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The Role of CO_2 Emission in Energy Demand and Supply

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Abstract: Problem statement: During the last few years in Malaysia, the amount of Carbon Dioxide (CO_2) released into the atmosphere has been rising extensively. The main source of CO_2 is power source of automobile and industry that are contributing the main role for these CO_2 emissions. But these sectors are also very important for economic growth and developments. The aim of this study is to examine the current status and identify the future trend of energy demand and supply and its impacts on CO_2 emissions in Malaysia. **Approach:** The data for analysis was obtained from the secondary sources. **Results:** The study discovered that the highest proportion of CO_2 emissions comes from energy sector. The future trend of energy demand and supply was estimated by the forecasting polynomial curve fitting method. The increase rate of energy supply and demand can rich up to 170 and 160% respectively during the year 2020 if the current situation last long. The study showed a linear trend of increasing intensity of energy and CO_2 emission with respect to Gross Domestic Product (GDP) by the year 2020. **Conclusion:** A significant share of CO_2 emissions can be avoided through improved energy efficiency while providing the same or higher level of energy services. In this regard, greater use of energy efficient, renewable energy and green technologies or options and behavioural changes can substantially reduce CO_2 emissions from the energy sector.

Key words: Energy trend, energy demand, energy supply, energy policy, Malaysia

INTRODUCTION

For the last two decades the world has been witnessing unprecedented effects of global warming. According to IPCC's Fourth Assessment Report, South East Asia is expected to be dangerously affected by the impacts of climate change since most economies are relying on agriculture and natural resources. The increasing CO_2 in the atmosphere gave rise to warmer global temperature (Pachauri and Reisinger, 2008). The main source of CO_2 is fossil fuel, main power source of automobile and industry that are directly linked with economic growth and developments. Higher economic development is expected when more energy is consumed. Therefore economic development is closely related to the energy consumption. Similarly, it is also equally likely that more energy efficiency is required at higher level of economic development. That is, better economic performance may be a catalyst for energy efficiency (Ang, 2008). The demand for energy is growing faster in Malaysia driven by the country's rapid economic growth. Malaysia is gifted with abundant natural resources and is a country which, until 1997, experienced remarkable economic growth, particularly in the industrial sector. As in any developing nation, energy consumption per capita in Malaysia is still low but is expected to expand at a rapid rate in cycle with economic development. The specific sources of these excessive CO_2 emissions are considered to be electricity generation, transportation, industrial process and daily energy usage. The highest amounts of CO_2 emissions are produced from power generation. Malaysia possesses significant potential in renewable resources. According to Subramaniam *et al*. (2008), Palm oil mills have excess energy from their biomass and harvested biogas is a very good sources of renewable energy. Still it is sad to say that such demands for this kind of renewable energy is very minimal in Malaysia. On the other hand reducing the impact of global warming is by implementing green roof technology which is roof that consists of vegetation and growing medium and sometime refers to

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roof garden in some places (Ismail *et al*., 2010; Dunnett and Kingsbury, 2004; UNDP, 2008). Therefore the Government of Malaysia has identified hydropower, renewable energy and natural gas as the primary sources for future energy production. The Malaysian Government has taken steps to meet this new challenge in the energy sector by formulating green technology policy and promoting Renewable Energy (RE) and Energy Efficiency (EE). One of the EE options currently being developed is the promotion of energy efficient appliances. For industrial sector labeling program for motor is currently being developed. For domestic sector, energy efficient refrigerators have been chosen as the first contender for the promotion. United Nations data shows Malaysia's carbon emissions in 2006 stood at 187 million tonnes or 7.2 tonnes from each Malaysian. During the United Nations climate change conference 2009, in Copenhagen, The prime minister of Malaysia announced that Malaysia is adopting an indicator of voluntary reduction of up to 40 percent in terms of emissions intensity of Gross Domestic Product (GDP) by the year 2020 compared to 2005 levels MyDigest, 2010. The aim of this study is to examine the current status and identify the future trend of energy demand and supply and its impacts on CO_2 emissions in Malaysia.

MATERIALS AND METHODS

Data attainment: The study conducted in University Kebangsaan Malaysia (UKM) since January, 2011 to August, 2011. Secondary data has been used in this study to attain the objectives. The data of the study has collected from the Green Technology Corporation of Malaysia and International Energy Agency (IEA). The study has used reliable data on energy demand, energy supply, GDP growth and CO_2 emission of Malaysia.

Energy trend: Malaysia's economy is fully depended on its energy sector because Malaysia's economy is progressing with the aim of vision 2020. The former Prime Minister of Malaysia, Mahathir bin Mohamad announced vision 2020 as a Malaysian ideal by during the tabling of the Sixth Malaysia Plan (1991-1995). The vision calls for the nation to achieve a self-sufficient industrialized nation by the year 2020, educational world class, social well-being, political stability, encompasses all aspects of life, from economic prosperity, as well as psychological balance. There is some problem for achieving this vision because to develop an economy the most important thing is all kinds of energy. But there are not enough energy proven reserves in Malaysia. Only natural gas and oil are effectively produced in Malaysia. Even though there is enough coal reserves in Malaysia but cannot utilized because of the lacking of proper technology. If this coal can be used properly then it can be possible to develop the industrial sector which can be the most important way to achieve the aim of development. Therefore, it is very important to deal with alternative source of energy such as, solar, thermal, wind power, hydro.

Energy policy: Currently Malaysian energy sector is mostly depends on non-renewable energy resources like natural gas and fossil fuel. But these energy resources are limited. Therefore there is a great possibility to encounter fuel crisis in future. Malaysian government realized this problem and applied various kinds of policy time to time. These policies are:

- The Petroleum Development Act (1974)
- The National Petroleum Policy (1975)
- The National Energy Policy (1979)
- The National Depletion Policy (1980)
- The fourth-fuel policy (1981)
- The Electricity Supply Act (1990)
- The Gas Supply Acts (1993)
- The Electricity Regulations (1994)
- The Gas Supply Regulation (1997)
- The Five-fuel Diversification Policy (1999)
- The Energy Commission Act (2001)

The main aim of these policies is to decrease the use of oil and natural gas. Currently, Malaysia is focusing on renewable energy and energy efficiency. But there are some barriers, like, difficult in securing energy efficiency project funding, lack of intensive for utilities to promote demand side management, fragmented legal and regulatory framework, high costs, unfavorable power pricing rules, perceived risks, environmental externalities, depending on weather for the renewable energy, Lack of legal framework for independent power producers.

Recently Malaysia launched new policy which is called "National green technology" policy. This policy is built on four pillars: energy, economy, environment and social. This is the time for finding out the best policy for diminishing CO_2 emission; otherwise it will be very difficult to maintain healthy life in Malaysia.

RESULTS

This study provides a scenario of impacts on CO_2 emission. This study uses the forecasting approach for the analysis. According to Schwartz (2004) prediction is a tool for ordering perceptions about alternative future environments and the end result might not be an accurate picture of tomorrow, but can give a better

decision about the future. No matter how things might actually turn out, but both the analyst and the policy maker will have a scenario that look like a given future and that will help one think through both the opportunities and the consequences of that future.

A number of studies suggest that enforcing the so-called Kyoto protocol will force the world, as well as Malaysian utilities, to drastically reduce their carbon emission, but nobody knows how much they should reduced in the future. There are several methods of predicting data. The most suitable method to be used to estimate long term time series forecasting is polynomial curve fitting (Makridakis *et al*., 1998). This method attempts to describe the relationship between variable x, as a function of available data and a response y. The method seeks to find a smooth curve that best fits the data but does not necessarily pass through any data points. Mathematically, a polynomial of order k in x is an expression of the form (Klienbaum *et al*., 2007):

$$y = c_0 + c_1 x + c_2 x^2 \ldots\ldots\ldots\ldots c_k x^k \quad (1)$$

There are two types of data to be analyzed from the Table 1, i.e., energy demand and energy supply data in Malaysia.

Based on the data shown in Table 1, using Eq. 1, the total energy supply in Malaysia from the year 2008-2020 can be predicted by the following Eq. 2:

$$Y_1 = 45.005x^2 + 2024.4x + 21126, R^2 = 0.9919 \quad (2)$$

Based on the data shown in Table 1, using Eq. 1, the total energy demand in Malaysia from the year 2008-2020 can be predicted by the following Eq. 3:

$$Y_2 = 12.061x^2 + 1509.2x + 11765, R^2 = 0.9932 \quad (3)$$

Another two types of data to be analyzed from Fig. 1, i.e., GDP and carbon dioxide emission data in Malaysia. Based on the data shown in Fig. 2, using Eq. 1, the GDP in Malaysia from the year 2008-2020 can be predicted by the following Eq. 4:

$$Y_4 = 182.73x^2 + 13709x + 183641, R^2 = 0.9798 \quad (4)$$

Based on the data shown in Fig. 1, using Eq. 1, the Carbon Dioxide emission in Malaysia from the year 2008-2020 can be predicted by the following Eq. 5:

$$Y_5 = 189.06x^2 + 3083.9x + 63501, R^2 = 0.973 \quad (5)$$

Table 1: Malaysian current energy demand and energy supply

Year	Energy demand (ktoe)	Energy supply (ktoe)
1990	13,217	21,471
1991	14,560	26,335
1992	16,185	29,291
1993	17,468	29,925
1994	19,287	31,662
1995	22,164	33,879
1996	24,167	37,840
1997	26,168	43,173
1998	25,558	40,996
1999	27,228	44,534
2000	29,699	50,710
2001	31,515	51,979
2002	33,290	53,196
2003	34,586	57,565
2004	37,323	62,358
2005	38,285	66,188
2006	40,318	67,878
2007	44,268	72,384

Sources: PTM, 2007 and IEA, 2007

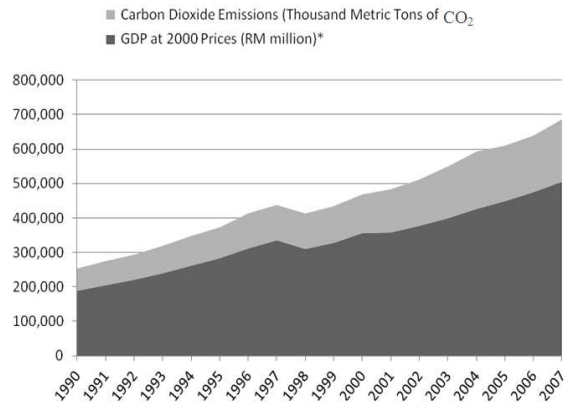

Fig 1: Current GDP growth and CO_2 emission. Source: PTM, 2007 and IEA, 2007

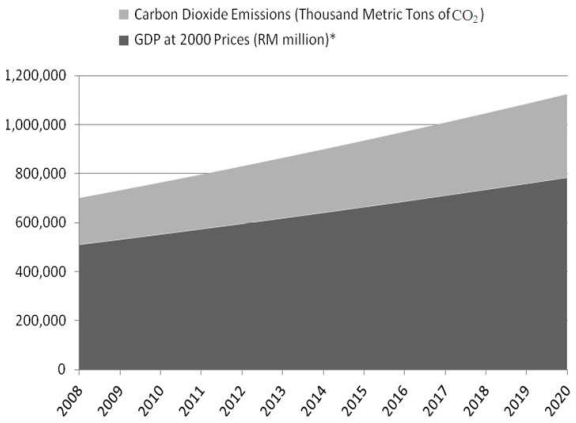

Fig 2: Predicted data of GDP growth and CO_2 emission in Malaysia Source: Compiled by the authors (e-estimation)

Table 2: Predicted data of energy supply and demand in Malaysia

Year	Energy supply (ktoe)	Energy demand (ktoe)
2008	75,836	44,794
2009	79,616	46,773
2010	83,486	48,777
2011	87,445	50,805
2012	91,495	52,857
2013	95,634	54,933
2014	99,864	57,033
2015	104,184	59,157
2016	108,593	61,306
2017	113,093	63,478
2018	117,683	65,675
2019	122,363	67,896
2020	127,132	70,141

Source: Compiled by the authors (e-estimation)

The results of the predicted data based on Eq. 2-5 from the year 2008-2020 are tabulated in Table 2 and Fig. 3. The energy supply and energy demand will be used to predict future GDP growth trend and CO_2 emission in Malaysia.

Table 1 presents the current status of energy demand and energy supply in Malaysia from the year 1990-2007. Table 2 presents the predicted data on energy demand and supply in Malaysia from 2008-2020.

Figure 1 shows the current GDP growth and CO_2 emission in Malaysia from the year 1990-2007. From Fig. 2 presented the predicted GDP growth and CO_2 emission in Malaysia (2008-2020).

DISCUSSION

According to the EPU, 2008, with this population growth, the energy supply is also increasing according to the demand. Malaysia has an abundant supply of natural energy-reserves, including oil, natural gas, coal, electricity and renewable energy resources to fulfill this demand. It has been seen an increasing trend energy demand and supply since 1990-2007. The final energy demand stood at 44,268 kilo tone of oil equivalent (ktoe) while the primary commercial energy supply was 72,384 ktoe in 2007 (Table 1). Malaysia's energy demand was dominated by two largest consumers i.e., the transportation and industrial sectors. The sectors together consumed almost 80% of total final energy demand in the country (PTM, 2007). On the other hand, the predicted data on energy demand and supply in Malaysia. It will be an increasing trend of energy demand and supply since 2008-2020. The final energy demand stood at 70,141 ktoe while the energy supply will be 127,132 ktoe in 2020 (Table 2). This increasing rate found to be 170%. At the same time, the energy demand is also increasing to the rate of 160%. It is found that energy consumption is closely related with growth of GDP that contributes to the higher CO_2 emission. Mahlia (2002) also found that 107,318 metric tons CO_2 will be produced by the year 2020, because of electricity generation. In line with Mahlia (2002), this study also found that by the year, one third of the total CO_2 emission might be from electricity generation. It shows that in future, there will be a huge amount of CO_2 emissions in Malaysia. The total CO_2 emissions might be about 340,789,000 metric tons by the year 2020 (Fig. 2).

The current GDP growth and CO_2 emission in Malaysia shows an increasing trend of GDP growth and CO_2 emission since 1990-2007. The final GDP growth stood at 505,353 RM million while the CO_2 emission was 180,267 Thousand Metric Tons of CO_2 in 2007 (Fig. 1). In contrast, Figure 2 also presents the predicted data on GDP growth and CO_2 emission in Malaysia. In 2008, the GDP growth was 510,078 RM million and it is also found an increasing trend up to 784,224 RM million by the year 2020. In addition the CO_2 emission was 190,346 Thousand Metric Tons of CO_2 and it is also found and increasing trend up to 340,789 Thousand Metric Tons of CO_2. Because of Malaysia's economy fully depended on its energy sector for the reason the Malaysia's economy is progressing with the aim of vision 2020. It is noted that, CO_2 emission is increasing the higher rate from the GDP growth. If the GDP growth remains constant as present situation, it can be assumed that the CO_2 emission will be increased drastically till 2020.

According to the United National Development Report (2007), Malaysia with 27 million people rank as the 26th largest CO_2 emitter in the world. Moreover, 2nd National Communication greenhouse inventory data, the highest proportion of CO_2 emitted from energy sector. After the break down of the energy sector, electricity generation and transport sector shows very importance. Figure 3 shows that the sectoral breakdown of total CO_2 emission in Malaysia's. In terms of the sectoral breakdown Malaysia has five CO_2 emission sector. The sectoral CO_2 emissions were as follows: energy (76%), waste (11%), Industrial process (10%) and agriculture (3%). Energy sector in Malaysia is a major source of CO_2 emission. This situation is a result of the energy sector's high dependency on fossil fuels. The energy sector also break into three sectors, these sectors are: fugitive emission (18%), fuel combustion (58%) and very low emission from the biomass fuel nearly 0%. Again focused on the fuel combustion, the breakdown shows that the CO_2 emissions based on final use by various activities of economy is as follows: electricity generation (18.1%), Transportation (17.4%), manufacturing and construction (11.8%), residential and commercial (1.9%) and others (8.8%).

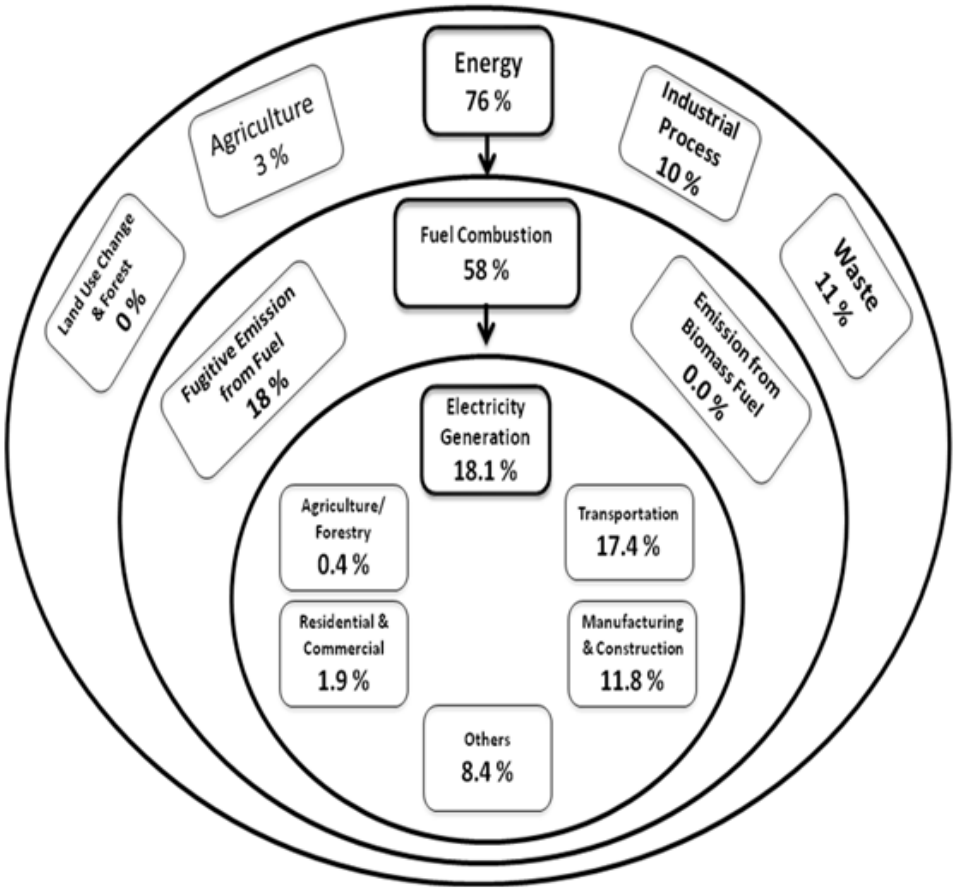

Fig 3: Sectoral breakdown of Malaysia's total greenhouse gas emission, 2000 Source: Compiled by the authors (e-estimation)

Here, the first position occupied by the electricity generation. Because of huge amount of electricity needed for the industrial area and the residential area. On the other hand, the transportation sector took second place. However, the CO_2 emission is increasing because of the excessive use of motor petrol and diesel in transport sector. But since last few years it can be seen that the energy consumption is decreasing in transport sector because of various kinds of governmental policy such as increasing rate petroleum product. According to the Bari *et al*. (2011) prediction the CO_2 emission from residential sector was 2, 347, 538 tonne and it can be increased up to 11, 689, 308 tonne by 2020 which is accelerated by the immense consumption of the electricity and LPG. As a result, this future scenario of CO_2 emissions by the recommended reduction level of electricity consumption could be given an indication for policy and decision making to reduce energy consumption and CO_2 emissions in this country.

CONCLUSION

Economic development is closely linked with energy consumption since higher economic development is expected when more energy is consumed. It is also clear that day by day the energy consumption and production is increasing in Malaysia. Therefore increasing trend of CO_2 emission can be seen which has a greater impact on environment. The main reason of CO_2 emission is the power generation sector. The study shows that since 1990-2020, the energy supply and demand are increasing with a higher rate. The study also found a linear trend of increasing GDP growth and CO_2 emission with respect to energy consumption by the year 2020. The current trend shows that power generation sector contributes a big percentage of CO_2 emission in the country. A significant share of these emissions can be avoided through improved energy efficiency while providing the same or higher level of energy services. In this regard,

greater use of energy efficient, renewable energy and green technologies or options and behavioral changes can substantially reduce carbon dioxide emissions from the energy sector. Considering global energy and environmental crisis, recently, Malaysian government announced its aim to emphasize building energy efficiency to reduce residential energy consumption and hence started several activities in line with that. Malaysian government already started few energy efficiency initiatives such as energy efficiency standards and labels for domestic refrigerator-freezers, established energy testing procedure/testing laboratory. Government also declared inclusion of renewable energy as 5% to total generation capability. These efforts certainly show the significance of energy study particularly at the residential sector of Malaysia. With respect to this, initiatives spearheaded by the government and non-government organizations could be focused on reducing the large amount of energy consumption and CO_2 emissions in the country. These will also contribute to the Malaysian Government's commitment up to 40% reduction of CO_2 emission intensity by the year 2020.

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