and they are responsible for approximately 16% of total Malaysia energy use in 2011 (MEC, 2013). Recognizing the decisive role of energy conservation in reducing emissions, the Malaysian Government has introduced corrective measures such as Electrical Equipments Labelling Programme and Energy Awareness

Campaign. In addition, the Government of Malaysia is currently in the process of finalizing a National Energy Efficiency Master Plan (NEEMP). The establishment of NEEMP is Malaysian government's effort to promote energy efficient use and to educate the public on energy saving in the country. The target of the plan is to reduce the electricity consumption by 10% in the year 2020. Hence, a key challenge of current policy efforts is to promote household energy-saving/conservation actions and identify the key determinants that influence people's energy saving behaviour. It is therefore urgent for Malaysia to improve the efficiency of energy use and encourage energy conservation.

Trends in Residential Sector's Growth and Energy Consumption Pattern

Energy Consumption Trends In Residential Sector

Residential or household have been identified by researchers as an essential target group for energy conservation. As reported by EIA(2014), energy use in the residential sector grows by 0.2 percent per year, or about 1.6 quadrillion Btu from 2011 to 2040. According to Saidur *et al.*, (2007), households account for 25% of the total energy use in the US, 26% in Japan and 50% in Saudi Arabia. In Malaysia, energy use of the residential sector accounts for 15% of that consumed by all sectors as shown in Figure 3. Although it is ranked at the fourth place after other major sectors such as industrial, transport and non-energy, energy consumption in the household sector has become important because the increase of energy consumption in household sector is portrayed as a major threat to the sustainability where it will increase the CO₂, and will generate major global problems like greenhouse gas effect, ozone layer depletion and acid rain. In this sector, energy is used for cooling and lighting homes, to operate electrical appliances and machines, water heating and cooking. These daily consumer activities and the use of these appliance at least in part can contribute to the increasing emissions of greenhouse gases. Given this, reducing the

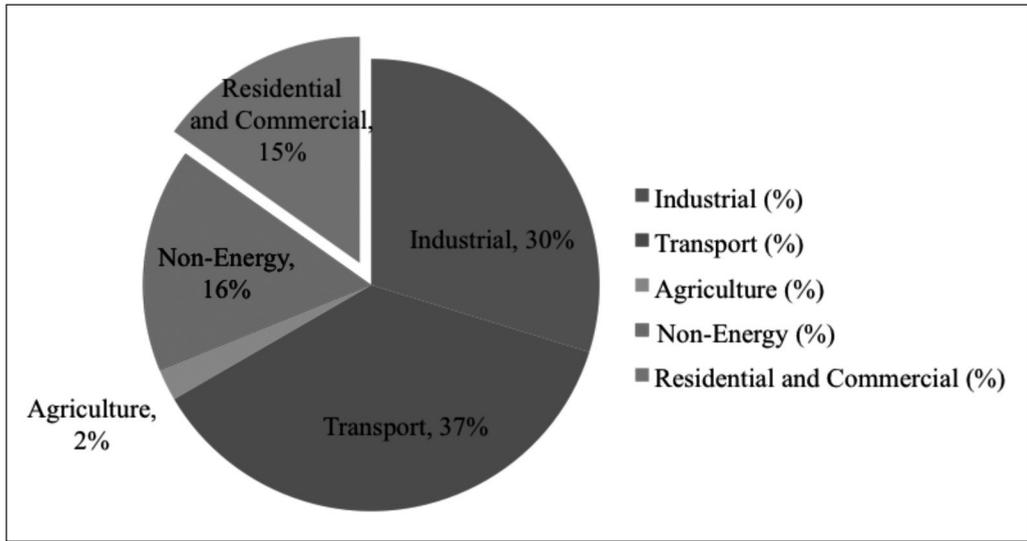


Figure 3: Residential and commercial energy consumption shown as percentage of national energy consumption, 2012

Source: MEC, 2014

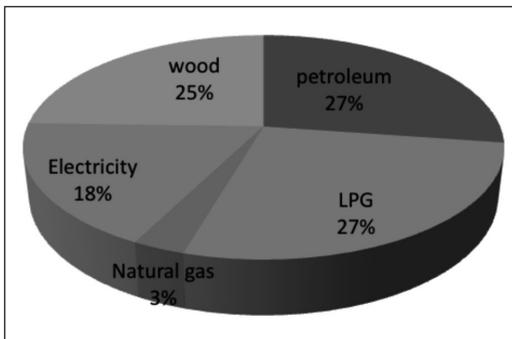


Figure 4: Energy consumption in the residential sector, 2011

Source: National Energy Balance (NEB) 2001-2011

inefficiency of household energy consumption can be effective means of decreasing global energy use and associated undesirable environmental impacts.

In 2011, as shown in Figure 4, dominance of energy resources in the energy consumption of the residential sector in Malaysia is apparent with LPG and petroleum products, which accounted for the largest share (27%),

followed by wood (25%), electricity and natural gas with a share of 18% and 3%, respectively.

In terms of the electricity consumption, as reported by Malaysia Energy Information Hub (MEC) (2014), the use of electricity in Malaysia has increased year by year (Figure 5). The increment of the electricity use attributed mainly from the increasing use of electrical appliances such as washing machines, TV, refrigerators, air-conditioner, refrigerator and many more. The major energy consuming appliance is refrigerator-freezer followed by air conditioner, washing machine, fan, rice cooker and iron (Saidur *et al.*, 2007). In line with the economic growth and increasing population growth, energy consumption in the residential sector experienced higher growth rates and it is expected that there will be an increase in the household ownership of electrical appliances.

Housing Growth Trends and Number of Households

The total number of population in the country have increased substantially year by year. In

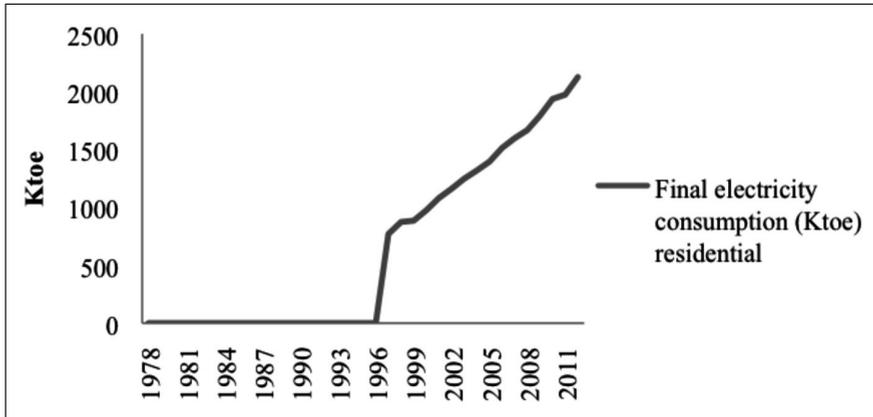


Figure 5: Residential electricity consumption in Malaysia (ktoe)

Source : MEC, 2014

Table 1: Number of housing units completed in Malaysia

	2007	2008	2009	2010	2011
No. of detached house	3457	2262	2831	1846	2028
No. of semi detached housing	12759	10718	12086	9374	8437
No. of terrace housing	79042	54455	51753	36133	33343
No. of town housing	1144	1371	948	3571	885
No. of cluster housing	2126	1094	1782	910	775
No. of low cost housing	8229	7341	4550	4220	4839

Sources: Department of Statistics, 2012

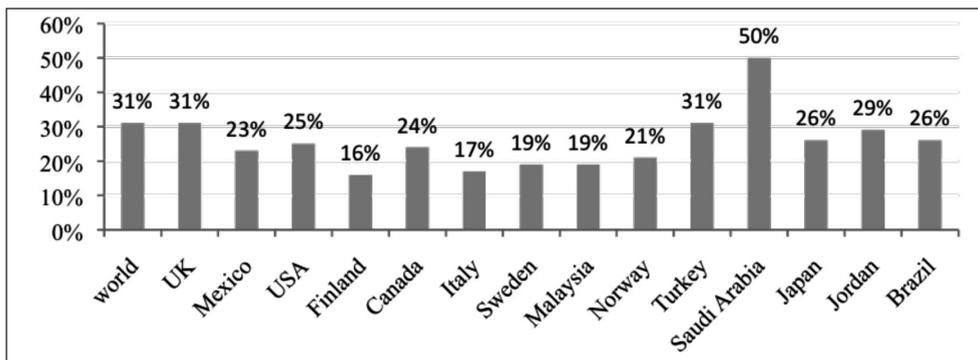


Figure 6: Worldwide residential energy consumption

Sources: Boardman, 2004; *et al.*, Lenzena, 2006; Ueno *et al.*, 2006; Saidur *et al.*, 2007.

addition, there are around 29.3 million people living in Malaysia in 2013 as compared to 23.3 million in 2000 (Department of Statistics, 2012). Tang (2008) in his study, suggested that population growth contribute to the increasing

trend of electricity use. Moreover, as reported by the Department of Statistics (2012), the growth in the number of housing units completed in the country showed an increased for each year (see Table 1).

According to EIA (2014), the number of households increases by 32 percent, and total residential square footage increases by 41 percent from 2011 to 2040. Therefore, without energy conservation improvements, energy demand for uses such as heating, cooling, and lighting would increase at similar rates.

Comparative Analysis of Residential Energy Consumption with Other Countries

Figure 6 presents the energy consumption of the residential sector shown as a percentage of national energy consumption for fourteen countries. Nationally, the residential energy consumption accounts for 16-50% of total energy use in different countries. Saudi Arabia has the highest level of energy consumption in the residential sector whereas Finland has the lowest energy consumption. In Malaysia, energy consumption from residential sector is 19%, which is slightly higher than Finland and Italy.

Important Findings

Rapid economic growth and population growth have led to increasing demand for energy in the residential sector. In order to encounter this demand, the residential sector has adopted a path which raises several issues from the energy and environment perspective. The key findings and issues from the analysis of past trends of energy consumption patterns, economic and population growth and residential sector growth are discussed as follows:

Rapid pace of residential sector in Malaysia

There are around 29 million people living in Malaysia and a total of 80 per cent live in the Peninsular Malaysia, which is also regarded as the focal point of the Malaysian's economy. With rising population, urbanization and increasing economic activities fuelled by expanding industrial and manufacturing sector and growing incomes of the population have resulted in higher demand of energy in the country. Therefore, the key drivers of rapid residential sector in Malaysia, among others, are

due to the growing GDP per capita, increasing population and urbanization.

Potential of energy savings in the residential sector

In order to promote energy efficiency to encourage productive use of energy, the government developed the National Energy Efficiency Master Plan (NEEMP) within the 10th Malaysian Plan (2011-2015). NEEMP is anticipated to be a holistic implementation roadmap to drive efficiency measures across all sectors with a goal to accomplish cumulative energy savings of 4,000 kilo tonnes of oil equivalent (ktoe) by 2015 (Economic Planning Unit, 2010). With regards to the residential sector, the initiatives to drive energy efficiency efforts are i) to phasing out of incandescent light bulbs by 2014 to reduce carbon dioxide emissions by an estimated 732,000 tonnes and reducing energy usage by 1,074 gigawatts a year, ii) increasing energy performance labelling from four (air conditioner, refrigerator, television and fan) to ten electrical appliances (six appliances – rice cooker, electric kettle, washing machine, microwave, clothes dryer and dishwasher). Labelling appliances enables consumers to make informed decisions as they purchase energy efficient products. In addition, there are several energy efficiency programmes are also implemented such as tiered electricity tariff structures, electricity bills rebate, sustainability achieved via energy efficiency (SAVE) rebate programme, Suria 1000 programme and the introduction of goods and service tax (GST). In the 2014 budget, government announced that GST of 6% will be chargeable to the 201st unit of electricity and above consumed by the residential sector starting effectively from 1 April 2015 (Ministry of Finance, 2013). These programmes and strategies aim to give a greater push for households to save energy use.

Government's incentives to encourage home ownership

The Government has several incentives to encourage home ownership by household; i)

Housing Allowance - All public servants are given housing allowances and incentives can be used to buy a home, ii) The Treasury of Housing Loan Eligibility increase - The Government has announced rises loan eligibility for civil servants through the budget 2002. Incentives to increase the ability of home buyers among civil servants, iii) The increase in Gross Income - Government undertook measures to add the gross income public servants or private sector through reducing income tax rates and reduced EPF deduction from 11 percent to 9 percent. With a reduction in the rates of the monthly disposable income will increase.

Heavy dependence of residential sector on electric products

Residential sector is heavily dependent on electric products, which accounts for almost 77% of the total consumption. The consumption of electric has been increasing rapidly with growing residential as well as increasing dependence on electric appliances such as refrigerator, washing machine, air conditioning, water heater, lighting and entertainment products. There is lack of diversification of fuel basket for the residential sector. One of the ways to reduce electricity consumption through awareness in energy efficiency. The last few decades, emphasis has been given on the promotion of saving energy in the country. Government also revised the Electricity Supply Regulations 1994 to ensure more efficient use of electricity.

Policy Implications

Energy use in the residential sector offers an essential opportunity for conserving resources. Currently, the Malaysian government is carrying out various energy policies to manage the energy consumption in the residential sector such as *Tiered Electricity Tariffs Structure, Electricity Bills Rebate, Sustainability Achieved via Energy Efficiency (SAVE) Rebate Programme, Suria 1000 Programme and Goods and Services Tax (GST)*. These policies mainly based on the pricing mechanism to control the energy usage in the residential control; given the fact that

price is obviously an important factor affecting residential energy consumption.

However, the recent growth developments in energy consumption in the residential sector suggest a strong case for undertaking interventions that can aid lessen the sector's dependent on electricity products. The potential interventions that can be considered are to introduce a variety of initiatives and measures to promote energy conservation. Overall, the source of energy is an important aspect in driving the economic growth of a country. Therefore, appropriate measures need to be developed from now on to ensure Malaysia could face an increasingly competitive energy market in the future. Furthermore, electricity consumption in the residential sector is increasing at a very rapid rate. Energy policies that have been introduced and implemented by the government will have to play an important role in terms of altering the current pattern of electricity in residential in terms of utilization. Government can consider adopting policies like discontinue the use of inefficient incandescent lighting energy and system upgrades for the use of electrical appliances in Malaysia.

Since household is the main consumer of energy in residential sector, it is important that the government encourages energy efficient movement in order to reduce dependence on electricity based fuels and the consequent pollution and emissions. In addition to promoting alternative and clean fuels as recommended above, government can target developing mandatory fuel efficiency norm. Parallel to these policy interventions, government should target encouraging the use of energy efficient technologies and improving fuel quality to support these policy interventions in achieving their objectives. There are also certain interventions the government can apply to promote energy conservation, such as providing information, demonstration, offering free energy saving products, giving feedbacks, rewards, financial support and legislation.

In addition, households need to learn on how to save energy and also need to be exposed on

how to use energy efficiently. There are research have been done which support this idea, showing that changing consumer behaviour is normally considered to be an alternative to decrease energy consumption. To that end, it would be appear that factors such as social, emotional influences, issue of learning and awareness, coupled with accessibility to technologies know how would be a central factor to formulating effective energy policies in the residential sector in Malaysia.

Conclusion

The aim of this study was to analyse on the past trends in residential sector's growth and energy consumption pattern in order to understand the key issues and challenges faced for residential in Malaysia. In addition, this study also discuss the some strategic options aimed towards energy efficient in Malaysia. Our findings reveal that household is an important target group for energy conservation and therefore can make a great contribution to energy conservation. As the third most energy consuming sector in Malaysia, opportunities exist to implement energy conservation measures.

The paper has highlighted various issues from the analysis of past trends of energy consumption and carbon dioxide emissions patterns as well as residential sector growth. From the preliminary assessment of the energy consumption and CO₂ emission from the year 1975 to 2011 in Malaysia, the results showed an increasing trend of total energy consumption and CO₂ emission. It is also noted that among the five types of fuel, petroleum, LPG and electricity use in residential sector causes the increment in energy consumption and CO₂ emission.

A shift to sustainable electricity consumptions is one of the ultimate options towards household energy conservation. It can be concluded that a significant share of the energy consumption and CO₂ emissions can be avoided through a number of other factors such as economic, demographic, attitudes, weather, public awareness, lifestyle and behavioral changes, consumer activities, improvement of

energy efficiency and utilization of renewable energy. The household towards energy efficient and sustainable use in residential sector demands new interventions from not only the policy makers but also from the political leadership. It also needs support from individuals, specifically households. Moreover, there is also a strong needs from an advancement in technology and major transformation of the energy market towards promoting efficient and sustainable residential in Malaysia. With respect to this, initiatives led by the government and non-government organizations could be centered on reducing the large amount of energy consumption and CO₂ emissions in the country.

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