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 source 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
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 CO₂ 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 CO₂ emission; otherwise it will be very difficult to maintain healthy life in Malaysia.

RESULTS

This study provides a scenario of impacts on CO₂ 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):

\[ y = c_0 + c_1 x + c_2 x^2 \ldots \ldots \ldots c_k x^k \]  

(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:

\[ Y_1 = 45.006x^2 + 2024.4x + 21126, \quad R^2 = 0.9919 \]  

(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:

\[ Y_2 = 12.061x^2 + 1509.2x + 11765, \quad R^2 = 0.9932 \]  

(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:

\[ Y_4 = 182.73x^2 + 13709x + 183641, \quad R^2 = 0.9798 \]  

(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:

\[ Y_5 = 189.06x^2 + 3083.9x + 63501, \quad R^2 = 0.973 \]  

(5)
the transportation and industrial sectors. The sectors' demand was dominated by two largest consumers i.e., 72,384 ktoe in 2007 (Table 1). Malaysia's energy demand stood at 44,268 kilo tone of oil equivalent (ktoe) while the primary commercial energy supply was 50,805 ktoe in 2007. The final energy demand and supply in Malaysia from 1990-2007. Table 2 presents the predicted data on energy demand and supply since 2008-2020. The final energy demand stood at 59,157 ktoe, and the energy supply was 64,773 ktoe in 2007. It has been seen an increasing trend energy demand and energy supply in Malaysia from 2008-2020. The final energy demand stood at 70,141 ktoe while the energy supply was 70,141 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 CO₂ emission. Mahlia (2002) also found that 107,318 metric tons CO₂ 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 CO₂ emission might be from electricity generation. It shows that in future, there will be a huge amount of CO₂ emissions in Malaysia. The total CO₂ emissions might be about 340,789,000 metric tons by the year 2020 (Fig. 2).

The current GDP growth and CO₂ emission in Malaysia shows an increasing trend of GDP growth and CO₂ emission since 1990-2007. The final GDP growth stood at 505,353 RM million while the CO₂ emission was 180,267 Thousand Metric Tons of CO₂ in 2007 (Fig. 1). In contrast, Figure 2 also presents the predicted data on GDP growth and CO₂ 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 CO₂ emission was 190,346 Thousand Metric Tons of CO₂ and it is also found and increasing trend up to 340,789 Thousand Metric Tons of CO₂. 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, CO₂ 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 CO₂ 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 CO₂ emitter in the world. Moreover, 2nd National Communication greenhouse inventory data, the highest proportion of CO₂ 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 CO₂ emission in Malaysia’s. In terms of the sectoral breakdown Malaysia has five CO₂ emission sector. The sectoral CO₂ emissions were as follows: energy (76%), waste (11%), Industrial process (10%) and agriculture (3%). Energy sector in Malaysia is a major source of CO₂ 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 CO₂ 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%).

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

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

**Source:** Compiled by the authors (e-estimation)

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. Table 2 presents the predicted data on energy demand and supply in Malaysia from 2008-2020.
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 CO₂ emissions in the country. These will also contribute to the Malaysian Government’s commitment up to 40% reduction of CO₂ emission intensity by the year 2020.

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REFERENCES

Ang, J.B., 2008. Economic development, pollutant emissions and energy consumption in Malaysia. J. Policy Modeling, 30: 271-278.

Bari, M.A., R.A. Begum, A.H. Jaafar, R.D.Z.R.Z. Abidin and J.J. Pereira, 2011. Future Scenario of Residential Energy Consumption and CO₂ Emissions in Malaysia. Universiti Kebangsaan Malaysia, Bangi.

Dunnett, N. and N. Kingsbury, 2004. Planting Green Roofs and Living Walls. 1st Edn., Timber Press, Portland, ISBN: 088192640X, pp: 254.

Ismail, A., Muna H.A. Samad and Abdul M.A. Rahman, 2010. Potted plants on flat roof as a strategy to reduce indoor temperature in malaysian climate. Am. J. Eng. Applied Sci., 3: 534-539. DOI: 10.3844/ajeassp.2010.534.539

Klienbaum, D.G., L.L. Kupper and K.E. Muller, 2007. Applied Regression Analysis and other Multivariable Methods. 4th Edn., Cengage Learning, Australia, Belmont, CA., ISBN-10: 0495384968, pp: 906.

Mahlia, T.M.I., 2002. Emissions from electricity generation in Malaysia. Renew. Energy, 27: 293-300. DOI: 10.1016/S0960-1481(01)00177-X

Makridakis, S.G., S.C. Wheelwright and R.G. Hyndman, 1998. Forecasting: Methods and Applications. 3rd Edn., John Wiley, USA., ISBN-10: 0471532339, pp: 642.

Pachauri, R.K. and A. Reisinger, 2008. Climate Change 2007: Synthesis Report. 1st Edn., IPCC, Geneva, Switzerland, ISBN-10: 9291691224, pp: 103.

PTM, 2007. National energy balance Malaysia. Malaysia Energy Centre Selangor Darul Ehsan, Pusat Tenaga Malaysia, Malaysia.

Schwartz, P., 2004. The Art of the Long View: Planning for the Future in an Uncertain World. 1st Edn., Richmond, North Sydney, ISBN-10: 1920688021, pp: 272.

Sixth Malaysia Plan, 1991-1995. Government of Malaysia. Percetakan Nasional Malaysia Berhad, Kuala Lumpur.

Subramaniam, V., M.A. Ngan, C.Y. May and N.M.K. Sulaiman, 2008. Environmental performance of the milling process of malaysian palm oil using the life cycle assessment approach. Am. J. Environ. Sci., 4: 310-315. DOI: 10.3844/ajeassp.2008.310.315

UNDP, 2008. Human Development Report 2007/2008: Fighting Climate Change: Human Solidarity in a Divided World. 5th Edn., Palgrave Macmillan, New York, USA., ISBN-10: 0230547044, pp: 384.