

Illuminating the Policies Affecting Energy Security in Malaysia's Electricity Sector

Hussain Ali Bekhet, Endang Jati Mat Sahid

Abstract—For the past few decades, the Malaysian economy has expanded at an impressive pace, whilst, the Malaysian population has registered a relatively high growth rate. These factors had driven the growth of final energy demand. The ballooning energy demand coupled with the country's limited indigenous energy resources have resulted in an increased of the country's net import. Therefore, acknowledging the precarious position of the country's energy self-sufficiency, this study has identified three main concerns regarding energy security, namely; over-dependence on fossil fuel, increasing energy import dependency, and increasing energy consumption per capita. This paper discusses the recent energy demand and supply trends, highlights the policies that are affecting energy security in Malaysia and suggests strategic options towards achieving energy security. The paper suggested that diversifying energy sources, reducing carbon content of energy, efficient utilization of energy and facilitating low-carbon industries could further enhance the effectiveness of the measures as the introduction of policies and initiatives will be more holistic.

Keywords—Energy security, electricity, energy policy, renewable energy, energy efficiency, Malaysia.

I. INTRODUCTION

ENERGY is one of the essential inputs for economic activities [1], [2]. Various literatures such as [3]-[5] indicated that energy and economic development are closely linked. These studies established that energy security is imperative to ensure continuous economic development in any country. Furthermore, [6]-[9] recognized that there are three fundamental aspects of energy security: physical security, economic energy, and environmental sustainability. Physical security combines both the availability and accessibility dimensions of energy resources, such as the availability of a particular fuel resource as an input for the electricity production or the availability of electricity supply to meet the demand. Economic security dealt with the affordability of energy resources, such as the cost of a particular energy resource as an input for electricity generation or the cost per unit of the electricity generation. Environmental sustainability deals with the environmental issues, such as greenhouse gas (GHG) emissions resulting from the utilization of a particular fuel resource.

Due to the importance of energy security, the issue has been

on the agenda of policy makers in many countries and regions such as Austria [10], Malaysia [11]-[13], United States [14], [15], Europe [16]-[20] and the Southeast Asia region [21]-[24]. For the Southeast Asia region, the area is blessed with conventional energy resources, namely oil, gas and coal. However, in this region, the main concerns are that the resources are unevenly distributed among the countries and sometimes are located away from the demand centres [23]. As for the European region, the main energy security agenda are on diversification and external energy dependence and particularly on natural gas sourced from Russia [16], [17]. In addition, [20] underlined the importance of geopolitical settings by proposing that energy policy becomes a fundamental part of European Union (EU) external trade and foreign relations and security policy. The study also suggested that the EU actively invest in dialogues with energy producer countries, such as those within the Gulf States, Africa and Russia. Furthermore, [18] discussed the importance of the geopolitical dimension in the future energy security for the EU.

Similar to other countries, Malaysia has also recognized the importance of energy security. Foo [11], Sahid et al. [12], [13], Kardoni et al. [25] and Basri et al. [26] highlighted that energy security concerns in Malaysia are mainly due to overdependence on fossil fuels and the resulting increasing dependence on energy imports, particularly for the electricity generation sector. In 2013, more than 90% of electricity was generated using coal and natural gas [27]. Overdependence on these has presented few challenges relevant to energy security. For example, the declining domestic gas production and overstretching of the gas supply system in Peninsular Malaysia led to frequent gas supply interruptions in the power generation sector [28]. In addition, coal used in the power plants in Peninsular Malaysia is fully imported, mainly from South Africa, Australia and Indonesia; thus, coal prices are subject to market forces. In terms of coal price, even though it has been stable for decades, it has increased after 2003 and surged to a new level due to the increase in global demand for that fuel source. Furthermore, increasing demand for fossil fuels, together with depleting domestic fossil fuel reserves, caused an increase in the country's net energy imports. Increasing dependence on energy source imports is further compounded by the nature of energy markets and contracts that normally allow for greater price volatility [12], [13], [25], [29]. The introduction of LNG for power generation in Peninsular Malaysia in 2013 at market price has translated into a higher electricity tariff [28]. Given that the issue of energy security is becoming more pressing.

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This study aims to identify major challenges in energy supply security in Malaysia, to highlight the policies that are affecting energy security in Malaysia and finally to explore possible options to enhance energy security.

This paper is organized as follows. After the introductory section, overview of the electricity sector is presented in Section II, followed by energy security challenges and relevant policies in Section III. Strategic options for energy security enhancement are then discussed in Section IV. Finally concluding remarks are presented in Section V.

II. OVERVIEW OF THE ELECTRICITY SECTOR

Economic growth and population are the main drivers for electricity demand [30]. The Malaysian economy grew at an average annual rate of 5.2 percent per year from 1990 to 2014 [31], [32]. The real GDP almost quadrupled from RM217 billion in 1990 to RM835 billion in 2014 (2005 prices) (Fig. 1). The increase was due to growth in both the service and industry sectors. In 2014, these sectors contributed 50 percent and 41 percent of the total GDP respectively. The Malaysia population grew at a rate of 2.2 percent per year during the same period. The population size increased from 18 million in 1990 to 30 million in 2014. Consequently, the increased of GDP per capita corresponds to the substantial growth of energy demand for the transport, commercial and residential sectors and brought about a further improvement in lifestyle.

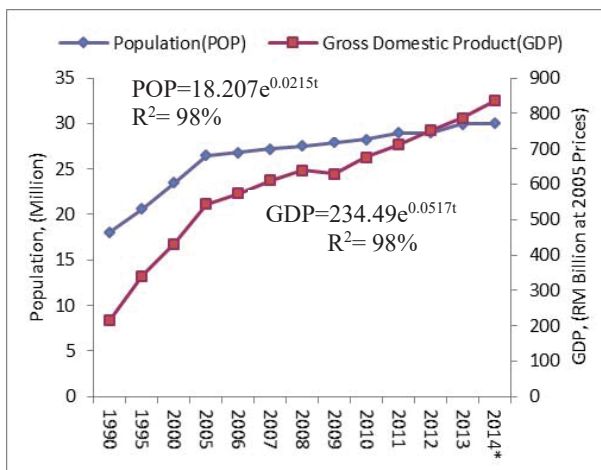


Fig. 1 GDP and Population Growth from 1990 to 2014 [31], [32]

To satisfy the thirst on energy brought about by the improvement of lifestyle, the final energy demand for Malaysia grew at a fast pace of 5.9 percent per year from 1990 to 2013 [33]. Consequently, total final energy demand increased by 3.2 times to reach about 54.0 MTOE in 2013 from 13.9 MTOE in 1990. Among the various fuel sources, oil contributed the biggest share in the total final energy demand, maintaining above 50 percent from 1990 to 2013. As for natural gas and electricity, their shares in final energy demand increased steadily from about 8 percent to 21 percent, and 12 percent to 21 percent in the same period, respectively [33].

Focusing on electricity generation, in 2013, about 90

percent of the electricity was generated by fossil fuels. The remaining share was generated by renewable energy sources (RE) [27]. Fig. 2 shows that the electricity generation fuel mix moved from oil to gas to coal dependency from 1990 to 2013. The transition of consumption from oil to gas and then to coal was mainly due to the introduction of the Four-Fuel Policy in 1981. However, in recent years, coal and natural gas dominated the electricity generation mix (more details in Section I). In 2013, the total fuel resources used in the electricity generation sector was 29 MTOE, with more than 90 percent of the total contributed by coal and gas at 48 percent and 39 percent shares respectively. Coal input in the electricity generation sector grew at a fast rate of 14.8 percent per year from 1990 to 2013, followed by natural gas (7.1 percent) and renewable energy sources (2.9 percent) during the same period. On the other hand, the contribution of fuel oil/diesel shrank at the rate of -6.6 percent per year from 1990 to 2013 [27]. The high dependence on coal and natural presents become a concern on energy security as discussed in Section I.

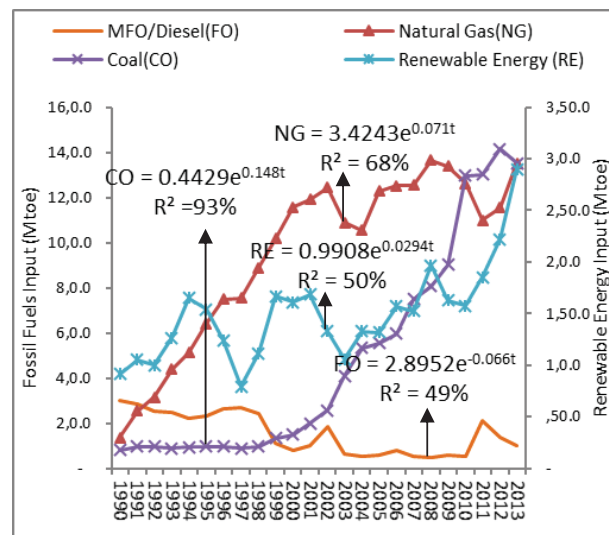


Fig. 2 Time Trend of the Fuels Input in Malaysian Power Generation (1990-2013) [27]

High utilization of coal in the power sector also presents challenges in terms of its environmental impact, particularly carbon dioxide (CO_2) emissions [34], [35]. CO_2 emissions for Malaysia grew at a fast average rate of 5.5 percent per year from 1990 to 2013, increasing from 15.7 MtC (million tonnes of carbon equivalent) in 1990 to 52.7 MtC in 2013 [36]. The electricity generation sector accounted for a 54 percent share of the total emissions in 2013, followed by the transport (27%), industry (15%) and residential and commercial sectors (3%). CO_2 emissions from the electricity generation sector grew at the fast rate of six percent per year, reaching 31.4 MtC in 2013 from 7.4 MtC in 1990. Most of the emissions from the electricity generation sector were emitted by coal-based power plants. In terms of emissions reduction, Malaysia has pledged a voluntary emission reduction target of 40 percent in CO_2 emissions intensity by 2020 [26], [37], [38]. The pledge is

expected to influence decisions on the fuel mix for electricity production in such a way that the coal share in the mix will be reduced and RE shares in the mix will be increased.

III. ENERGY SECURITY CHALLENGES AND ENERGY POLICES IN MALAYSIA

In this section, the major challenges in energy supply security and the policies that are affecting energy security in Malaysia are identified.

A. Energy Security Issues and Challenges

Three major concerns regarding sustainable energy resources both for the supply and demand side have been discussed. The energy supply issues including over dependency to fossil fuel and the increasing of dependency to energy imports. While the energy demand issue identified is increasing of per capita energy consumption.

In previous section, it has been highlighted that fossil fuels have contributed around 90 percent shares in the electricity generation sector from 1990 to 2013. The high dependency of fossil fuels together with limited domestic fossil fuel reserves has necessitated Malaysia to increase import of fossil fuels at market price where the fuel prices are volatile. Therefore, [39] suggested that an optimum fuel mix is important to reduce over dependency to fossil fuels in the country. Various studies have highlighted their concerns on high dependency of fossil fuels in Malaysia such as [25], [26], [34].

Demand for fossil fuels, coupled with the depleting domestic fossil fuel reserves, has resulted in increasing the country's net import [33]. In 2013, Malaysia is a coal net importer at 14 MTOE mainly due to the increased of coal utilization in power generation sector. As for natural gas, in 2013 Malaysia was a net importer at about 6.5 MTOE and a net exporter of LNG at 25.5 MTOE. As mentioned in Section I, increasing dependence on energy imports is further will bring concerns on price fluctuations and volatility [12], [13], [25], [29]. For example, the introduction of fully imported LNG for power generation sector in Peninsular Malaysia in 2013 has translated into a higher electricity tariff for the region [28].

The increased of the economic growth has stimulated further energy consumption and brought about a substantially increase of the energy demand in all sectors, namely the transport sector, residential and commercial sectors and agricultural sector [30]. The GDP per capita, which increased from RM11,990 in 1990 to RM27,833 in 2014 (2005) prices, has driven the increased of energy consumption per capita from 0.73 toe to 1.72 toe in the same period. One of the main reasons for the high energy demand per capita is due to the subsidized fuel prices enjoyed by the consumer which result in inefficient utilisation of energy resources, such as the case for the transportation sector [37].

B. Energy Policies

Over-dependency on fossil fuel, increasing dependency to the imported fuels sources and high per capita energy consumption has resulted in concerns on the energy security.

To address these issues, the government has formulated and introduced various energy policies and programmes throughout the years to ensure sustainable of energy development and to enhance energy security in the country [11], [25], [26], [30], [34], [40], [41]. In this paper the energy policies in Malaysia are grouped into two different period of time of formulation. The first period was from 1970s to 2000 which provides the earliest policies direction in the energy sector with the inclusion of four fuels energy mix and the second period was from 2001 onwards with the inclusion of five fuels energy mix and energy efficiency.

1. Four-Fuels Strategy

Due to the abundance of domestic energy resources, policies introduced from 1970s to 2000 focused on the objective of energy availability, accessibility and affordability [12]. In 1975, the National Petroleum Policy was formulated with the objectives of bringing about efficient utilization of petroleum resources for industrial development as well as ensuring national control over the management and operation of the petroleum industry. The policy goals are including ensuring adequate energy supplies at reasonable prices. In order to prolong the life of the economy's oil and gas reserve, The National Depletion Policy was formulated in 1980. Consequently, the upper limits of oil and natural gas productions were imposed.

A more significant policy to energy security in the country was introduced in 1979, namely the National Energy Policy. The policy addressed three objectives namely; supply objective, utilization objective and environment objective. These objectives have adequately addressed the energy security concerns for the country in terms of physical and economic security and environment sustainability. Physical and economic security by ensuring the provision of adequate, secure and cost-effective energy supply by developing indigenous energy resources, both non-renewable and renewable, using least-cost options, and diversifying supply sources both within and outside the economy. Environment sustainability was by minimizing the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment. Environment sustainability was also addressed by promoting the efficient utilization of energy and the elimination of wasteful and non-productive patterns of energy consumption.

After two international oil crises and increased of oil prices in 1973 and 1979, respectively, a series of policies were formulated to diversify the country's fuel sources. The Four-Fuel Policy was introduced to complement the National Depletion Policy in 1980 to ensure the reliability and security of energy supply. The implementation of the strategy was to reduce the country's dependence on oil, and its goal is to achieve an optimum mix of oil, gas, hydropower and coal in the supply of electricity. As a result of this policy implementation, the country dependency on oil for the electricity sector reduced drastically whilst the shares of natural gas and coal have increased in electricity generation fuel mix, as discussed in Section II.

2. Five-Fuels Strategy

From 2001 onwards, the policies framework is enhanced to include new objectives such as renewable energy and energy efficiency (EE). The period of 2000-2015 focused mostly on the role of RE as one of the energy fuel mix in the country. Few policies have been introduced to emphasize on the green technology and environment aspects of energy development. Among the policies introduced are the Five-Fuel Diversification Policy (2001), the National Biofuel Policy (2006), the National Green Technology Policy (2009) and the National Policy on Climate Change (2010).

In 2000, The Five-Fuel Policy was formulated under the 8th Malaysia Plan to encourage the utilization of renewable resources for electricity generation. To promote the implementation of the Five-Fuel Policy, Small Renewable Energy Power Program (SREP) was introduced in 2001. Under the SREP program, the utilization of all types of RE sources are encouraged, including biomass, biogas, municipal solid waste, solar, mini hydro and wind. However, slow take-up rate of RE projects have led to the introduction of Renewable Energy Act in 2010. The Act provides for the establishment and implementation of a Feed-in-Tariff (FiT) system. The FiT scheme has encouraged adoption of RE sources by bridging the gap between the cost of fossil fuel and renewable sources. In addition, the Act also ensures RE developers having a guaranteed access to the grid and able to sell electricity to the power distributors through a long-term contract. These specific policies and programmes on RE have resulted the unprecedented planting up and development of RE sources in the country [11].

To boost RE and energy efficiency (EE) development in the country, few additional policies were introduced, namely; the National Green Technology Policy (2009) and the National Policy on Climate Change (2010). The National Green Technology Policy (2009) has five main objectives, only one of the objectives is directly relevant to the energy sector that is reducing the usage of energy while increasing economic growth. The National Policy on Climate Change (2010) on the other hand, highlights the role of Energy Efficiency in the supply and demand sector. Specifically, it aims to consolidate the energy policy incorporating management practices that enhances renewable energy (RE) and energy efficiency (EE) through: burden sharing between government and power producers; establishment of EE and RE targets/standards; inclusion of RE in generation mix by power producers; and promotion of RE generation by small and independent developers. Furthermore, EE initiatives have been undertaken in three sectors, namely; industry, commercial and residential. In the industry sector, the Efficient Management of Electrical Energy Regulations 2008 was introduced under the Electricity Supply Act. This regulation will ensure that any installation which consumes more than 3 million units (kWh) of electricity over a period of six months to engage an electrical energy manager. The energy manager will then be responsible for efficient utilization of energy in the installation.

In the commercial sector, the government has taken several

pro-active actions in promoting EE through the constructions and operations of several low-energy buildings or green buildings. Such as, Low Energy Office (LEO) building of the Ministry of Energy, Green Technology and Water in 2004 and the Green Energy Office (GEO) of Malaysia Green Technology Corporation (MGTC) in 2008. In addition to the demonstration projects, a green building rating tool called the Green Building Index (GBI) has also been introduced for all types of buildings to encourage the construction of green buildings. To further promote RE and EE, the Code of Practice on the Use of Renewable Energy and Energy Efficiency in Non-Residential Buildings under MS 1525:2001 has also been incorporated in the amendments to the Uniform Building By-Laws (UBBL) for all buildings in Malaysia.

As for the residential sector, one of the EE initiatives is the introduction of 'Star Labeling' in 2002. The labeling identifies that five (5) stars products being the most efficient product and one (1) star being the least efficient products. At least four (4) household appliances have been issues 'star label' namely; television, refrigerators, domestic electric fans and air conditioners.

IV. STRATEGIC OPTIONS FOR ENERGY SECURITY ENHANCEMENT

Managing the energy security for a rapidly developing economy like Malaysia will require much thought, analysis and planning. It is imperative to make a progress from policy statements to an implementation stage. Apart from diversifying fuel mix to include alternative energy, Malaysia needs deeper policy responses. The strategic options governing energy resources could also act as potential mitigation measures for addressing the energy security concerns. These measures can be segregated into the following five main segments namely [13]; A) diversifying sources of energy supplies, B) reducing carbon content of energy, C) efficient utilization of energy, and D) facilitating low-carbon industries and service development to promote economic growth.

A. Diversifying Sources of Energy Supplies

The first strategy covers diversifying sources of energy supply includes intensifying indigenous gas and renewable energy resources development [25], [34], [40] strengthening and expanding supply infrastructures to facilitate regional interconnection, securing more gas from foreign sources and exploring nuclear options [23]. Even though the Five-Fuel Diversification policy has identified oil, natural gas, coal, hydro and RE to be the main energy sources for Malaysia, the current fuel mix is far from optimal. Therefore, it is important to find the optimum fuel mix for the country while meeting the energy security agenda [35]. In addition, there are current regional approaches to energy security that is regional interconnection of gas pipeline and power grid, namely Trans-ASEAN gas pipeline and ASEAN Power Grid [24]. Malaysia is currently interconnected with other countries in the region through this infrastructure [23]. Further expansion of this infrastructure could be one of the strategies for energy security

enhancement in the country.

B. Reducing Carbon Content of Energy

The second strategy includes reducing carbon content of energy, may include initiatives on introduction of nuclear power plant; expanding use of decentralized and centralized renewable energy-based power generation; and utilization of bio-energy in transport sector and industry sector [13], [37], [41]. As discussed in Section III, Malaysia is serious in promoting the utilisation of domestic RE sources. This can be seen by the introduction of Five Fuel Policy in 2001, Biofuel Policy in 2006, RE Act and subsequently Feed-in-Tariff (FiT) mechanism in 2011. The later policy was introduced due to low plant-up rate of RE projects. With the financial incentive given to RE developers in the FiT, the plant-up rates of RE projects are encouraging [11]. However, FiT is constrained by its limited fund. Therefore, as prices for green technology remain high relative to conventional technology, further R&D in the area of renewable energy technology is expected to bring down its cost.

C. Efficient Utilization of Energy

The third strategy covers efficient utilization of energy, may include among others making major improvements in energy efficiency and conservation both in the supply and demand sectors [30]; moving towards a low-energy intensive industry; transition to service-based economy; improvements in the transportation sector [37], [41]-[43]. One of the options for efficient utilization of energy from the transport sector is to change human behavioral perception in public transport. Shifting from private vehicles to public transport system utilization will contribute to reduction GHG emissions. To facilitate modal shifts, a better connectivity between cities, shops, shopping and culture centre for passengers should be improved and provided. Another options for efficient utilization of energy is smart cities, which place an emphasis on the use of information and communication technologies (ICT) to deliver its services in a more intelligent and efficient in the use of resources. This will contribute towards cost and energy savings, improved service delivery and quality of life as well as reduced environmental footprint.

D. Facilitating Low-Carbon Industries and Service Development

The final strategy includes facilitating low-carbon industries and service development to promote economic growth, including introduction of Feed-in Tariff Mechanism [11], [25], [34], [40], smart grid system and smart metering products; manufacturing high energy efficiency products for example LED or PV-LED, and promoting energy efficiency improving services. In addition, human capital in a variety of different specialized disciplines is required and needed for the success of low carbon economy environment. This is because energy security enhancement will require proper formulating of legislation and policy, law and political science, appropriate technological training and education to ensure work forces such as scientists, engineers, climatologists and energy and climate experts to meet the industry's needs.

V. CONCLUSIONS AND RECOMMENDATIONS

Malaysia is fortunate that it is blessed with conventional energy sources as well as renewable sources. However, in tandem with economic development and growing population, the country's energy demand has increased substantially. As a result, the total final energy demand increased by more than three-fold to reach about 54.0 MTOE in 2013 from 13.9 MTOE in 1990. This paper has identified two major issues concerning energy supply security in Malaysia, namely over-dependency to fossil fuel and increasing of energy import dependency. In 2013, more than 90% of electricity was generated using coal and natural gas which has caused some concerns such as frequent gas supply interruptions in the power generation sector. Furthermore, increasing dependence on energy source imports is further compounded by the nature of energy markets and contracts that normally allow for greater price volatility. Subsequently, this paper discussed the evolution of energy policies, the recent energy demand trend, energy security and challenges and subsequently relevant strategic options towards achieving sustainable energy development which could also enhance energy supply security for the country. The strategic options governing energy resources could also act as potential mitigation measures for addressing the energy security concerns. The strategic options identified are diversifying sources of energy supplies, reducing carbon content of energy, efficient utilization of energy, and facilitating low-carbon industries and service development to promote economic growth.

ACKNOWLEDGMENT

This research is funded by Kursi Biasiswa Ekonomi Tenaga, a post graduate scholarship program administered by Institute of Energy Policy and Research and supported by Malaysia Energy Supply Industry Trust Account, a trust account under the administration of Ministry of Energy, Green Technology and Water, Government of Malaysia.

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2. H.A. Bekhet, 'Assessing Development Efficiency in Malaysian Economy: Input-Output Approach', *International Journal of Economics & Business Research (IJEER)*, vol.4, pp. 297-325, 2012.
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